

RESEARCH/PD ANNUAL REPORT - PROGRESS REPORT

2015 annual report - progress

Lorenz Hauser

A new native species for shellfish aquaculture and precautionary guidelines to protect wild populations: local adaptation, population differentiation and broodstock development in rock scallops

R/SFA/N-1

Submitted On: 04/29/2016 01:03:05 AM

METRICS & MEASURES

Metric/Measure	Value	Note
Acres of coastal habitat	0	
Fishermen and seafood industry personnel	0	
Communities - economic and environmental development	0	
Stakeholders - sustainable approaches	0	KL NOT COUNTING PSRF: construction, maintenance and oversight of shellfish quarantine facility Taylor Shellfish: scallop broodstock, larval and juvenile husbandry
Informal education programs	0	KL NOT DOUBLE-COUNTING BETWEEN REPORTS - Estimated number of visitors at our booth at the Discover Science Weekend, Seattle Aquarium, November 2015.(200) Bellingham Technical College Aquaculture Program: Scallop Grow-out Experiments (50 students) (NOT INFORMAL ED)
Stakeholders who receive information	130	Staff at Taylor Shellfish and the Puget Sound Restoration Fund Hatchery attended talks by Molly Jackson and Natalie Lowell. Both also gave talks at the 69th Annual Pacific Coast Shellfish Growers / National Shellfisheries Association Pacific Coast Section Conference and Tradeshow, which was attended by dozens of industry experts, hatchery managers and owners and scientists. Bellingham Technical College Aquaculture Program: Scallop Grow-out Experiments (50 students) MESA students (50)
Volunteer hours	0	KL NOT COUNTING - NOT VOLUNTEER HOURS SPENT ON PROJECT (OUTSIDE TIME SPENT BY PROJECT STAFF) Saturday Academy through Seattle MESA is a weekend enrichment program for students with backgrounds underrepresented in the STEM field. It focuses on hands-on learning in marine and food sciences. Natalie Lowell volunteers by facilitating learning in the classroom and on field trips about once a month through the academic year. Lorenz Hauser, Natalie Lowell, and Molly Jackson volunteered at the Seattle Aquarium's Discovery Science weekend by hosting an

		interpretive booth about fisheries genetics.
P-12 students reached	50	Natalie Lowell volunteers in the Marine Science and Food Science classes at Seattle MESA's Saturday Academy
P-12 educators	0	

REQUESTED INFORMATION

Publications

No **Publications** information reported

Students Supported

Molly Jackson (New Student)
mollyj@taylorshellfish.com
University of Washington, School of Aquatic and Fishery Sciences

Field of Study:

Advisor: Lorenz Hauser

Degree Type: MS

Degree Year: 2017

Student Project Title: Local adaptation in purple-hinged rock scallops from reciprocal transplant experiments

Involvement With Sea Grant This Period (capstone, fellow, intern, etc.): Matching RA

Post-Graduation Plans (employer, grad school, etc.): Broodstock hatchery manager at Taylor Shellfish

Was this thesis/dissertation supported by Sea Grant?: Yes

Thesis / Dissertation: Local adaptation in purple-hinged rock scallops from reciprocal transplant experiments

New or Continuing?: New

Degree awarded this reporting period?: No

Financially supported?: Yes

Natalie Lowell (New Student)
nclowell@uw.edu
University of Washington, School of Aquatic and Fishery Sciences

Field of Study:

Advisor:

Degree Type: PhD

Degree Year: 2019

Student Project Title: Genetic and environmental effects on the response to ocean acidification

Involvement With Sea Grant This Period (capstone, fellow, intern, etc.): PhD student

Post-Graduation Plans (employer, grad school, etc.):

Was this thesis/dissertation supported by Sea Grant?: Yes

Thesis / Dissertation: Genetic and environmental effects on the response to ocean acidification

New or Continuing?: New

Degree awarded this reporting period?: No

Financially supported?: Yes

Narratives

Scallop Year 1 Narrative

Uploaded File: [NOAA_rock_scallop_progress_report_v3.pdf](#)

Partners This Period

NOAA Manchester

Types: Government

Scale: FEDERAL or NATIONAL

Notes:

Puget Sound Restoration Fund

Types: NGO

Scale: REGIONAL

Notes:

Baywater Inc.

