

CONTRACT

Between

**Interstate Shellfish Sanitation Conference
and
New Jersey Department of Environmental Protection
Bureau of Marine Water Monitoring**

This Contract shall be effective from October 1, 2014 to August 31, 2015, between the Interstate Shellfish Sanitation Conference, (hereinafter referred to as ISSC) and the New Jersey Department of Environmental Protection Bureau of Marine Water Monitoring (hereinafter referred to as the Contractor).

The parties to this Contract agree as follows:

I. SCOPE OF WORK

Identify and evaluate the effectiveness of techniques and practices that could potentially reduce the risk of Vibrio illnesses. The study will offer viable control options for the shellfish industry that will reduce risk of Vibrio illnesses. The study will consider issues associated with the effects of water temperature on initial levels at harvest and the effects of post-harvest temperature control as a means of reducing risk of illness. The detail of this work is in the Proposal which is a part of this Contract.

II. TIME OF PERFORMANCE

This Contract shall be effective from October 1, 2014 and reported on by August 31, 2015. A final report shall be submitted within thirty (30) days of the end of the contract period.

III. COMPENSATION

The total amount of the contract shall be Twenty Four Thousand Four Hundred Nineteen and 32/100 (\$24,419.32) dollars.

IV. METHOD OF PAYMENT

The initial payment shall be for one-half of the contractual amount. The balance is payable upon completion of the contract and the submission of an acceptable final report.

V. TERMS AND CONDITIONS

- A. The Contractor shall agree to make positive efforts to utilize the services and products of small and minority owned businesses and individuals where applicable.
- B. Any changes to this Contract, which are mutually agreed upon between ISSC and the Contractor shall be incorporated in written amendments to this Contract.
- C. The Contractor shall maintain and retain all records and other documents relating to this Contract for a period of twenty-four (24 months from the date of final payment under the Contract, and shall make the documents available for inspection and audit by authorized ISSC and Federal officials.
- D. No person shall be excluded from participation, be denied the benefits of, or be subjected to discrimination in relation to any activities carried out under this Contract on the grounds of race, color, sex, religion or national origin.
- E. All project deliverables included on Page 7 of 18 of the NJDEP Bureau of Marine Water Monitoring Proposal (attached) shall be completed. In the event all deliverables are not fully rendered as provided for in the Contract, any monies which have been paid by the agency under the Contract must be refunded to ISSC.
- F. The contractor will submit a progress report no later than June 15, 2015. This progress report shall be a summary of activities completed (a brief summary of no more than two (2) pages).
- G. Notwithstanding any other provisions of the Contract, the parties hereto agree that the charges to ISSC by the Contractor are payable from federal grant monies. In the event sufficient grant monies are not made available to ISSC to pay the charges hereunder, this contract shall terminate without further obligation of ISSC. In such event, the ISSC shall certify to the Contractor the fact that sufficient funds are not available to ISSC to meet the obligations of the Contract and such written certification shall be conclusive upon the parties.
- H. The Contractor certifies that he/she shall not engage in the unlawful manufacture, distribution, dispensation, possession or use of a controlled substance in the performance of this Contract. This certification also applies to any individual employed by the Contractor.
- I. The performance of work under this contract may be terminated by the Executive Director, ISSC, in accordance with this clause whenever he shall determine that such termination is in the best interest of the ISSC. The ISSC shall pay all reasonable costs associated with this Contract that the Contractor has incurred up to the date of

termination of the contract. Two (2) weeks advance notice of the Contract termination will be provided by the Executive Director, ISSC. Either party may terminate this Contract by giving written notice at least 14 days prior to the effective date of such termination.

J. All records, documents, and reports developed in the performance of this contract shall be the property of and available to the ISSC for its use without payment of royalty or additional cost and shall not be subject of an application for a copyright by, or on behalf of, the contracted Contractor.

VI. The Contractor shall deliver to the ISSC, on or before the final date of this Contract, one electronic copy (MSWord) and three hard copies of the final report.

The parties to this Contract hereby agree to any and all provisions as stipulated above.

AS TO ISSC

AS TO THE CONTRACTOR

BY: _____

BY: _____

TITLE: _____

TITLE: _____

DATE: _____

DATE: _____

WITNESSES:

WITNESSES:

MAILING ADDRESS:

MAILING ADDRESS:

209-2 Dawson Road
Columbia, SC 29223-1740

EMPLOYER ID#:

EMPLOYER ID#:

52-1656630

NJDEP Bureau of Marine Water Monitoring



Proposal for Techniques and Practices for Vibrio Reduction

Submitted to the ISSC Interstate Shellfish Sanitation
Conference

July 31, 2014

EXECUTIVE SUMMARY

Aware of the relationship between temperature and prevalence of pathogenic strains of *Vibrio parahaemolyticus* and *V. vulnificus*, the Bureau of Marine Water Monitoring of New Jersey Department of Environmental Protection is proposing a study that will identify and evaluate various oyster handling practices/techniques that could potentially reduce the risk of Vibrio illnesses. The handling methods that we shall be looking at are as follows:

- a. Immediate cooling on ice after harvesting before analysis;
- b. Shading of oysters for 6-7 hours before analysis;
- c. Shading of oysters for 6-7 hours and refrigerated overnight before analysis;
- d. Analysis of oyster from harvester; and
- e. Tracking and analysis of same oyster lot from retail establishment.

Little is known regarding the fate of *V.p.* and *V.v.* after it leaves the certified dealer. This study will continue to look at the fate of *V.p.* and *V.v.* post-harvest, but also gather info regarding *V.p.* and *V.v.* growth after it leaves the certified dealer end route to the consumer by tracking product to a retail establishment. We will collect samples of oysters from commercial harvesters after harvest, collect samples prior to shipment from the certified dealer (same lot if practical), and work with the FDA to track and collect samples of the lot (same lot if practical) at its final destination (retail establishment). If the same lot is not available, we will analyze retail samples and compare them to data collected on the nearest date.

All samples will be tested for total *V.p.* (tlh+), pathogenic *V.p.* (tdh+ and trh+) and *V. vulnificus* (vvh) using Official FDA BAM chapter 9 and Nordstrom *et al.*, 2007. We plan to start the execution of this proposal from August 2014 for handling methods a-c above while sampling from commercial harvesters d-e will commence from May/June 2015 through August 2015.

APPROACH AND METHODOLOGY

The study aim is to look at the relationship between water temperature, air temperature and salinity as it affects the total *V.p.* (tlh+) and pathogenic *V.p.* (tdh+ and trh+) strains. We will also be looking at the levels of total *V.p.* and pathogenic strains along the distribution chain (harvest to retail).

The collection time frame and sample sites for *Vibrio parahaemolyticus* (*V.p.*) presence in the oyster tissue will specifically take place in the month of August 2014, and from May through August 2015 at various Delaware sub tidal commercial harvest locations. Although June through August are traditionally considered the months for *V.p.* bacterial sampling, May has been added in in an attempt to analyze and compare various parameters along with *V.p.* presence in oyster tissue, during time frames preceding and following oyster spawning.

Sub tidal collection is proposed to take place four times during each month for Delaware Bay. Two of the sampling events will be performed by the Bureau's staff, from active commercial harvest areas; this sampling is to continue previous analyses on New Jersey's Harvest Practices. The other two sampling events will require the collection of Oysters from a commercial harvester that will be used to monitor the effects of handling, and will cover from harvest to retail. Each sampling event will require one field day for collection, and three consecutive days of lab time for preparation and analysis. During the study period, animal [Oyster – *Crassostrea virginica* (Cv)] will be analyzed for *V.p.* using Official FDA BAM chapter 9 and Nordstrom *et al.*, 2007 for the enumeration of genes, specific for total and pathogenic *V.p.*

The acquisition of oysters will require the collection of sample sets when visiting each site. For a sub tidal site in Delaware Bay, one of nine sites (harvest/quota dependent) will be gathered each week from May to August. Each visit requires the collection of 45 larger oysters, which will be used for three different harvest/post-harvest handling method comparisons. Each method will examine 15 oysters. The exact methodology for collection in sub tidal waters is detailed below:

- 1) Label all plastic shellfish bags prior to arriving at sample location(s) with station ID's and handling method letters. Use an indelible marker (e.g., Sharpie) on Autoclave Tape (striped tape acquired from bacteriological lab) that is placed on the outside of plastic bag.
- 2) Prior to oyster collection you will have acquired an insulated ice chest/cooler and placed approximately two inches of ice on the bottom. On top of that ice you will place a raised rack (e.g., a sample bottle rack from bacteriological lab) where you can place your site collected oysters' samples. Oysters should be covered with bubble wrap and layers of ice packs placed over top of the bubble wrap.
- 3) Verify site location w/ GPS and attempt to sample within a half mile of the general GPS coordinates shown on lab/field sheets for sub tidal locations.
- 4) Oysters can be harvested by dredging or tonging with subsequent hand culling for placement in plastic bags for sub tidal waters.
- 5) Cull oysters, selecting best size for lab processing (attempt to select larger specimens).
- 6) For each site, collect 15 larger species for each required handling method.
- 7) Oysters should be cleaned, removing mud, macro algae, debris, etc.
- 8) Place oysters in a sealed plastic bag and place in cooler as noted in step 2 above.

- 9) Plan to collect shellfish for delivery to process lab within five hours for Delaware Bay.

Sample collection and analysis will also require acquisition of air temperature, water temperature, DO, salinity, pH, and out of water shell temperature from the collection site. Sub tidal waters require the recording of water temperature, DO, salinity, and pH from surface and bottom locations in the water column. For handling methods requiring shellfish shading after field acquisition, a pre-process shaded shell temperature and pre-process shaded air temperature is required. Additionally, for Delaware Bay oysters that are put on ice immediately, a pre-process meat temperature should be taken.

In order to fully understand what happens along distribution chain to the retailer, we will also be getting samples of oysters from commercial harvesters immediately after harvesting and put on ice or in refrigeration, and will collect samples before the same lot of oyster is shipped when loading into the truck. We will track the lot to its final destination and collect additional sample for analysis. This will be done in conjunction with USFDA. Prior to collection of samples, air temperature and shell temperature will be taken using calibrated hand held meter.

PROJECT DELIVERABLES

The deliverables from this project will be as follows:

1. We will capture air, water and out of water shell temperatures at every sampling location to better understand how this affect presence of pathogenic strains of V.p and V.v
2. Effects of cooling immediately after harvesting using ice chest or refrigerated chamber will also be examined. The levels of total (tlh+) and pathogenic strains (tdh+ and trh+) as well as vvh from samples that were cooled immediately after harvesting will be compared to those stored under a tarp (shaded) at ambient air temperatures for 6-7 hours before processing as well as those refrigerated overnight after left in the shaded air for 6-7 hours. Ambient air temperatures and shell temperatures will be taking prior to sample analysis.
3. This study will provide better understanding of how handling and shipping processes can affect pathogenicity of *Vibrio parahaemolyticus* and *V. vulnificus* before it get to the final consumer.
4. We will serotyped all pathogenic strains isolated during this study to give us the prevalence as well as to better understand if they are temperature dependent.
5. Statistical analysis of the results obtained and recommendations shall be developed and submitted to ISSC.

PROJECT MANAGEMENT APPROACH

The project will be managed as described below:

Project Director: Bruce Friedman, Chief, Bureau of Marine Water Monitoring, will provide the overall management of the project.

Principal Investigator (PI): Robert Schuster, Interim Section Chief, Bureau of Marine Water Monitoring, will manage the data, perform the assessment, and manage the execution of the project.

Field officer: Marc Resciniti will be the lead field officer to collect field data, shellfish, and oversee other field staff needed to perform the study.

Laboratory Technicians: Three Laboratory Technicians will be available to assist in the analysis of samples under the supervision of PI.

DETAILED AND ITEMIZED PRICING

Materials and Supplies

Supplier	Catalog Number	Item	Amt.	Total Cost
VWR	BDH8014	Sodium Chloride	3	\$181.47
VWR	90000-744	Nutrient Agar	2	\$258.22
VWR	61001-506	Peptone	2	\$179.74
VWR	95022-388	TCBS Agar	3	\$443.70
VWR	95020-770	CPC Agar	2	\$2,039.80
VWR	95057-782	CPC Supplement	2	\$168.80
VWR	95060-676	API Kit	1	\$1,306.17
VWR	90003-676	Voges-Proskauer A	1	\$65.00
VWR	90003-678	Voges-Proskauer B	1	\$76.50
VWR	95060-952	TDA Reagent	1	\$39.07
VWR	95060-956	NIT 1/NIT 2 Reagent	1	\$70.30
VWR	95060-946	Mineral Oil	1	\$31.26
VWR	95060-974	James Reagent	1	\$39.07
VWR	10052-582	Vibrio Antisera Kit K-Set	1	\$6,041.58
VWR	10052-578	Vibrio Antisera Kit O-Set	1	\$858.90
VWR	25388-581	50x9mm Tight Fit Plates	2	\$308.04
VWR	25384-252	100x15mm Petri Plates	4	\$849.52
VWR	12000-806	1uL Inoculating Loops	10	\$1,287.90
VWR	12000-814	Inoculating Needles	5	\$643.95
VWR	89003-420	100-1,000uL Pipette Tips	4	\$582.28

VWR	89092-962	0.1-10uL Pipette Tips	4	\$615.80
VWR	53510-012	1-40uL Pipette Tips	1	\$175.65
VWR	53510-070	1-100uL Pipette Tips	1	\$161.30
VWR	53510-106	1-200uL Pipette Tips	2	\$319.48
VWR	33503-136	70% Alcohol Wipes	1	\$559.45
VWR	414004-429	Small Latex Gloves	2	\$334.60
VWR	414004-430	Medium Latex Gloves	1	\$167.30
VWR	21150-478	0.6 mL Amber Microcentrifuge Tubes	1	\$39.44
VWR	22179-004	1.5mL Clear Microcentrifuge Tubes	6	\$472.68
Life Technologies	10977-015	PCR-Grade Water	1	\$29.00
Life Technologies	10966-034	Platinum Taq Polymerase	10	\$4,590.00
Life Technologies	4316034	Custom TaqMan Probe MGBNFQ trh_133-23 –Vic Seq: 5'- AGAAATACAACAATCAAACACTGA-3'	1	\$255.00
Life Technologies	4316034	Custom TaqMan Probe MGBNFQ Tdh_269-20_FAM Seq: 5'- TGACATCCTACATGACTGTG-3'	1	\$255.00
BioGX	760-0001	VP IAC DNA	1	\$550.00
IDT	Custom tl_884F	5'- ACTCAACACAAGAAGAGATCGACA A-3'	1	\$8.75
IDT	Custom tl_1091R	5'-GATGAGCGGTTGATGTCCAAA-3'	1	\$7.35
IDT	Custom trh_20f	5'-TTGCTTTCAGTTTGCTATTGGCT- 3'	1	\$8.05
IDT	Custom trh_292R	5'-TGTTTACCGTCATATAGGCGCTT- 3'	1	\$8.05
IDT	Custom tdh_89F	5'-TCCCTTTTCCTGCCCCC-3'	1	\$5.95
IDT	Custom tdh_321R	5'- CGCTGCCATTGTATAGTCTTTATC-3'	1	\$8.40
IDT	Custom IAC_46F	5'-GACATCGATATGGGTGCCG-3'	1	\$6.65
IDT	Custom IAC_186R	5'-CGAGACGATGCAGCCATTC-3'	1	\$6.65
IDT	Custom vvhF	5'- TGTTTATGGTGAGAACGGTGACA-3'	1	\$8.05
IDT	Custom vvhR	5'- TTCTTTATCTAGGCCCAAACCTTG-3'	1	\$8.40

IDT	Custom IAC_109	5Cy5'- TTCATGCGTCTCCCTGGTGAATGT G-3'-BHQ_2	1	\$315.00
IDT	Custom vvh Probe	56-FAM-5'- CCGTTAACCGAACCACCCGCAA-3'- BHQ_2	1	\$195.00
IDT	Custom tl_1043	56-JOEN- 5'CGCTCGCGTTCACGAAACCGT-3'- BHQ_2	1	\$420.00
Total Costs				\$24,419.32

*Cost does not include shipping and handling.

APPENDIX: REFERENCES

As part of our *Vibrio* sampling and monitoring plan, the Bureau of Marine Water Monitoring has been studying the relationship between water, air and out of water shell temperatures and pathogenic strains of *V.p.* for the past three years. We also mimic three handling methods:

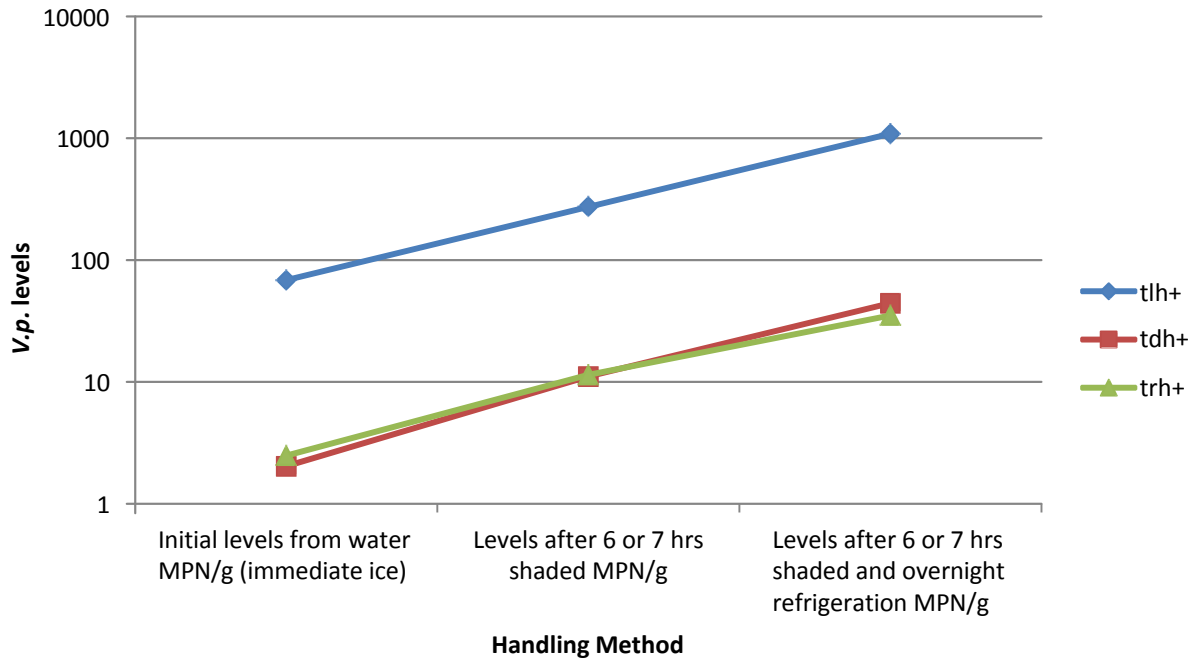
- a. Immediate cooling on ice after harvesting before analysis
- b. Shading of oysters for 6-7 hours before analysis;
- c. Shading of oysters for 6-7 hours and refrigerated overnight before analysis.

