

Update Report

Period: 2/1/2012 - 1/31/2013

VanBlaricom, Glen

Project: R/LME/N-1 - *Community and multi-trophic implications of structure additions associated with intertidal geoduck aquaculture*

:: STUDENTS SUPPORTED

Blanchette, Jessica, jpb23@u.washington.edu, University of Washington, School of Aquatic and Fishery Sciences, status:new, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

grad school

Ferguson, Lise, lise88@u.washington.edu, University of Washington, Program on the Environment, status:new, field of study:Environmental Studies, advisor:P.S. McDonald, degree type:BA, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 Internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Fuller, Joshua, jfuller2@u.washington.edu, University of Washington, Chemical Engineering, status:new, field of study:Chemical Engineering, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Herlambang, Katrina, katjh@u.washington.edu, University of Washington, School of Aquatic and Fishery Sciences, status:new, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Howard, Sylvia, sylvfh08@u.washington.edu, University of Washington, Program on the Environment, status:new, field of study:Environmental Studies, advisor:P.S. McDonald, degree type:BA, degree date:2012-12-01, degree completed this period:Yes

Student Project Title:

ENVIR 350 Internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

Environmental consulting

Huynh, Loan, lhuynh10@u.washington.edu, University of Washington, Program on the Environment, status:new, field of study:Environmental Studies, advisor:P.S. McDonald, degree type:BA, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 Internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Le, Lynda, leyinyue@gmail.com, University of Washington, School of Aquatic and Fishery Sciences, status:cont, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

Effects of Algae Cover on the Growth and Survivorship of Commercial Geoducks (*Panopea generosa*).

Involvement with Sea Grant This Period:

Capstone

Post-Graduation Plans:

grad school

Lee, Jordan, jordanl7@u.washington.edu, University of Washington, Biology, status:new, field of study:Biological, advisor:P.S. McDonald, degree type:BS, degree date:2014-06-01, degree completed this period:No

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

grad school

McPeck, Katherine, mcpeek@uw.edu, University of Washington, School of Aquatic and Fishery Sciences,

status:cont, field of study:Fisheries and aquaculture, advisor:G.R. VanBlaricom, degree type:MS, degree date:2013-08-01, degree completed this period:No

Student Project Title:

Effects of geoduck aquaculture structures on predator-prey interactions in southern Puget Sound

Involvement with Sea Grant This Period:

Graduate research assistant

Post-Graduation Plans:

environmental consulting

Muncaster-Jones, Felicia, tippi93@u.washington.edu, University of Washington, School of Aquatic and Fishery Sciences, status:new, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Oyafuso, Zach, unknown, University of Washington, School of Aquatic and Fishery Sciences, status:cont, field of study:Fisheries and oceanography, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

Investigating the Effects of Geoduck Aquaculture on the Benthic Community During the Planting Stage.

Involvement with Sea Grant This Period:

Intern

Post-Graduation Plans:

grad school

Richards, Marion, marionr2@uw.edu, University of Washington, Environmental Studies, status:new, field of study:Environmental Studies, advisor:P.S. McDonald, degree type:BA, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 Internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Robbins, Kaitlyn, mynx2008@u.washington.edu, University of Washington, School of Aquatic and Fishery Sciences, status:new, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2012-06-01, degree completed this period:Yes

Student Project Title:

FISH 498 Internship/Experiential Learning

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

grad school

Schooler, Sarah, schooler@u.washington.edu, University of Washington, School of Environmental and Forest Resources, status:new, field of study:Environmental Science, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

Sienkiewicz, Alison, sienka@u.washington.edu, University of Washington, School of Environmental and Forest Resources, status:new, field of study:Environmental Science, advisor:P.S. McDonald, degree type:BS, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

grad school

Soto, Kaitlin, kaitlinasoto@gmail.com, University of Washington, School of Aquatic and Fishery Sciences, status:cont, field of study:Fisheries and aquaculture, advisor:P.S. McDonald, degree type:BS, degree date:2012-08-01, degree completed this period:Yes

Student Project Title:

The influence of algal cover on biodiversity around geoduck (*Panopea generosa*) farms.

