

Population Differentiation of Clam Species in British Columbia

Laura Gutierrez Funderburk¹

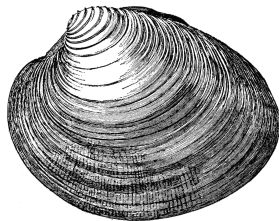
Simon Fraser University¹ Vancouver Island University² University of Victoria³

April 2019
BC UMSC

*This is joint work with Felix Breden¹, Anne Salomon¹, Skye Augustine¹,
Deanna Ferguson², Simon Wang¹, Ben J.G. Sutherland³*

- 1 Background
- 2 Materials & Methods
- 3 Results
- 4 Discussion
- 5 Open Questions
- 6 Acknowledgements

Background



Summer Internship for Indigenous Peoples in Genomics (SING) Canada 2018



Photograph by Dale Northey (2018)

Organizers:

Kim TallBear (PhD), Jessica Bardill (PhD), Jessica Kolopenuk (PhD Candidate), Felix Breden (PhD), Jamie Scott (PhD, MD),
Pam Borghardt, Simon Wang (PhD), Deborah Bolnick (PhD), Marcia Guno, Laura Gutierrez Funderburk

Clam Gardens

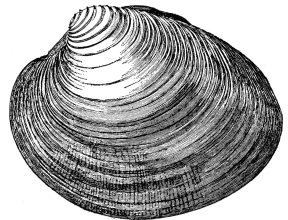


Google Earth image of clam garden EbSh-13 on Quadra Island, British Columbia by Dana Lepofsky *et al.* (2015)

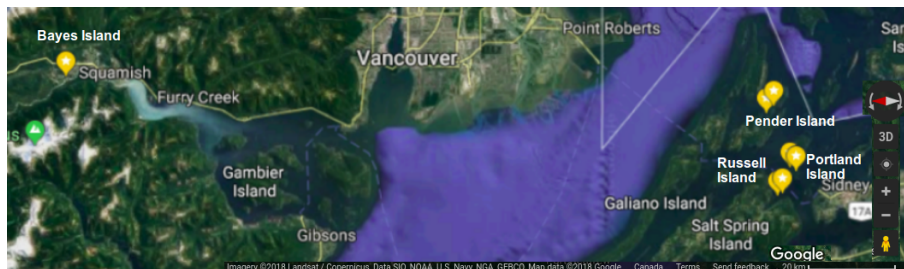
Motivation

- To contribute knowledge towards the Gulf Islands National Park Reserve partnership with the Hul'q'umi'num and WSÁNEĆ nations to restore clam gardens
- We work, learn and play in the unceded, traditional and occupied territories of the x^wməəkwəyəm (Musqueam), Skwxwú7mesh (Squamish), Səlílwətaʔɬ/Selilwitulh (Tsleil-Waututh) and Kwikwetlem Nations, and have a lot to learn from them

Materials & Methods



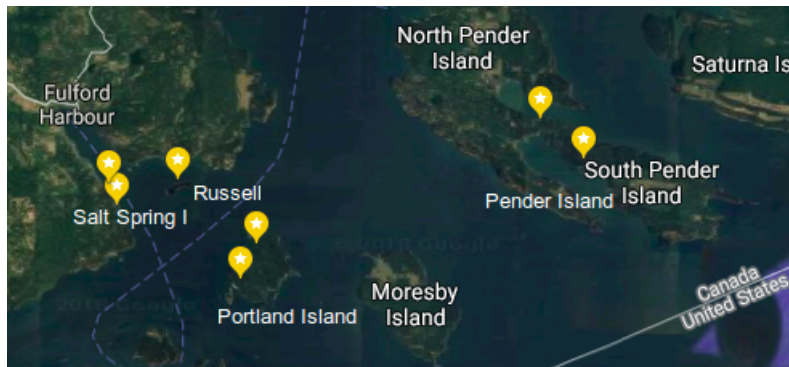
Collected Samples



Saxidomus gigantea and *Leukoma staminea* samples were collected:

- Baynes Island Ecological Reserve
- two clam gardens in Salt Spring Island
- a clam garden in Russell Island
- two non-walled sites in Pender Island
- one non-walled site and one unidentified site in Portland Island

Close up on Southern Populations



The questions

- Are the different populations structured?
- How related are clams from these different sites?
- Are the clams on the two nearby clam gardens (Fulford Harbour and Russell Island) closely related or very distinct?
- Would restoring clam populations at select beaches help support nearby clam populations?
- And if so, which beaches, if restored, are likely to best support nearby clam populations?