Our preliminary results showed that the level of pathogenic strains (tdh+ and tlh+) from samples that were put on ice immediately after harvesting were little to none. We noticed an increase of these genes from oysters that were shaded for 6-7 hours while the levels either increased or remained constant for the overnight refrigerated samples.

2014 Delaware Bay *V.p.* Sample Results (Preliminary)

	Date	Initial levels from water MPN/g	Levels after 6 hrs shaded MPN/g	Levels after 7 hrs shaded MPN/g	Levels after 6 or 7 hrs shaded and overnight refrigeration MPN/g
tlh+	5/12/2014	<3		0.92	0.92
tdh+	5/12/2014	<3		0.36	0.92
trh+	5/12/2014	<3		0.36	0.92
tlh+	5/19/2014	9.3		4.3	15
tdh+	5/19/2014	4.3		0.74	9.3
trh+	5/19/2014	1.5		1.5	7.5
tlh+	5/28/2014	93		210	2400
tdh+	5/28/2014	0.36		11	2.3
trh+	5/28/2014	9.3		15	14
tlh+	6/2/2014	200		1500	1500
tdh+	6/2/2014	<3		<3	<3
trh+	6/2/2014	0.3		<3	<3
tlh+	6/9/2014	93		93	15,000
tdh+	6/9/2014	3.6		43	15,000
trh+	6/9/2014	7.4		43	9,300
tlh+	6/16/2014	43		75	1,500
tdh+	6/16/2014	<0.3		15	430
trh+	6/16/2014	<0.3		15	230
tlh+	6/23/2014	240		2,900	4,300
tdh+	6/23/2014	<3		43	43
trh+	6/23/2014	3.6		43	43
tlh+	6/30/2014	240		24,000	4,300
tdh+	6/30/2014	<3		120	210
trh+	6/30/2014	<3		110	210
tlh+	7/7/2014	21	4,300		15,000
tdh+	7/7/2014	<3	43		93
trh+	7/7/2014	3.6	23		23
tlh+	7/14/2014	930	930		7,500
tdh+	7/14/2014	3.6	23		93
trh+	7/14/2014	9.2	23		23

Geometric Metric Mean of Delaware Bay 2014 (May - July) Data by Gene Type and Handling Method



APPENDIX: PROJECT TEAM STAFFING

Management Personnel:

1. Bruce Friedman, Chief
Bruce Friedman has been with the New Jersey Department of Environmental Protection for 26 years. He has extensive experience with Water Enforcement and Compliance and NJPDES Permitting. Bruce helped develop, implement and manage USEPA's Phase II stormwater program in New Jersey, regulating the discharge of stormwater from municipal separate storm sewers. He currently manages NJDEP's Leeds Point Laboratories. He has been involved in source track down and restoration efforts within the Wreck Pond Watershed. Bruce is a graduate of Stockton State College with a Bachelor of Science Degree in Environmental Studies and is a member of New Jersey's Water Monitoring Council, Barnegat Bay Science and Technical Advisory Committee, Interstate Environmental Commission, Interstate Shellfish Sanitation Conference, and the Wreck Pond Watershed Committee.
2. Robert Schuster, Interim Section Chief
Robert holds a Bachelor of Science Degree in Chemistry with 24 years of experience in both the Chemical and Bacteriological analyses in Marine waters, for the NSSP, USEPA ambient monitoring programs, and the implementation of new technologies, which includes real-time water quality data from buoys, and the development of New Jersey's program for aircraft remote sensing of chlorophyll *a*. He is currently in charge of the laboratory, assessment, and field sections of the NJDEP's Bureau of Marine Water Monitoring.

Laboratory Personnel:

1. Abolade Oyelade – Research Scientist 3.
Abolade holds Master's degree in Microbiology with over 14 years' experience in research and teaching. He is currently in charge of Advanced Microbiology Laboratory that oversees Vibrio analysis using Multiplex Real-Time PCR Assay as well as Direct Plating Techniques.
2. Elena Heller – Environmental Specialist 3
Elena holds Bachelor of Arts degree in Environmental Science with over 24 years' experience in performing special projects involving bacteriological analyses of shellfish and marine waters.
3. Carrie Lloyd – Environmental Specialist 2
Carrie holds Bachelor's Degree in Biology with over 9 year experience at NJDEP Bureau of Marine water monitoring. Techniques and skills acquired during time of employment are membrane filtration, multiple tube analysis, qPCR analysis, direct plating analysis, and other basic laboratory skills such as media preparation and

quality assurance.

4. Eric Feerst – Section Chief (Retired)
Eric has Bachelor's Degree in Biology with 37 years' experience in Shellfish sanitation, lab methods, Vibrio monitoring. Presently he is a part-time consultant in Vibrio monitoring program.

Field Personnel:

1. Marc Resciniti – Captain State Boat
Marc has a Bachelor of Science Degree in Environmental Science with 10 years' experience in fisheries sampling and management, and 4 years' experience with the collection of shellfish and water samples for the Bureau's NSSP compliance.
2. Rodney Sloan – Captain State Boat
Rodney has 4 years of experience with the collection of shellfish and water samples for the Bureau's NSSP compliance.
3. Lonnie LeVance- Captain State Boat
Lonnie has 2 years of experience with the collection of shellfish and water samples for the Bureau's NSSP compliance.
4. Keith Murphy - Captain State Boat
Keith has 12 years of experience with the collection of shellfish and water samples for the Bureau's NSSP compliance.
5. Ken Hayek – Principal Environmental Technician
Ken has 17 years of experience with the collection of shellfish and water samples for the Bureau's NSSP compliance, and water quality sampling techniques for EPA Ambient monitoring projects.
6. Rich Rand- Principal Environmental Technician
Rich has 15 years of experience with the collection of shellfish and water samples for the Bureau's NSSP compliance, and water quality sampling techniques for EPA Ambient monitoring projects.

CONTRACT

Between

**Interstate Shellfish Sanitation Conference
and
Connecticut Department of Agriculture
Bureau of Aquaculture**

This Contract shall be effective from October 1, 2014 to August 31, 2015, between the Interstate Shellfish Sanitation Conference, (hereinafter referred to as ISSC) and the Connecticut Department of Agriculture Bureau of Aquaculture (hereinafter referred to as the Contractor).

The parties to this Contract agree as follows:

I. SCOPE OF WORK

Identify and evaluate the effectiveness of techniques and practices that could potentially reduce the risk of Vibrio illnesses. The study will offer viable control options for the shellfish industry that will reduce risk of Vibrio illnesses. The study will consider issues associated with the effects of water temperature on initial levels at harvest and the effects of post-harvest temperature control as a means of reducing risk of illness. The detail of this work is in the Proposal which is a part of this Contract.

II. TIME OF PERFORMANCE

This Contract shall be effective from October 1, 2014 and reported on by August 31, 2015. A final report shall be submitted within thirty (30) days of the end of the contract period.

III. COMPENSATION

The total amount of the contract shall be Twenty One Thousand Six Hundred Seventy Six and 08/100 (\$21,676.08) dollars.

IV. METHOD OF PAYMENT

The initial payment shall be for one-half of the contractual amount. The balance is payable upon completion of the contract and the submission of an acceptable final report.

V. TERMS AND CONDITIONS

- A. The Contractor shall agree to make positive efforts to utilize the services and products of small and minority owned businesses and individuals where applicable.
- B. Any changes to this Contract, which are mutually agreed upon between ISSC and the Contractor shall be incorporated in written amendments to this Contract.
- C. The Contractor shall maintain and retain all records and other documents relating to this Contract for a period of twenty-four (24 months from the date of final payment under the Contract, and shall make the documents available for inspection and audit by authorized ISSC and Federal officials.
- D. No person shall be excluded from participation, be denied the benefits of, or be subjected to discrimination in relation to any activities carried out under this Contract on the grounds of race, color, sex, religion or national origin.
- E. All project deliverables included on Page 9 of 25 of Connecticut Department of Agriculture Bureau of Aquaculture proposal (attached) shall be completed. In the event all deliverables are not fully rendered as provided for in the Contract, any monies which have been paid by the agency under the Contract must be refunded to ISSC.
- F. The contractor will submit a progress report no later than June 15, 2015. This progress report shall be a summary of activities completed (a brief summary of no more than two (2) pages).
- G. Notwithstanding any other provisions of the Contract, the parties hereto agree that the charges to ISSC by the Contractor are payable from federal grant monies. In the event sufficient grant monies are not made available to ISSC to pay the charges hereunder, this contract shall terminate without further obligation of ISSC. In such event, the ISSC shall certify to the Contractor the fact that sufficient funds are not available to ISSC to meet the obligations of the Contract and such written certification shall be conclusive upon the parties.
- H. The Contractor certifies that he/she shall not engage in the unlawful manufacture, distribution, dispensation, possession or use of a controlled substance in the performance of this Contract. This certification also applies to any individual employed by the Contractor.
- I. The performance of work under this contract may be terminated by the Executive Director, ISSC, in accordance with this clause whenever he shall determine that such termination is in the best interest of the ISSC. The ISSC shall pay all reasonable costs associated with this Contract that the Contractor has incurred up to the date of

termination of the contract. Two (2) weeks advance notice of the Contract termination will be provided by the Executive Director, ISSC. Either party may terminate this Contract by giving written notice at least 14 days prior to the effective date of such termination.

J. All records, documents, and reports developed in the performance of this contract shall be the property of and available to the ISSC for its use without payment of royalty or additional cost and shall not be subject of an application for a copyright by, or on behalf of, the contracted Contractor.

VI. The Contractor shall deliver to the ISSC, on or before the final date of this Contract, one electronic copy (Microsoft Word) and three hard copies of the final report.

The parties to this Contract hereby agree to any and all provisions as stipulated above.

AS TO ISSC

AS TO THE CONTRACTOR

BY: _____

BY: _____

TITLE: _____

TITLE: _____

DATE: _____

DATE: _____

WITNESSES:

WITNESSES:

MAILING ADDRESS:

MAILING ADDRESS:

209-2 Dawson Road
Columbia, SC 29223-1740

EMPLOYER ID#:

EMPLOYER ID#:

52-1656630

Techniques and Practices for Vibrio Reduction Proposal

State of Connecticut Department of Agriculture Bureau of Aquaculture

1. Executive Summary

During the summers of 2012 and 2013, *V. parahaemolyticus* infections of a strain previously traced only to the Pacific Northwest were associated with consumption of oysters and other shellfish from several Atlantic Coast harvest areas¹. These outbreaks were caused by elevated levels of the naturally occurring bacteria *Vibrio parahaemolyticus* in shellfish. This marine bacterium occurs naturally in brackish and salt-water environments, and may be found in higher concentrations from April through October when coastal waters are warm. Consumers may be exposed to these pathogenic, or disease-causing, bacteria by eating raw or undercooked shellfish, including oysters, clams, lobster, and crab.

Connecticut growing waters were the source of at least 23 confirmed cases of *Vibrio parahaemolyticus* during the summer of 2013, with another additional 15 cases potentially linked to Connecticut waters.

Environmental monitoring for *Vibrio parahaemolyticus* bacteria in Connecticut shellfish has been limited in previous years by federal and state laboratory and resource constraints. In 2013, the Connecticut Department of Agriculture Bureau of Aquaculture (DA/BA) acquired qPCR technology (Life Technologies 7500 Fast Real Time PCR System) which will allow the DA/BA in their role as the State Shellfish Authority to conduct environmental monitoring for total *V.p.*, *tdh+* and *trh+* indicators at a statewide scale.

In order to gain a better understanding of *Vibrio parahaemolyticus* levels and their relevance to implementing meaningful Vibrio controls in Connecticut growing waters, the 2014 DA/BA monitoring plan includes the collection of environmental parameters such as water temperature, air temperature, salinity and depth that may correlate to levels of Vibrio bacteria in shellfish. In addition, post-harvest time and temperature controls currently in place as required by the Connecticut 2014 *Vibrio parahaemolyticus* Control Plans will be evaluated by using continuous temperature data loggers (ACR Smart Button) to determine the effectiveness of post-harvest temperature controls and correlate these controls to quantifiable impacts on Vibrio levels.

Real time Vibrio monitoring and continuous environmental observations will be used to inform our understanding of the temporal variability and spatial distribution of *V.p.* in LIS growing areas. This data may provide an early warning system and allow the DA/BA to proactively manage risk of illness by limiting harvest from specific locations or requiring more stringent controls under certain environmental conditions.

In addition, with the assistance of collaborating research partners at the University of Connecticut's Department of Marine Sciences, this proposed ISSC project will analyze previously collected and ongoing observations to establish how *V.p.* levels vary with LIS environmental conditions. The existing FDA model, "Quantitative Risk Assessment on the Public Health Impact of Pathogenic *Vibrio parahaemolyticus* in Raw Oysters" (4) will be used to tailor the pre-harvest component of the model to the LIS using the analyzed observations and apply it for retrospective analysis and forecasts.

As requested by the ISSC RFP, this study will evaluate the effectiveness of a variety of post-harvest practices that could potentially reduce the risk of Vibrio illnesses. One of the major components of this work will be the field evaluation of control options for the shellfish industry that would reduce risk of Vibrio illnesses.

Proactive pre-harvest controls, such as identification of lower risk harvest areas, limiting harvest under specific environmental conditions, or applying specific controls under certain environmental conditions will also be evaluated in terms of the effectiveness of the actions on limiting *Vibrio* growth.

This research team has the ability to initiate data gathering by August 2014 as the DA/BA has been actively involved in data collection and *Vibrio* monitoring since June of 2014.

This work will complement research being proposed by Co-PIs Whitney (UCONN), Ward (UCONN), and DeRosia-Banick (DA/BA) for Connecticut Sea Grant RFP for the 2014-2016 funding cycle *Modeling Vibrio parahaemolyticus Outbreaks in Commercial Shellfish Areas in Western Long Island Sound: Research Linking Local Environmental Factors and Uptake by Oyster*.

The chief project **objectives** are to:

- Evaluate post-harvest time and temperature controls currently in place as required by the Connecticut 2014 *Vibrio parahaemolyticus* Control Plans using continuous temperature data loggers (ACR Smart Button) to determine the effectiveness of post-harvest temperature controls and quantify how these controls impact *Vibrio* levels
- Collect and analyze *Vibrio* bacteria levels (total *V.p.*, tdh+ and trh+) from growing areas throughout Long Island Sound, with a focus on the Norwalk/Westport outbreak areas
- Collect and analyze environmental data including water temperatures, air temperatures, salinity, depth in order to apply FDA *Vibrio* Risk Assessment model to Connecticut environmental data and *Vibrio* monitoring data
- Work with stakeholders, managers, and scientists at the state, regional, and national level to:
 - 1) translate this research into viable harvest and control options for the shellfish industry that would reduce risk of *Vibrio* illnesses;
 - 2) to assess regional and environmental differences that may better define the combination(s) of post-harvest time and temperature controls that will be most effective for a given region or state and;
 - 3) ensure that the results of these research efforts will be fully considered by the membership of the ISSC.

2. Approach and Methodology

The research will test the following **hypotheses**:

- Shellfish in deeper offshore growing areas have consistently lower *V.p.* levels than nearshore areas due to lower near-bottom temperatures. These are less likely to require *V.p.*-related closures.
- Post-harvest controls, such as rapid cooling of oysters to 50°F within 1 hour of harvest, will reduce the proliferation of *Vibrio* bacteria and associated risk of illness associated with Connecticut oysters
- A linear regression model (following FDA methods) linking the logarithm of *V.p.* counts in shellfish to water temperature and salinity values supplied by a hydrodynamic model will show statistically significant agreement with observations in LIS growing areas.

The project will combine observations, models, and laboratory experiments to answer the research question for the 2014-2015 period and inform *V.p.* management efforts.

The specific tasks for the observational and laboratory efforts are described in the Methodological Approach section.

Field Observations:

Long Island Sound Environmental Data:

Beginning in June of 2014, DA/BA deployed 16 HOBO Water Temp Pro v2 temperature data loggers at near- bottom depth (Onset Corp) and six DST conductivity, temperature, and depth (CTD) data loggers have been deployed at near-surface and near-bottom depth at 3 locations in Westport and Milford (Star-Oddi) (Figure 1). Vantage Pro 2 remote weather stations (Davis) have been purchased and will be deployed in Norwalk and in Milford to collect meteorological conditions, including rainfall and air temperature as close to the growing area as possible.

Additional environmental data to be collected via the ISSC funding will include near-surface temperature data at locations where near-bottom temperatures are being collected (16 additional Hobo Water Temp Pro v2), conductivity/temperature loggers for additional continuous salinity measurements (6 Hobo Temperature and Conductivity Data Loggers), and GPS located temperature, salinity and depth profiles at the time of oyster sample collection (YSI CastAway). See attached budget for equipment being requested in support of this proposal.

Station locations have been identified to provide spatial coverage throughout Connecticut growing waters that are actively in use for oyster cultivation. A higher intensity of data collection is focused on the waters of Norwalk and Westport, where the majority of oysters associated with the 2013 *Vibrio parahaemolyticus* outbreak were harvested.