Involvement with Sea Grant This Period:

Capstone student

Post-Graduation Plans:

Environmental consulting

Stewart, Julie, jas6@u.washington.edu, University of Washington, Program on the Environment, status:new, field of study:Environmental Studies, advisor:P.S. McDonald, degree type:BA, degree date:2013-06-01, degree completed this period:No

Student Project Title:

ENVIR 350 Internship

Involvement with Sea Grant This Period:

intern

Post-Graduation Plans:

unknown

:: CONFERENCES / PRESENTATIONS

Conference oral presentation: McPeek KC, VanBlaricom GR, Beauchamp D, McDonald PS (2012) Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA. Oral presentation at the Western Society of Naturalists Annual Meeting, Seaside, CA, November 8-11, public/profession presentation, 35 attendees, 2012-11-10

Presentation: McPeek KC. Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA: Results from mark-recapture and stable isotope studies. Presentation to the Washington Cooperative Fish and Wildlife Research Unit Annual Meeting, Seattle, WA, September 27, 2012, public/profession presentation, 45 attendees, 2012-09-27

Conference oral presentation: McDonald PS, Galloway, AE, Price, JL, McPeek KC, VanBlaricom GR (2012) Macrofauna associated with geoduck aquaculture: SCUBA and seining results. Oral presentation at the Pacific Coast Shellfish Growers Association Annual Conference, Tulalip, WA, September 25-27, public/profession presentation, 200 attendees, 2012-09-26

Conference oral presentation: McPeek KC, VanBlaricom GR, Beauchamp D, McDonald PS (2012) Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA: Results from mark-recapture and stable isotope studies. Oral presentation at the Pacific Coast Shellfish Growers Association Annual Conference, Tulalip, WA, September 25-27, public/profession presentation, 200 attendees, 2012-09-26

Conference oral presentation: McDonald PS, Stevick PF, Galloway AE, McPeek KC, Armstrong DA, VanBlaricom GR (2012) Nekton, nets, and tubes: macrofauna response to intertidal geoduck aquaculture operations in Puget Sound, Washington. Oral presentation at the National Shellfish Association Annual Meeting, Seattle, WA, March 25-29, public/profession presentation, 55 attendees, 2012-03-26

Conference oral presentation: McPeek KC, VanBlaricom GR, McDonald PS, Beauchamp D (2012) Effects of geoduck aquaculture on the growth and stable isotope signatures of staghorn sculpin. Oral presentation at the National Shellfish Association Annual Meeting, Seattle, WA, March 25-29

, public/profession presentation, 55 attendees, 2012-03-26

:: ADDITIONAL METRICS

K-12 Students Reached:0

Acres of degraded ecosystems restored as a result of Sea Grant activities:0

Curricula Developed:0

Resource Managers who use Ecosystem-Based Approaches to Management:0

Volunteer Hours:350

HACCP - Number of people with new certifications:0

more than 20 University of Washington students volunteered their time to assist with field and lab work. These students did not receive academic credit for their service.

Cumulative Clean Marina Program - certifications:0

:: PATENTS AND ECONOMIC BENEFITS

Description	Patents	Economic Benefit (\$)	Businesses Created	Businesses Retained	Jobs Created	Jobs Retained
None	2012 - 1/31/2013) : 0	0	0	0	0	0
	Anticipated 0 (2/1/2013 - 1/31/2014) :	0	0	0	0	0

:: TOOLS, TECH, AND INFORMATION SERVICES

Description	Developed	Used	Names of Managers	Number of Managers
Information for evaluation of design options for predator exclusion structures used in Puget Sound geoduck aquaculture operations to select options that sustain aquaculture productivity with minimal ecosystem-scale disruption.	Actual 1 (2/1/2012 - 1/31/2013) :	0	Anticipate for 2013, from 2012 note -- NOAA, USDA, state agencies (eg. Agriculture, Ecology), local planners (incl. WA Shoreline Master Plans).	0
R/LME/N-1	Anticipated 1 (2/1/2013 - 1/31/2014) :	1		

:: HAZARD RESILIENCE IN COASTAL COMMUNITIES

Name of coastal community	County	Number of resiliency trainings / technical assistance services provided	Was community hazard resiliency improved (e.g., via changes in zoning ordinances)
None	Actual 0 (2/1/2012 - 1/31/2013) :		?
	Anticipated 0 (2/1/2013 - 1/31/2014) :		Yes

:: ADDITIONAL MEASURES

<u>Safe and sustainable seafood</u>	
Number of stakeholders modifying practices	Number of fishers using new techniques
Actual (2/1/2012 - 1/31/2013) : 0	Actual (2/1/2012 - 1/31/2013) : 0
Anticipated (2/1/2013 - 1/31/2014) : 2	Anticipated (2/1/2013 - 1/31/2014) : 0
Agency managers in Washington state are	

anticipated to modify their practices based on project outcomes. Washington Department of Natural Resources will likely make decisions about future lease agreements based on findings of this and related projects. Similarly, Department of Ecology is expected to modify the guidance provided to counties engaged in shoreline Master Plan updates, based on project results.

Sustainable Coastal Development

Coastal

Ecosystem

s

Actual (2/1/2012 - 1/31/2013) : 0

Actual (2/1/2012 - 1/31/2013) : 0

Anticipated (2/1/2013 - 1/31/2014) : 7

Anticipated (2/1/2013 - 1/31/2014) : 0

Managers in Mason, Thurston, Pierce, Clallam, Kitsap, Skagit, and Snohomish counties will be able to utilize this guidance to implement policy as part of Shoreline Master Program updates. Jurisdictions that have completed their SMP updates – King, Jefferson, and Whatcom counties - will apply findings in their scheduled updates.