Basic (Biology) Concepts

- DNA & DNA sequence
- Gene
- Allele
- Single Nucleotide Polymorphisms (SNPs)
- Haplotype
- Sequence alignment
- Phylogeny

The Mathematical Models

Percent ID Matrix (PID)

Let n be the total number of sequences in a sequence alignment. Let $0 \leq p_{ij} \leq 100$ denote the percent identity (PI) for two given sequences i, j . The PID of an alignment is an $n \times n$ matrix such that

$$a_{ij} = \begin{cases} 100 & , \text{if } i = j \\ p_{ij} & , \text{if } i \neq j \end{cases}$$

where i, j denote, resp, the i th, j th sequences within an alignment.

The Mathematical Models

Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (Sokal and Michener 1958)

An approach to constructing a rooted phylogenetic tree from a distance matrix (in particular a PID). Let d_{AB} denote the PI between two (different) units, say A, B .

- Identify smallest distance between units A, B . Cluster them to form unit AB
- Compute new distance between AB and the remaining units X

$$d_{(AB)X} = \frac{1}{2}(d_{AX} + d_{BX})$$

- Repeat this process until only two units are left

The Statistical Models

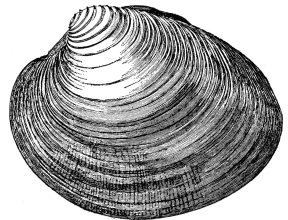
Analysis of Molecular Variance (AMOVA) and ϕ -Statistics (Excoffier (1992))

AMOVA detects population differentiation using molecular markers (haplotypes in our case). ϕ -statistics estimate different levels of hierarchical subdivision between and within populations and groups within them.

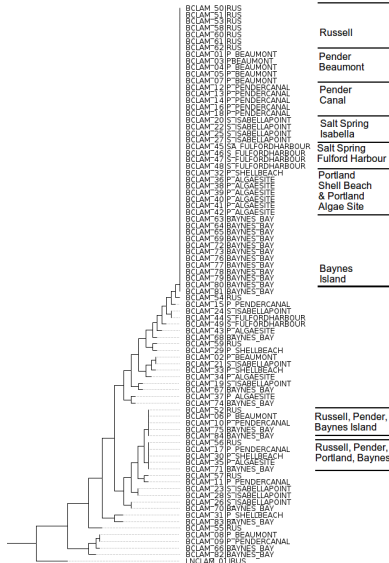
$$\phi_{ST} = \frac{\sigma_a^2 + \sigma_b^2}{\sigma^2} \quad \phi_{CT} = \frac{\sigma_a^2}{\sigma^2} \quad \phi_{SC} = \frac{\sigma_b^2}{\sigma_b^2 + \sigma_c^2}$$

where a denotes a group, b the populations and c individuals within populations. The expected square deviations are denoted by $\sigma_a^2, \sigma_b^2, \sigma_c^2$, respectively.