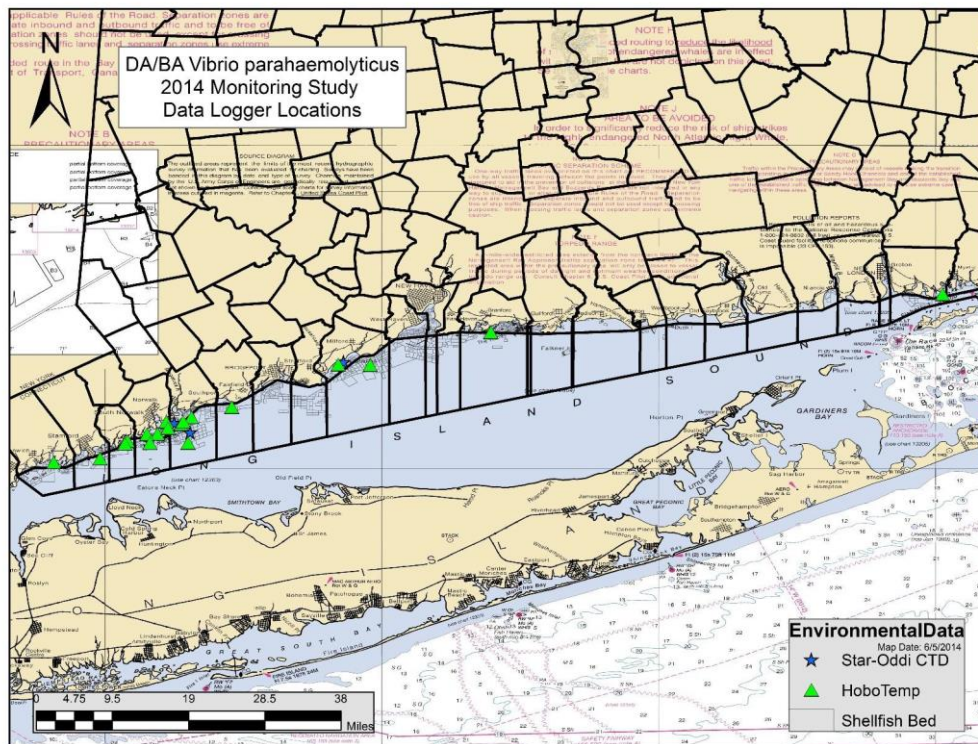


Figure 1. 2014 *Vibrio parahaemolyticus* environmental data monitoring locations.

In addition, SmartButton (ACR Systems) continuous temperature data loggers are being deployed to collect data and evaluate the effectiveness of post-harvest controls on shellfish temperatures and *Vibrio* levels.

Funding to purchase an additional 25 SmartButton loggers is being requested via this ISSC proposal to support expanded data collection to evaluate post-harvest controls.

***Vibrio parahaemolyticus* Monitoring Data:**

From June 15 to October 31, 2014, and June 1 through October 31, 2015, 16 shellstock samples will be collected on a bi-weekly basis by DA/BA staff and analyzed using a for total *V.p.*, *tdh+*, and *trh+* levels (Figure 2. 2014 *Vibrio parahaemolyticus* sample collection locations. Samples will be analyzed for Total *Vibrio parahaemolyticus*, *tdh+*, and *trh+* levels.). More intensive sampling will be focused on the Westport/Norwalk inner island waters that were associated with the 2013 outbreak, as well as the offshore waters in these towns.

Shellfish samples will be analyzed for total *Vibrio parahaemolyticus* using MPN-real-time PCR (MPN-Rti-PCR) as previously described by Jones et al (5). A second multiplex Rti-PCR method targeting the *tdh* and *trh* genes, with an internal amplification control (IAC) will be used for identification of pathogenic *V. parahaemolyticus* as described by Jones and Lüdeke (6).

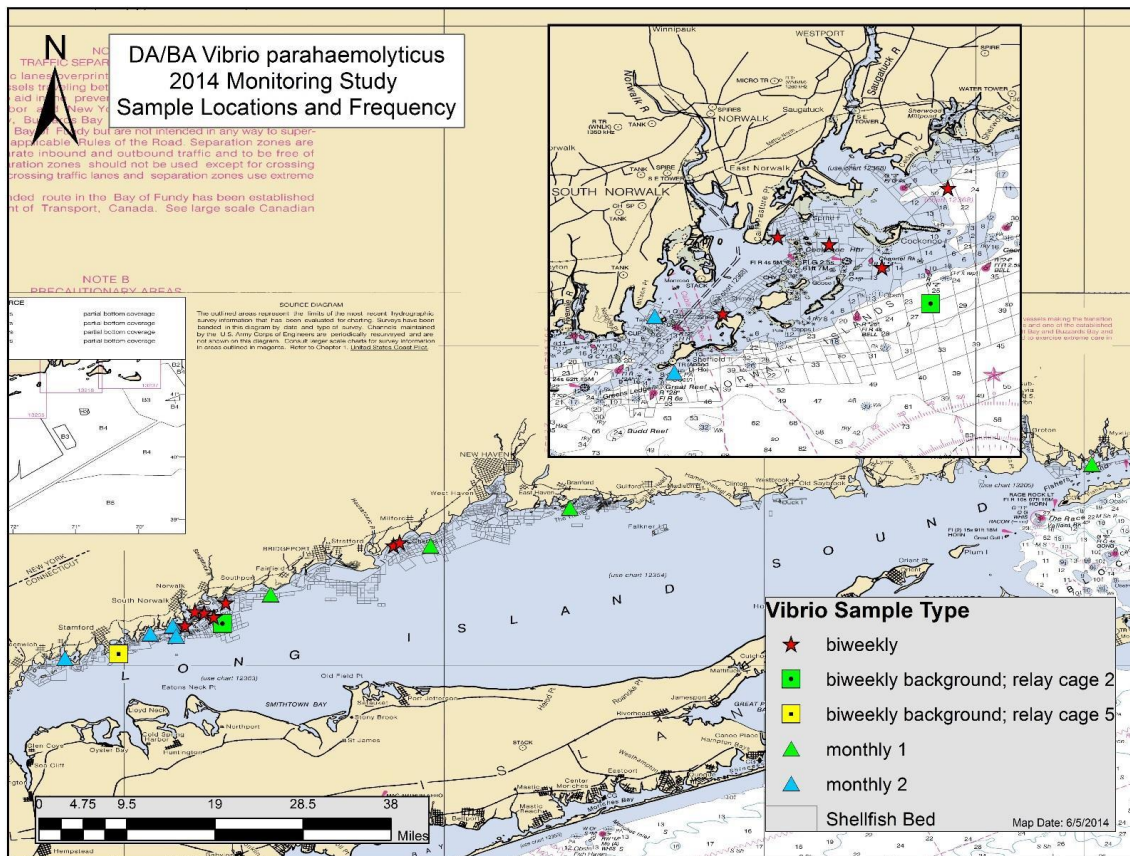


Figure 2. 2014 Vibrio parahaemolyticus sample collection locations. Samples will be analyzed for Total Vibrio parahaemolyticus, tdh+, and trh+ levels.

On a rotating basis, 2 of the 16 samples biweekly will be dedicated to investigating the impacts of the various post-harvest temperature controls on Vibrio levels. Connecticut will have several different Vibrio control plans in place during 2014; the general CT VPCP which allows 5 hours from harvest to refrigeration and 5 hours to an internal temperature of 50°F, as well as rapid cooling to internal temperature of 50°F using either ice or mechanical refrigeration. As this research is implemented during 2014 and 2015, a number of different Vp controls may be in effect depending on how the season progresses, and this portion of the study will be conducted in order to gain the most useful information in terms of how successful these various controls are in terms of limiting the proliferation of Vibrio bacteria.

Modeling:

V.p. modeling follows the approach described in Appendix 5 of the FDA Risk & Safety Assessment (ref???) (Administration, 2005) relating the base-10 logarithm of Vp count per gram sample tissue (Vp count) to water temperature in Celsius (T) and salinity in psu (S) and an error term (ε):

$$\ln_{10}(Vp) = \alpha + \beta T + \gamma_1 S + \gamma_2 S^2 + \varepsilon$$

The coefficients in the preceding equation (α, β, γ₁, γ₂) and the standard deviation (σ) of the random normal error from

the fit are estimated using a Tobit regression model. Table YYY includes regression coefficients and errors based on three studies including in the FDA Risk & Safety Assessment.

Table 1. Regression coefficients and error standard deviation for *V.p.* model equation

Study	α	β	γ ₁	γ ₂	σ
DePaola et al, 1990	-2.63	0.12	0.18	-0.0042	1.00
FDA/ISSC, 2001	-2.05	0.10	0.20	-0.0055	0.73
Washington DOH, 2000, 2001	-1.02	0.30	-0.39	0.0084	0.87

Even though the salinity coefficient is larger than the temperature coefficient, the FDA operational *V.p.* model currently excludes the salinity dependence. For the proposed project the salinity dependence will be included because the data are available and freshwater plumes entering western LIS (e.g Housatonic and Norwalk) create salinity variations in time and space.

3. Project Deliverables

Vibrio parahaemolyticus Analysis (Total *V.p.*, tdh+ and trh+)

Sample Dates (week of)	Process Study Sample #	Environmental Monitoring Sample #	Environmental Data Collection
10/06/14		8	
10/20/14		8	Pull Hobos
05/18/15			Deploy Hobos
05/25/15			Deploy Shellfish Cages
06/01/15	8	8	
06/15/15	8	8	
06/22/15			Offload Hobo Data
06/29/15	8	8	
07/06/15			Cage Maintenance
07/13/15	8	8	
07/20/15			Offload Hobo Data
07/27/15	8	8	
08/03/15			Cage Maintenance
08/10/15	8	8	
08/17/15			Offload Hobo Data
08/24/15	8	8	
08/31/15			Cage Maintenance
09/07/15	8	8	
09/14/15			Offload Hobo Data
09/21/15	8	8	
09/28/15			Cage Maintenance
10/05/15	8	8	
10/12/15			Offload Hobo Data
10/19/15	8	8	
10/26/15			Pull Hobos and Cages
Total ISSC Samples (October 1, 2014 through August 31, 2015)	56	72	

Key Project Deliverables include:

- Informing improved regional understanding of how environmental factors such as water temperature, air temperature, depth, and salinity correlate to total *V.p.*, tdh+, and trh+ levels and making these results available to regional and national partners via a webinar presentation sharing the Connecticut findings;
- Determining the impact of post-harvest time and temperature controls on the proliferation of total and pathogenic *V.p.* and using this data to identify controls that are most effective for Connecticut and the Northeast Region and making these results available to regional and national partners via a webinar presentation sharing the Connecticut findings;

- Translating this research into viable harvest and control options for the shellfish industry that would reduce risk of Vibrio illnesses and sharing this information with industry via a webinar or in-person presentation.

4. Project Management Approach

Project results will be translated into state, regional and national management tools through cooperation with the Connecticut Department of Agriculture Bureau of Aquaculture, National Oceanic and Atmospheric Administration, US Food and Drug Administration, Interstate Shellfish Sanitation Conference, and State Shellfish Authorities and shellfish industry members in the Northeast Region. This task will be conducted with the target audience of state shellfish authorities, FDA regional shellfish specialists, environmental managers and scientists via conference calls and meetings discussing research plans and results throughout the project on a quarterly basis.

An initial conference call occurred during 2014 and guided this proposal development as well as the Connecticut Sea Grant proposal.

Environmental and vibrio data collected and generated by DeRosia-Banick and DeCrescenzo will be shared with collaborating researchers via email updates of data in Excel spreadsheet form along with GIS shapefiles or latitude and longitude correlating to data collection locations to facilitate modeling.

Conference calls between collaborative partners FDA, and the appropriate committees of the ISSC will be scheduled on a quarterly basis in order update interested parties on research progress. Deliverables generated may be disseminated amongst managers and stakeholders prior to the end of project as deemed appropriate by the group.

5. Detailed and Itemized Pricing

Total Match CT Department of Agriculture Commitment: \$32,560

Analyst Hourly Rate (includes benefits):
Salary: \$45.00/hour
Time match: 272 hours* \$45/hour = \$ 12,240 over the 2 year period
Boat Captain Hourly Rate (includes benefits):
Salary: \$55.00/hour
Time match: 192 hours* \$55/hour = \$10,560 over the 2 year period
Microbiologist Hourly Rate (includes benefits):
Salary: \$45.00/hour
Time match: 80 hours* \$45/hour = \$3600 over the 2 year period
Boat Fuel: 7 gal/hr * \$5/gal = \$35/hour fuel
176 hours * \$35 per hour = \$6160

Funding Requested:

Item	Supplier	Item #	Quantity	Unit	Total Price
PCR Freezer Paks	Fisher Scientific	5115-0032	2	152.02	304.04
Mini-Centrifuge	Fisher Scientific	S67601B	1	276.25	276.25
Dry Block Heater	Fisher Scientific	07-201-839	1	689.85	689.85
Pipet tips 0.1-10	Fisher Scientific	02-707-439	1 pack	41.66	41.66
Pipet tips 2-10	Fisher Scientific	02-707-432	1 pack	41.66	41.66
Pipet tips 20-200	Fisher Scientific	02-707-430	1 pack	41.66	41.66
Tube racks 1.5ml	Fisher Scientific	14-810-31	4 cases	98.67	394.68
Tube racks 2.0ml	Fisher Scientific	05-541	1 cases	119.92	119.92
Rnase away	Fisher Scientific	14-375-35	1	71.84	71.84
2 ml Tubes	Fisher Scientific	02-682-558	1 pack	43.68	43.68
Block well 24 (1.5ml)	Fisher Scientific	07-201-842	2	84.50	169.00
Block well 24 (2ml)	Fisher Scientific	07-201-840	2	84.71	169.42
Pipet tips 100-1000	Fisher Scientific	02-707-404	1	41.66	41.66
Micro tubes black	Fisher Scientific	03-391-161	1	32.09	32.09
Micro tubes 1.5ml	Fisher Scientific	05-408-131	4	24.16	96.64
Hobo Temperature and Conductivity Data	Onset	U24-002-C	6	750.00	4,500.00
HOBO Water Temperature Pro v2	Onset	U22-001	20	129.00	2,580.00
SmartButton (25-Pack)	ACR Systems	01-0185	2	1,245.00	2,490.00
CastAway CTD-YSI	Interactiv Oceanographics	400000	1	5,515.00	5,515.00
ultra-pure	life tech	500 ml	1	29.00	29.00
ROX Dye	life tech	500ul	1	41.60	41.60
platinum DNA Polymerase	life tech	120 reactions	2	99.00	198.00
HAC	IDT	100 Nm	1	315.00	315.00
TL-1043	IDT	250 NM	1	420.00	420.00
TL-884F	IDT	100 NM	1	13.75	13.75
TL-1091R	IDT	100NM	1	11.55	11.55
TRH 20 F	IDT	100 NM	1	12.65	12.65
iac-186r	IDT	100NM	1	10.45	10.45
trh292r	IDT	100 nm	1	12.65	12.65
tdh 89f	IDT	100 nm	1	9.35	9.35
tdh 321r	IDT	100 nm	1	13.20	13.20
iac46f	IDT	100nm	1	10.45	10.45
PCR Nuc Mix	Roche		1	328.00	328.00
VP-IAC	BioGX		1	500.00	500.00
Custom TAQMAN	Life Tech	vic	1	153.00	153.00
Custom TAQMAN	Life Tech	Fam	1	153.00	153.00
platinum Tac	Life Tech	600 reactiuons	1	459.00	459.00
T Buffer	Fisher	4 liters	1	244.38	244.38
Micro 8 tube strip	Life Tech	1000 tubes	2	102.00	204.00
adhesive film	Life Tech	100 covers	2	219.00	438.00
96 well plate	Life Tech	20 plates	2	134.00	268.00
8 cap strips	Life Tech	300 strips	2	106.00	212.00
Total Funding Requested					21,676.08

6. Appendix: References

1. Scallan E, Hoekstra RM, Angulo FJ, et al. Foodborne illness acquired in the United States—major pathogens. *Emerg Infect Dis* 2011;17:7–15.
2. Martinez-Urtaza J, Baker-Austin C, Jones JL, Newton AE, Gonzalez-Aviles GD, DePaola A. Spread of Pacific Northwest *Vibrio parahaemolyticus* strain. *N Engl J Med* 2013;369:1573–4.
3. CDC. Increase in *Vibrio parahaemolyticus* illnesses associated with consumption of shellfish from several Atlantic coast harvest areas, United States, 2013. Atlanta, GA: US Department of Health and Human Services, CDC; 2013. Available at <http://www.cdc.gov/vibrio/investigations/index.html>
4. USFDA. Quantitative Risk Assessment on the Public Health Impact of Pathogenic *Vibrio parahaemolyticus* in Raw Oysters, Unites States, 2005.
5. Jones, J. L., Y. Hara-Kudo, J. A. Krantz, R. A. Benner, Jr., A. B. Smith, T. R. Dambaugh, J. C. Bowers, and A. DePaola. 2012. Comparison of molecular detection methods for *Vibrio parahaemolyticus* and *Vibrio vulnificus*. *Food Microbiol.* 30:105-111.
6. Jones, J. L. and Lüdeke, C. H. M. 2012. Improved Detection of Pathogenic *Vibrio parahaemolyticus* from Oyster, Water, and Sediment Using Real-Time PCR. Final Program 112th Gen. Meet. Am. Soc. Microbiol. American Society for Microbiology, Washington, DC.