:: PARTNERS

Partner Name: Agriculture Research Service (USDA)

Partner Name: Aquatic Resources Division, Washington State Department of Natural Resources

Partner Name: Chelsea Farms

Partner Name: Pacific Shellfish Institute

Partner Name: Puget Sound Restoration Fund

Partner Name: Seattle Shellfish LLC

Partner Name: Taylor Shellfish Company

Partner Name: University of Washington

Partner Name: University of Washington, Program on the Environment, College of the Environment (UW)

Partner Name: Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, College of the Environment (UW)

:: IMPACTS AND ACCOMPLISHMENTS

Title: **Sea Grant-supported research investigates geoduck aquaculture's effects on intertidal community dynamics**

Type: accomplishment

Description:

Relevance: The expansion of geoduck aquaculture in Puget Sound has raised concern among managers, conservationists, and the public about possible environmental impacts. Sediment disturbance in intertidal areas caused by geoduck planting (using nets and tubes) and harvesting (using hoses to liquefy sediment) could affect a number of intertidal ecological functions, including fish distribution, benthic community dynamics, and food web interactions.

Response: A Sea Grant National Strategic Investment is supporting a two-year study to compare cultured geoduck areas to nearby reference beaches. Objectives are to characterize changes in benthic communities

associated with geoduck planting and harvest; explore differences in fish abundance and movement between cultured areas and reference beaches; evaluate differences in fish diets in relation to prey abundance and availability; and determine the effects of diet shifts on fish growth and survival.

Results: In 2012, researchers completed sampling at cultured and reference beaches at three locations. They found that target fish abundance did not vary between the two types of sites, despite the greater habitat complexity of the cultured beaches, but fish appeared to grow faster on the cultured beaches than on the reference beaches. Fish did not move between cultured and uncultured plots. They consumed different types of prey in the two habitats, but their tissues were chemically similar, suggesting that food-web energy pathways remained similar in both despite some differences in prey chemistry.

Recap:

Sea Grant-sponsored researchers investigate the ecological effects of geoduck aquaculture by comparing fish abundance, movements, diets, and energy budgets on cultured and uncultured beaches.

Comments:

Primary Focus Area – LME (SSSS)

Secondary Focus Areas – LME (HCE), COCC (SCD)

Associated Goals: Support conservation and sustainable use of living marine resources through effective and responsible approaches, tools, models and information for harvesting wild and cultured stocks and preserving protected species (SSSS, Industry).

Strengthen ecosystem approaches to management of living marine resources through improved understanding of marine biodiversity, marine and coastal ecosystem function, climate change and other sources of variability (HCE, Science).

Improve capacity to manage ocean and coastal ecosystems and resources for societal benefit under changing climatic and demographic conditions (SCD, Inter-relation).

Related Partners:

Agriculture Research Service (USDA, ARS)

Aquatic Resources Division, Washington State Department of Natural Resources

Chelsea Farms

Pacific Shellfish Institute

People for Puget Sound

Puget Sound Restoration Fund

Seattle Shellfish LLC

Taylor Shellfish Company

University of Washington, Program on the Environment, College of the Environment (UW)

University of Washington, School of Aquatic and Fishery Sciences, College of the Environment (UW)

Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, College of the Environment (UW)

:: PUBLICATIONS

No Publications Reported This Period

:: OTHER DOCUMENTS

No Documents Reported This Period

:: LEVERAGED FUNDS

Type: influenced Period: 2012-12-15::2013-03-15 Amount: \$6675

Purpose:

1-quarter tuition/stipend scholarship to Kate McPeek

Source: Whiteleather Scholarship administered by School of Aquatic and Fishery Sciences, Recruitment, Admissions, and Scholarship Committee (RASC)

Type: influenced Period: 2012-11-08::2012-11-12 Amount: \$1000

Purpose:

Travel award to Kate McPeek for conference attendance, Western Society of Naturalists

Source: Gilbert B. Pauley Award for best lecture, USGS Washington Cooperative Fish and Wildlife Research Unit

Type: influenced Period: 2012-11-08::2012-11-11 Amount: \$500

Purpose:

Travel award to Kate McPeek for conference attendance, Western Society of Naturalists

Source: NSA-PCS best student paper award

WASHINGTON SEA GRANT PROGRESS REPORT

for the period 2/1/2012 – 1/31/2013

Project Title: Sea Grant Aquaculture Research Program 2010: Community and multi-trophic implications of structure additions associated with intertidal geoduck aquaculture

Principal Investigator(s) and Affiliation:

Glenn R. VanBlaricom School of Aquatic & Fishery Sciences, University of Washington

