Human Perceptions and Attitudes Regarding Geoduck Aquaculture in Puget Sound, Washington: A Q Methodology Approach

Paul N. Rudell

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Marc L. Miller, Chair

Penelope Dalton

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Abstract

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Paul N Rudell

Chair of the Supervisory Committee:
Professor Marc L. Miller
School of Marine and Environmental Affairs

Geoduck (*Panopea generosa*) clam aquaculture on Washington State tidelands is causing disagreement and debate among coastal stakeholders. This study uses Q methodology to investigate the subjective perceptions and attitudes of 36 coastal stakeholders involved in the geoduck aquaculture debate and to identify central issues. A total of 1,338 potential Q statements were generated resulting in a set of 55 Q statements that were chosen to represent the full range of viewpoints. Analysis discovered two social perspectives held by participants, emphasized areas of consensus and disagreement and identified four highly contentious issues. Those following Perspective 1 generally thought favorably about the potential growth of geoduck culture and included participants identified as managers, academic scientists, shellfish growers, tribal members, and students. Those following Perspective 2 were generally against further development of geoduck culture and included waterfront landowners and non-governmental organizations. This study demonstrates the ability of Q methodology to provide framework and

structure to the geoduck aquaculture debate, and highlight promising areas to be addressed by research and outreach.

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Introduction

The importance of marine aquaculture to food production and economic development in coastal regions is well documented (FAO 2010, FAO 2008). At the same time, population growth in coastal zones is increasing competition between aquaculture and other users while resource space remains limited (Nash 2011, p. 189, NRC 2010, p. 100). Perceptions of negative environmental impacts from culture methods and disagreement over land use can make marine aquaculture controversial (Marine Aquaculture Task Force 2007, p. 2). While a limited amount of research exists on community perceptions of aquaculture, understanding the social acceptability of aquaculture development has become a subject of serious research in Puget Sound (Northern Economics 2009) and worldwide (Whitmarsh and Palmieri 2009, Mazur and Curtis 2008).

Shellfish aquaculture on private and public tidelands in Washington State is a tradition extending back over 100 years (NMFS 2009, p. 1). It is important to the culture, heritage, and economy of rural coastal communities. Shellfish aquaculture is impacted spatially and temporally by water quality issues related to pollution and a growing Puget Sound population (WDOH 2011). While most shellfish farming takes place in rural coastal counties, these regions are poised for rapid population growth that could further impact water quality and space available for tideland users (Lombard 2007, p. 6). Having begun in the last twenty years, the farming of geoduck clams, or geoduck aquaculture, represents a relatively new and innovative form of shellfish aquaculture (NMFS 2009, p. 15).

Several ongoing or recent coastal management activities have a nexus with geoduck aquaculture and may have stimulated the controversy. The state legislature created a Shellfish Aquaculture Regulatory Committee (SARC) to advise on geoduck management guidelines and oversee geoduck research (WDOE 2012). The United States Army Corps of Engineers (COE)

issued Nationwide Permit (NWP) 48 covering all existing shellfish aquaculture activities in Washington, including geoduck farms in operation prior to March 19, 2007 (NMFS 2009). Washington State Department of Ecology (WDOE) amended the state Shoreline Management Act on February 11, 2011, adopting several rules with language directly addressing geoduck aquaculture (WDOE 2012b). Washington State Department of Natural Resources continues to consider the potential for leasing state owned (public) tidelands for geoduck culture and revenue generation (WDNR 2012). The expansion of geoduck farms on private tidelands combined with these coastal management activities has generated substantial public discourse and conflict with shoreline residents (Gordon 2007, p. 1, WDOE 2009, p. 3, Ma 2009). At times this debate has been heated and controversial as reflected in newspaper and journal articles, magazines, websites, e-mails, public forums and agency reports. This is a land-use conflict that includes divergent perceptions of state agency responsibilities and environmental and social sustainability.

This research case study uses Q methodology as a means to systematically study the subjective opinions, beliefs and attitudes of coastal stakeholders in relation to the aquaculture of geoduck in Puget Sound, Washington. In 2007, the state legislature mandated environmental impact research on geoduck farming, leading to development of the Geoduck Aquaculture Research Program (GARP) administered by Washington Sea Grant (WSG 2009, p. 1) and overseen by SARC. However, GARP did not provide for research on social perspectives or issues surrounding geoduck aquaculture. This case study is an example of human dimensions research that can augment the research produced by GARP, aiding in future agency planning and decision making by providing social systems research along with natural systems research. This research fills some of this gap by utilizing Q methodology to: (i) clarify the social perspectives of

coastal stakeholders affected by geoduck aquaculture; (ii) identify which participants agree with each perspective; (iii) isolate consensus and disagreement statements and (iv) identify highly contentious statements that provide avenues for research and outreach.

Q Methodology

Q methodology is a systematic method for analyzing an individual's subjective opinions, viewpoints and attitudes that exist on an issue (Brown 1980, Webler et al. 2009). Developed at Oxford by the physicist-psychologist William Stephenson in 1935 (Brown 2004), initial applications of Q methodology were in the field of psychology. More recently the method has been applied to natural resource management (Webler and Tuler 2001, Asah et al. 2009), sustainability (Ray 2011, Clarke 2002, Sweden 2006) and environmental policy (Steelman and Maguire 1999, Webler et al. 2009). Q has been described as a useful tool for aiding the resolution of contentious environmental policy issues (Sweden 2006, Addams 2000) and applications to coastal management are growing (e.g., Tuler and Webler 2009, Bischof 2010).

Q method has been described as an alternative to conventional survey techniques (Woolley and McGinnis 2000, p. 341). The results of a Q study differs from typical survey methods by explaining the framework and underlying structure of existing viewpoints, instead of providing a description of the individuals or population involved in the test (van Excel and de Graf 2005). Q methodology uses statements that are naturally rendered or derived directly from the discourse of stakeholders (through interviews, written communications, etc.), rather than questions determined ahead of time by the researcher, leading to a process that is "relatively uncontaminated by scientist's intrusions" (Brown 1997, p. 14). Instead of responding to isolated statements, Q participants respond to and rank statements in relation to each other while considering the context of all statements included in the study (Webler et al. 2001, p. 437).

Factor analysis is performed to identify relevant statements that the researcher uses to create social narratives and to interpret group comprehension of the topic. Results illuminate areas and extent of consensus and disagreement on particular subjects.

Q methodology is a "small sample investigation" requiring a small number of participants rather than drawing upon a large population (van Excel and de Graf 2005, p. 3). Q utilizes suitably diverse and well-informed participants to demonstrate the range of points of view on the relevant topic and to show how these participants order and arrange the representative statements (Woolley and McGinnis 2000, p. 3). The findings of a Q study cannot be generalized beyond those that participated directly in the research, but do characterize real and operant perspectives on the issue or problem being studied (Asah et al. 2009, p. 17). While Q methodology allows for the development of a social perspective or "narrative" that can help to define a group of respondents, it is important to remember that no member of the group may ascribe exactly to this perspective. However, the social narrative best approximates the values of the entire group and is representative (Brown 1993).

Geoduck Aquaculture

The geoduck clam is a native to the Pacific Northwest's soft inter and sub-tidal aquatic lands with a range extending from Alaska to Baja California and possibly to Japan (Goodwin and Pease 1989, p. 1, Straus et al. 2009, p. 1). The largest burrowing clam in the world (NMFS 2009, p. 15) and a locally produced delicacy, the geoduck is a part of Northwest heritage – ensconced in song and poetry, numerous television programs, the mascot of Evergreen University, and the star of its very own festival. The clam has been a part of indigenous diets for centuries (Welch 2010, p. 48), is hunted recreationally for sport and supports a sub-tidal commercial fishery that began in the 1970s (WDFW 2012).

Geoduck aquaculture refers to the farming of geoduck clams on aquatic tidelands that began in the mid 1990s. In Puget Sound, geoduck aquaculture operations are primarily sited in intertidal and shallow subtidal areas of South Puget Sound, but are also present in Hood Canal, North Puget Sound and on the Straits of Juan de Fuca. Total acreage of farms is difficult to identify, the WDNR website says the total extent of private tidelands under cultivation is about 200 acres (WDNR 2012). However, discussions with growers, managers and non-governmental organizations put the number between 300-400 acres of private tidelands currently under cultivation. The total acreage of aquatic lands under shellfish cultivation in Washington in 2009 was 38,327 (NMFS 2009). Geoduck farming therefore represents less than one percent of the total acreage of shellfish farmed on state tidelands.