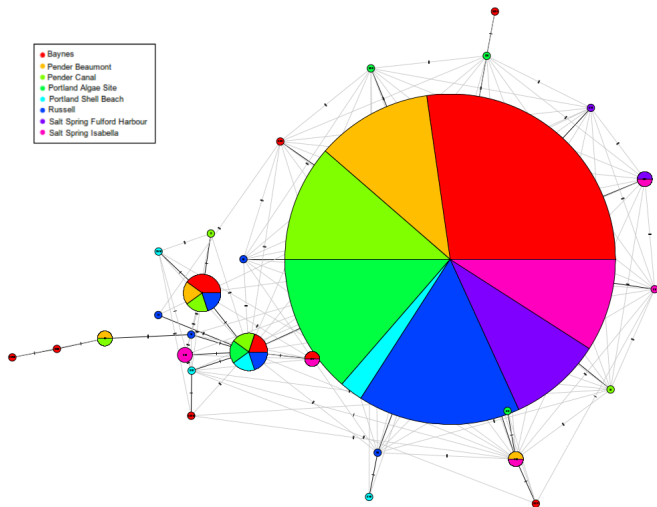
Results



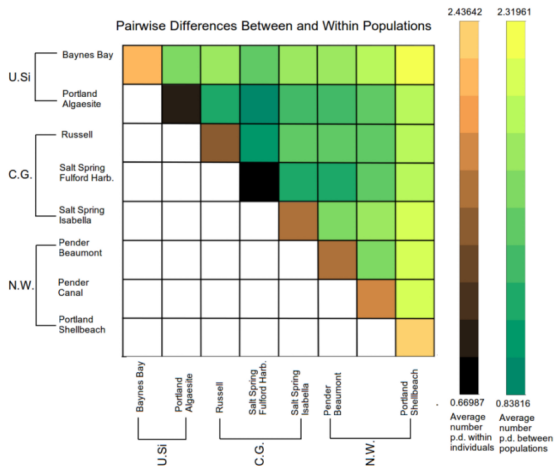
Phylogeny: *S. gigantea* & *L. staminea*



Haplotype Network: *S. gigantea*



AMOVA: *S. gigantea* Clam gardens, non-walled and unidentified sites

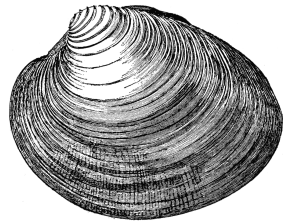


Source of variation	d.f.	Sum of squares	Variance components	Percentage of variation
Among groups	2	1.789	0.00626 V_a	0.75
Among populations	5	3.734	-0.00972 V_b	-1.16
Within populations	76	63.700	0.83815 V_c	100.41
Total	83	69.222	0.83469	
Fixation Index				
		ϕ_{SC}	-0.01174	
		ϕ_{ST}	-0.00415	
		ϕ_{CT}	0.00750	

Two Potential Candidates



Discussion



What Does This Mean for Clam Garden Restoration?

- We learned that there is little to no structure between the populations
- Clams from different sites shared one common haplotype
- Clams the two nearby clam gardens (Fulford Harbour and Russell Island) were closely related
- Fulford Harbour clam gardens are good candidates for further exploration, however we must be careful before introducing new taxa into sites
- This means that clam gardeners from different sites within the area we covered can collaborate with one another

Open Questions

- Can we identify source or sink populations?
- Is there some sort of “signal” on a sequence level that would help us identify clams from clam gardens vs clams from non-walled sites?
- Revisit candidate sites for uniform, larger data sets

Acknowledgements



Vice President, Academic
Department of Biology
Department of Molecular
Biology & Biochemistry
Department of Mathematics



Indigenous Student Centre at SFU



LifeLabs®



FACULTY OF
HEALTH
SCIENCES



MERCK



PIMS



INDIGENOUS
science | technology | society



Genome
British Columbia
Leading • Investing • Connecting



prion

ALBERTA
PRION RESEARCH
INSTITUTE



UNIVERSITY OF
ALBERTA

Faculty of Native Studies

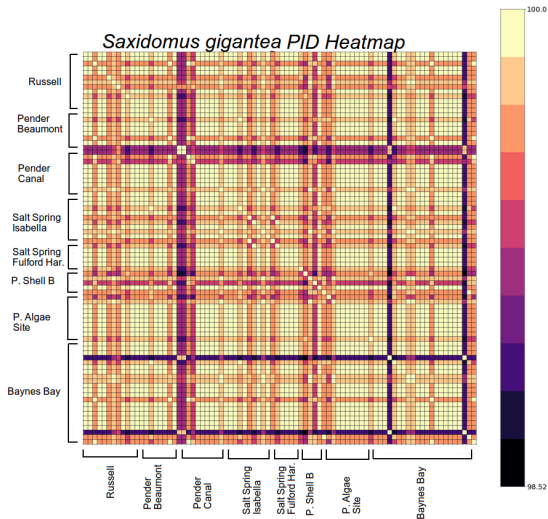


FACULTY
OF SCIENCE

Acknowledgements

- Dr. Felix Breden and Dr. Jamie Scott, my two supervisors, for making my R.A. an amazing experience
- Department Chair Dr. Mary-Catherine Kropinski and MATH 498 instructor Dr. Jonathan Jedwab, for creating a supportive, open and encouraging learning environment as I wrote my thesis
- Dr. Veselin Jungic and Dr. Cedric Chauve, for their continuous mentorship and support in my development

PID *S. gigantea*



PID *S. gigantea* & *L. staminea*