Types: Industry/Business

Scale: LOCAL

Notes:

Makah Nation

Types: Government

Scale: Tribal

Notes:

Taylor Shellfish

Types: Industry/Business

Scale: REGIONAL

Notes:

Wildcatch Seafood Products

Types: Industry/Business

Scale: REGIONAL

Notes:

Catalina Sea Ranch

Types: Industry/Business

Scale: FEDERAL or NATIONAL

Notes: Collection of CA scallops

Alutiq Pride Hatchery

Types: Industry/Business

Scale: FEDERAL or NATIONAL
Notes: Collection of AK scallops

Port Gamble S'Klallam Tribe
Types: Government
Scale: Tribal
Notes:

Jamestown S'Klallam Tribe
Types: Government
Scale: Tribal
Notes:

Suquamish Tribe
Types: Government
Scale: Tribal
Notes:

University of Washington
Types: Academic Institution
Scale: STATE
Notes: Steven Roberts

Bellingham Technical College
Types: Academic Institution
Scale: REGIONAL
Notes:

STANDARD QUESTIONS

Impacts and Accomplishments

(1)

Type	accomplishment
Title	Filling a gap: Washington Sea Grant researchers devise a lab system for testing acidification impacts on marine populations
Relevance	Local adaptation to ocean acidification (OA) is a major issue in fisheries and aquaculture. Population-specific responses can be addressed by exposing animals from different locales to the same conditions in common garden experiments. These experiments must be carried out in quarantine facilities to avoid spreading disease from imported animals. But there are no OA systems within quarantine facilities, hindering efforts to predict future responses as climate and carbon dioxide levels change.
Response	Washington Sea Grant supported-researchers worked with the Puget Sound Restoration Fund to develop an experimental system for measuring acidification effects on marine organisms and populations at NOAA's Ken Chew Center for Shellfish Research and Restoration quarantine

	facility in Manchester, Washington.
Results	The OA system was built and optimized. It performs well, allowing direct comparison of populations of a wide variety of organisms across their entire ranges.
Recap	Washington Sea Grant-supported researchers developed a system that can be used to compare responses to ocean acidification in different populations of a wide variety of marine organisms.
Comments	
Primary Focus Area	Sustainable Fisheries and Aquaculture
Secondary Focus Areas	Healthy Coastal Ecosystems
Goals	Ocean and coastal resources are managed using ecosystem-based approaches. Aquaculture operations and shellfish harvests are safe, environmentally sustainable and support economically prosperous businesses.
Partners	Alutiq Pride Shellfish Hatchery Baywater Inc. Bellingham Technical College Catalina Sea Ranch Makah Nation Northwest Fisheries Science Center, Manchester Research Station (DOC, NOAA, NMFS) Port Gamble S'Klallam Tribe Puget Sound Restoration Fund Suquamish Tribe Taylor Shellfish Company Wildcatch Seafood Products
PI Draft	* Type accomplishment * Title Development of an OA system within a quarantine facility * Relevance Adaptation to ocean acidification is a major issue in fisheries and aquaculture. Experimental systems to quantify adaptive population differentiation and organismal response do not exist, complicating prediction of future responses to climate change * Response Washington Sea Grant supported researchers developed an OA system within a quarantine facility allowing direct comparison of population across their entire range for a wide variety of organisms. * Results The OA system has been constructed and optimized and performs well. * Recap Washington Sea Grant supported researchers developed a system that can be used for population comparisons in ocean acidification response in a wide variety of organisms. Comments Primary Focus Area Sustainable Fisheries and Aquaculture Secondary Focus Areas Healthy Coastal Ecosystems, Ocean Literacy and Workforce Development Goals Aquaculture operations and shellfish harvests are safe, environmentally sustainable and support economically prosperous businesses., Seafood consumers understand the health benefits, safety and environmental sustainability of their seafood choices. Partners Puget Sound Restoration Fund NOAA Manchester lab Baywater Inc

Tools, Technologies, Information Services / Sea Grant Products**(1)**

Description	Ocean acidification research facility within a quarantine facility at the Kenneth K. Chew Center for Shellfish Research and Restoration Hatchery.
Developed (in the reporting period)?	Yes
Used (in the reporting period)?	Yes
Used for EBM?	No
ELWD product?	No
Number of managers	0
Description/Names of managers	

(2)

Description	Shellfish common garden experimental setup for rock scallop larvae.
Developed (in the reporting period)?	Yes
Used (in the reporting period)?	No
Used for EBM?	No
ELWD product?	No
Number of managers	0
Description/Names of managers	

(3)

Description	Protocol for scallop broodstock husbandry.
Developed (in the reporting period)?	Yes
Used (in the reporting period)?	Yes
Used for EBM?	No
ELWD product?	No
Number of managers	0
Description/Names of managers	

(4)

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Description	Culture system for rock scallop juveniles.
Developed (in the reporting period)?	Yes
Used (in the reporting period)?	Yes
Used for EBM?	No
ELWD product?	No
Number of managers	0
Description/Names of managers	

Economic Impacts

No **Economic Impacts** information reported

Community Hazard Resilience

No **Community Hazard Resilience** information reported

Meetings, Workshops, Presentations

(1)