Relative to other forms of shellfish aquaculture in Washington State, geoduck clams are a new species to culture, and farming techniques are still evolving (NMFS 2009, p. 15). Oysters represent the majority of acreage of tidelands under culture and have been farmed for well over a century in Washington (Allen 2004). Manila clams and mussel culture are more recent but were well established by the mid 1970s. Those who have lived on the coast for some time have been exposed to these types of culture practices. In contrast, WDFW pioneered the initial techniques for hatchery and planting methods in the 1980s to enhance wild geoduck stocks on several public beaches (WDFW 2010). Commercial growers in Washington adapted the hatchery and planting methods and began farming on private tidelands within the past two decades (WDFW 2010).

After acquiring or raising geoduck seed (juveniles), the farming operation begins with site preparation that may involve raking and removal of debris, seaweed and other growth. Small sections of PVC tube are used to protect the geoduck seed. Rows of four to six inch diameter pieces of nine to twelve inch long PVC are placed on end, inserted into the substrate

leaving two to three inches exposed. Two to four geoduck seed are then added to each tube by hand (WDNR 2012). To defend against predators mesh netting may be placed over each tube and secured by rubber band or large sections of net may be extended over the tubes together or in place of individual nets to prevent wave damage and lost materials (NMFS 2009, p. 15).

After two years the predator nets and tubing are no longer needed and are removed for reuse or disposal in landfills. The geoducks reach a market size of about two pounds after four to seven years. Harvesting of clams takes place at low tide or with the use of divers at high tide (NMFS 2009, p. 15). A pressurized hose and nozzle (stinger) delivering approximately 20 gallons per minute of seawater at 40 pounds per square inch of pressure is used to soften surrounding sediment before removing the clam by hand (NMFS 2009, p. 15). A generator is used to power a water pump and lights (night tides), usually residing on a barge or boat offshore of harvesting operations (WDNR 2012). After harvest, the clams are taken directly to processing or distribution facilities, and are typically marketed in the live, fresh form (DeFrancesco and Murray 2010, p. 18).

The brief description of farming practices above is general and most common. From discussion with multiple growers including Brian Allen of Allen Shellfish LLC, not all farms use exactly the same practices and methods are evolving and changing (personal communication 6/29/2011). New techniques and materials are being developed as growers attempt to respond to knowledge gained from experience and research. For a more comprehensive discussion of geoduck aquaculture farming procedures, see Davis (2004).

The economic demand for geoduck has helped drive shellfish growers to increase the number of privately owned acres under geoduck cultivation. The continuing demand and high market value for wild and farmed geoduck was subject to a front page article in the Seattle times

on Sunday April 22, 2012 (Welch). The state legislature of Washington has shown interest in the potential revenue generation of leasing public tidelands for geoduck aquaculture and concern over the potential economic impact of increased supply from geoduck culture on market price (Northern Economics 2004). In 2003 the state legislature ordered WDNR to consider leasing public tidelands for geoduck farming (WDNR 2012).

Methods

Very generally, Q methodology is a systematic technique for studying subjective viewpoints, opinions and attitudes of individuals (Brown 1980, van Excel and de Graf 2005). All Q studies begin with a decision on a subject area of interest. Considering Q methodologies growing application to conflicted resource management situations (Sweden 2006, Steelman and Maguire 1999), geoduck aquaculture provides a model study subject with current contentions over the existence and growth of the industry. The length and public nature of the debate provides large numbers of documents for analyzing the discourse surrounding geoduck aquaculture. In addition, many stakeholders have been polarized by the debate and are looking for ways to be involved in participatory research.

The first step in Q methodology is to generate or define a "concourse", in this case the body of literature or "flow of communicability" covering the full range of topics pertinent to geoduck aquaculture (Brown 1993, p. 93, Webler et al. 2009, p. 5). This was done by using literature reviews and informal semi-structured interviews (Anderson and Killenberg 2009). Interviews were conducted with a broad range of stakeholders identified through public documents and through the interview process itself, referred to as "snowball" sampling (Goodman 1961). Research materials for the concourse included text from local newspapers, magazines, state and federal agency reports, journal articles, flyers, web sites and directly from interviews.

The second step is to select statements from the literature and interviews that represent the full range of values and opinions held by stakeholders. An unstructured sampling technique was followed (Steelman and Maguire 1999, p. 366) that considered the pertinence of each statement and the overall balance of pro, con and neutral statements (Eden et al. 2005, p. 417).

Statement collection was terminated when further analysis of literature and stakeholder interviews were no longer uncovering new viewpoints, indicating a saturation point had been reached (Asah et al. 2009, p. 13).

A total of 1,338 potential Q statements were generated that reflect the range of sentiments and positions regarding geoduck aquaculture. The list of statements was refined by removal of repetitive statements resulting in 1,182 statements. Further manipulation of statements was avoided to preserve the intent and meaning of the individual making the statement. Q statements were then subjected to a thematic analysis in which pro, con and neutral statements were grouped into like categories and sub-categories based on content. Primary, secondary and tertiary issues were identified based on the number of recurring statements related to each issue. Primary issue categories were; Natural systems, Land Use Conflict/Class Conflict, Legal/Management Environment, Public Education, Public Health, Economic Development, Cultural Value and Sustainability. Next, 55 statements (the Q set or Q sample) were chosen that balance pro, neutral and con viewpoints surrounding the primary issues identified by the thematic analysis. To ensure statement quality, statements were chosen to be as divergent as possible and to include "excess meaning" (Webler et al. 2009, p. 9) Secondary and tertiary issues were not included in further analysis so that focus would center on the primary issues surrounding the geoduck aquaculture debate. Statements were numbered 1-55 and printed individually on index cards.

In step three, coastal stakeholders were identified to participate in the study, referred to as the P-set (van Excel and de Graf 2005, p. 5). The method dictates that participants be chosen based on their having familiarity and knowledge of the topic, and that participants provide the most diverse range of opinions available (Brown 1980, p. Sweden 2006, p. 195). Selected participants included people who: are currently or were involved in geoduck aquaculture

planning and management activities; are active growers on private lands; study geoduck and geoduck aquaculture; represent non-governmental organizations active in geoduck aquaculture discussions; or are involved in public meetings and own land that is adjacent to or nearby geoduck aquaculture operations. Participants were assigned pseudonyms to protect privacy and to indicate which stakeholder group they most closely associate (See Table 2). Additionally, a number of student volunteers from the University of Washington were recruited to participate after completing a graduate level course on aquaculture that included instruction on geoduck aquaculture techniques.

To protect participant privacy the study was submitted to the University of Washington Human Subjects Division for review and approval before individuals were contacted. A total of 42 stakeholders were invited to participate in the Q study via email or phone, all were sent an introductory letter electronically (Appendix 1).

In step four, between June 2011 and December 2011 a total of 36 stakeholders participated in the Q sorting exercise. The sorting exercise took place at participant's homes, coffee shops, restaurants, work places, conferences and at the University of Washington. Each exercise began with an introduction to the research and reading and signing consent forms (Appendix 2). This was followed by the researcher providing a verbal and written "condition of instruction" for carrying out the procedure that also included a short post-sort survey (Appendix 3). Participants were each given a score sheet (Appendix 4) for recording data and a deck of index cards consisting of 55 statements. They were asked to read through the pile, then sort the cards into three piles based on how much they agreed, disagreed or felt neutral (unimportant or inconsequential) about the statement printed on the index card. This was followed by sorting the index cards in finer detail. The score sheet provided a forced quasi-normal distribution that

helped recipients to think carefully about each statement and systematically about the ranking process (Sweden 2006, p. 196, Steelman and Maguire 1999, p. 367). Participants sorted on a scale of +5 to -5 based on how much they agreed or disagreed with each statement and with zero indicating ambivalence or unimportance. After ranking all 55 cards and thoughtfully considering last changes, all statement numbers were added to the score sheet and double checked by the researcher. How the participants scored each statement is referred to as the Q sort. The post-sort survey allowed participants to record demographic information and elaborate on the statements that they agreed with the most or least. Participants were also asked for insight on the completeness of the Q set, their understanding of sustainable aquaculture, and to elaborate on how they identify themselves as a stakeholder. Throughout the sorting exercise the researcher took notes to record detailed observations on the process and comments from the participants. All told the process averaged 1.5 hours for each participant.

In step five each participant's Q sort data was factor analyzed. The 36 Q sorts were loaded into PQ Method version 2.11 software for quantitative analysis (Schmolck 2002). A correlation matrix of the 36 sorts was generated, followed by subjecting the matrix to principal component factor analysis. This resulted in 8 un-rotated factors (or perspectives) on geoduck aquaculture, all with Eigen values > 1. This was followed by varimax orthogonal rotation of the preliminary results. The factor analysis process requires judgment in determining the relevant factors (Webler and Tuler 2001, p. 32). For this reason, factors were selected based on the following conditions: (1) explanatory value > 7%, (2) at least two subjects loaded significantly, (3) the factor was theoretically important and (4) inter-factor correlations were <0.5.