1. PROJECT OBJECTIVES (from original proposal)

We propose to investigate the effects of intertidal culture operations for Pacific geoduck clams (*Panopea generosa*) on community dynamics and trophic interactions in South Puget Sound, Washington. The proposed work contributes to NOAA Sea Grant program priorities by involving multiple partners, and leveraging of resources by utilizing infrastructure and data of an existing Washington State program. We will coordinate these efforts with similar regional investigations on the effects of shellfish aquaculture conducted elsewhere to extend the relevance and applicability of our results. We focus on comparison of areas containing cultured geoducks (+ structure, + geoducks) and reference beaches (— structure, — geoducks). Our objectives are: (1) characterize changes in benthic communities associated with the planting of geoducks and the placement of aquaculture structures; (2) explore differences in fish abundance and site fidelity among cultured areas and reference beaches; (3) evaluate differences in fish diets in relation to prey abundance and availability using physical and chemical methods; and (4) determine the energetic consequences of diet shifts for growth and survival of fishes. We will also train undergraduate students in the use of field and laboratory techniques, dietary models based on isotope ratios and lipid biomolecular markers and spectra, and bioenergetics models.

2. PROJECT PROGRESS

We are investigating the effects of intertidal culture operations for Pacific geoduck clams (*Panopea generosa*; hereinafter “geoduck”) on community dynamics and trophic interactions in southern Puget Sound, Washington. The project contributes to NOAA Sea Grant program priorities by involving multiple partners and by leveraging resources through utilization of infrastructure and data associated with an existing Washington State program. We are also coordinating these efforts with similar regional investigations on the effects of shellfish aquaculture conducted elsewhere to extend the relevance and applicability of our results. We are focusing on comparisons of areas containing cultured geoducks (+ predator exclusion structure, + geoducks) and reference beaches (– structure, – geoducks). During the early part of our study we identified Pacific staghorn sculpin (*Leptocottus armatus*), as an indicator predator with which to assess trophic dynamics at three field research sites (Table 1). Over the past year, we focused on field collection and laboratory processing of hundreds of samples including gut contents and tissue of staghorn sculpin, as well as prey organisms that constitute infauna and epifauna.

During each monthly sampling interval, we used beach seines to assess the fish community at our sites. All captured staghorn sculpin were measured (Standard length, SL), and individuals larger than 65 mm SL were weighed and tagged with uniquely numbered anchor tags (Floy Tag, Seattle, WA). Tagged sculpin were released after a recovery period as part of our mark-recapture study. A subsample of fish from each location and habitat type was retained for laboratory analyses of stable isotope ratios or gut content studies. We used coring methods and pumps, developed in our previous work and Years 1-2 of this study, to characterize changes in infauna and epifauna communities associated with the presence of geoducks and aquaculture structures in April, June, and August, 2012. Infauna and epifauna samples allowed us to quantify the abundance of organisms, and tissues were used for carbon and nitrogen stable isotope analysis of important prey groups. Standardized photo-quadrats were used to develop a record of changes in algal cover throughout the study period.

As part of our laboratory activities, we have identified and enumerated more than 50 infauna and epifauna taxa in nearly 360 core and pump samples. We have also processed and analyzed over 300 gut content samples to describe general patterns in the food habits of staghorn sculpin and identified infauna and epifauna taxa that constitute important prey for fish associated with our project sites. Eight prey categories were identified for subsequent chemical characterization from the physical diet evidence, and we have analyzed nearly 250 samples, including fish and prey tissues, for carbon and nitrogen stable isotopes. In addition, approximately 270 photos have been evaluated to determine changes in percent algae cover (%).

A continuous record of temperature was collected in both habitat types at the three study sites using submersible data recorders. Data on recaptured sculpin have been used to determine growth rates at liberty. These data and the diet information above, have informed preliminary bioenergetics modeling efforts to estimate prey consumption by individual staghorn sculpin.

The mark-recapture study indicated that staghorn sculpin show fidelity to their site of initial capture and may grow at different rates at geoduck farms and reference areas (Table 2). Research on sculpin diet showed that types of prey consumed differed by habitat type in most months. Nevertheless, preliminary results from carbon and nitrogen stable isotope analysis suggest that sculpin diets are chemically similar within geoduck aquaculture plots and reference areas, despite some differences among prey groups (Fig 1 & 2).

Research efforts during 2013 will focus on elucidating the nature of predator-prey relationships at geoduck aquaculture sites through bioenergetics modeling and multivariate data analysis of stable isotope and diet data. These methods will allow us to further explore differences in energetic resources and sculpin carrying capacity between the two habitat types. The work contributes to previous and ongoing studies by examining linkages within these communities and evaluating the trophic implications of structure additions. These data are critical to determine the effects of expanding geoduck aquaculture practices on nearshore food webs. We anticipate developing a greater understanding of the effects of placing predator exclusion structures and the out-planting of juvenile geoducks on key components of soft-sediment intertidal communities in Puget Sound.