Type of Event	Public or professional presentation
Description	Molly Jackson, Natalie Lowell, Brady Blake, Jonathan Davis, Brent Vadopalas, Lorenz Hauser. Investigating Local Adaptation in Washington State Purple Hinge Rock Scallops. 69th Annual Pacific Coast Shellfish Growers Association / National Shellfish Association Pacific Coast Section Conference & Tradeshow 2015. Hood River, Oregon
Event Date	09-24-2015
Number of Attendees	60

(2)

Type of Event	Public or professional presentation
Description	Molly Jackson, Jonathan Davis, Brent Vadopalas, Lorenz Hauser. The Commercial Potential of Rock Scallops. Taylor Shellfish Farm Managers Meeting 2016. Olympia, Washington
Event Date	01-28-2016
Number of Attendees	60

(3)

Type of Event	Public or professional presentation
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Description	Lowell N, Vadopalas B, Hauser L, Jackson M, Crim R, Davis J, Blake B (2015) Assessing population structure and local adaptation of rock scallops to inform aquaculture practice. 69th Annual Pacific Coast Shellfish Growers Association / National Shellfish Association Pacific Coast Section Conference & Tradeshow 2015. Hood River, Oregon
Event Date	09-24-2015
Number of Attendees	30

(4)

Type of Event	Public or professional presentation
Description	Davis J, Saska K (2015) Prospects for purple-hinge rock scallop cultivation on the US West Coast: Washington State studies on aquaculture potential. 69th Annual Pacific Coast Shellfish Growers Association / National Shellfish Association Pacific Coast Section Conference & Tradeshow 2015. Hood River, Oregon
Event Date	09-24-2015
Number of Attendees	30

Leveraged Funds

(1)

Purpose	Sentinels for maturation; development of husbandry techniques for broodstock, larvae and juveniles; development of culture techniques for growout.
Source	Western Regional Aquaculture Center
Amount	186667
Start Date	10-01-2014
End Date	01-31-2016

(2)

Purpose	A new native species for shellfish aquaculture and precautionary guidelines to protect wild populations: local adaptation, population differentiation and broodstock development in rock scallops - monitoring instrumentation for OA system
Source	NOAA Manchester lab
Amount	9000
Start Date	09-01-2015

End Date	04-28-2016
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(3)

Purpose	A new native species for shellfish aquaculture and precautionary guidelines to protect wild populations: local adaptation, population differentiation and broodstock development in rock scallops - supplies for quarantine facility
Source	School of Aquatic and Fishery Sciences
Amount	3000
Start Date	12-24-2015
End Date	01-13-2016

A new native species for shellfish aquaculture and precautionary guidelines to protect wild populations: local adaptation, population structure and broodstock development in rock scallops (*Crassadoma gigantea*)



Objective 1. Quantify genome wide molecular genetic differentiation among populations

Activities. Sample collection, DNA extraction.

Participants. Natalie Lowell, PhD student, Molly Jackson, MS student

Results. Live scallops were collected from three locations in Washington (Hood Canal, San Juans, Strait of Juan de Fuca) in a combined effort among project partners. In addition, samples from Alaska and California were sent by collaborators (Table 1). Tissue samples were collected from most individuals held at Taylor Shellfish – the others were not sampled to avoid stimulating premature spawning. DNA was extracted from most tissue samples with a specific mollusk DNA extraction kit (Omega). DNA was of high quality and could easily be PCR-amplified using universal primers, demonstrating its suitability for RAD sequencing.

Table 1: Collections of scallop as broodstock and for tissues. Scallop numbers collected and currently available, as well as the number of tissues and number of individuals DNA extracted are shown. The first three sites are in Washington State, and will be used for the Taylor Shellfish (TS) reciprocal transplant experiment. The last four sites (two WA, one AK, one CA) will be used for the common garden experiment at PSRF. Two shipments of California scallops were received because of high mortality in the first shipment

Collection Site	Date Collected	Collection Partners	Number Collected	Date transferred to PSRF	Current #	Tissue #	DNA #	Current Location
San Juan Islands (Burrows Channel and Cypress Island)	2/2/15 & 2/3/15	PSRF, Taylor Shellfish	54		48	49	34	TS
Strait of Juan de Fuca (Seiku)	2/10/2015	Jamestown S'Klallam, PSRF	71		30	30	30	TS
				6/25/15	31			PSRF
Hood Canal (Pulali Point)	2/3/15 & 2/13/15	Taylor Shellfish, Port Gamble S'Klallam	57		32	32	32	TS
				6/25/15 7/20/15	24			PSRF
Catalina Island, California	?	Kelly Stromberg, Catalina Sea Ranch	73 (47 + 26)	6/18/15 11/18/15	26	19		PSRF
Ketchikan, Alaska	?	Jeff Hetrick, Alutiiq Pride Shellfish Hatchery	27	6/29/15	13	9		PSRF

Challenges. We have not yet sampled all individuals because the stimulation can cause premature spawning. Dying scallops were often not sampled because of rapid tissue deterioration. Final sample sizes may therefore be smaller than indicated in Table 1. RAD sequencing was delayed because effort was concentrated on preparing facilities for objective 2.