To summarize, the general goal of a Q study is to display the diversity and salience of stakeholder perspectives on a general topic as these viewpoints are taken to reflect underlying

values and opinions. Q methodology first casts a wide net to collect candidate Q statements which constitute a foundation data set; this set is then systematically reduced to produce a final set of Q statements which are then presented to stakeholders for their consideration in a sorting task. In this case, 1338 candidate statements were collected and these ultimately generated 55 Q statements which were sorted by 36 stakeholders. Sorting data were then subjected to factor analysis as required by Q methodology.

Results

Identifying the relevant factors was a process of examination and re-examination. Factor solutions were calculated for 8, 7, 6, 5, 4, 3, and 2 factor rotations. Based on the criteria mentioned in the methods section, Q sort analysis resulted in identification of two significantly different factors, explaining 51% of the variance, on the primary issues surrounding geoduck aquaculture on Puget Sound tidelands. Table 1 provides composite (or idealized) Q sorts for each factor, providing a representation of how a hypothetical respondent with a 100% loading on the factor would have placed statements on the scorecard during the Q sort. Normalized factor scores, Z-scores, are provided along with Q sort values to provide finer distinction between Q sort rankings. Normalized factor scores identify the distance of each Q statement from the center of the idealized Q sort (Webler et al. 2009). A high positive value represents a statement from the far right hand side of the score sheet whereas low negative value represents a statement from the left (Appendix 4).

Table 1. Composite Q sort factor array with normalized Z-scores

#	Statement	Factors	
		1	2
1	Recreational and commercial shellfish beds are critical areas under the Shoreline Management Act.	1 (0.49)	0 (0.21)
2	The State of Washington now faces an important decision about whether to allow private geoduck aquaculture on state lands. This decision is multi faceted: it must include economic, biological, ecological and social factors.	4 (1.32)	5 (2.07)
3	The Department of Natural Resources should be far more interested in protecting NATURAL beauty resources than anything else.	-3 (-1.17)	-2 (-0.41)
4	The Department of Natural Resources must balance the public good including the revenue generation from resource lands.	1 (0.40)	4 (1.27)
5	Due to social conflict, a decision on leasing public tidelands for geoduck aquaculture will not be made under current Department of Natural Resources leadership, the state ordered Geoduck Aquaculture Research Program is not likely to influence the outcome.	0 (-0.01)	-1 (-0.19)

Table 1 continued

6	Regarding public access, one of the joys of what we do is being able to show our farms to people that have never seen the aquaculture process. In the locations where we farm, beach access has never become an issue.	0 (0.15)	-4 (-1.70)
7	Sustainable small-scale family farms that began over 100 years ago on Washington shorelines are being replaced by large-scale industrial operations without state or most counties requiring environmental permits.	-3 (-1.24)	1 (0.25)
8	The conversion of the few recreational beaches and tidelands of Puget Sound into "feedlots" that produce a non-essential commodity is not consistent with the stated mission or vision statement of the DNR or the mindset of the population of those who are residents of the Puget Sound area and those who visit this precious gem in our back yard.	-5 (-1.55)	2 (0.76)
9	If upland property owners do not wish to see geoduck farms on state tidelands then they should compensate the state for their personnel benefit at the states expense.	-1 (-0.50)	-5 (-1.82)
10	The Shoreline Management Act very clearly gives priority to single family residences and shoreline recreational uses over aquaculture as a preferred use.	-3 (-1.17)	0 (-0.06)
11	Inconsistent and confusing laws from multiple layers of local, county, state, and federal jurisdictions can produce an uncertain legal environment for the shellfish industry.	5 (1.56)	1 (0.42)
12	Expansion is a thorny issue, particularly for Non Governmental Organizations, who feel there is not enough science to support the carrying capacity of Puget Sound to support more commercial growing.	-1 (-0.18)	3 (1.13)
13	Still, some environmentalists and coastal homeowners want to block new farms and have existing ones dismantled.	0 (0.23)	1 (0.32)
14	The visual impact of the tubes and nets used to protect geoducks from predators has been identified as an issue that should be addressed.	0 (0.20)	3 (1.17)
15	As regulations continue to become more numerous and compliance more costly there exists the possibility that growers, especially smaller operations, will find it an economic impossibility to remain in business.	4 (1.48)	-2 (-0.52)
16	Until the geoduck aquaculture operations began in each of these neighborhoods, neighbors walked freely down the beach without seeing "No Trespassing signs" or receiving warnings.	-1 (-0.65)	-1 (-0.18)
17	As for aesthetics? All shellfish farms are just plain ugly. They disrupt the natural beauty and habitat function of the tidelands. They cause noise and debris pollution to nearby residents.	-5 (-1.75)	-1 (-0.14)
18	Unfortunately, we have encountered people who had no interest in the farm activity or beach ecology; they simply wanted to berate our employees or take photos that could be manipulated to show an anti-aquaculture point of view.	1 (0.52)	-3 (-1.04)

Table 1 continued

19	I don't understand why the state would spend millions (billions) to restore habitat for the benefit of wildlife while at the same time consider leasing pristine shoreline for the expansion of industrial shellfish cultivation.	-2 (-1.14)	3 (0.96)
20	Many of our shellfish farms have co-existed with residential uses for decades, and we have largely enjoyed very positive relationships with our neighbors.	2 (0.90)	-1 (-0.34)
21	Shellfish growing operations that restrict foot or boat traffic in nearshore waters or tidal areas face issues of public use and access rights.	-1 (-0.13)	5 (1.74)
22	Even if the vocal complainers won't admit it, their sole issue is about aesthetics, and everything else is a smokescreen.	-1 (-0.16)	-5 (-2.22)
23	Growers support education, outreach, research and public policies that ensure activities in their watersheds are understood and negative impacts on the marine ecosystem are minimized.	3 (1.24)	-2 (-0.58)
24	Public beaches, boat launches and upland residential developments might conflict with geoduck operations.	0 (0.05)	2 (0.71)
25	Industry can try to make it sound like they are doing this to help provide working wage jobs, but it is clear that the main people that benefit are the owners at the expense of the citizens of Washington.	-3 (-1.37)	4 (1.33)
26	Farmed oysters, clams, mussels and geoducks contribute approximately $100 million annually (refers to farmgate/wholesale value).	2 (0.64)	0 (0.01)
27	There's a close link between commercial shellfish production and shellfish restoration. Combined the two approaches could make a significant contribution to restoring water quality in coastal waters.	5 (1.49)	-3 (-1.32)
28	Presently, geoduck are commercially farmed on about 150 acres - 1/1000th of Washington's total tidelands. By contrast, DNR estimates there are 44,000 acres of sub-tidal wild geoduck beds.	0 (0.15)	-1 (-0.24)
29	Don't forget there is an economic value to shipping them overseas to the Chinese and Japanese markets. This is not a bad thing considering our balance of trade in this country.	1 (0.61)	-2 (-0.37)
30	Property owners on waterfront bought that property to be away from industrial noise and pollution. We do not need to be subjected to private use of the beaches for profit of private industry.	-2 (-1.13)	3 (1.14)
31	Farmed geoduck provides crucial living wage jobs in struggling rural economies. For example in Pacific County shellfish culture represents the single largest employer and in Mason County it is second.	3 (1.12)	-2 (-0.56)
32	Shellfish farming has a long and proud tradition in Washington. Shellfish has been grown commercially here for more than 150 years - before statehood - and many farmers are the fourth and fifth generation in their families to grow shellfish.	3 (1.19)	0 (0.11)
33	Private culture production has the potential to lower - perhaps substantially- the world ex-vessel price for geoduck.	-1 (-0.47)	-1 (-0.34)