7. Appendix: Project Team Staffing

Kristin DeRosia-Banick (Co-PI) Environmental Analyst II Connecticut Department of Agriculture Bureau of Aquaculture	190 Rogers Avenue Milford, CT 06460 Kristin.DeRosia-Banick@ct.gov 203-874-0696 ext 112
Joseph DeCrescenzo (Co-PI) Microbiologist II Connecticut Department of Agriculture Bureau of Aquaculture	190 Rogers Avenue Milford, CT 06460 Joseph.DeCrescenzo@ct.gov 203-874-0696 ext 112
Michael M. Whitney (collaborating researcher) Associate Professor Department of Marine Sciences University of Connecticut	1080 Shennecossett Road Groton, CT Michael.whitney@uconn.edu 860-405-9157
Evan Ward (collaborating researcher) Professor Department of Marine Sciences University of Connecticut	1080 Shennecossett Road Groton, CT Evan.Ward@uconn.edu 860-405-9073

See attached Curriculum vitae for investigators and collaborators on this proposal.

8. Appendix: Company Overview

9. Appendix: Background ISSC Proposal 13-204

Proposal 13-204 was recommended for adoption by the 2013 Task Force II. FDA concurred with Conference action on Proposal 13-204 with the following comments and recommendations.

- FDA urges the ISSC to consider that the evidence most needed for determining the public health

benefit of various control strategies would be to compare *Vibrio* levels at harvest to levels achieved with currently implemented time to temperature control measures and levels achieved using various other control strategies, including immediate cooling.

- To expand further, a more comprehensive approach could examine changes in *Vibrio* levels as half shell product moves from harvest through processing and distribution.
- These data could inform allocation of regulatory resources to achieve the greatest public health benefit.

Efforts outlined above are intended to help improve existing *Vibrio* controls, identify additional approaches for reducing risk and improve the effectiveness of the National Shellfish Sanitation Program (NSSP).

ISSC has been allocated \$75,000 by the FDA and is seeking to fund multiple studies to identify and evaluate the effectiveness of techniques and practices that could potentially reduce the risk of *Vibrio* illnesses. The purpose of the RFP is to invite qualified entities to propose studies that could offer viable control options for the shellfish industry that would reduce risk of *Vibrio* illnesses.

***Vibrio parahaemolyticus* Illnesses in Connecticut**

(excerpted from FDA's FY 2013 *Vibrio* Risk Management Plan Implementation Program Element Evaluation Report (PEER) for Connecticut)

1. In 2013, Connecticut experienced their first *V.p.* outbreak. That outbreak was associated with oysters harvested from Westport and Norwalk and resulted in a recall of those species harvested from specific lots between July 3 and August 2, 2013. The recall also included clams on a precautionary basis because some of the 2013 illnesses involved both clam and oyster consumption. Thus a mandatory *V.p.* Control Plan for Connecticut will be required to be implemented through the 2018 season unless another *V.p.* outbreak pushes the cut-off date further into the future. No *Vibrio vulnificus* illnesses have been documented as a result of individuals consuming shellstock from the waters of Connecticut.
2. There were no *Vibrio* illness outbreaks associated with CT shellfish in FY12. The DA/BA has investigated or participated in investigations in seven single illness cases of *V.p.* and one single illness case of *Vibrio fluvialis* in FY12 (Table 2). Three *V.p.* illnesses were linked to the Oyster Bay, NY outbreak. Three *V.p.* cases implicated CT oysters; one case was epidemiologically confirmed to be associated with CT oysters. The *V.f.* illness had a multi-state shellstock exposure.
3. As illustrated in Table 2, the number of cases attributed to *Vibrio* has remained steady 2009- 2012. The number of cases epidemiologically linked to CT shellstock remained steady through 2012 when mandatory *V.p.* controls were instituted for oysters in late July and voluntary controls were instituted for clams. However, in 2013 the number of *V.p.* cases numbers jumped significantly.

Table 2. *Vibrio* Illness Investigations in Connecticut 2009 through 2012

Year	Number of Cases	Source States
2009	7 (5 involving CT)	1 MA (clams August) 1 CT or RI (oysters August) 1 CT or NY (clams August) 1 Unknown (oysters September) 3 definitely CT (1 oysters, 1 clams, 1 unknown)
2010	5 (3 involving CT)	1 ME, MD or VA (mussels or oyster August) 1 CT, ME, or WA (oysters August) 1 NY, WA, ME, MA (oysters) 2 definitely CT (1 clams July, 1 clams June)
2011	6 (5 involving CT)	1 CT, PE, NY (clams and oysters August) 1 Unknown (clams August) 3 definitely CT (1 <i>V.f.</i> oysters July, 1 <i>V.f.</i> and <i>V.p.</i> oysters August, 1 clams September) 1 CT or WA
2012	7 (4 involving CT)	1 definitely CT (oysters June) 1 NY or CT (oysters June) 1 MA (oysters May) 1 case NY (clams July) 1 case NY or CT (oysters late May/early June) 1 (CT, NY, ME, MA, PE) <i>V.f.</i> confirmed (clams and oysters July) 1 case RI (clams August)

Table 3. Connecticut *Vibrio* Illness Investigations 2013

Traceback Code	Traceback Investigation Conclusion	Number of Cases
1	CT Confirmed to Outbreak/Closure Area	11
2	CT Confirmed (Outbreak/Closure plus other CT)	8
3	CT Confirmed (single source outside of outbreak area)	2
4	Out-of-State Confirmed	7
5	CT Outbreak Plus Out-of-State (with PFGE Match)	4
6	CT Plus Out-of-State (Unconfirmed/NO PFGE Match)	6
7	Unconfirmed case, CT Product	2
8	Recreational Case	3
0	Traceback Pending	0
9	CT Confirmed Multiple Possible Sources Outside Outbreak Area	2
	Total CT Confirmed Cases (Traceback Code 1, 2, 3, 9)	23
	CT Outbreak Area (Traceback Code 1 & 2)	19
	Total <i>V.p.</i> Related	45

4. In general, the CT Department of Public Health (DPH) receives an average of 20 – 25 reports of *Vibrio* infections annually. These reports typically increase in mid-summer and cases are most often related to shellfish consumption or recreational water exposure. When cases are reported to the DPH, the Department of Public Health, Epidemiology and Emerging Infections Program (EEIP) works closely with local health departments (LHDs) to conduct case investigations, utilizing the Cholera and other *Vibrio* Illness Surveillance Report (COVIS) form issued by the Centers for Disease Control and Prevention (CDC). When seafood consumption is reported by the case, the EEIP notifies the Department of Public Health, Food Protection Program (FPP) for further seafood investigation, as warranted. The FPP will need to follow up with the DA/BA, if warranted. Because Connecticut is a FoodNet site, the EEIP is expected to forward the COVIS report to the CDC within 30 days of the specimen collection date for the case. Therefore, when feasible the DA/BA makes every attempt to complete page 4 of the COVIS form within this 30-day period so it can be included with the initial COVIS form submission to CDC. When this is not feasible, the DA/BA will forward an updated COVIS report to the FPP and/or EEIP for submission to CDC once available.
5. The occurrence of continuing sporadic *Vibrio* illnesses compounded by the 2013 *V.p.* outbreak affects Connecticut's *Vibrio* Management Plan. The occurrence of an outbreak on the New York shore of Long Island Sound, and a single epidemiologically confirmed illness associated with Connecticut oysters, precipitated the precautionary closure of growing area waters, and the implementation of the first mandatory *Vibrio* controls at the harvester/dealer level for oysters in 2012. Additionally, the DA/BA began conducting routine testing of oysters and clams for total and pathogenic *V.p.* levels, instituted voluntary controls at the harvester/dealer level for clams, and increased harvester/dealer education efforts. The *Vibrio* MOAs between the CT DA/BA and oyster harvester/dealers were modified to reflect actual aquaculture operations. In many instances, the modified MOAs were more restrictive than the mandatory 5 hours from harvest to refrigeration requirement established by the DA/BA. The DA/BA collaborated with the harvester/dealers operations on a case-by-case basis and made recommendations that reflected best practices for the individual operation.

Connecticut's 2014 *Vibrio parahaemolyticus* Control Plan (VPCP)

In response to the 2013 illness outbreak of *Vibrio parahaemolyticus* illnesses related to Connecticut shellfish harvested from the waters of Norwalk, Westport, and Darien, the DA/BA recommended several different options for mandatory VPCP to be implemented at the harvester/dealer level during the 2014 season. Because all illnesses during the 2013 season were associated with these waters, and other harvest areas in Connecticut were not implicated, a more stringent control plan was required for the waters of Norwalk, Westport and Darien. The VPCP for these waters requires rapid cooling of oysters on-board the harvest vessel to an internal tissue temperature of 50°F within 1 hour of harvest. The 2014 Connecticut VPCP for growing areas outside of the outbreak area requires 5 hours from harvest to refrigeration, and 5 hours to achieve an internal temperature of 50°F.

The DA/BA held an industry meeting on December 13th, 2013 to educate harvesters on the 2013 outbreak and to present the results of the 2014 *Vibrio* Risk Assessment and the 2014 VPCP requirements. The following recommendations were made in a January 15th, 2014 letter to the industry which were mailed to

all shellfish harvesters licensed in Connecticut along with copies of the two 2014 *Vibrio parahaemolyticus* Control Plans.

1. The Department is strongly recommending that ***all Connecticut oyster producers*** use an on-board ice slurry method of rapid cooling during the 2014 VPCP control plan months (June 1 through August 31). This method has been proven by FDA to effectively limit the post-harvest growth of *Vibrio* bacteria, and is our best chance of reducing the risk of illness associated with oysters produced in Connecticut.

2. The Department is **requiring that all oysters harvested from ALL WATERS of Darien, Norwalk, and Westport** be rapidly cooled using an on-board ice slurry method capable of cooling oysters to an internal temperature of 50°F within 1 hour of harvest or time of first exposure. This requirement has been implemented due to the large number of illnesses associated with oysters produced in Darien, Norwalk and Westport. Several illnesses were associated with oysters produced outside of the closure area, and hence this requirement is for all waters in Darien, Norwalk and Westport, rather than limited to the 2013 closure area.

DA/BA followed this letter up with calls to each individual oyster harvest working in the Norwalk, Westport, and Darien growing areas reminding them that they should make an appointment with DA/BA to present their plans for a rapid cooling process, if they planned on harvesting oysters from these waters. The DA/BA collaborated with the harvester/dealers operations on a case-by-case basis and made recommendations that reflected best practices for the individual operation in terms of the rapid cooling process implemented by each of the companies and that were appropriate for the volume and practices of each company. DA/BA expanded rapid cooling approvals to allow direct ice and mechanical refrigeration in addition to ice slurry, if the process was found to be capable of achieving internal temperatures of 50°F within 1 hour of harvest.

During 2014, a number of different rapid cooling processes were approved by the DA/BA in order to reduce oyster temperatures to an internal temperature of 50°F within 1 hour of harvest:

- 1) Ice slurry processes using large insulated totes into which dredge loads of loose oysters could be placed for large-scale harvest operations
- 2) Ice slurry processes using large insulated totes into which sorted and bagged oysters are placed for cooling and then transferred onto ice for holding
- 3) Direct ice system into which loose rough sorted oysters are placed for transport back to land-based refrigerated facility for final sorting and bagging
- 4) On-board mechanical refrigeration into which oysters are placed in totes for rapid cooling and holding for transport back to land-based refrigerated facility for final sorting and bagging.

In addition, in growing areas not required to rapidly cool oysters, the general Connecticut VPCP was also in place which requires harvesters to place oysters under temperature control within 5 hours of harvest, and to reduce internal temperatures to 50°F with 5 hours of harvest.

BIOGRAPHICAL SKETCH

J. Evan Ward University of Connecticut

CONTRACT between ISSC and
Connecticut Department of Agriculture
Bureau of Aquaculture

Professional Preparation:

Memorial University of Newfoundland, Ocean Sciences Center, Canada	Invertebrate Physiology	Post-Doc, 1990-1992
University of Delaware, Delaware	Marine Biology/Biochem.	Ph.D., Dec., 1989
University of Delaware, Delaware	Marine Biology/Biochem.	M.S., June, 1985
Stockton State College, New Jersey	Marine Science/Biology	B.S., June, 1981

Appointments:

Professor, University of Connecticut, Department of Marine Sciences, Groton, CT, 2009 - present

Visiting Scholar, University of Exeter, Department of Biosciences, Exeter, UK, August 2011 - January 2012.

Associate Professor, University of Connecticut, Department of Marine Sciences, Groton, CT, 2003 - 2009 (promoted)

Visiting Professor, University of Panama, Department of Marine Science and Limnology, Republic of Panama, July 2004 - January 2005

Assistant Professor, University of Connecticut, Department of Marine Sciences, Groton, CT, 1997 - 2003 (promoted & awarded tenure)

Assistant Professor, Salisbury State University, Department of Biological Sciences, Environmental Marine Studies Program, Salisbury, MD, 1994 - 1997

Adjunct Research Associate, University of New Brunswick, Department of Biology, Saint John, New Brunswick, Canada, 1992 - 1994

Five Products Relevant to Proposal:

- * Pierce, M.L., **J.E. Ward** & F.C. Dobbs, 2014. False positives in Biolog EcoPlates™ and MT2 MicroPlates™ caused by calcium. *J. Microbiolog. Meth.* 97: 20–24.

Allam, B., W.E. Carden, **J.E. Ward**, G. Ralph, S. Winnicki & E. Pales Espinosa, 2013. Early host pathogen interactions in marine bivalves: Evidence that the alveolate parasite *Perkinsus marinus* infects through the oyster mantle during rejection of pseudofeces. *J. Invert. Path.* 113: 26-34.

- * Lyons, M. M., **J. E. Ward**, H. Gaff, R. Hicks, J. Drake & F.C. Dobbs, 2010. Theory of island biogeography on a microscopic scale: Are organic aggregates islands for aquatic pathogens? *Aquatic Microbial Ecology*, 60: 1–13.

- * Lyons, M.M., Y.T. Lau, W.E. Carden, **J.E. Ward**, S.B. Roberts, R.S. Smolowitz, J. Vallino & B. Allam, 2007. Characteristics of marine aggregates in shallow-water ecosystems: Implications for disease ecology. *EcoHealth*. 4: 406-420.

- * Lyons, M.M., **J.E. Ward**, R. Smolowitz, K.R. Uhlinger & R.J. Gast, 2005. Lethal marine snow: Pathogen of bivalve mollusc concealed in marine aggregates. *Limnol. & Oceanogr.* 50: 1983-1988.

- * - students trained in the Ward lab & funded by external grants

Five Other Products:

Shumway, S.E., **J.E. Ward**, E. Heupel, B.A. Holohan, J. Heupel, T. Heupel & D.K. Padilla, 2014.

Observations of feeding in the common Atlantic slippersnail *Crepidula fornicata* L., with special reference to the "mucus net." *J. Shellfish Res.* 33: 1–13.

Wall, C.C., C.J. Gobler, B.J. Peterson & **J.E. Ward**, 2013. Contrasting growth patterns of suspension feeding molluscs (*Mercenaria mercenaria*, *Crassostrea virginica*, *Argopecten irradians*, *Crepidula fornicata*) across a eutrophication gradient in the Peconic Estuary, NY, USA. *Estuaries & Coasts* . 36: 1274-1291.

- * Rosa, M., **J.E. Ward**, S.E. Shumway, G.H. Wikfors, E. Pales Espinosa & B. Allam, 2013. Effects of particle surface properties on feeding selectivity in the eastern oyster *Crassostrea virginica* and the blue mussel *Mytilus edulis*. *J. Exp. Mar. Biol. Ecol.* 446: 320-327.

Cranford, P.J., **J.E. Ward** & S. Shumway, 2011. Bivalve filter feeding: variability and limits of the aquaculture biofilter. In: S.E. Shumway (ed.), Shellfish Aquaculture and the Environment, John Wiley & Sons Publ., 81-124.

* Kach, D. & **J.E. Ward**, 2008. The role of marine aggregates in the ingestion of picoplankton-size particles by suspension-feeding molluscs. *Mar. Biol.* 153: 797-805.

* - students trained in the Ward lab & funded by external grants

Five Synergistic Activities and Achievements:

- Elected member of the Connecticut Academy of Science and Engineering, 2013 to present
- Elected co-Chair of the 2014 Gordon Research Conference on Oceans and Human Health, 2012-2014
- Awarded Fulbright Foreign Scholarship, CIES, International studies and research: **1)** University of Exeter, Exeter, United Kingdom, 2011; and **2)** University of Panama, Republic of Panama, 2004
- Director / Lead PI, Interdisciplinary Research & training Initiative on Coastal ecosystems & Human Health (I-RICH), Graduate Training Consortium, NOAA, Oceans and Human Health Initiative, 2008-2013 (completed)
- Awarded NSF, Faculty Early Career Development Grant (CAREER), 1999-2004

Recent Collaborators:

Bassem Allam, Stony Brook Univ.; Ivar Babb, NURTEC, Univ. of Connecticut; Monica Bricelj, Rutgers Univ.; Celia Chen, Dartmouth Coll.; Peter Cranford, Fisheries and Oceans Canada; Hans Dam, Univ. of Connecticut; Lewis Deaton, Univ. of Louisiana; Sylvain DeGuise, Univ. of Connecticut; Fred Dobbs, Old Dominion Univ.; John Drake, Univ. of Georgia; Emanuelle Pales Espinosa, Stony Brook Univ.; Salvatore Frasca, Univ. of Connecticut; Holly Gaff, Old Dominion Univ.; Tamara Galloway, Univ. of Exeter, UK; Randall Hicks, Univ. of Minnesota Duluth; Brian Huey, Univ. of Connecticut; Brian Jackson, Dartmouth Coll.; Milton Levin, Univ. of Connecticut; Bruce MacDonald, Univ. of New Brunswick, St. John, NB, Canada; Robert Mason, Univ. of Conn.; Dianna Padilla, Stony Brook Univ., Stony Brook, NY; Tracy Romano, Mystic Aquarium & Institute for Exploration; Sandra Shumway, Univ. of Connecticut; Charles Wall, Stony Brook Univ.; Gary Wikfors, National Marine Fisheries Service, Milford, CT

Graduate/Post-graduate Advisors:

Melbourne Carriker, Deceased, University of Delaware (MS advisor) Nancy

Targett, University of Delaware (PhD advisor)

Bruce MacDonald, University of New Brunswick, Saint John, Canada (Post-doc advisor) Ray

Thompson, Memorial University, St John's, Canada (Post-doc advisor)

Advisees in Last Five Years: (total graduate students = 11, total post-docs = 2) Students

Dustin Kach (MS - graduated), University of Connecticut, Groton, CT Maille

Lyons (PhD - graduated), University of Connecticut, Groton, CT Dana Frank

(MS, PhD - graduated), University of Connecticut, Groton, CT John Doyle (PhD

- graduated), University of Connecticut, Groton, CT Maria Rosa (MS - graduated,

PhD), University of Connecticut, Groton, CT Melissa Pierce (PhD), University

of Connecticut, Groton, CT

Vena Haynes (PhD), University of Connecticut, Groton, CT Post-

docs

Maille Lyons (completed), University of Connecticut, Groton, CT & ODU, Norfolk, VA

KRISTIN DEROSIA-BANICK

**CONNECTICUT DEPARTMENT
OF AGRICULTURE**

BUREAU OF AQUACULTURE 190 ROGERS AVE.