Table 1. Description of local conditions and biota at geoduck aquaculture research sites in Puget Sound.

Site/Status	Description	Resident Biota
<i>Rolf site – planted 07/2011</i>		
5,100 m ² cultured; 2,500 m ² each plot	The site is North of Wilson Pt on Hartstine Island (47° 19.181'N, 122°50'28.21"W). Sandy substrate. (~ 500 μm grain size); slope moderate from +0.61 m to -0.61 m MLLW; reference plot is on county property adjacent to state park.	Horse clams and oysters present; Sand dollars patchy.
<i>Foss/Joemma Beach site – planted 08/2010</i>		
4,450 m ² cultured; 4,450 m ² each plot	The site is West of Joemma Beach State Park on Case Inlet (47°13'23.36"N, 122°49'4.36"W). Sandy substrate. (~ 500 μm grain size); slope moderate from +0.61 m to -0.61 m MLLW; Reference plot is adjacent to state park property.	Horse clams and cockles present; sand dollars in some areas.
<i>Manke site – planted 07/2010</i>		
10,600 m ² cultured; 2,500 m ² each plot	The site is South of Wilson Pt on Hartstine Island (47°11'55.33"N, 122°50'28.21"W). Sandy with some fines (~ 250-500 μm grain size). Freshwater seepage from uplands occurs. The reference plot is nearby on private tidelands.	Horse clams and cockles are present; Sand dollars patchy.

Table 2. Summary results from mark-recapture studies of Pacific staghorn sculpin within geoduck aquaculture (Cultured) and adjacent reference areas (Reference) at three sites (Foss, Manke, and Rolfs) in Puget Sound in 2011 and 2012.

Site	Plot	Year	Total Sculpin Tagged	Total Recaptures	Recapture %	Average growth rate g d ⁻¹	Average growth rate mm d ⁻¹
Foss	Reference	2011	290	10	3.448	0.081	0.383
Foss	Cultured	2011	296	8	2.703	0.134	0.423
Foss	Reference	2012	459	16	3.486	0.0679	0.264
Foss	Cultured	2012	132	2	0.758	0.0517	0.310
Manke	Reference	2012	581	21	3.614	0.0838	0.331
Manke	Cultured	2012	395	10	2.532	0.175	0.430
Rolfs	Reference	2012	412	4	0.971	0.037	0.259
Rolfs	Cultured	2012	116	0	0.000	n/a	n/a