Table 1 continued

34	There is a paucity of peer-reviewed information on *Panopea generosa* or its congeners (relatives).	0 (0.12)	-1 (-0.19)
35	Clearly the development of geoduck aquaculture operations in a site will initiate or alter a number of geochemical and ecological processes potentially significant to local habitats and benthic communities.	-2 (-0.78)	5 (1.42)
36	Leasing State-owned inter-tidal lands could represent a significant source of revenue for the Department of Natural Resources.	2 (0.67)	0 (-0.06)
37	Geoduck and other types of shellfish farming also provide lease income to some tideland owners who face increasing shoreline taxes.	2 (0.75)	1 (0.32)
38	The geoduck is a Pacific Northwest celebrity	0 (0.19)	0 (-0.09)
39	Shellfish farming is a clean industry and the private firms practicing in our area have been strong advocates for continued water quality improvements thereby enhancing our tourism efforts.	3 (1.03)	-3 (-1.15)
40	In addition to a robust demand from Asia, domestic demand for geoduck is increasing, but the capture fishery cannot satisfy demand in an ecologically sustainable fashion.	1 (0.56)	-3 (-0.92)
41	Many people were injured by stepping on or tripping over tubes. Swimmers were entangled in the netting. Several windsurfers were injured by hitting junk in the water.	-2 (-1.16)	-2 (-0.59)
42	Why are polluting our waterways for a food that is not largely consumed by Americans but rather exported to other countries?	-4 (-1.38)	1 (0.46)
43	Clearly, model selection is an important step, and location may be highly influential in estimating carrying capacity and determining appropriate siting for a farm.	1 (0.51)	2 (0.79)
44	Upland property owners have a right to the quality and enjoyment of life that they expected when they purchased the property.	-2 (-0.77)	2 (0.75)
45	For the shoreline aquaculture opposition groups, the science is moot. They do not care what the best available science reveals.	2 (0.64)	-4 (-1.82)
46	The current available science tells us that geoduck aquaculture does have adverse impacts on the ecosystem and habitat.	-4 (-1.37)	1 (0.27)
47	With coastal populations on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site septic systems, storm water runoff, domestic animal waste, increased recreational use without adequate facilities, and increasing population densities in the Puget Sound watershed.	5 (1.89)	4 (1.30)
48	The bottom line is that the main benefit that this industry can claim is that the export increases for the governor's report, but few dollars really reach the citizens of the state.	-4 (-1.39)	1 (0.52)
49	Considerable research has shown that the environmental issues raised by these opponents are unfounded and that geoduck farming does not harm the environment.	0 (0.16)	-5 (-2.59)

Table 1 continued

50	Industrial geoduck sites are the equivalent of a cattle feed lot parked on the floor of the Puget Sound.	-5 (-2.15)	0 (0.01)
51	Geoducks are the target of the most economically important clam fishery in North America.	1 (0.26)	0 (-0.13)
52	The results from our ongoing research will help enable better-informed management decisions and will assist managers in moving beyond responses to public demands based solely on speculation concerning geochemical and ecological effects.	4 (1.35)	2 (0.70)
53	Most of the harvest goes to China, where cooks in Shanghai and Beijing simmer the clams in hot pots. A single geoduck may fetch $60 in a Hong Kong fish market.	-1 (-0.04)	0 (-0.02)
54	With no use of herbicides, pesticides, antibiotics, growth hormones or feed, this is THE most sustainable food production system.	2 (0.93)	-4 (-1.41)
55	The few jobs that new geoduck farms would provide are far outweighed by the risks to jobs fishing, recreation, tourism, retirement communities and many other sectors for which the desirability of Puget Sound, including environmental health, is a draw.	-2 (-1.12)	2 (0.89)

Table 2 provides factor loading scores for each stakeholder on both factors. This reveals the extent to which each participant associates with the two perspectives. Loading scores range from +1.00 (indicating complete agreement with the factor) to -1.00 (indicating complete dissimilarity or disagreement with the viewpoints that define this factor). Values in bold represent individuals that are loading significantly for that factor. Standard error for factor loadings was calculated using the equation $SE = 1/\sqrt{N}$, with N representing number of items (statements) in the Q sample (McKeon and Thomas 1988, p. 50). Consequently, for our sample $SE = 1/\sqrt{55} = 0.1348$. Factor loadings that exceeded 2.58*SE = +/-0.347 are therefore significant at the .01 level ($P<0.01$). The factor matrix has clarity and simplicity, suggesting participants had well thought out and distinct viewpoints regarding geoduck aquaculture (Webler and Tuler 2001).

Table 2. Factor loading scores for each participant and stakeholder identification

Participant Number	Q Sorts/Participant ID	Loadings	
		Factor 1	Factor 2
1	UWAquacultureStudent-1	0.1928	0.2249
2	UWAquacultureStudent-2	**0.637**	0.0469
3	UWAquacultureStudent-3	**0.4809**	-0.042
4	UWAquacultureStudent-4	**0.5978**	0.1334
5	UWAquacultureStudent-5	**0.4027**	0.2786
6	UWAquacultureStudent-6	**0.6473**	0.0235
7	UWAquacultureStudent-7	**0.6559**	-0.3036
8	Geoduck Grower-1	**0.7856**	-0.094
9	Geoduck Grower-2	**0.7847**	-0.2686
10	Geoduck Grower-3	**0.7537**	-0.3417
11	Geoduck Grower-4	**0.8661**	-0.2144
12	Geoduck Grower-5	**0.7943**	-0.2692
13	Geoduck Grower-6	**0.7556**	-0.2887
14	Tribe Member (Suquamish)	**0.6711**	-0.0337
15	Tribe Member (Lummi)	**0.6454**	-0.1184
16	GeoduckAcadScientist-1	**0.793**	0.264
17	GeoduckAcadScientist-2	**0.8198**	0.1517
18	GeoduckAcadScientist-3	**0.7122**	0.1704
19	GeoduckAcadScientist-4	**0.5057**	**0.4827**
20	GeoduckAcadScientist-5	**0.5399**	**0.5565**
21	Waterfront Landowner-1	-0.3366	**0.6474**
22	Waterfront Landowner-2	-0.3029	**0.6648**
23	Waterfront Landowner-3	**-0.3599**	**0.5677**
24	Waterfront Landowner-4	-0.3167	**0.6876**
25	Waterfront Landowner-5	0.0546	**0.6219**
26	Waterfront Landowner-6	-0.0741	**0.7148**
27	Waterfront Landowner-7	0.2187	**0.7071**
28	Manager-1 (Federal, NOAA)	**0.8421**	0.1996
29	Manager-2 (PS Partnership)	**0.8676**	-0.0385
30	Manager-3 (WDOH)	**0.6394**	-0.0068
31	Manager-4 (WDFW)	**0.5088**	0.0034
32	Tribal NatResManager-1	**0.7713**	-0.2049
33	Tribal NatResManager-2	**0.6847**	0.2495
34	Env NGO (Trout Unlimited)	0.1183	**0.5474**
35	Env NGO (Sierra Club)	-0.3372	**0.6789**
36	Env NGO (People for PS)	0.273	**0.4031**
	% Explanatory Value	**36%**	**15%**
	Total Defining Q Sorts	**24**	**11**
	Total Loading	**26**	**12**

Each factor, also called a perspective or discourse, represents a set of highly correlated viewpoints that are uncorrelated with other viewpoints (van Excel and de Graf 2005, p. 9) and can be interpreted as clusters of participants with statistically similar Q sorts. The typical method for describing results of a factor analysis is to create a title for each factor and to provide a narrative for each (Webler et al. 2001, p. 439). In this case the narratives describe differing viewpoints on the primary issues surrounding the farming of geoduck. The two perspectives are described in the following sections along with stakeholders associated with each perspective.

In passing, it is noted that while it is commonplace among Q methodologists to label underlying perspectives, this convention is not followed here. The utility of named perspectives is that the labels provide overarching terms of reference which can simplify presentation of results, especially when factor analysis has revealed more than a few perspectives. However, perspective labels—precisely because they are generalizations—also can lead readers to underestimate the internal complexities of a perspective. In addition, perspective labels have the potential to lead stakeholders (as opposed to analysts) to overemphasize differences between different perspectives and impede, rather than foster productive dialogue among stakeholders. This can be the case if, for example, perspectives are labeled in ways which have strong "positive/negative" or "good/bad" connotations (e.g., "pro-literacy perspective" vs. "anti-literacy perspective," or "conservation perspective" vs. "development perspective").

Perspective l

Participants in this group believe increasing coastal populations and their activities degrade water quality and threaten shellfish growing areas (47), and that a combination of commercial shellfish production and shellfish restoration could help to restore Puget Sound water quality (27). They think the shellfish industry faces an uncertain legal environment due to inconsistent and

confusing laws enforced by multiple layers of government (11) and as costs of compliance increase, growing operations, especially smaller operations, could become unprofitable and close (15). They disagree that small sustainable farms are being replaced by unregulated/unpermitted large-scale industrial operations (7).

They believe results of research from the GARP program administered by WSG will enable informed management decisions, helping management move beyond public demands based on speculated environmental impacts (52). They agree WDNR has an important decision to make regarding allowing private geoduck farms on public tidelands and think the decision should be based on economic, biological, ecological and social factors (2). They disagree with characterizing geoduck farms as "feedlots" producing non-essential commodities for foreigners and do not think public leasing is inconsistent with WDNR mandates (8). They reject the idea that the Shoreline Management Act gives clear priority to single family residences and tourism over aquaculture (10), and that WDNR should protect natural beauty above all else (3).