MILFORD, CT 06460

EMAIL: KRISTIN.DBANICK@SNET.NET

OFFICE: 203-874-0696 EXT 112

CELL: 203-231-8662

Environmental Analyst with over ten years of experience in environmental program implementation, shellfish resource management, environmental health and food protection, and geographic information systems

CONNECTICUT COLLEGE, 09/1989 through 05/1991

Major: Liberal Arts, 60 credits completed

Education:

SOUTHERN CONNECTICUT STATE UNIVERSITY, May 2003, B.S. in Biology

Major: B.S. in Biology, Concentration in Marine Biology

Honors: Graduated *magna cum laude*; Dean's List, Alumni Association Scholarship

UNIVERSITY OF NEW HAVEN, 11/2004 through 5/2006

M.S. in Environmental Health and Environmental Ecology, 19 credit hours completed

Professional Experience: CONNECTICUT DEPARTMENT OF AGRICULTURE, BUREAU OF AQUACULTURE

Environmental Analyst III June 2013 - present

Shellfish Sanitation Program: Acting lead analyst for illness investigations and shellfish recalls; Lead analyst for Connecticut's *Vibrio parahaemolyticus* Control Plan and statewide *Vibrio* monitoring program; Investigate and make recommendations during illness outbreaks and recalls in order to protect public health and minimize additional illnesses; Design environmental quality studies or comprehensive shoreline assessments; research and evaluate aquaculture programs for hazards and define new policy; serve as department representative on state, regional and national advisory boards, in legislative hearings, on state councils and Interstate Shellfish Sanitation Conference (ISSC) committees; Design environmental quality studies or comprehensive shoreline assessments which involve conducting a site investigation of each property on the shoreline of the town being studied, conducting and evaluating hydrographic studies, pollution source sampling, assessing water pollution control authority (WPCA) treatment quality, and growing area water quality monitoring; Develop GIS data, provide technical assistance, technical analysis and program data to bureau staff and Director, local and state agencies, state legislature, and federal programs; Write and review legislation and assess and formulate policy for existing and emerging industries;

Environmental Analyst II December 2006 – June 2013

Design and conduct shoreline survey pollution source assessments as required by National Shellfish Sanitation Program (NSSP); develop new programs and regulations to implement environmental policy regarding shellfish and aquaculture; prepare informational materials regarding shellfish program policy for state and federal agencies and stakeholders; develop GIS data and provide technical analysis to staff, state and federal agencies; lead analyst for illness investigations; research and evaluate aquaculture programs for hazards and define new policy; serve as department representative on advisory boards, legislative hearings, state councils, environmental committees, etc.

Environmental Analyst April 2004 - December 2006

Conduct site investigation of shoreline properties which included conducting and evaluating hydrographic studies, pollution source sampling, assessing Water Pollution Control Authority (WPCA) treatment quality, and growing area water quality monitoring; analyze sanitary survey and water quality monitoring data to classify growing areas according to federal standards; statistical analysis of data and preparation of comprehensive assessments for each growing area; evaluate applications for shellfishing activities and inspection of shellfish operations for compliance with NSSP guidelines for sanitation, records and HACCP.

YALE UNIVERSITY, MOLECULAR BIOPHYSICS AND BIOCHEMISTRY

Research Assistant August 2003 – April 2004-

Utilize molecular and biochemical techniques in support of RNA structural research in academic setting; responsible for radiation and chemical safety inspections of laboratory.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, WEST NILE VIRUS SURVEILLANCE PROGRAM

Research Assistant May 2003 – August 2003

Enumerate and identify mosquitoes to species level for virus surveillance and public health protection; establish and maintain colonies; set traps and collect mosquitoes in field.

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION, BUREAU OF WATER MANAGEMENT

Research Assistant May 2002 – November 2002

Collect water, sediment, benthic invertebrate, and plankton samples from Long Island Sound and tributaries; prepare and analyze samples and deliver to laboratory; prepare charts and graphs for analysis of environmental data

Recent Publications and Presentations

February 2014: Northeast Shellfish Sanitation Association Presentation Overview of Connecticut's 2013 *Vibrio parahaemolyticus* Season

February 2014: Milford Aquaculture Seminar/NESSA Joint Session on Vibrio Presentation Regional Overview of the 2013 *Vibrio Parahaemolyticus* Season
Panel Discussion Member

February 2014: Connecticut Shellfish Initiative Presentation
Clean Waters, Safe Shellfish, Christopher Sullivan and Kristin DeRosia-Banick

Spring/Summer 2014: Wracklines Volume 14, Number 1.
Clean Waters, Safe Shellfish, Christopher Sullivan and Kristin DeRosia-Banick December 2013: Industry

Meeting: 2014 *Vibrio parahaemolyticus* Control Plan for CT

January 2013: Connecticut Sea Grant, Municipal Shellfish Gathering
Vibrio Bacteria Guidance for Recreational Shellfishing Programs Presentation

December 2012: Seaweed Regulatory Workgroup Presentation
Seaweed Cultivation in Long Island Sound: An Analysis of Species and Process Specific Hazards

September 2012: 50th Annual Yankee Conference on Environmental Health Presentation Conducting *Vibrio* Illness Investigations

DeRosia-Banick, K. 2012. Naturally-occurring bacteria threat in the Sound. Long Island Sound Study Sound Update Fall 2012.

DeRosia-Banick, K. 2012. State Responds to the Threat of Naturally Occurring Bacteria in Long Island Sound. The Dredge Volume 5(1): Fall 2012.

March 2012: Connecticut Department of Agriculture Bureau of Aquaculture Shellstock Shipper Owner/Operator Training Seminar
Presentation on Changes to Federal Regulatory Guidance for Shellfish Handling

Certificates/Training:

NOAA Remote Sensing for Spatial Analysts 07/18/2008 Introduction to ArcGIS II 03/28/2008

Shellfish Growing Areas (FD242) 05/10/2007

State of CT Department of Public Health Phase I Subsurface Sewage Disposal 03/2006 State of CT Department of Public Health Food Inspector Certification 02/2006

State of CT Department of Public Health Procedures to Investigate Food borne Illness 2005 Seafood HACCP Regulator Training Program (FD249) 05/04/2005

Basic Shellfish Plant Sanitation (FD 140) 01/13/2005

FDA Training Curriculum for State, Local, and Tribal Regulators (*Shellfish Curriculum*) 2004-2005

Interstate Shellfish Sanitation Conference Certificate of Hazard Analysis and Critical Control Point (HACCP) Course Completion 10/21/2004

AFDO Seafood Education Alliance Seafood HACCP Training Course 10/12/2004

Committees and Advisory Boards:

Interstate Shellfish Sanitation Conference, Vibrio Research Committee Interstate Shellfish Sanitation Conference, Recall Guidance Committee Connecticut Sea Grant Extension Advisory Board

Connecticut Geospatial Information Council Connecticut Coastal Health Officials

Sasco Brook Pollution Abatement Committee

Department Of Agriculture, Bureau Of Aquaculture

P.O.Box 97 Milford, Connecticut 06460

Phone (203) 874-0696 ext.125

joseph.decrescenzo@ct.gov

Joseph August DeCrescenzo

To learn and grow as a Microbiologist in the shellfish and Dairy community.

2002-Present

State of Connecticut

Milford, Connecticut

Microbiologist 2

- Perform Bacteriological analyses of seawater, sewage effluent, and shellfish, Prepare media reagents for bacteriological examination, Maintain records, Perform qPCR for total and pathogenic *Vibrio parahaemolyticus* in oyster meats, Perform histopathological examination on shellfish, Prepare reports, Laboratory Evaluation Officer for both Dairy and Shellfish labs in Connecticut, Evaluate 12 dairy Laboratories and 2 Shellfish Laboratories in Connecticut, Supervise a Microbiologist 1.

1999-2001

State of Connecticut

Milford, Connecticut

Microbiologist 1

- Perform Bacteriological analyses of seawater, sewage effluent, and seafood, Process shellfish for histopathological examination, Perform histopathological examination, Prepare media reagents for bacteriological examination, Use a bioassay for the detection of Paralytic Shellfish Poisoning, Maintain equipment and laboratory.

1998

State of Connecticut

Milford, Connecticut

Internship

Performed independent research project utilizing histopathological techniques. Upon completion of project, reported and published data gathered at annual conference.

Publications:

THE PRESENCE OF VIBRIO PARAMAEMOLYTICUS IN CRASSOSTREA AT SPECIFIC LOCATIONS ALONG THE CONNECTICUT AND LONG ISLAND SHORE – FDA SURVEY FOR JUNE 1999 TO JUNE 2000. Leonora Porter and Eugene Zamojcin, State of New York, Department of Environmental Conservation, 205 North Belle Mead Rd., East Setauket, NY 11733; Joseph DeCrescenzo, Inke Sunila, and John Karolus, State of Connecticut, Department of Agriculture, Bureau of Aquaculture, P.O. Box 97, Milford, CT 06460

PRINCIPAL DISEASE OF CONNECTICUT’S OYSTERS. Inke Sunila, Joseph DeCrescenzo, John Karolus, and John Volk. State of Connecticut, Department of Agriculture, Bureau of Aquaculture, P.O. Box 97, Milford, Connecticut 06460

* HISTOPATHOLOGICAL SURVEY OF THE QUAHOG, *MERCENARIA MERCENARIA*, ALONG THE CONNECTICUT COASTLINE. Joseph DeCrescenzo, Inke Sunila, John Karolus, and John Volk. State of Connecticut, Department of Agriculture, Bureau of Aquaculture, P.O. Box 97, Milford, Connecticut 06460

References: References given upon request

Education:

1994-1999 Unity College, Unity, Maine

Bachelor Degree in Science, Emphasis in Biology

2004-2006 Southern Connecticut University, New Haven, CT

9 credits in Graduate level Microbiology Courses

University of Delaware, College of Marine Studies

Fall 1998 to Spring 2003

- Ph.D. 2003, Physical Ocean Science & Engineering (GPA: 4.00)
- Advisor: Dr. Richard Garvine, Harrington Professor of Marine Studies

Yale University

Fall 1992 to Spring 1996

B.S. 1996, *cum laude* (GPA: 3.72)

- Majors: Geology and Geophysics (Atmosphere and Ocean Track), Environmental Studies

EMPLOYMENT

Summer 2005 to Present

University of Connecticut, Department of Marine Sciences

- Associate Professor (promoted in 2012)

Yale University, Geology and Geophysics, Department

Fall 2012

- Visiting Fellow (while on sabbatical from University of Connecticut)

Oregon State University, College of Oceanic and Atmospheric Sciences

Fall 2003 to Summer 2005

- Postdoctoral research associate for Dr. J. S. Allen

University of Delaware, College of Marine Studies

Summer 2003 to Fall 2003

- Postdoctoral researcher for Dr. Richard Garvine

University of Delaware, College of Marine Studies

Fall 1998 to Spring 2003

- Research Assistant and Graduate Fellow

Ocean Surveys, Inc., Old Saybrook, CT

Summer 1996 to Fall 1998

- Project scientist in the oceanography department

CURRENT FUNDING

- M. M. Whitney, CAREER: The Influence of Distributed River Inputs and Coastal Embayments on Dynamics of Large Estuaries, National Science Foundation, 6/1/2010-5/31/2015.
- M. M. Whitney (Uconn PI), D. Codiga (URI PI), D. Ullman (URI Co-PI), Collaborative Research: Investigating Tidal Influences on Subtidal Estuary-Coast Exchange Using Observations and Numerical Simulations, National Science Foundation, 9/1/2008-8/31/2013.
- M. M. Whitney (Uconn PI), F. Bryan (NCAR PI), J. Dennis (NCAR Co-PI), P. MacCready (UW PI), Collaborative Project: Improving the representation of coastal and estuarine processes in earth

- system models, Department of Energy, 9/1/2011-8/31/2014.
- M. M. Whitney and J. Edson, Sea Breezes and Estuary-Shelf Response in Areas with Spatial Sea Surface Temperature Variability and Complex Coastal Geometry, National Aeronautics and Space Administration, 1/1/2013-12/31/2015.
- M. M. Whitney and P. Vlahos, Measuring and Predicting the Fate and Transport of Perfluorinated Contaminants Entering the Long Island Sound from Municipal Wastewater in the Housatonic Watershed, Connecticut Sea Grant, 2/1/2012-1/31/2015.

TEACHING AND ADVISING

- MARN 170 & MARN 171 (now MARN 1002 & 1003) Introduction to Oceanography (Fall 2005-2010)
- MARN 172 (now MARN 1004) Introduction to Oceanography Laboratory (Fall 2005-2010)
- MARN 270 (now MARN 4060) Descriptive Physical Oceanography (Spring 2007-2011, Fall 2012-2014)
- MARN 410 Coastal Ocean Circulation (Spring 2006, Fall 2007)
- MARN 5898 Special Topics: River Influences in the Marine Environment (Spring 2012-2013)
- Major advisor for 3 PhD students and 2 Masters students
- Associate advisor for 3 PhD students and 4 Masters students
- Undergraduate advisor for Marine Sciences and Environmental Sciences students

PEER-REVIEWED PUBLICATIONS

- **Whitney, M. M.**, D. L. Codiga, D. S. Ullman, P. M. McManus and R. Jorle. Tidal Cycles in Stratification and Shear and Their Relationship to Gradient Richardson Number and Eddy Viscosity Variations in Estuaries. *J. Phys. Oceanogr.*, 42, 1124-1133.
- O'Donnell, J., R. Wilson, K. Lwiza, **M. M. Whitney**, W. F. Bohlen, D. L. Codiga, T. Fake, M. Bowman, J. Varekamp. 2013. *Physical oceanography of Long Island Sound*. Elsevier, in press.
- **Whitney, M. M.** and D. L. Codiga. 2011. Response of a large stratified estuary to wind events: Observations, theory, and simulations of Long Island Sound. *J. Phys. Oceanogr.*, 41, 1308-1327.
- Xia, M., L. Xie, L. J. Pietrafesa, and **M. M. Whitney**. 2011. The response of a Gulf estuary plume to wind forcing: its connection with salt flux and a Lagrangian view. *J. Geophys. Res.*, doi: 10.1029/2010JC006689.
- **Whitney, M. M.** 2010. A study on the variability of river discharge and salinity in the Middle Atlantic Bight and Long Island Sound. *Cont. Shelf Res.*, 30, 305-318.
- **Whitney, M. M.** and J. S. Allen. 2009. Coastal wind-driven circulation in the vicinity of a bank: Part 1. Modeling flow over idealized banks. *J. Phys. Oceanogr.*, 1273-1297.
- **Whitney, M. M.** and J. S. Allen. 2009. Coastal wind-driven circulation in the vicinity of a bank: Part 2. Modeling flow over the Heceta Bank complex. *J. Phys. Oceanogr.*, 1298-1316.
- Rice, A. E., **M. M. Whitney**, R. W. Garvine, and P. Huq. 2008. Energetics in Delaware Bay: Comparison of two box models with observations. *J. Mar. Res.*, 66, 873-898.
- **Whitney, M. M.** and R. W. Garvine. 2008. Estimating tidal current amplitudes outside estuaries and characterizing the zone of estuarine tidal influence. *Cont. Shelf Res.*, 28, 280-290.
- Garvine, R. W. and **M. M. Whitney**. 2006. An estuarine box model of freshwater delivery to the coastal ocean for use in climate models. *J. Mar. Res.*, 64, 173-194.
- Wetz, M. S., B. Hales, P. A. Wheeler, Z. Chase, and **M. M. Whitney**. 2006. Riverine input of macronutrients, iron, and organic matter to the coastal ocean off Oregon, USA, during the winter. *Limnol. Oceanogr.*, 51, 2221-2231.
- **Whitney, M. M.** and R. W. Garvine. 2006. Simulating the Delaware buoyant outflow: Comparisons to observations. *J. Phys. Oceanogr.*, 36, 3-21.
- Tilburg, T. E., J. T. Reager, and **M. M. Whitney**. 2005. The physics of blue crab larval recruitment in Delaware Bay: A model study. *J. Mar. Res.*, 63, 471-495.
- **Whitney, M. M.** and R. W. Garvine. 2005. Wind influence on a coastal buoyant outflow. *J. Geophys. Res.*, 110, doi:10.1029/2003jc002261.
- **Whitney, M. M.** 2003. Simulating the Delaware Coastal Current. University of Delaware dissertation.