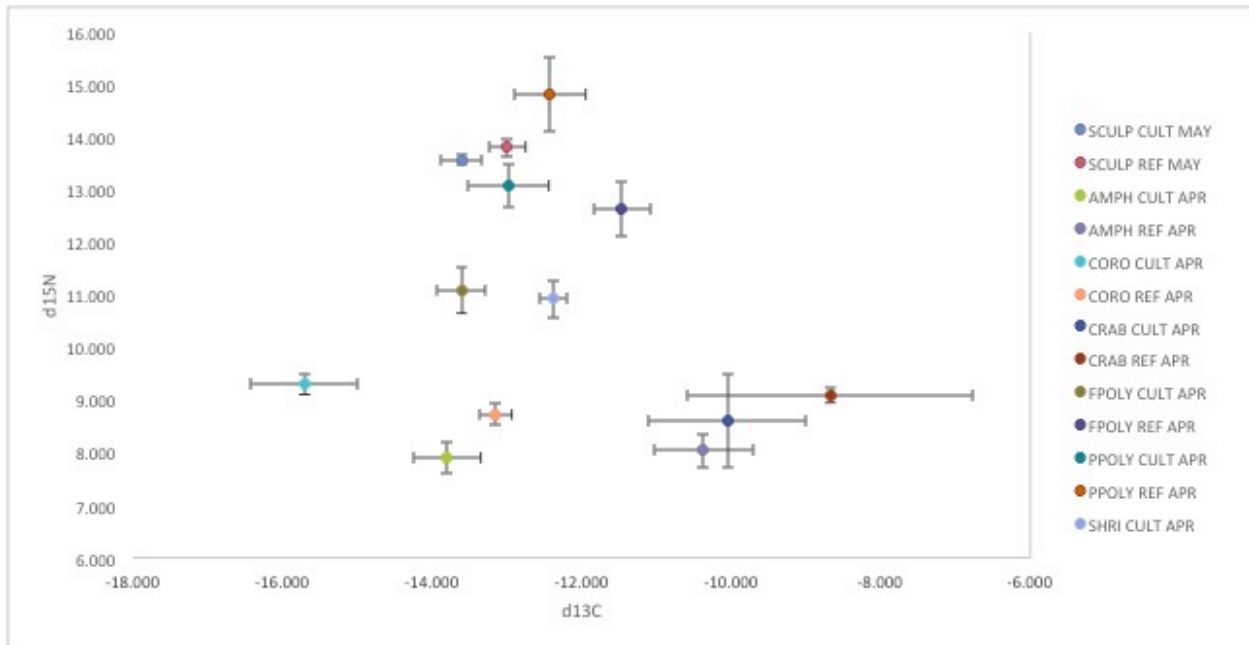


Figure 1. Carbon and Nitrogen stable isotope signature for staghorn sculpin and key prey groups within geoduck aquaculture (CULT) and adjacent reference areas (REF) in April 2012. Mean isotope signatures for sculpin (SCULP), epibenthic amphipods (AMPH), benthic *Corophium* spp (CORO), crabs (CRAB), suspension-feeding polychaetes (FPOLY), predatory polychaetes (PPOLY) and caridean shrimp (SHRI).

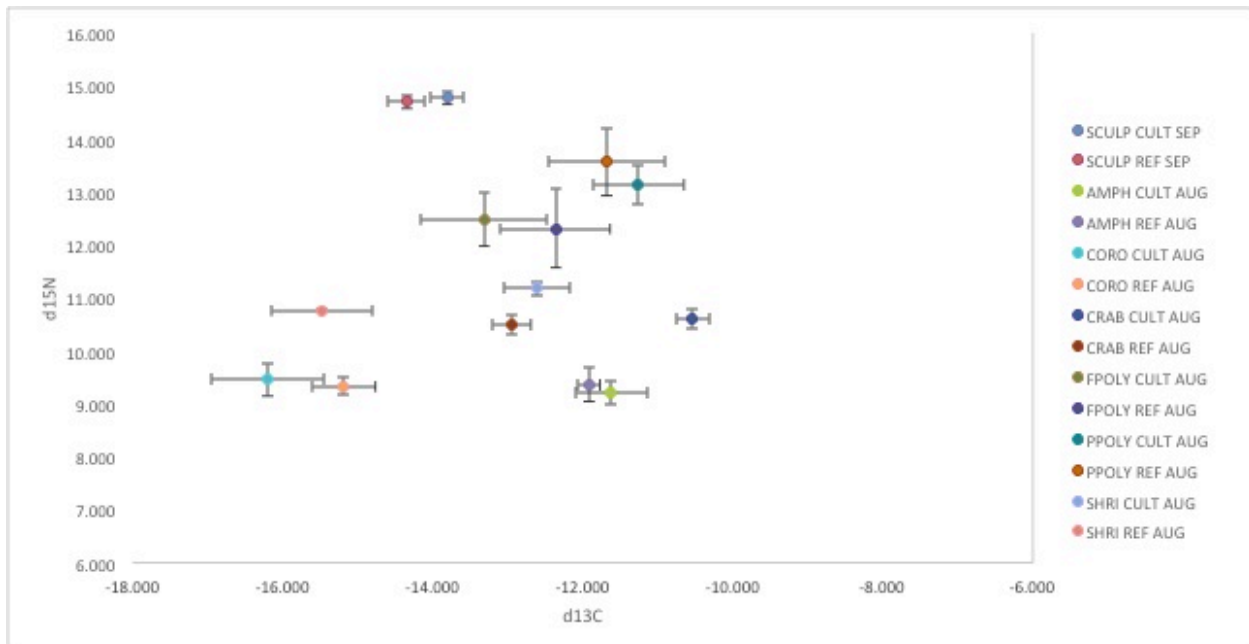


Figure 2. Carbon and Nitrogen stable isotope signature for staghorn sculpin and key prey groups within geoduck aquaculture (CULT) and adjacent reference areas (REF) in August 2012. Mean isotope signatures for sculpin (SCULP), epibenthic amphipods (AMPH), benthic *Corophium* spp (CORO), crabs (CRAB), suspension-feeding polychaetes (FPOLY), predatory polychaetes (PPOLY) and caridean shrimp (SHRI).

3. ACCOMPLISHMENTS AND IMPACTS

Accomplishment Statement

Title: Sea Grant-supported research helps elucidate the impact of aquaculture on predator-prey relationships

Relevance: Expansion of geoduck aquaculture operations in Puget Sound has raised concern among managers, conservation organizations and the public regarding their environmental impacts. Addition of aquaculture structures may affect a number of ecological functions and processes over several years, such as predator distribution.

Response: Sea Grant National Strategic Investment funding is enabling university researchers to investigate the effects of intertidal culture operations for Pacific geoduck clams (*Panopea generosa*) on community dynamics and trophic interactions. Building on results from ongoing Washington state-funded research, investigators identified key prey for fish and crab associated with geoduck farm sites. Working with the industry, they have identified three research sites and conducted studies of the site fidelity, growth and stable isotope signatures of a local ubiquitous predator, Pacific staghorn sculpin (*Leptocottus armatus*) within a geoduck farm and nearby reference area. This species is useful as an indicator of potential changes in the ecosystem associated with aquaculture impacts.