Stakeholders with this perspective think commercial shellfish growing is a proud and important part of Washington's heritage, going back 150 years, with farms often passed down to the next generation (32). They think growers support education, outreach, research and public policies that help people understand their activities and that reduce marine ecosystem impacts (23). They believe shellfish farming provides important jobs to rural coastal communities (31) and reject the statement that few dollars reach state citizens and benefit only the grower's income (25) and governor's export reports (48). Stakeholders believe that it is a clean industry that advocates for clean water, thereby enhancing local efforts to increase tourism (39). They disagree that current science indicates geoduck culture has a negative environmental impact (46), and they strongly disagree that geoduck farming can be compared to a cattle feed lot (50) and

that all farms disrupt natural beauty and are ugly while causing noise pollution and marine debris (17). See Table 3 for the normalized factor scores for statements that define perspective one.

Table 3. Normalized factor scores for the Perspective 1 (P<0.01)

#	Statement	Z Scores
47	With coastal populations on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site septic systems, storm water runoff, domestic animal waste, increased recreational use without adequate facilities, and increasing population densities in the Puget Sound watershed.	1.89
11	Inconsistent and confusing laws from multiple layers of local, county, state, and federal jurisdictions can produce an uncertain legal environment for the shellfish industry.	1.56
27	There's a close link between commercial shellfish production and shellfish restoration. Combined the two approaches could make a significant contribution to restoring water quality in coastal waters.	1.49
15	As regulations continue to become more numerous and compliance more costly there exists the possibility that growers, especially smaller operations, will find it an economic impossibility to remain in business.	1.48
52	The results from our ongoing research will help enable better-informed management decisions and will assist managers in moving beyond responses to public demands based solely on speculation concerning geochemical and ecological effects.	1.35
2	The State of Washington now faces an important decision about whether to allow private geoduck aquaculture on state lands. This decision is multi faceted: it must include economic, biological, ecological and social factors.	1.32
23	Growers support education, outreach, research and public policies that ensure activities in their watersheds are understood and negative impacts on the marine ecosystem are minimized.	1.24
32	Shellfish farming has a long and proud tradition in Washington. Shellfish has been grown commercially here for more than 150 years - before statehood - and many farmers are the fourth and fifth generation in their families to grow shellfish.	1.19
31	Farmed geoduck provides crucial living wage jobs in struggling rural economies. For example in Pacific County shellfish culture represents the single largest employer and in Mason County it is second.	1.12
39	Shellfish farming is a clean industry and the private firms practicing in our area have been strong advocates for continued water quality improvements thereby enhancing our tourism efforts.	1.03
10	The Shoreline Management Act very clearly gives priority to single family residences and shoreline recreational uses over aquaculture as a preferred use.	-1.17
3	The Department of Natural Resources should be far more interested in protecting NATURAL beauty resources than anything else.	-1.17

Table 3 continued

7	Sustainable small-scale family farms that began over 100 years ago on Washington shorelines are being replaced by large-scale industrial operations without state or most counties requiring environmental permits.	-1.24
25	Industry can try to make it sound like they are doing this to help provide working wage jobs, but it is clear that the main people that benefit are the owners at the expense of the citizens of Washington.	-1.37
46	The current available science tells us that geoduck aquaculture does have adverse impacts on the ecosystem and habitat.	-1.37
42	Why are polluting our waterways for a food that is not largely consumed by Americans but rather exported to other countries?	-1.38
48	The bottom line is that the main benefit that this industry can claim is that the export increases for the governor's report, but few dollars really reach the citizens of the state.	-1.39
8	The conversion of the few recreational beaches and tidelands of Puget Sound into "feedlots" that produce a non-essential commodity is not consistent with the stated mission or vision statement of the DNR or the mindset of the population of those who are residents of the Puget Sound area and those who visit this precious gem in our back yard.	-1.55
17	As for aesthetics? All shellfish farms are just plain ugly. They disrupt the natural beauty and habitat function of the tidelands. They cause noise and debris pollution to nearby residents.	-1.75
50	Industrial geoduck sites are the equivalent of a cattle feed lot parked on the floor of the Puget Sound.	-2.15

There were twenty six stakeholders that significantly agreed with this perspective. Several stakeholder groups are clearly associated with this perspective. Included were all six stakeholders representing geoduck growers, all five academic geoduck research scientists, all four federal and state managers, both tribal natural resource managers, both tribe members, and six out of seven aquaculture students. Two of the five academic scientists were confounders, loading on both perspectives. There is one stakeholder (Waterfront Landowner-3) that significantly disagrees with this perspective, and four other stakeholders categorized as waterfront landowners that disagreed with this perspective but not to a level that is significant. One student does not load on either perspective, review of factor solutions showed this individual had a unique perspective, not shared by other participants.

Perspective 2

Perspective 2 stakeholders agree WDNR has an important decision to make regarding allowing private geoduck farms on public tidelands and think the decision should be based on economic, biological, ecological and social factors (2) and that public use and access rights are an issue when farms impede foot and boat traffic (21). At the same time they agree that WDNR must balance public good, including revenue generation from public land (4). They reject the idea that growers welcome visitors to their farms and that beach access is not an issue (6). They consider the potential impact to habitat caused by culture operations counter to state spending on Puget Sound cleanup and restoration (19).

Participants with this perspective believe increasing coastal populations and their activities degrade water quality and threaten shellfish growing areas (47) and geoduck aquaculture development causes significant change to geochemical and ecological processes potentially impacting local habitats (35). They think non-governmental organizations find geoduck culture expansion to be a "thorny" issue because science does not support increasing Puget Sound aquaculture capacity (12). Stakeholders reject the belief that geoduck farming is a clean industry that advocates for clean water, thereby enhancing local efforts to increase tourism (39) and do not agree that a combination of commercial shellfish production and shellfish restoration could help to restore Puget Sound water quality (27). They strongly disagree with that available science supports geoduck aquaculture development and opponent's environmental concerns are unfounded (49). They also disagree science is a moot point to opposition groups and reject the statement that these groups do not care what best available science reveals (45). Stakeholders in this group do not believe that lack of pesticides, herbicides, growth hormones or

feed make geoduck culture sustainable (54) nor the premise that rising local and international demand will not be met sustainably by the wild geoduck fishery (40).

These participants think the geoduck industry is being misleading about creation of working wage jobs, and that benefits go to farm owners at the expense of citizens (25). They believe people buy waterfront property to escape industrial noise and pollution and should not be subjected to tideland activities that profit private industry (30). They reject the idea that upland property owners adjacent to public tidelands should compensate the state to prevent aquaculture development (9). They agree the aesthetic impact of tubes and nets have been identified as an issue that must be addressed (14) but disagree with the assertion that vocal complainers are only concerned with aesthetics, using other arguments as a smokescreen (22). These stakeholders disagree with grower accusations that opponents approach, berate employees and take photos that are manipulated to support an anti-aquaculture perspective (18). See Table 4 for the normalized factor scores for statements that define perspective two.

Table 4. Normalized factor scores for Perspective 2

#	Statement	Z Scores
2	The State of Washington now faces an important decision about whether to allow private geoduck aquaculture on state lands. This decision is multi faceted: it must include economic, biological, ecological and social factors.	2.07
21	Shellfish growing operations that restrict foot or boat traffic in nearshore waters or tidal areas face issues of public use and access rights.	1.74
35	Clearly the development of geoduck aquaculture operations in a site will initiate or alter a number of geochemical and ecological processes potentially significant to local habitats and benthic communities.	1.42
25	Industry can try to make it sound like they are doing this to help provide working wage jobs, but it is clear that the main people that benefit are the owners at the expense of the citizens of Washington.	1.33
47	With coastal populations on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site septic systems, storm water runoff, domestic animal waste, increased recreational use without adequate facilities, and increasing population densities in the Puget Sound watershed.	1.3