SCIENTIFIC OUTREACH AND PROFESSIONAL SERVICE

- Presenter for over 40 scientific oral and poster presentations at colleges and regional and international conferences
- Contributor to many science outreach workshops including the Groton Maritime Academy, Northeast Academy Math and Science Day, and “Y.E.S. I Can” (Youth Endeavoring to Succeed)
- Convener of 2012 Middle Atlantic Bight Physical Oceanography and Meteorology Workshop
- Co-convener of special sessions at 2010, 2012, 2014 AGU Ocean Sciences Meetings
- Reviewer for the National Science Foundation, Sea Grant, Journal of Physical Oceanography, Journal of Marine Research, Journal of Marine Systems, and Estuaries and Coasts
- Member of American Geophysical Union, Coastal and Estuarine Research Federation, and Thames River Basin Commission

AWARDS

- National Science Foundation CAREER Award (2010)
- College of Marine Studies Frances Severence Award for best thesis in Physical Ocean Science & Engineering (2004)
- College of Marine Studies E. Sam Fitz Award for academic excellence (2003)
- University of Delaware Competitive Fellowship (2000, 2001, 2002)
- American Meteorological Society/NOAA Scholarship (1998)
- Yale University Pat Wilde Prize for excellence in marine geology and oceanography (1996)
- American Meteorological Society Howard H. Hanks Scholarship (1995)

CONTRACT

Between

**Interstate Shellfish Sanitation Conference
and
Pacific Shellfish Institute**

This Contract shall be effective from October 1, 2014 to August 31, 2015, between the Interstate Shellfish Sanitation Conference, (hereinafter referred to as ISSC) and the Pacific Shellfish Institute (hereinafter referred to as the Contractor).

The parties to this Contract agree as follows:

I. SCOPE OF WORK

Identify and evaluate the effectiveness of techniques and practices that could potentially reduce the risk of Vibrio illnesses. The study will offer viable control options for the shellfish industry that will reduce risk of Vibrio illnesses. The study will consider issues associated with the effects of water temperature on initial levels at harvest and the effects of post-harvest temperature control as a means of reducing risk of illness. The detail of this work is in the Proposal which is a part of this Contract.

II. TIME OF PERFORMANCE

This Contract shall be effective from October 1, 2014 and reported on by August 31, 2015. A final report shall be submitted within thirty (30) days of the end of the contract period.

III. COMPENSATION

The total amount of the contract shall be Twenty Nine Thousand One Hundred Eleven and no/100 (\$29,111.00) dollars.

IV. METHOD OF PAYMENT

The initial payment shall be for one-half of the contractual amount. The balance is payable upon completion of the contract and the submission of an acceptable final report.

V. TERMS AND CONDITIONS

- A. The Contractor shall agree to make positive efforts to utilize the services and products of small and minority owned businesses and individuals where applicable.
- B. Any changes to this Contract, which are mutually agreed upon between ISSC and the Contractor shall be incorporated in written amendments to this Contract.

- C. The Contractor shall maintain and retain all records and other documents relating to this Contract for a period of twenty-four (24) months from the date of final payment under the Contract, and shall make the documents available for inspection and audit by authorized ISSC and Federal officials.
- D. No person shall be excluded from participation, be denied the benefits of, or be subjected to discrimination in relation to any activities carried out under this Contract on the grounds of race, color, sex, religion or national origin.
- E. All project deliverables included on Page 9 of 26 of the Pacific Shellfish Institute Proposal (attached) shall be completed. In the event all deliverables are not fully rendered as provided for in the Contract, any monies which have been paid by the agency under the Contract must be refunded to ISSC.
- F. The contractor will submit a progress report no later than June 15, 2015. This progress report shall be a summary of activities completed (a brief summary of no more than two (2) pages).
- G. Notwithstanding any other provisions of the Contract, the parties hereto agree that the charges to ISSC by the Contractor are payable from federal grant monies. In the event sufficient grant monies are not made available to ISSC to pay the charges hereunder, this contract shall terminate without further obligation of ISSC. In such event, the ISSC shall certify to the Contractor the fact that sufficient funds are not available to ISSC to meet the obligations of the Contract and such written certification shall be conclusive upon the parties.
- H. The Contractor certifies that he/she shall not engage in the unlawful manufacture, distribution, dispensation, possession or use of a controlled substance in the performance of this Contract. This certification also applies to any individual employed by the Contractor.
- I. The performance of work under this contract may be terminated by the Executive Director, ISSC, in accordance with this clause whenever he shall determine that such termination is in the best interest of the ISSC. The ISSC shall pay all reasonable costs associated with this Contract that the Contractor has incurred up to the date of termination of the contract. Two (2) weeks advance notice of the Contract termination will be provided by the Executive Director, ISSC. Either party may terminate this Contract by giving written notice at least 14 days prior to the effective date of such termination.
- J. All records, documents, and reports developed in the performance of this contract shall be the property of and available to the ISSC for its use without payment of royalty or additional cost and shall not be subject of an application for a copyright by, or on behalf of, the contracted Contractor.

VI. The Contractor shall deliver to the ISSC, on or before the final date of this Contract, one electronic copy (Microsoft Word) and three hard copies of the final report.

The parties to this Contract hereby agree to any and all provisions as stipulated above.

AS TO ISSC

AS TO THE CONTRACTOR

BY: _____

BY: _____

TITLE: _____

TITLE: _____

DATE: _____

DATE: _____

WITNESSES:

WITNESSES:

MAILING ADDRESS:

MAILING ADDRESS:

209-2 Dawson Road
Columbia, SC 29223-1740

EMPLOYER ID#:

EMPLOYER ID#:

52-1656630

Pacific Shellfish Institute Proposal
Techniques and Practices for Vibrio Reduction

1. Executive Summary

Vibrio parahaemolyticus is a common bacterial contaminant of bivalve shellfish, primarily oysters, and a major source of seafood-related food poisoning. Numerous outbreaks of *V. parahaemolyticus* illnesses associated with consumption of raw or poorly cooked shellfish have occurred between 1997 and 2013, both in the United States and elsewhere. On the U.S. West Coast and particularly in Washington, elevated *V. parahaemolyticus* levels in waters where shellfish are grown, and associated illnesses, continue to cause extensive seasonal harvest closures and product recalls. The closures cause reduced farm and harvester revenue, payrolls, and lost opportunity for tribal and recreational harvest. *V. parahaemolyticus* levels in many growing areas nationwide appear to be increasing and outbreaks could occur with higher frequency and severity across a greater geographic range in the future.

The Pacific Shellfish Institute (PSI) has been engaged in laboratory and field experiments focused on *Vibrio* for over a decade. We believe existing research provides preliminary evidence that elevated *V. parahaemolyticus* levels in intertidal cultivated shellfish can be mitigated by on-site exposure to ambient water conditions. In Washington State and other locations with access to tidelands, shellfish farmers have an enhanced ability to apply innovative post-harvest methods for reducing *V. parahaemolyticus* in their oysters and other shellfish crops, but further studies are needed. In all likelihood, findings would be relevant to other *Vibrio* strains and certainly to other coastal regions. We propose the following two low-cost, high-return ideas for ISSC funding:

- 1. Assess the effectiveness of deepwater to purge *V. parahaemolyticus*.** In preliminary experiments, Taylor Shellfish researcher Kurt Johnson demonstrated the effectiveness of deepwater to purge *V. parahaemolyticus* from oysters collected at beaches with historically high levels. The intake is located at their hatchery in Dabob Bay and can be run 24 hours/day. The temperature in waters from this intake is typically 10.5°C (51°F). Oysters placed in this water from warmer intertidal beaches (18°C, 64°F average) continued to feed and thus purged bacteria. Levels of MPN/g dropped from >11,000 at day 0 (2 replicates of 3 oysters each, not placed in deepwater) to 2400 or 230 at day 1 (per each 5 l replicate) and 0 and day 2 (both replicates). Results were less spectacular in oysters from beaches where summertime temperatures reached 40°C (104°F) likely due to shock which temporarily halted or greatly slowed feeding and purging behaviors.
- 2. Assess the effectiveness of re-immersion in sink floats to purge *V. parahaemolyticus*.** Immersion of oysters in deeper, cooler waters has been used to successfully prevent *V. parahaemolyticus* related illness from oysters in Alaska. Washington Department of Health (WDOH) is currently testing its potential in collaboration with a local South Puget Sound producer. These proposed experiments will collaborate with that same producer, and with another producer, also located in a growing area with historically high levels of *V. parahaemolyticus*.

The current management of *V. parahaemolyticus* in shellfish focuses on two primary tactics: (1) closure of growing areas for harvest when contaminated shellfish are found and when environmental factors indicate high risk of further contamination, and 2) restriction of post-harvest times to refrigeration. Most other measures tend to alter the freshness of the product, have uncertain efficacy, and increase the cost to the processor and consumer. PSI and others have investigated a few alternative tactics that showed promise but were inconclusive due to low levels of naturally occurring *V. parahaemolyticus* which limited experimental treatment, and problems with the analytical technique used to quantify *V. parahaemolyticus*. The relay of oysters to waters with lower ambient *V. parahaemolyticus* levels and/or different temperature and salinity conditions was particularly encouraging. The focus of the proposals outlined here, to ISSC, center on the relay of oysters from intertidal culture to: 1) recirculating tanks with deepwater; and (2) sink floats with deeper water.

PSI staff is familiar with the particular challenge of studying *Vibrio* in the field (e.g., identification of appropriate study sites, specialized sample collection and transport needs to avoid cross contamination, etc.). Furthermore, we have a long-standing relationship with the West Coast shellfish aquaculture industry, including Pacific Coast Shellfish Growers Association (PCSGA) members and staff. Recent and proposed PSI research features strong collaboration with both shellfish farmers and regulatory agencies, including the WDOH and FDA. If selected through this 2014 ISSC RFP, PSI would collaborate closely with these entities to complete the proposed research.

2. Approach and Methodology

The proposed research is a collaborative effort to address the project objectives in one year. The research has two primary integrated task elements which assess the potential of alternative post-harvest tactics to suppress the development of *V. parahaemolyticus* in oysters. Ancillary assessments will address some current practices associated with the monitoring of *V. parahaemolyticus* in oysters.

All experiments will depend upon the presence of naturally occurring *V. parahaemolyticus*, so field trials will target sample sites identified as having elevated *V. parahaemolyticus* levels during routine WDOH monitoring. These will likely be the same as those used in previous studies, which consistently exhibit high levels of *V. parahaemolyticus* during the summer months (Figure 1).

All samples will comprise 13 representative oysters taken from the same tidal elevation and the same general area at each study area. Nine oysters will be assayed for *V. parahaemolyticus*, 3 will be reserved for measurement of internal temperatures, accidental loss, and laboratory error, and 1 oyster will be delivered to WDOH for validation of assay results by their laboratory. Oysters will be in the shell with no gapers or broken shells. Oysters will be rinsed with fresh or sea-water to remove sediment, and then be placed in waterproof plastic bags and held on ice or in refrigeration prior to shipment for assay. Holding and shipping conditions and procedures will be the same as those used by WDOH,

except in the ancillary studies which directly assess those procedures.

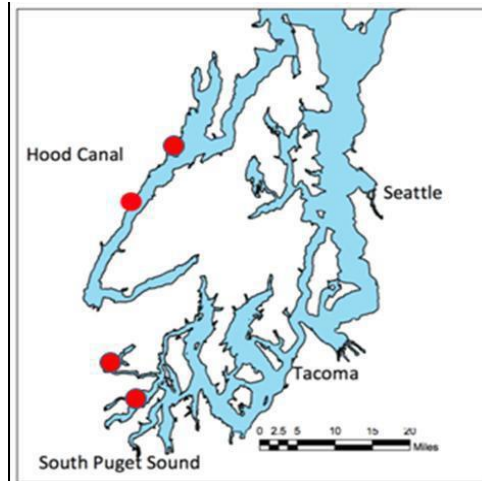


Figure 1 Likely locations of study sites.

Samples will be analyzed by the Environmental Engineering Laboratory (EEL), part of the Institute of Environmental Health (IEH), (IEHEEL) in San Diego, and by WDOH for quantitative PCR to gather MPN/g of *V. parahaemolyticus*. The laboratories feature high throughput realtime PCR protocol to quantify *V. parahaemolyticus* (*V.p.*), thermolabile hemolysin (tlh+), and thermostable-direct hemolysin positive (tdh+) *V.p.* This assay provides quantitative results for both *V.p.* and tdh+ *V.p.* in as little as 24 hours. The protocol will be similar to the multiplexed real-time PCR TaqMan fluorescent probe assay described in Ward and Bej (2006). Shipping methods will be the same as the WDOH methods using Styrofoam shipping boxes and gel packs for refrigeration, except when those methods are compared with alternative tactics.

Transfer Permits will be acquired from the Washington Department of Fish and Wildlife in association with the transport of oysters among areas.

Task 1. Compare levels of *V. parahaemolyticus* clearance in oysters from areas with consistently high levels of *V. parahaemolyticus* after holding in deepwater intake for various time intervals.

We propose to augment Kurt Johnson's preliminary studies in collaboration with Mr. Johnson and Taylor Shellfish. Three separate studies will be conducted in succession:

- Purging will be reduced from 24, 48, and 72 hrs to 12, 24, and 36 hrs (untreated oysters from time 0 will also be assayed for levels of *V. parahaemolyticus*).
- Temperature of the deepwater will be elevated by 5°C to test purging in oysters from especially warm beaches.
- A third test will be conducted to further refine or more precisely test the result of either of the first two tests.

For each experiment, oysters removed from the deepwater treatment will be immediately placed in ice-slurry for ½ hr prior to packing with gel ice pack and shipped with over-night delivery to the laboratory for analysis, in keeping with Mr. Johnson's previous protocols.

The internal temperatures of an ancillary replicate sample of oysters will be measured prior to ice-slurry and shipment.

Task 2. Compare levels of *V. parahaemolyticus* clearance in oysters from areas with consistently high levels of *V. parahaemolyticus* to oysters resubmerged in nearby deeper cooler waters using sink floats.

This technique has been used to successfully prevent *V. parahaemolyticus* illness from oysters in Alaska and WDOH is currently testing its potential in collaboration with a local South Puget Sound producer. These proposed experiments will collaborate with that same producer, and with another producer, also located in a growing area with historically high levels of *V. parahaemolyticus*.

The experiment will be conducted at each study site, beginning when numbers of total *Vibrio* and *tlh+* numbers are elevated, as determined in consultation with WDOH. For each experiment, 3 replicate samples of oysters will be collected at the experiment's onset and shipped immediately to the laboratory for quantitative assay of *V. parahaemolyticus*. The internal temperatures of 3 ancillary replicate samples will also be measured and tissue will be sampled at the experiment's onset. An additional 12 replicate samples will be placed in a sink float located in deeper, cooler water. Three samples will be removed and shipped for assay at 1, 3, and 7 days post the initial submergence. The internal temperatures will be measured and tissue will be sampled for each of the 3 remaining replicate samples at each sample interval.

Additional observations will comprise:

- During immersion sampling, water temperature will be recorded with temperature loggers. Salinity and dissolved oxygen will also be measured on site to duplicate WDOH protocols. In-water elements will also be measured off-site to provide ancillary information.
- Internal oyster temperatures will be taken along with tissue samples by opening a market sized oyster, pushing the thermometer into the meat as far as the dimple (or 1 inch), and measuring the temperature. This oyster will not be a part of the tissue sample.

Results will be compared among immersion interval and repetition using analysis of variance. Trends among the variables will also be examined visually.

Ancillary assessments

Compare levels of *V. parahaemolyticus* in oysters placed in ice-slurry prior to shipment with ice-gel packs to shipment no ice-slurry treatment and shipment with ice-gel packs only.

Additional pre-treatment samples from the sink-float studies will be assayed for levels of *V. parahaemolyticus* after shipment to the laboratory in California using Mr. Johnson's ice-slurry pre-shipment protocol or WDOH protocol featuring ice-gel packs only. In anticipation of high variability among replicates and low difference between shipment methods, 9 replicate samples per method will be assayed rather than 3.

Validation of California EEL laboratory results with results from WDOH laboratory.

As previously noted, an additional sample at each of the sample interval for both tasks 1 and 2 will be shipped or hand-delivered to WDOH for comparative analysis and validation with their laboratory.

If possible, apply field data to assess key environmental parameters for correlations and interactions with *V. parahaemolyticus* growth and clearance to potentially better predict and manage elevated levels in oysters.

In previous studies, samples collected from areas in Hood Canal, Washington consistently had higher levels of *V. parahaemolyticus* in oysters and sediments compared to samples collected from sites in the southern main basin of Puget Sound, Washington. Water salinity and temperatures are often very similar at these two areas, but Hood Canal is known to differ from the rest of Puget Sound in terms of dissolved oxygen levels, types and abundances of phytoplankton, and the dynamics of water circulation. Further investigation of the oceanographic and biological conditions associated with *V. parahaemolyticus* during the summer season would be of great value in developing tools to predict levels of *V. parahaemolyticus* and areas at risk in Hood Canal and elsewhere.

PSI currently has a moderate data base of the key environmental factors and associated levels of *V. parahaemolyticus* in oysters at the same site and time. Though the proposed studies are small in scale and sample size, they are better replicated than previously, and would augment that base.

Data from all PSI and potentially WDOH studies will be analyzed using correlation analysis, trend and analysis, and potentially multivariate analysis.

3. Project Deliverables

Results of the research outlined above would provide shellfish growers and harvesters across the country with two proactive post-harvest management practices to reduce and/or minimize the risk of *V. parahaemolyticus* derived food poisoning in raw and under-cooked shellfish.

Specific deliverables would be recommendations toward the feasibility of submerging oysters with high levels of using *V. parahaemolyticus* in 1) recirculating deepwater and 2) deeper cooler water using sink floats. These tactics would allow oysters to purge and depurate *V. parahaemolyticus*. For each tactic, recommendations will include optimal post-harvest holding temperatures and duration for effective *Vibrio* reduction. In addition to ongoing discussions with research collaborators (Taylor Shellfish and WDOH), recommendations will be detailed in a final report to ISSC. The final report will summarize the scope, approach, results, statistical analysis of results, and recommendations stemming from this research.

Adoption of these post-harvest management practices would improve harvest predictability during periods of potential *V. parahaemolyticus* contamination in shellfish, increase consumer confidence in the safety of the products, reduce or minimize the *V. parahaemolyticus* related closures, recalls, and associated economic losses.