Results: The mark-recapture study indicated that staghorn sculpin show fidelity to their site of initial capture and grow at significantly different rates at the farm plot relative to the adjacent reference area. Analysis of new diet samples and comparison to previous data showed that sculpin consume different types of prey within each habitat; yet results from carbon and nitrogen stable isotopes suggest that sculpin are chemically similar at farm and reference areas across summer months, despite some differences in prey chemistry. These results are providing new insights into the way geoduck aquaculture may modify prey availability and alter predator-prey relationships.

Recap: A Washington Sea Grant-supported researcher is using traditional food habits techniques and chemical analyses to examine the effects of geoduck aquaculture operations on trophic relationships in Puget Sound, with preliminary results suggesting changes in predator-prey relationships.

Impact Statement

Not applicable. Results are preliminary and have not yet yielded significant economic, societal, and/or environmental benefits.

4. PUBLICATIONS

Peer-reviewed journal articles: **none.**

Proceedings, Symposia (entire publication): **none.**

Peer-reviewed book chapters: **none.**

Paper in Proceedings: **none.**

Handbooks, Manuals and Guides: **none.**

Newsletters and Periodicals: **none.**

Technical reports: **none.**

Brochures, Fact sheets, etc. **none.**

Media Placements (print, radio, TV and internet coverage): **none.**

Web site: **none.**

Videos, DVDs, Software and other non print formats: **none.**

Books or Monographs: **none.**

Theses and dissertations: **1.**

Soto, K. (2012). The Influence of Algal Cover on Epifaunal Community Composition in Geoduck Aquaculture. Undergraduate Capstone thesis, School of Aquatic & Fishery Sciences, University of Washington.

Conference/Workshop activity, Presentation or Seminar: **6.**

Conference oral presentation: McPeek KC, VanBlaricom GR, McDonald PS, Beauchamp D (2012) Effects of geoduck aquaculture on the growth and stable isotope signatures of staghorn sculpin. Oral presentation at the National Shellfish Association Annual Meeting, Seattle, WA, March 25-29

Conference oral presentation: McDonald PS, Stevick PF, Galloway AE, McPeek KC, Armstrong DA, VanBlaricom GR (2012) Nekton, nets, and tubes: macrofauna response to intertidal geoduck aquaculture operations in Puget Sound, Washington. Oral presentation at the National Shellfish Association Annual Meeting, Seattle, WA, March 25-29

Conference oral presentation: McPeek KC, VanBlaricom GR, Beauchamp D, McDonald PS (2012) Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA: Results from mark-recapture and stable isotope studies. Oral presentation at the Pacific Coast Shellfish Growers Association Annual Conference, Tulalip, WA, September 25-27

Conference oral presentation: McDonald PS, Galloway, AE, Price, JL, McPeek KC, VanBlaricom GR (2012) Macrofauna associated with geoduck aquaculture: SCUBA and seining results. Oral presentation at the Pacific Coast Shellfish Growers Association Annual Conference, Tulalip, WA, September 25-27

Presentation: McPeek KC. Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA: Results from mark-recapture and stable isotope studies. Presentation to the Washington Cooperative Fish and Wildlife Research Unit Annual Meeting, Seattle, WA, September 27, 2012

Conference oral presentation: McPeek KC, VanBlaricom GR, Beauchamp D, McDonald PS (2012) Patterns of utilization of geoduck aquaculture plots by Pacific staghorn sculpin in Puget Sound, WA. Oral presentation at the Western Society of Naturalists Annual Meeting, Seaside, CA, November 8-11

5. STUDENTS

Please provide the following information for every student that worked with you during the reporting period.

Please indicate with a check mark here if no students were involved in the project.

Student Name: Lynda Le.

Involvement with WSG: undergraduate intern and Capstone student.
Degree track: B.S.
Whether degree was **completed** during the reporting window: NO.
New or continuing student on WSG support: New.
Department: University of Washington, School of Aquatic and Fishery Sciences.
Major/Degree field: Aquatic and Fishery Sciences.
Major Professor: Patrick Sean McDonald.
Dissertation/Thesis title (anticipated): Effects of Algae Cover on the Growth and Survivorship of Commercial Geoducks (*Panopea generosa*).
Date of graduation (anticipated): December 2012.
If student has graduated, please provide name of current employer, if known: N/A

Student Name: Kathleen McPeek.
Involvement with WSG: M.S. student supported on project.
Degree track: M.S.
Whether degree was **completed** during the reporting window: NO.
New or continuing student on WSG support: CONTINUING.
Department: University of Washington, School of Aquatic and Fishery Sciences.
Major/Degree field: Aquatic and Fishery Sciences.
Major Professor: Glenn R. VanBlaricom.
Dissertation/Thesis title (anticipated): Effects of geoduck aquaculture structures on predator-prey interactions in southern Puget Sound (anticipated).
Date of graduation (actual or anticipated): Spring 2013 (anticipated).
If student has graduated, please provide name of current employer, if known: Not applicable.