Table 4 continued

4	The Department of Natural Resources must balance the public good including the revenue generation from resource lands.	1.27
14	The visual impact of the tubes and nets used to protect geoducks from predators has been identified as an issue that should be addressed.	1.17
30	Property owners on waterfront bought that property to be away from industrial noise and pollution. We do not need to be subjected to private use of the beaches for profit of private industry.	1.14
12	Expansion is a thorny issue, particularly for Non Governmental Organizations, who feel there is not enough science to support the carrying capacity of Puget Sound to support more commercial growing.	1.13
19	I don't understand why the state would spend millions (billions) to restore habitat for the benefit of wildlife while at the same time consider leasing pristine shoreline for the expansion of industrial shellfish cultivation.	0.96
40	In addition to a robust demand from Asia, domestic demand for geoduck is increasing, but the capture fishery cannot satisfy demand in an ecologically sustainable fashion.	-0.92
18	Unfortunately, we have encountered people who had no interest in the farm activity or beach ecology; they simply wanted to berate our employees or take photos that could be manipulated to show an anti-aquaculture point of view.	-1.04
39	Shellfish farming is a clean industry and the private firms practicing in our area have been strong advocates for continued water quality improvements thereby enhancing our tourism efforts.	-1.15
27	There's a close link between commercial shellfish production and shellfish restoration. Combined the two approaches could make a significant contribution to restoring water quality in coastal waters.	-1.32
54	With no use of herbicides, pesticides, antibiotics, growth hormones or feed, this is THE most sustainable food production system.	-1.41
6	Regarding public access, one of the joys of what we do is being able to show our farms to people that have never seen the aquaculture process. In the locations where we farm, beach access has never become an issue.	-1.7
45	For the shoreline aquaculture opposition groups, the science is moot. They do not care what the best available science reveals.	-1.82
9	If upland property owners do not wish to see geoduck farms on state tidelands then they should compensate the state for their personnel benefit at the states expense.	-1.82
22	Even if the vocal complainers won't admit it, their sole issue is about aesthetics, and everything else is a smokescreen.	-2.22
49	Considerable research has shown that the environmental issues raised by these opponents are unfounded and that geoduck farming does not harm the environment.	-2.59

There were twelve stakeholders significantly associated with this perspective. This included all seven waterfront landowners, all three non-governmental organization members and two academic scientists that loaded on both factors (confounders).

Comparing Perspectives

For the two perspectives, there were two multiple positive loaders representing participants with viewpoints that may be described as a hybrid perspective or an ability to see more than one side of the issue (Geoduck Academic Scientist-4 and -5). There was one non-loader, a participant that does not significantly agree or disagree with either perspective (UW Aquaculture Student-1).

One participant (Waterfront Landowner-3), has a significant positive loading score on perspective two and significant negative loading score on perspective one. Significant loadings that occur at both positive and negative ends of a perspective indicate bipolarity. While no other participants had significant negative loadings on Perspective 1 or 2, five of seven waterfront landowners and one of three NGO members loaded negatively on perspective one. All six geoduck growers, two managers, two tribal members, one tribal natural resource manager and two students had non-significant negative loadings on perspective two. Consequently, for both perspectives evidence of bipolarity and disagreement are present. See Table 5 for inter-perspective correlations, correlations values are determined from the standardized Z-scores for each statement representing a perspective. The correlation value extends from -1 to +1, with

Table 5. Inter-perspective correlation values for Perspective 1 and 2

Perspective	1	2
1	1.00	
2	-0.1696	1.00

opposite ends of the range representing opposing viewpoints and disagreement. The negative correlation value between perspective one and two (-0.1696) indicates the disagreement.

Consensus, Agreement and Disagreement Statements

Although the two perspectives are distinct, there are many common viewpoints between them. Viewpoints that are agreed upon or disagreed upon by participants identifying with either perspective provide common ground that is useful for shedding light on differences and "give direction for how the group can move forward" (Webler et al. 2009, p. 35). There were twelve Q-defined consensus statements. In Q methodology a consensus statement is identified when all perspectives agree or disagree with a statement and there is no significant difference between levels of agreement or disagreement (Asah 2009, p. 27). These statements do not distinguish between either perspective. Four Q-defined consensus statements were agreed upon by participants from both perspectives, including statements; 1, 13, 37, and 43 (See Table 6 for consensus statements and associated Z-scores). Four Q-defined consensus statements were disagreed upon by participants from both perspectives, including statements; 5, 16, 33, and 53. Four Q-defined consensus statements were not technically agreed upon by both perspectives but had Z-scores that were not significantly different, including statements; 28, 34, 38, and 51.

It is possible to have consensus without having exactly the same levels of agreement or disagreement. Consequently, in addition to the Q defined consensus statements both perspectives agree at varying levels with the following nine statements: 2, 4, 11, 14, 24, 26, 32, 47 and 52 (see Table 1). Two of these statements were used to define both social perspectives; Statement 2: "The State of Washington now faces an important decision about whether to allow private geoduck aquaculture on state lands" and Statement 47: "With coastal populations

Table 6. Consensus statements that do not distinguish between either perspectives. Statements are non-significant at P>0.01, statements flagged with as * are also non-significant at P>0.05

#	Statement	Factors	
		1	2
1	*Recreational and commercial shellfish beds are critical areas under the Shoreline Management Act.	0.49	0.21
5	*Due to social conflict, a decision on leasing public tidelands for geoduck aquaculture will not be made under current Department of Natural Resources leadership, the state ordered Geoduck Aquaculture Research Program is not likely to influence the outcome.	-0.01	-0.19
13	*Still, some environmentalists and coastal homeowners want to block new farms and have existing ones dismantled.	0.23	0.32
16	Until the geoduck aquaculture operations began in each of these neighborhoods, neighbors walked freely down the beach without seeing "No Trespassing signs" or receiving warnings.	-0.65	-0.18
28	Presently, geoduck are commercially farmed on about 150 acres - 1/1000th of Washington's total tidelands. By contrast, DNR estimates there are 44,000 acres of sub-tidal wild geoduck beds.	0.15	-0.24
33	*Private culture production has the potential to lower - perhaps substantially- the world ex-vessel price for geoduck.	-0.47	-0.34
34	*There is a paucity of peer-reviewed information on *Panopea generosa* or its congeners (relatives).	0.12	-0.19
37	Geoduck and other types of shellfish farming also provide lease income to some tideland owners who face increasing shoreline taxes.	0.75	0.32
38	*The geoduck is a Pacific Northwest celebrity	0.19	-0.09
43	*Clearly, model selection is an important step, and location may be highly influential in estimating carrying capacity and determining appropriate siting for a farm.	0.51	0.79
51	Geoducks are the target of the most economically important clam fishery in North America.	0.26	-0.13
53	*Most of the harvest goes to China, where cooks in Shanghai and Beijing simmer the clams in hot pots. A single geoduck may fetch $60 in a Hong Kong fish market.	-0.04	-0.02

on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site septic systems, storm water runoff, domestic animal waste, increased recreational use without adequate facilities, and increasing population densities in the Puget Sound watershed .

This decision is multi faceted: it must include economic, biological, ecological and social factors." These two statements in particular may provide some common ground between participants with differing perspectives.

Viewpoints that both perspectives disagree upon also provide common ground that may present a direction for decreasing tension between stakeholders. Both perspectives disagree at varying levels with the following six statements: 3, 9, 10, 17, 22 and 41 (see Table 1).

Highly Contentious Statements

Analysis identified four issues that can be described as highly contentious between Perspective 1 and Perspective 2 (Table 7). These statements are defined as highly contentious based on previous work (Bischof 2010, p. 609). Using this technique a Q defined highly contentious statements is one with a gap value greater > 6. Gap values are the difference between composite Q sample rankings. For example, statement 27 received a +5 from Perspective 1 and -3 from holders of Perspective 2 resulting in a gap value of 8. Large gap values stress the importance and magnitude of this statement in relation to geoduck culture. On the other hand, the difference between rankings for statement 36 resulted in a gap value of 2 indicating a low amount of contention over the content of the statement. Table 7 lists the highly contentious statements along with composite factor rankings and gap values for each statement.

Table 7. Highly contentious statements (gap value>6)

#	Statement	Perspectives		Gap
		1	2	Value
27	There's a close link between commercial shellfish production and shellfish restoration. Combined the two approaches could make a significant contribution to restoring water quality in coastal waters.	5	-3	8

Table 7 continued

25	Industry can try to make it sound like they are doing this to help provide working wage jobs, but it is clear that the main people that benefit are the owners at the expense of the citizens of Washington.	-3	4	7
8	The conversion of the few recreational beaches and tidelands of Puget Sound into "feedlots" that produce a non-essential commodity is not consistent with the stated mission or vision statement of the DNR or the mindset of the population of those who are residents of the Puget Sound area and those who visit this precious gem in our back yard.	-5	2	7
35	Clearly the development of geoduck aquaculture operations in a site will initiate or alter a number of geochemical and ecological processes potentially significant to local habitats and benthic communities.	-2	5	7

Statement 25 and 35 are particularly good examples of contentious issues that Q methodology has identified, providing specific topics to be addressed through research and outreach. Statement 25 concerns perceptions of economic impact and job creation potential of geoduck culture. Perspective 2 strongly agrees with this statement which claims that geoduck growers use job creation to hide their large economic gains, while citizens of the state lose (public access, environmental degradation). Perspective 1 disagrees with this perspective, believing local job growth is both real and important, and that the state generates revenue from farming tidelands while the farming practices are sustainable. The need for research that provides evidence of the economic benefits of shellfish culture to the state of Washington has been an ongoing topic of discussion in the aquaculture community (Rasmussen, personal communication, 3/19/2012). While economics research related to shellfish aquaculture is underway at Pacific Shellfish Institute (Hudson 2012, Cheney et al. 2012), work that measures economic benefits of geoduck aquaculture independent of other culture methods would be most useful for addressing statement 25. Economics research specific to geoduck culture could help

provide insight on revenue generation for growers and the state, and resolve inconsistencies between the two perspectives.