The proposal outlined above would also complement other *Vibrio* research on shellfish. It would contribute to the cooperative relationships between local, state and federal regulatory agencies, tribes, academic institutions, shellfish growers and scientific consultants distributed along the entire West Coast. Findings would also assist ISSC and public health regulators in providing valuable feedback to the FDA regarding the *V. parahaemolyticus* risk assessment.

4. Project Management Approach

PSI will collaborate closely with Taylor Shellfish and WDOH to establish the location and specifics of the study design outlined in section 2 “Approach and Methodology” above. However, project oversight will be the responsibility of PSI, including financial management. Roles of specific PSI staff will be as follows:

As Executive Director, Bobbi Hudson will be responsible for the organization and management of this grant within PSI. She will actively supervise all PSI staff and subcontractors supported by this grant and conducting the research. Ms. Hudson will also be actively involved in all aspects of the research and the production of the final report to ISSC. She will also be responsible for submitting all necessary financial data and information to fulfill project deliverables and reporting requirements. Ms. Hudson will be actively involved in outcome dissemination and communication of this project.

Dr. Cheney will be responsible for final experimental design, data interpretation and contribute to the final report to ISSC.

Dr. Steven Booth will be responsible for experimental design, product procurement, data acquisition, data evaluation, data interpretation and contribute to the final report to ISSC. He will also be actively involved in analysis and reporting and outcome dissemination.

Andy Suhrbier will be responsible for conducting studies, especially sample procurement and data acquisition. He will be involved with finalizing experimental design and collecting

information and data for all activities for this grant. He will be responsible for data evaluation and interpretation with the consulting help of Drs. Cheney and Booth. He will also be actively involved in collaboration with Taylor Shellfish, other shellfish aquaculture farms, WDOH, and the outcome dissemination and communication of this project.

5. Detailed and Itemized Pricing

The research outlined above is detailed by major task below. Laboratory and shipping costs for individual experiments are separated to allow comparison. *PSI encourages ISSC to consider partial funding of this proposal if 100% funding is not available, and/or a portion of this proposal is not of significant interest to ISSC.*

Task 1.

Deep Water: Testing to see timing of depuration of Hood Canal Oysters in 100ft intake water.

Samples:	36 samples in 3 experiments (deepwater, elevated water, best one) 12 Samples each experiment (3 samples at 0, 12, 24 and Overnight shipping (including boxes and ice):	
Sample Analysis:	\$168	40
# samples	36	36
Total:	\$6,048	\$ 1,440
Experimental Total:		\$ 7,488

Ancillary comparison of ice-slurry to normal gel-pack shipping

Sample Analysis:	\$168	40
ice-slurry # samples	6	6
gel-pack only # samples	9	9
Total:	\$ 2,520	\$600
Experiment Total:		\$3,120

Task 2.

Sink Float: Testing to see timing of depuration of South Puget Sound Oysters in sink floats.

Samples:	24 samples (12 Samples at each site.) 3 samples at 0, 1, 3 and 7 days. Overnight shipping (including boxes and ice):	
Sample Analysis:	\$168	40
# samples	24	24
Total:	\$4,032	\$960
Experiment		\$4,992

Budget for PSI staff time and expenses:

Personnel	Amt. of effort			
Executive Director	25%	1.50	months	\$2,065
Research Director	25%	1.00	months	\$1,997
Senior Scientist	25%	1.50	months	\$2,408
Senior Biologist	25%	2.00	months	\$2,700
Total Salaries and Wages				\$9,169
Direct Staff Benefits (35%)				\$3,209
<hr/>				
Total Personnel Costs				\$12,379

Travel

Domestic Travel

Auto travel (\$0.56/mile)	\$952
Other travel (meals & incidental reimbursement)	\$180 Total
<hr/>	
Travel	\$1,132

As detailed above, the total budget for Task 1, Task 2 and ancillary studies is \$29,111. No overhead or indirect fees are included. Matching funds of at least 1:2 can be documented through in-kind and direct expenses associated with Task 1 and Task 2, but exact amounts will depend on which tasks and/or ancillary studies ISSC encourages. Collaboration with WDOH, Taylor Shellfish and two additional shellfish aquaculture farms will be the source of matching funds. If allowable, PSI can also demonstrate matching funds through circumvented indirect costs (PSI's currently approved indirect rate with the Department of Commerce is 46.22%).

Citations:

Ward, L. N. and A. K. Bej (2006). "Detection of *Vibrio parahaemolyticus* in shellfish by use of multiplexed real-time PCR with TaqMan fluorescent probes." Applied and Environmental Microbiology **72**(3): 2031-2042.

Appendix A: References

PSI has conducted numerous grant-funded *Vibrio* studies for the NOAA Saltonstall-Kennedy grant program and the NOAA/National Sea Grant Aquaculture Research Program. Current grant program administrators are:

Dr. Gene Kim

NOAA National Sea Grant Program Director for Aquaculture

(301) 734-1281

gene.kim@noaa.gov

Penelope D. Dalton, M.S.

Washington Sea Grant Director

(206) 685-9215

pdalton@u.washington.edu

All recent PSI studies focused on *Vibrio parahaemolyticus* have included substantial collaboration with the Washington Department of Health, Office of Shellfish and Water Protection, Division of Environmental Public Health. Numerous staff within the division can speak to PSI's research capabilities and *Vibrio* knowledge, but the main point of contact is:

Jerrod Davis, P.E.

Office of Shellfish and Water Protection Director

Washington State Department of Health

(360) 236-3391

Jerrod.Davis@DOH.WA.GOV

Appendix B: Project Team Staffing

Project staff will include executive director Bobbi Hudson, senior scientists Dr. Daniel Cheney and Dr. Steven Booth, and senior biologist Andrew Suhrbier. All staff is familiar with the particular challenge of studying *Vibrio* in the field, including identification of appropriate study sites, specialized sample collection and transport needs to avoid cross contamination. PSI staff will also work closely with Kurt Johnson at Taylor Shellfish, and Washington Department of Health staff, including Laura Wigand. Recent and currently proposed PSI research features strong collaboration with both shellfish farmers and regulatory agencies, and this project would continue PSI's well-established reputation in this regard.

All PSI project staff is hourly or salaried regular employees of PSI. PSI carries a \$2,000,000 business liability insurance policy and a \$1,000,000 Directors and Officers (D&O) insurance policy. No current PSI employees have ever been convicted of a felony.

Biographies follow for the following PSI staff that will contribute to this project:

- a. Bobbi Hudson, MSc, *Executive Director*
- b. Daniel Cheney, PhD, *Research Director*
- c. Steven Booth, PhD, *Senior Scientist*
- d. Andrew Suhrbier, BSc, *Senior Biologist*

Pacific Shellfish Institute

120 State Ave NE #1056, Olympia, WA 98501

Tel: (360) 754-1359; Cell: (360) 490-6910

Email: bobbi@pacshell.org

PROFESSIONAL QUALIFICATIONS

M.S., Evergreen State College – Environmental Science -- 2005

B.S., Evergreen State College – Environmental Science, Fisheries -- 2001

DISSERTATIONS

MS thesis: *Environmental, economic & policy considerations of the net-pen salmon farming industry in Washington State*

PROFESSIONAL COLLABORATIONS

Thom Allen, Alexis Bond, Steven Booth, Susan Burke, Daniel Cheney, Aimee Christy, Leah Cuyno, Jonathan Davis, Ralph Elston, Joao Ferreira, Caroline Friedman, Julie Hampden, Molly Jackson, Teri King, Brian Kingzett, Leah Kuehl, David Landkamer, Mary Middleton, Danna Moore, Betsy Peabody, David Preikshot, Kristin Rasmussen, William Schenken, Sue Shotwell, peter Steinberg, Andrew Suhrbier, Brent Vadopalas, Katherine Wellman

PROFESSIONAL AFFILIATIONS

Member, National Shellfisheries Association

RELAVENT EXPERIENCE

Executive Director, Pacific Shellfish Institute, Olympia, Washington, July 2013 – Present

The Pacific Shellfish Institute (PSI) is a non-profit research organization originally created by the Pacific coast commercial shellfish industry in 1995. PSI retains a diverse portfolio of biological, oceanographic and social science research projects. Routine tasks of the executive director include grant and technical writing, research design and execution, presentations, public outreach, response to public, government and media inquiries and overall management of the organization. Bobbi's primary research interests include valuation of ecosystem services, economic impacts of shellfish cultivation, social and ecological carrying capacity, and intertidal ecology. Bobbi also specializes in evaluation of sustainable bivalve aquaculture production in near shore environments.

Research Biologist, Pacific Shellfish Institute, Olympia, Washington, Nov. 2006 – June 2013

Conducted research, project management, and technical writing. Contributed to applied research projects on the interactions of shellfish culture with the natural environment, organic pollutants, and disease and environmental stress. Directed a multi-faceted project evaluating the benefits and costs of shellfish in Washington State, and a survey-based study of the economic contributions of the West Coast shellfish industry. Served as an inspector for sustainable shellfish product certifications.

Public Information Officer, Wash. Dept. Retirement Systems, Olympia, WA, Feb. 2002 – Dec. 2005 Produced a wide variety of print and web-based communications for agency staff, retirees, public officials and the Governor. Communications lead to implement new legislation.

Biological Science Technician, U.S. Fish and Wildlife Service, Flagstaff, AZ, Oct. 1998 – Sept. 2000 Conducted fisheries research in remote areas of Grand Canyon National Park and adjacent tribal lands. Prepared reports and delivered presentations about research and analysis at regional meetings. Extensive research, writing and editing of technical reports, some published. Trained other personnel in fish species identification, PIT tagging ESA species, and habitat classification.

SELECTED PUBLICATIONS & REPORTS

Wellman, K.F., **Hudson, B.M.**, Schenken, W.S., Bond, A. and L. Cuyno. *In prep.* The Economic Impact of Shellfish Aquaculture in Washington State.

Hudson, B., Christy, A., and A. Suhrbier. 2014. Nutrient bio extraction using wild set of blue mussel (*Mytella trossulus*) in Budd Inlet, Southern Puget Sound, Washington State. *Abstracts*: 106th Annual Meeting, National Shellfish Association, Jacksonville, FL. (abstract).

Davis, J., Vadopalas, B., Suhrbier, A., Cheney, D., Middleton, M., **Hudson, B.**, Rasmussen, K., Kuehl, L. and C. Friedman. 2012. Growth and Maturation in Triploid Pacific Geoducks (*Panopea generosa*) in Puget Sound, Washington. *Abstracts* World Aquaculture Society (WAS)/National Shellfisheries Association (NSA)/American Fisheries Society (AFS) Finfish Section meeting, Nashville, Tennessee, February 21-25, 2013. (abstract).

Hudson, B. and K. Wellman. 2012. Economic impact of West Coast shellfish aquaculture. *Abstracts*: 104th Annual Meeting, National Shellfish Association, Seattle, WA. (abstract).

Davis, J., Vadopalas, B., Jackson, M., Suhrbier, A., Cheney, D., Middleton, M., **Hudson, B.**, Rasmussen, K., Kuehl, L. and C. Friedman. 2013. Performance of Triploid Geoducks. *Abstracts*: 104th Annual Meeting, National Shellfish Association, Seattle, WA. (abstract).

Hudson, B. 2011. Washington State Shellfish Production and Restoration - Environmental and Economic Benefits and Costs. National Sea Grant Final Report for NA08OAR4170822.

Gorman, O., R. Bramblett, **B. Herwin (Hudson)**, D. Van Haverbeke, and D. Stone. 2005. Distribution and abundance of native and non-native fishes of the Colorado River ecosystem in Grand Canyon, Arizona, p. 78–94. In: M. Brouder, C. Springer, and S. Leon (eds.). The lower Colorado River: restoring natural function and native fish within a modified riverine environment; proceedings of July 8–9, 1998 and July 13–14, 1999 symposia in Las Vegas. U.S. Fish and Wildlife Service, Albuquerque, NM. 188 p.

SELECTED PRESENTATIONS

What's All the Fuss About? Gauging Public Perceptions of Shellfish Farming. Washington Sea Grant 21st Conference for Shellfish Growers. Union, Washington, March 3-4, 2014.

Engaging and Communicating with the Public: A Review of Creative Seafood and Fisheries-Related Outreach Tools, Technologies and Activities. Pacific Coast Shellfish Growers Association (PCSGA)/National Shellfisheries Association (NSA)-Pacific Coast Section 67th Annual Shellfish Growers Conference. Sunriver, Oregon, October 1-3, 2013.

Economic Impact of West Coast Shellfish Aquaculture. National Working Waterfronts & Waterways Symposium. Tacoma, Washington, March 25-28, 2013.

Money & Jobs: The Economic Impact of Shellfish Aquaculture in WA, OR & CA. Pacific Coast Shellfish Growers Association (PCSGA)/National Shellfisheries Association (NSA)-Pacific Coast Section 66th Annual Shellfish Growers Conference. Tulalip, Washington, September 24-27, 2012.

Environmental, Economic & Social Benefits of Washington State Shellfish Production. World Aquaculture Society (WAS)/National Shellfisheries Association (NSA)/American Fisheries Society (AFS) Finfish Section meeting, San Diego, California, March 1-5, 2010.

Hudson, B., Cheney, D., Wellman, K., Davis, J., Peabody, B., Steinberg, P., Hampden, D., and S. Burke. 2010. Environmental, Economic & Social Benefits of Washington State Shellfish Production. World Aquaculture Society (WAS)/National Shellfisheries Association (NSA)/American Fisheries Society (AFS) Finfish Section meeting, San Diego, California, March 1-5, 2010 (poster).

Biographical Sketch Daniel P. Cheney

Pacific Shellfish Institute

120 State Ave NE #1056, Olympia, WA 98501
Tel: (360) 754-2741; Fax: (360) 754-2246; Cell: (360) 791-2796
Email: cheney@pacshell.org

PROFESSIONAL QUALIFICATIONS

Ph.D., University of Washington -- Fisheries, Physiology --
1975 M.S., University of Hawaii -- Zoology, Biochemistry -
- 1967
B.S., University of Washington -- Fisheries, Mathematics --
1964 Postdoctoral, Vanderbilt University – Zoology – 1973

PROFESSIONAL COLLABORATIONS

Peter Becker, Steve Booth, Aimee Christy, Jeffery Cordell, Jonathon Davis, William Dewey,
Brett Dumbauld, Ralph Elston, Dennis Hedgecock, Bobbi Hudson, Joao Ferreira, Carolyn
Freidman, Adam James, Kurt Johnson, Gordon King, Chris Langdon, Jeff Layton, David
Preikshot, Andrew Suhrbier, Brent Vadopalas

PROFESSIONAL AFFILIATIONS

Member, World Aquaculture Society
Member, past member-at-Large and section Chairman, National Shellfisheries Association

RELAVENT EXPERIENCE

Senior Scientist, 2009 – Present; Executive Director, 1996 – 2009. Pacific Shellfish Institute (PSI).
PSI is a non-profit research and public education organization originally created by the Pacific coast commercial shellfish industry. Dan is PSI's project developer, principal investigator and research scientist for regional and federally funded applied research to: 1) examine the environmental and economic interactions of shellfish production practices; 2) develop new species and production methods; 3) explore methods to control *Vibrio* bacteria contamination and reduce the public health risk of raw shellfish; 4) assess pollutants in west coast shellfish and human health risks; 5) examine harvest and production methods to improve shellfish quality; 6) and other related shellfish studies. His associated activities include management of collaborative research teams from regional and national research organizations, presentations of project results at national and international conferences and workshops, and communications with members of the shellfish industry, and the regulatory and research communities. Dan is a board member of the University of Washington Center for Urban Waters, a water quality research and education center based in Tacoma, Washington. He is also a co-owner and board member of Baycenter Farms, an oyster and clam production and processing company based in Willapa Bay, southwest Washington State.

Program Director, 1993 – 1996.

Provided management and technical support for USAID and Asian Development Bank (ADB) funded projects in the south Pacific dealing with development of tuna and bottom fish resources (Tonga and Tuvalu) and a cultured black pearl industry (Cook Islands).