Changes None

Objective 2: Compare performance of different populations exposed to elevated pCO₂ in common garden larval rearing experiments

Activities. Collection of broodstock, broodstock husbandry, construction of larval common garden systems, design, construction, and testing of pCO₂ manipulation (OA system) system.

Participants. Natalie Lowell, PhD student, Molly Jackson, MS student, Hollie Putnam, post-doc, Steven Roberts, Puget Sound Restoration Fund staff, PIs.

Results. Broodstock was transferred to PSRF in the NOAA Manchester lab last summer to allow scallops ample time to acclimatize to the common conditions (Table 1). The breeding experiments did not begin during the reporting period. The quarantine room and the OA facility have been almost finished and are almost ready to receive larvae. The OA system has been tested with bivalve larvae and microalgae over a period of 4 weeks and is fully functional. Full monitoring instrumentation for the OA system was provided by NOAA Manchester.

Challenges. The primary challenge so far has been the time necessary to ensure all facilities, systems, and equipment are fully operational and ready to run the experiments.

Changes. The original plan for 'off the shelf' OA systems (MOATs, Paul McElhany, NOAA) proved untenable because of insufficient flow for our larval common garden designs. We therefore designed a relatively simple dual reservoir system controlled by Honeywell durafet probes. Seawater is first equilibrated with atmospheric CO₂ via venturi injection of outside air, then pulsed with pure CO₂ via solenoid valves and small venturi injectors to attain pCO₂ setpoints in treatment and control reservoirs, controlled via durafets. Real-time monitoring is achieved via separate durafets in common garden tanks. Discrete samples for seawater chemistry will be taken throughout the experiments to back-truth durafet data.

Initiation of the experiment, originally planned for Y1 of the grant, has been shifted to Y2 due to unforeseen delays in construction of the quarantine system, finalizing the OA system, and the timing of annual maturation of the broodstock. The delays are not entirely unwelcome given that the broodstock have now been in common conditions for more time than originally planned, thereby increasing the likelihood of reproductive synchrony among populations.

Objective 3: Test for local adaptation by reciprocal transplant experiments

Activities. Collection of broodstock, broodstock husbandry, construction of hatching and settlement systems, ascertaining growout locations, spawning, hatching, and larval rearing.

Participants. Molly Jackson, Taylor Hatchery staff, PIs.

Results. Broodstock were collected and held at the Taylor hatchery (Table 1). Hatching, larval rearing, and settlement systems have been completed. Most of the growout locations have been secured. The exception is the westernmost location in Neah Bay, for which UW-Makah Tribe negotiations are in process. We have identified an alternate Strait of Juan de Fuca site if the Neah Bay site proves unavailable.

The first spawn for the reciprocal transplant occurred in May 2015. Single pair crosses were placed in individual 5 gallon buckets (N=100) in a large water bath held at 14 C. The hatching rate and larval survival overall was very low through day 4 post-fertilization. The experiment was terminated due to insufficient numbers of larvae.

Challenges. Reproductive synchrony among groups remains a challenge. While serotonin injection can reliably produce spawning behaviors, temporal variability in gamete maturation among individuals may yield immature gametes from induced spawns. We suspect low quality gametes caused the low hatching rate in our first trial.

Changes. We are using broodstock from a Western Regional Aquaculture Center (WRAC) project as sentinels for maturation status, to avoid wasting valuable gametes from the NOAA broodstock groups prior to the experiment. WRAC broodstock is held in common conditions with the NOAA animals at the Taylor hatchery. The WRAC group is exposed (approximately every 2 weeks) to elevated temperature and increased microalgal concentration to ascertain maturation status: mature individuals typically readily spawn when provided with these stimuli. Visual assessments of gonadogenesis are made concurrently. We will attempt to spawn NOAA broodstock when a majority of the WRAC broodstock appears mature.

Objective 4: Integrate results in a population model of local adaptation

Activities. We have not initiated activities on this objective; it is dependent on forthcoming experimental data.

Outreach

Activities. A growout site is being used as a teaching and learning opportunity for approximately 50 students attending Bellingham Technical College's Aquaculture program.

Participants. Molly Jackson, Earle Steele, Bellingham Technical College Instructor.

Results.

Challenges.

Changes. The online portal, workshop, and professional outreach components are dependent on results, thus will be conducted in Y2 of the grant.