Statement 35 deals with one of the central themes of the geoduck aquaculture debate, the potential geochemical and ecological impacts of planting, maintenance and harvest. Holders of Perspective 2 strongly believe there are negative environmental impacts associated with culture while Perspective 1 disagrees. Peer reviewed literature on geoduck culture impacts is limited (Straus et al. 2009). However, preliminary results from the GARP program that began in 2008 are being finalized and initial results have been presented by researchers. When finalized and published these results will represent peer reviewed science that directly addresses several aspects of the environmental sustainability of geoduck culture. The appearance of this statement as contentious suggests results of the GARP could help all stakeholders better understand the environmental impacts of geoduck culture and thereby reduce confusion over perceived and real impacts of culture methods. The importance of this statement may also support further exploration into the long-term impacts of culture methods and other aspects of contention such as plastics pollution. Some opponents continue to point out the limitations of the preliminary results reported by GARP researchers and lack of research on plastics pollution (Woodwirth and Penberthy 2012).

Discussion

In the context of coastal resource management in the Puget Sound, four findings potentially are significant to resource managers and research organizations. First, two social perspectives were identified that resulted in social narratives that provide insight on participants involved in the geoduck debate. Second, it was indicated which participants agree or disagree with each perspective. Third, it was shown that while there is strong disagreement between holders of Perspective 1 and 2, there are areas of strong consensus indicating some agreement and providing common ground for all participants.

Finally, Q exposed highly contentious statements and suggest to management agencies, non-governmental organizations or stakeholder groups that the content of these statements are a starting point for research and outreach that could help to de-escalate the geoduck aquaculture debate. The implications of these four statements for particular research institutions and state agencies follow.

Strong disagreement exists over the ecological benefits and link between commercial shellfish culture and shellfish restoration. Statement 27 points toward an area that might be addressed with existing research and outreach as considerable research exists on this topic (NRC 2010). Four participants, two natural resource managers and two geoduck academic scientists, were asked to comment on the contentious statements identified in the Q study, all professed surprise that statement 27 was the most contentious statement. It is suggested that WSG or the Pacific Shellfish Institute (PSI) could increase efforts to disseminate current knowledge on the link between commercial shellfish growing and shellfish restoration activities. Research that is focused specifically on how geoduck culture links to shellfish restoration does not exist at this time, providing a potential area for WSG to focus further academic research.

The Pacific Shellfish Institute (PSI) is a 501(c)(3) non-profit organization that was created in 1995 to conduct research and disseminate information related to shellfish issues. PSI and several partners have research underway that will quantify the economic impact of shellfish culture in Washington (Hudson 2012). PSI and partners have also finished and disseminated research considering economic value associated with ecological impacts of culture and restoration activities in Washington (Cheney et al. 2012). While previous economics research exists and ongoing research is both useful and timely, it does not address statement 25 directly. Statement 25 focused on the disagreement over the economic growth and job potential of geoduck culture. To more directly address debate regarding the economic impact and job potential of geoduck farming, research needs to be conducted that considers the value of geoduck alone.

Interviews with stakeholders and participants identifying with either perspective commonly recognized confusion regarding WDNR's duties as a state agency responsible for managing the use or non-use of public tidelands. This is demonstrated in statement 8, which includes direct reference to the WDNR mission statement. Holders of perspective 1 may have disagreed with more than one facet of this statement, however in light of interviews it can be concluded that strong disagreement remains regarding how WDNR should proceed with a public leasing program for geoduck culture. Contention over how WDNR should balance its role continues despite WDNR having a visible mission statement available on their agency website. While WDNR has worked to notify coastal stakeholders of planning and management activities, further outreach and direct communication with affected stakeholders seems to be warranted. These communications should attempt to clarify the agencies management goals as well as keep coastal stakeholders informed and engaged in planning and decision making activities.

It was not a surprise to find disagreement over the ecological and geochemical impacts of aquaculture. Interviews and concourse development identified numerous statements in which stakeholders had opposing viewpoints and supporting evidence. Statement 35 demonstrates the ongoing debate revolving around environmental impacts. This finding suggests it will be important for WSG to make results of the GARP research projects widely available and pursue peer review of research results. Preliminary results have been made available and presented in public meetings. Continued contention suggests final results should be disseminated as soon as possible. Further, peer review of results would add a level of credibility and validity that would be useful for managers and stakeholders in addressing environmental concerns. The debate that continues despite preliminary GARP findings (PCC 2012) also suggests further research may be necessary. Research into plastics pollution and long-term sustainability of culture activities are recommended to address stakeholder concerns over the impacts of geoduck aquaculture activities.

The viewpoints and perspectives identified in this research, similar to all applications of Q methodology, cannot be generalized across the public. However, the perspectives that have been identified are real and operant among coastal stakeholders involved in geoduck aquaculture discussions. Moreover, it is not uncommon to use the results of a Q study to inform a survey that can then utilized on a large scale that would allow findings to be generalized across a population. Danielson (2009) provides guidance on using Q method to develop social surveys. This would allow survey development with a more limited influence from those creating the survey. The original Q statements were generated from the stakeholders, in essence allowing the stakeholders help frame the questions. It is suggested that the Q defined highly contentions statements, consensus statements and disagreement statements would be instructive in this process.

In considering the potential limitations of Q methodology it is important to consider that perceptions can be missed if key stakeholders do not participate. While serious effort was made to incorporate as wide a range of participants as possible, funding was unavailable to add more participants. While WDNR and WDOE employees were helpful as key informants and provided interviews, request for study participants were denied. As coastal management agencies directly involved in geoduck aquaculture their perspectives are important and would have been useful. Q studies are also limited by the number of statements in the study, thereby limiting the breadth of expression of the participants (Danielson et al. 2010, p. 95). Many different issues have come up in the stakeholder discourse surrounding geoduck culture and the 55 statements used in this study attempted to focus upon and balance the primary issues surrounding geoduck culture identified in our thematic analysis as described earlier in the methods section.

To be clear about study limitations, the final set of Q statements employed in a Q study facilitates analysis of stakeholder perspectives on these particular statements, and by generalization, on the larger set of candidate Q statements and also the topic concourse consisting of the full body of discourse on a topic. In interpreting the significance of results, it is important to note that concourses are sometimes subject to change over time. This is simply to say that over time it is commonplace for stakeholders to receive new information about topics, and to develop new insights, priorities and viewpoints. Thus a Q study reports stakeholder values and opinions at a particular point in time, and with a respect to a particular vocabulary (concourse).

Conclusion

Even though sustainable management of Puget Sound tidelands is dependent on the social and environmental acceptability of the activities that take place, engaging and soliciting the opinions of coastal stakeholders is often difficult and left out of planning and management decisions. This research illustrates how clarifying stakeholder perspectives and issues that are contentious can help identify areas of concern that can be addressed by managers. Here Q methodology was used to describe the social perspectives of participants, explain which participants agree with each perspective and point out contentious issues that directed research and outreach could focus on to reduce conflict. Analysis revealed two perspectives and identified which perspective was held by each participant. In addition, four highly contentious statements were described and numerous statements were identified that showed consensus, agreement and disagreement between perspectives.

It is anticipated these results can be valuable in the context of coastal and aquaculture management. In considering usefulness beyond Puget Sound, Q methodology provides a practical technique for marine resource managers in other regions. This method could be applied in numerous areas in coastal and ocean management. For example the investigation of the social acceptance and viewpoints surrounding: coastal and marine tourism, marine spatial planning, marine protected areas, development of ocean energy, deep sea mining, etc. Finally, it is suggested that this study demonstrates that Q methodology would be a systematic and practical technique for managers to have in their "tool box" when approaching contentious coastal management issues.

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Appendix 1: Participant Invitation Letter

SCHOOL OF
Marine & Environmental Affairs
College of the Environment • University of Washington

June 8, 2011

Dear Washington resident,

You are invited to take part in a study about Geoduck (*Panopea generosa*) aquaculture in Washington State. You have been selected as a possible participant because we want to include your opinion in any possible management or regulatory decisions about geoduck aquaculture in Washington that this study may influence. The methodology being utilized for this research is considered one of the most unbiased ways of studying what people think regarding an issue or problem.