SELECTED PUBLICATIONS

- Cheney, D.P. 2010. *Bivalve shellfish quality: From the hatchery to the consumer*. Journal of the World Aquaculture Society. 41(2):192-206.
- Cheney, D.P., Langan, R., Heasman, K., Friedman, B., and Davis, J. 2010. *Shellfish and shellfish culture in the open ocean: The shellfish farming industry, lessons learned for offshore expansion*. Marine Technology Society Journal. 44(3):55-67.
- Cheney, D.P., Davis, J., Ferreira, J., King, T., Preikshot, D., Roberts, and M. Bricker. 2012-2014. *Planning for sustainable shellfish aquaculture in complex multiple use environments: Determining social and ecological carrying capacity for south Puget Sound, Washington*. NOAA Sea Grant Aquaculture Research Program; progress reports.
- Cheney, D.P., Dewey, B., Davis, J., Cordell, and J. Ferreira. 2010-2013. *Evaluation and development of advanced farm management and harvesting tools for economically efficient and environmentally sustainable production of Manila clams*. NOAA, Saltonstall-Kennedy Program, Silver Spring, MD; progress reports.
- Chae, M. J., D. Cheney, et al. 2009. *Temperature effects on the depuration of Vibrio parahaemolyticus and Vibrio vulnificus from the American Oyster (crassostrea virginica)*. Journal Of Food Science 74(2): M62-M66.
- Cheney, D.P. and C. Friedman. 2009-2013. *Harvest management tools to control the levels of vibrio parahaemolyticus in oysters and other bivalve shellfish*. NOAA, Saltonstall-Kennedy Program, Silver Spring, MD; progress reports.
- Cheney, D.P., Davis, J. and B. Vadopalas. 2009-2013. *Biosecure domestication of native geoduck clams*. NOAA, Saltonstall-Kennedy Program, Silver Spring, MD; progress and completion reports.
- Burge, C.A., Judah, L.R., Conquest, L.L., Griffin, F.J., Cheney, D.P., Suhrbier, A., Vadopalas, B., Olin, P.G., Renault, T. and C.S. Friedman. 2007. *Summer seed mortality of the pacific oyster, Crassostrea gigas Thunberg grown in Tomales Bay, California, USA: the influence of oyster stock, planting time, pathogens, and environmental stressors*. Journal of Shellfish Research 26(1):163-172.
- Cheney, D.P., Davis, J., Luckenback, M., Newell, C., Richardson, J. Getchis, T., Dumbauld, B. and S. Nelson. 2006-10. *The environmental effects of alternative shellfish culture methods*. NOAA, National Aquaculture Research Initiative, Silver Spring, MD; progress and completion reports.
- Cheney, D.P., Davis, J., Luckenback, M., Newell, C., Richardson, J., Getchis, T. and D. Angel. 2003-05. *Environmental effects of marine shellfish aquaculture on benthic fauna and water column characteristics in the northwest and east coasts of the U.S.* NOAA, National Aquaculture Research Initiative, Silver Spring, MD; progress and completion reports.
- Cheney, D.P., Macdonald, B.F. and R. A. Elston. 2000. *Summer mortality of Pacific oysters, Crassostrea gigas (Thunberg): Initial findings on multiple environmental stressors in*

- Puget Sound, Washington, 1998.*** Journal-of-Shellfish-Research 19(1): 353-359.
- Cheney, D.P., Suhrbier, A.D., Christy, A.E., Beltran, H.S., Davis, J.P., Brooks, K.M. and F.J. Smith. 2003. ***Mussel growth and food utilization in relation to water column conditions on raft systems in Puget Sound, Washington.*** Journal of Shellfish Research 22:324 / NOAA, National Aquaculture Research Initiative, Silver Spring, MD; completion reports.
- Cheney, D.P. and T. Mumford. 1986. ***Commercial harvest and culture of shellfish and seaweeds in Puget Sound.*** University of Washington Press, Seattle. 160 p.
- Saurel, C., Ferreira, J., Cheney, D., Suhrbier, A., Dewey, B., Davis, Jonathan, and J. Cordell. Submitted. ***Ecosystem goods and services from Manila clam culture in Puget Sound—a modelling analysis.*** Aquaculture – Environment Interactions.
- Suhrbier, A.D., Cheney, D.P., Middleton, M.E., Booth, S.R., and J.P. Davis. Submitted. ***Examination of farmed geoduck (Panopea generosa gould, 1850) predator protection efficacy and environmental effects.*** Journal-of-Shellfish-Research.
- Christy, A.E., Cheney, D.P. and I. Stupakoff. 2011. ***Cadmium in Pacific oysters (Crassostrea gigas): A survey of the United States West Coast and Mitigation Strategies.*** World Aquaculture Magazine. 42(1):52-57.
- Dewey, W., Davis, J.P. and D.P. Cheney. 2011. ***Shellfish aquaculture and the environment: an industry perspective,*** pp. 33-50. In: Shellfish aquaculture and the environment. Shumway, ed. Wiley-Blackwell. 507 p.
- Dumbauld, B.R., Booth, S.R, Cheney, D.P., Suhrbier, A and H. Beltran. 2006. ***An integrated pest management program for burrowing shrimp control in oyster aquaculture.*** Aquaculture. 261(3): 976-992.
- Elston, R., Cheney, D., MacDonald, B. and A. Suhrbier. 2004. ***Tolerance and response of Manila clams, Venerupis philippinarum (A. Adams and Reeve, 1850) to low salinity.*** Journal-of-Shellfish-Research 22(3):667-674.
- Hamdoun A.M., Cheney, D.P. and G.N. Cherr. 2003. ***phenotypic plasticity of hsp70 and hsp70 gene expression in the pacific oyster (Crassostrea gigas): Implications for thermal limits and induction of thermal tolerance.*** Biol. Bull. 205:160-169.
- Elston, R.A. and D.P. Cheney. 2000. ***Shellfish high health program.*** Journal-of-Shellfish-Research 19(1): 688-689. Herwig, R.P., Estes, R.M., Messey, C.L., and D.P. Cheney. 2000. ***Distribution of Vibrio parahaemolyticus in Puget Sound oysters, water, and sediments during summer 1999.*** Journal-of-Shellfish-Research 19(1): 657.

Pacific Shellfish Institute

120 State Ave NE #1056, Olympia, WA 98501

Tel: (360) 754-1359; Cell: (360) 490-6910

Email: bobbi@pacshell.org

PROFESSIONAL QUALIFICATIONS

Ph.D., Oregon State University -- Entomology --

1992 M.S., Western Washington University --

Biology -- 1982 B.A., University of Iowa --

Zoology -- 1975

PROFESSIONAL COLLABORATIONS

Dr. Kim Patten, Dr. Chris Grue, Dr. Brett Dumbauld, Dr. Joth Davis, Kurt Johnson

PROFESSIONAL AFFILIATIONS

Member, National Shellfisheries Association

RELATED EXPERIENCE

Sr. Scientist, Pacific Shellfish Institute, Olympia, Washington, Fall 2007 – Present Collaborate with other scientists to study issues related to bivalve aquaculture. Developed experimental designs and protocols, executed them, analyzed results, and presented findings both orally and in writing to scientific and grower groups.

IPM Coordinator, Willapa Grays Harbor Oyster Growers Association, Summer 2001- February 2011. Coordinated activities among growers, investigators, and regulators to develop and implement an IPM plan for burrowing shrimp on commercial oyster beds. Primary and ghost author of several grants to fund research projects involving physical, cultural, and biological control alternatives to carbaryl application. Principal investigator of study of the impact of carbaryl on the benthic infauna and co-investigator of several other studies of alternative management tactics. Contributed to development of NPDES permit, NWP 48 Biological Assessment: Screening Level Risk Assessment to Threatened and Endangered Species from the Use of Carbaryl to Control Burrowing Shrimp in Washington State Shellfish Aquaculture, and furnished Commentary on Draft Biological Opinions Issued under the Endangered Species Act.

Consultant Entomologist / Research Scientist, Winter 2000 -2007. 1) In collaboration with Frem Biosciences, research and development of organic slug control materials. 2) Occasional consultant for Crop Health Advising & Research, Kelowna, B.C. regarding root weevil management strategies. 3) In 2003, I completed a study to "Define the status of the invasive crane fly, *Tipula oleracea* L., as a pest in Oregon and Washington: its biology, distribution, and management potential" funded by contracts with WSDA and ODA Nurserymen Associations. 4) Authored QAPP for Pacific Conservation District for "Grayland Cranberry Water Quality BMP Project" for submission to Wash. State Dept. of Ecology.

Research Associate & Consultant Spring, 1998-Winter 2000. Washington State University Long Beach Res. Unit & Pacific Coast Cranberry Research Foundation. Evaluated biorational insecticides and improved tactics to better manage insect pests of cranberry. Implemented “low-risk” insect IPM program via on-farm demonstration trials, grower workshops, and extension bulletins. Monitored seasonal and geographic distributions of recently introduced pests.

Research Associate Spring 1993-Spring 1998. Washington State University Vancouver Res. & Ext. Unit. Investigated non-chemical control strategies, especially microbials, to suppress subterranean insect pests of small fruits. Isolated indigenous strains of entomopathogenic fungi, compared their virulence in laboratory bioassays, and, in collaboration with colleagues at Oregon State University,

sequenced their genomes using PCR techniques. Developed a low-cost technology to produce, at moderate scales, a dried mycelium formulation of *Metarhizium anisopliae* and demonstrated its efficacy against black vine weevil and cranberry girdler. Investigated the mechanism of induced resistance to spider mites in raspberry and strawberry.

Postdoctoral Fellow Summer 1991-Spring 1993. Kelowna, B.C. British Columbia Fruit Growers Association. Investigated and implemented predator-compatible program to manage pear pests in the Okanagan Valley. Investigated “soft” insecticides, alternative ground covers or hedgerows, and other tactics to encourage indigenous natural enemy immigration to pear. Compared season-long alternative programs to standard programs among commercial blocks. Several field and laboratory trials focused on the predatory potential of the European earwig, *Forficula auricularia*, and the predaceous mirid, *Deraeocoris brevis*.

Research Cooperator Spring 1991. Oregon State University. Investigated potential of mating disruption/pheromone confusion for orange tortrix in Oregon caneberries. Conducted preliminary survey of predator and phytophagous mites on hops in the Willamette Valley, OR

Graduate Teaching Assistant 1990. Oregon State University, Corvallis, OR. IPM III.

Certification Inspector 1990-1991. Oregon Tilth. Inspected farms for compliance with standards of organic production and made recommendations to certification committee.

Graduate Research Assistant 1986-90. Oregon State University, MCAREC. Hood River, OR. To fulfill Ph.D. requirements, completed course work and conducted dissertation. Described the taxonomic composition of a complex of 43 arthropod natural enemies that colonize and suppress pear psylla in orchards of differing chemical regime, orchard structure, and vegetational setting.

Research Assistant 1983-1987. Oregon State University. Investigated the economic entomology of several orchard pests and beneficials. Conducted pesticide trials, monitored pheromone traps in whole of upper Willamette Valley, determined thresholds of pupal development for apple maggot and walnut husk fly, analyzed data, prepared graphs, and supervised several part-time employees.

Environmental Consultant 1982. Bellingham, WA. Assessed the suitability of ten small streams in the Nooksack Watershed for the establishment of small scale hydro-electric power plants. An index of food available to salmonid populations was calculated based on the abundance and composition of the benthic community at high and low elevations, early and late season, at mid-day and mid-night. Aquatic invertebrates were sampled by surber, kick, and drift-net. Salmonids were sampled by electroshock, and the stomach contents were frequently

examined.

Graduate Teaching Assistant 1980-1982. Western Washington University. General Entomology, Aquatic Entomology, Field Entomology, Alpine Limnology, Biological Kingdoms, Introductory Biology; 1991. Oregon State University. IPM III.

RELEVANT PUBLICATIONS AND REPORTS

Booth, S.R. 2012, revised 2014. Dichotomous Key and Illustrated Guide to the Pests of Bivalve Aquaculture in Washington and Oregon. Funded by Prime Award No. 2007-51120-03885, Subaward No.07-001492-WAS15 from the USDA National Institute for Food and Agriculture.

Booth, S.R. and K. Rasmussen. 2013. Impact of imidacloprid on epi-benthic and benthic invertebrates: 2011 studies to describe the Sediment Impact Zone (SIZ) related to imidacloprid treatments to manage burrowing shrimp. Submitted to WSU, Oct, 2013.

Booth, S.R. and K. Rasmussen. 2013. Impact of imidacloprid on epi-benthic and benthic invertebrates: 2012 studies to describe the Sediment Impact Zone (SIZ) related to imidacloprid treatments to manage burrowing shrimp. Submitted to WSU, May, 2013.

Booth, S.R. and D. Tufts. 2003 – 2010. Willapa Bay-Grays Harbor Oyster Growers Association Annual Operations Plan for Carbaryl-based Management of Burrowing Shrimp. Submitted to WDOE June 1 of every year.

Booth, S.R. and D. Tufts. 2002 – 2010. Willapa Bay-Grays Harbor Oyster Growers Association Annual Report for Burrowing Shrimp Management. Submitted to WDOE December 1 of every year.

Booth, S.R. 2007. An Updated Plan for Integrated Pest Management of Burrowing Shrimp on Commercial Shellfish Beds Submitted to: Washington Department of Ecology February 1, 2007. 34 pp.

CURRICULUM VITAE

Andrew D. Suhrbier

120 State Avenue NE #1056
Olympia, WA 98501
Tel: (360)754-2741; FAX: (360)754-2246; Cell: (360)280-1517
E-mail: suhrbier@pacshell.org

PROFESSIONAL QUALIFICATIONS

B.S. Texas Lutheran University, Seguin, Texas --Molecular Biology, 1996

PROFESSIONAL COLLABORATIONS

Alan Barton, Peter Becker, Jeffery Cordell, Jonathon Davis, William Dewey, Beniot Eudeline, Joao Ferreira, Burke Hales, Adam James, Kurt Johnson, Vassili Kalashnikov, Gordon King, Jan Newton, Kim Patton, Brent Vadopalas

PROFESSIONAL AFFILIATIONS

Member, National Shellfisheries Association

RELEVANT EXPERIENCE

Senior Biologist, Pacific Shellfish Institute, Olympia, WA; 2000 to present

Involved in PSI's marine benthic/water quality sampling and analysis, mapping of marine habitats, data analysis, project development and management. Current projects include the potential of polyculture systems; interactions of shellfish culture with the natural environment; the impact of organic pollutants, and bacterial contaminants on bivalve shellfish; efficiencies of production, and disease and environmental stress studies of shellfish. Interacts with shellfish producers regarding growing areas and methods in California, Oregon and Washington. Developed shellfish certification standards for the west coast shellfish industry for the certification entity: "The Food Alliance". Maintains a coast-wide water quality monitoring related to ocean acidification, part of Northwest Association of Networked Ocean Observing Systems (NANOOS). Charged with the maintenance, deployment, and retrieval of a Sontek current meter, ISCO water samplers, YSI multiparameter dataloggers, pCO₂ sensor package, Onset dataloggers, Honeywell meters and PSI developed dataloggers.

Experimental Biologist Aide, Oregon Department of Fish and Wildlife, Nehalem, OR, 1999
Conducted creel surveys of recreational salmon fishermen along the Nehalem river system.

Observer, Saltwater, National Marine Fisheries Service, Anchorage, AK, 1998-1999
Evaluated and enumerated the catch and by-catch of U.S. commercial pacific and black cod fishing vessels in the Bering Sea and Gulf of Alaska.

SELECTED PUBLICATIONS

Suhrbier, A. D., D.P. Cheney, M. E. Middleton, S. R. Booth, J. P. Davis. 2014. Examination of Farmed Geoduck (*Panopea Generosa* Gould, 1850) Predator Protection Efficacy and Environmental Effects, Journal of Shellfish Research, In press.

Cheney, D.P., Dewey, W.F., Suhrbier, A.D., Ferreira, J.G., Cordell, J.R., and J.P. Davis. 2012. Production and environmental effects of manila clam farming in North Puget Sound: Comparison of yields and responses of macrofauna to mechanical and hand harvest.

Abstracts: 104th Annual Meeting, National Shellfish Association, Seattle, WA. (abstract).

Suhrbier, A.D. 2012. Water quality monitoring at Washington State shellfish hatcheries and setting sites. *Abstracts:* 104th Annual Meeting, National Shellfish Association, Seattle, WA. (abstract).

SELECTED PRESENTATIONS

Vibrio Relay Update. PSCGA/NSA Annual Meeting. Bend, OR. October 2, 2013.

Cantwell Project Update: Water quality monitoring efforts at hatcheries and setting sites in Oregon and Washington (with Alan Barton, PCSGA). PSCGA/NSA Annual Meeting. Bend, OR. October 2, 2013.

Manila Clam Harvest Method Evaluation in Samish Bay, WA. PSCGA/NSA Annual Meeting. Tulalip, WA, September 26, 2012.

Appendix C: Pacific Shellfish Institute Company Overview

1. Name: Pacific Shellfish Institute
DUNS: 948618624
Address: 120 State Avenue NE #1056, Olympia, WA 98501
Telephone: (360) 754-2741
Fax: (360) 754-2246
E-mail: psi@pacshell.org



2. Key Contact: Bobbi Hudson, Executive Director
Address: 120 State Avenue NE #1056, Olympia, WA 98501
Telephone: (360) 754-2741
Fax: (360) 754-2246
E-mail: bobbi@pacshell.org

3. Authorized person: Same as Key Contact (above)

4. The Pacific Shellfish Institute (PSI) is a Section 501(c)(3) private nonprofit organization whose mission is: “*Sustainable shellfish resources and healthy marine environment through research and education.*” PSI formed in 1995 to develop and disseminate scientific and technical information of value to the general public, shellfish farmers, and public officials in connection with shellfish-related environmental and animal/human health and safety issues. Current PSI research encompasses a broad range of biological, ecological, chemical and social science. Highlighted projects include investigations into the ecological impacts of mechanical clam harvest, *Vibrio parahaemolyticus* reduction strategies, ecological carrying capacity modeling, ocean acidification impacts on shellfish seed rearing, nutrient bioextraction studies, clam population surveys, and water quality monitoring for siting of new shellfish aquaculture infrastructure.

PSI staff, including executive director Bobbi Hudson, senior scientists Dr. Daniel Cheney and Dr. Steven Booth, and senior biologist Andrew Suhrbier are familiar with the particular challenge of studying *Vibrio* in the field (e.g., identification of appropriate study sites, specialized sample collection and transport needs to avoid cross contamination, etc.). Furthermore, PSI has a long-standing relationship with the West Coast shellfish aquaculture industry, including Pacific Coast Shellfish Growers Association (PCSGA) members and staff. Recent and proposed PSI research features strong collaboration with both shellfish farmers and regulatory agencies, including the Washington Department of Health and FDA. If selected through this 2014 ISSC RFP, PSI would collaborate closely with these entities to complete proposed research.

5. PSI staff members and board of directors must abide by the established “Conflict of Interest Policy for the Pacific Shellfish Institute”, which specifically states:

“A conflict of interest is defined as an actual or perceived interest by a staff or Board member of the Pacific Shellfish Institute (PSI) in an action that results in, or has the appearance of resulting in, personal, organization, or professional gain. Officers and members are obligated to always act in the best interest of the organization. This obligation requires that any officer or member, in the performance of duties, seek only the furtherance of the organization’s mission. At all times, officers and Board members are prohibited from using their job title or the organization’s name or property, for private profit or benefit.”

Furthermore, the policy describes how conflicts of interest shall be resolved:

“When a conflict of interest is relevant to a matter requiring action by the Board, the interested person(s) shall call it to the attention of the Board and said person(s) shall not vote on the matter. In addition, the person(s) shall not participate in the final decision or related deliberation regarding the matter under consideration. When there is a doubt as to whether a conflict exists, the matter shall be resolved by vote of the Board, excluding the person(s) concerning whose situation the doubt has arisen. The official minutes of the Board shall reflect that the conflict of interest was disclosed and the interested person(s) did not participate in the final discussion and did not vote on the matter.”