Student Name: Zack Oyafuso
Involvement with WSG: undergraduate intern.
Degree track: B.S.
Whether degree was **completed** during the reporting window: NO.
New or continuing student on WSG support: New.
Department: University of Washington, School of Aquatic and Fishery Sciences.
Major/Degree field: Aquatic and Fishery Sciences.
Major Professor: Patrick Sean McDonald.
Project title (actual): Investigating the Effects of Geoduck Aquaculture on the Benthic Community During the Planting Stage.
Date of graduation (anticipated): June 2013.
If student has graduated, please provide name of current employer, if known: N/A

Student Name: Kaitlin Soto
Involvement with WSG: undergraduate intern and Capstone student.
Degree track: B.S.
Whether degree was **completed** during the reporting window: NO.
New or continuing student on WSG support: New.
Department: University of Washington, School of Aquatic and Fishery Sciences.
Major/Degree field: Aquatic and Fishery Sciences.
Major Professor: Patrick Sean McDonald.

Dissertation/Thesis title (actual): The influence of algal cover on biodiversity around geoduck (*Panopea generosa*) farms.

Date of graduation (actual): August 2012.

If student has graduated, please provide name of current employer, if known: N/A

Other students receiving internship credit at University of Washington: Jessica Blanchette, Lise Ferguson, Joshua Fuller, Katrina Herlambang, Sylvia Howard, Loan Huynh, Jordan Lee, Felicia Muncaster-Jones, Marion Richards, Kaitlyn Robbins, Sarah Schooler, Julie Stewart

6. PARTNERSHIPS

Please list any partners that you work with on your project. Please specify the partner type and level and describe the nature of the partnership.

Partner	Specify Type (Academic, Government, Industry/Business, NGO, SG Program, Other)	Specify level (International, Federal, Regional, State, Local)	Nature of Partnership
<i>Taylor Shellfish</i>	<i>Industry/Business</i>	<i>State/Local</i>	<i>Managers consulted on site selection and scheduling of maintenance activities at study sites.</i>
<i>Seattle Shellfish</i>	<i>Industry/Business</i>	<i>State/Local</i>	<i>Owner consulted on site selection and project logistics.</i>
<i>Chelsea farms</i>	<i>Industry/Business</i>	<i>State/Local</i>	<i>Owner & managers consulted on site selection and scheduling of maintenance activities at study sites.</i>
<i>People for Puget Sound</i>	<i>NGO</i>	<i>State</i>	<i>Scientists and outreach specialists consulted on project activities, preliminary results, and volunteer requests.</i>
<i>Pacific Shellfish Institute</i>	<i>NGO</i>	<i>Regional</i>	<i>Scientists consulted on project activities and provided temperature data for ongoing modeling work.</i>
<i>Puget Sound Restoration Fund</i>	<i>NGO</i>	<i>State</i>	<i>Scientists consulted on project activities and coordination of data collection and processing techniques.</i>
<i>School of Aquatic and Fishery Sciences, University of Washington</i>	<i>Academic</i>	<i>State</i>	<i>Undergraduate program coordinator consulted on internship opportunities and volunteer requests.</i>

<i>Program on the Environment, University of Washington</i>	<i>Academic</i>	<i>State</i>	<i>Undergraduate program coordinator consulted on internship opportunities and volunteer requests.</i>
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7. OUTREACH AND INFORMATION/TECHNOLOGY TRANSFER

Please describe any specific outreach or information/technology transfer activities that **have taken place** relative to your work that are not captured in the performance metrics tables below. What follow-up activities (by you, WSG or other partners) **would** ensure that the results of this project are fully applied?

8. LEVERAGED FUNDS

Travel award to Kate McPeek for conference attendance, Western Society of Naturalists (\$500)

Travel award to Kate McPeek for conference attendance, Western Society of Naturalists (\$1000)

Richard T. Whiteleather Scholarship to Kate McPeek for tuition and stipend, School of Aquatic and Fishery Sciences (\$13,349)

Source Entity/Partner and Description (limit to ONE source/partner per line)	Amount
<i>Western Society of Naturalists - Travel award to Kate McPeek for conference attendance, NSA-PCS best student paper award</i>	\$500
<i>Western Society of Naturalists - Travel award to Kate McPeek for conference attendance, Gilbert B. Pauley Award for best lecture</i>	\$1000
<i>Richard T. Whiteleather Scholarship administered by School of Aquatic and Fishery Sciences, Recruitment, Admissions, and Scholarship Committee (RASC), 1-quarter tuition/stipend scholarship to Kate McPeek</i>	\$13,349

**SEE BELOW FOR PERFORMANCE
METRICS REPORTING REQUIREMENTS**