The intent of this study is to give structure to different attitudes concerning the farming of geoduck on private tidelands as well as to inform Washington Department of Natural Resources decision making regarding leasing public tidelands for geoduck aquaculture. This method will provide structure and empirical validation of perspectives that will help us better understand your concerns and underlying values, attitudes, and beliefs.

Participation in this study will require an investment of 30- 60 minutes of your time. You will be given a deck of small note cards (55) containing statements about the geoduck aquaculture issue.

During this process you will begin by reading through all of the note cards to get a sense of the range of statements represented. Next, cards are sorted into three piles reflecting how you agree, disagree, or feel neutral about each statement. The final step of this process is to make finer distinctions among the statements by sorting them onto a grid that will be provided. When finished, you will also be asked to record demographic information and comment on the sorting procedure on a brief questionnaire.

All personal information will be kept confidential and destroyed upon completion of the study. We will provide two copies of a consent form that speaks to this and has been signed by the principal investigator. We ask that you sign both copies and return one to us, together with your response sheet. Reports and publications of research findings will not include any information that will make it possible to identify you.

Involvement in this research is voluntary and your time commitment is deeply appreciated.

Thank you for your participation!

Paul Rudell
Master of Marine Affairs Candidate
School of Marine and Environmental Affairs
prudell@u.washington.edu
(206)354-4021

Dr. Marc L. Miller
Professor
School of Marine and Environmental Affairs
mlmiller@u.washington.edu
(206)962-9449

Appendix 2: Consent Form for Participants

Consent Form

Human perceptions and attitudes toward geoduck aquaculture in Puget Sound, Washington: a Q-method approach

Researchers: Paul Rudell and Dr. Marc L. Miller, School of Marine and Environmental Affairs, University of Washington

You are invited to be in a research study about public perceptions and attitudes on geoduck aquaculture and management in Washington. You are selected as a possible participant because we find your perspective of interest to our understanding of stakeholder concerns and ideas about the farming of geoduck on private tidelands as well as the possibility of farming of public tidelands managed by the Washington Department of Natural Resources. The intent of this consent form is to give you the information you will need to help you decide whether to participate in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

Purpose of the Study:

The purpose of this research is to understand how Washington residents and coastal stakeholders frame values and concerns about geoduck aquaculture and management.

Study Procedures:

If you consent to participation in this study, we will ask you to carry out the following:

- You will be given a deck of 55 cards containing statements about geoduck and geoduck aquaculture. These statements have been selected from a Washington State Department of Natural Resources online public forum, scientific articles, magazines, newspapers, books and websites that contain statements about the farming of geoduck on private and/or public lands.
- Next, participants will be asked to carefully read all the statements in order to get a complete sense of the variety of ideas contained in the deck of cards.

- After reading the complete set of cards, participants will be asked to sort the statements into three categories based on how much you agree, disagree or feel neutral about the statement.
- After the statements have been split into three piles, participants will be asked to make finer distinctions and rankings of the statements from each deck by placing card numbers into a grid that will be supplied to all participants.
- After placing the cards on the grid provided, participants will be asked to briefly discuss the sorting activity by responding to a short survey. Participants may be contacted after involvement by the researchers in order to clarify the results of their sort.
- The participation in this research is expected take between 30 minutes to 1 hour.

Risks and Benefits of being in the Study

The benefit of your participation in this study is that you will aid management and regulatory agencies in future decision making processes regarding geoduck aquaculture. In addition knowledge gained from this work may help inform education and outreach specialists that could in-turn help coastal stakeholders understand the controversy surrounding geoduck aquaculture . For lack of funding volunteers for this study will not be compensated.

Confidentiality:

All records from this study will be kept private. Reports and publications that result from this research will not include any identifiable information that will make it possible to identify participants. Research records will be stored securely and only researchers will have access.

Voluntary Nature of the Study:

Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Washington. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researchers conducting this study are: Paul N. Rudell and Dr. Marc L. Miller, of the University of Washington. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact Paul at 206-354-4021; prudell@u.washington.edu or Dr. Miller at mlmiller@u.washington.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researchers, **you are encouraged** to contact the Human Subjects Division, 4333 Brooklyn Ave NE, Box 359470, Seattle, WA 98195-9470; (206) 543-0098.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study. If I have questions later about the research, I can ask one of the researchers listed above. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098. I will receive a copy of this consent form.

Signature:_____ Date: _____

Signature of Investigator:_____ Date: _____

Signature of Investigator:_____ Date: _____

Appendix 3: Directions for Participants and Survey

Sorting Instructions and Short Questionnaire

Thank you for volunteering to participate in this survey. Please carefully read through each step of the instructions before beginning. You will be provided with a pencil and eraser along with a table or surface to sort out the study materials.

1. Locate the deck of cards and score sheets that have been provided. Lay the score sheet out in front of you. Each card contains a statement about geoduck aquaculture in Washington. These statements were selected from comments submitted to the Washington Department of Natural Resources public forum (2010), peer reviewed scientific articles, industry science, magazines, newspapers, books and online blogs. We are asking you to answer the following: "To what extent do you agree with the following statements?" There are no wrong or right answers. We would like to rank-order these statements from your own point of view. The numbers on the cards (from 1 to 55) have been assigned to the cards randomly and are only relevant for recording your response.

2. Read all 55 statements carefully and separate them up into three piles: a pile for statements you tend to agree with, a pile for those you tend to disagree with, and a pile for those you neither agree or disagree with (neutral), or that are not relevant or applicable to you. When you have finished sorting the cards into three piles, count the number of cards in each pile and write down this number in the corresponding box on the score sheet: AGREE BOX: number of cards in the agree pile; NEUTRAL or NOT RELEVANT BOX: number of cards the neutral or not applicable pile, and DISAGREE BOX: number of cards in the disagree pile. To repeat, this is an attempt to better understand your perspectives, there is no right or wrong way to sort the cards. Please be certain the numbers in the three boxes add up to a total of 55 statements.

3. Take the cards from the AGREE pile and re-read each. Select the three statements that you most agree with and write the card numbers in the three boxes under column K on the score sheet; it does not matter which one goes on top or below. Next, from the remaining cards in the agree pile, select the next three statements that you most agree with and write the card numbers in the three boxes in column J of the score sheet. Next, from the remaining cards in the agree pile, select four statements that you most agree with and write the card numbers in the four boxes in column I. Follow this procedure for all cards in the agree pile. Below each column, the numbers within the parentheses indicate how many statements should be placed in that column.

4. Now take the cards from the DISAGREE pile and read them again. Select the three statements that you most disagree with and write their numbers in the two boxes under column A on the score sheet. Next, from the remaining cards in the disagree pile, select three statements that you most disagree with and write their numbers in the three boxes under column B. Follow this procedure for all cards in the DISAGREE pile.

5. Finally, take the remaining cards in the NEUTRAL or NOT APPLICABLE pile and read through them again. Arrange the cards in the remaining open boxes of the score sheet as they fit your level of agreement or disagreement. It is okay to put statements in columns F that you slightly agree or disagree with.

6. When you have written the numbers of all cards on the score sheet, please go over your distribution once again and erase and re-write card numbers if you so desire. Please make sure that all boxes are filled and that no card number is in more than one box. A second score sheet has been provided on the back of the first in case you need to re-write the card numbers for clarity.

7. Please explain why you agree most with the three statements that you have placed in column K:

8. Please explain why you disagree most with the three statements that you have placed in column A:

9. Please use the space below to share any other comments about geoduck or about this exercise:

10. Please provide the following information:

Gender: _____ Zip code: _____

In what year were you born? _____

	Never	Rarely	Sometimes	Often	Very Often
I recreate on Washington public tide lands					
I grow or have grown shellfish in Washington					
I have visited a geoduck aquaculture site and observed farming activities					
I participate in public meetings concerning geoduck aquaculture					
I submitted comments on the leasing plan to the Department of Natural resources					
I read about geoduck aquaculture					
I hear/talk about geoduck aquaculture					

a. What is the highest level of education that you have completed? (check one)
☐ Some high school ☐ Some college
☐ High school diploma or GED ☐ College degree
☐ Some vocational or technical school ☐ Some graduate or professional school
☐ Graduated vocational or technical school ☐ Graduate or professional degree

b. Have you received training or taken coursework related to sustainable aquaculture? If so, please describe.

_____

c. Can you briefly define what sustainable geoduck aquaculture means to you?

_____

_____

d. What is your occupation?

e. With which stakeholder or interest group(s), if any, do you most closely associate yourself? (for example, grower, landowner, environmentalist, etc.)

f. If you did not consider yourself as an environmentalist in the previous question, would you also consider yourself as an environmentalist?

g. Do you own waterfront property on Puget Sound?

h. Do you own tidelands of Puget Sound? If so, do you grow shellfish or lease to growers?

Appendix 4: Participant Score Sheet