Fall 2016

Hypothetical proposed Hale Passage salmon aquaculture site: environmental impact assessment

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HYPOTHETICAL PROPOSED HALE PASSAGE SALMON AQUACULTURE SITE: ENVIRONMENTAL IMPACT ASSESSMENT

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(Photo Credit: Northwest Indian Fisheries Commission)

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Date 12/7/2016

Dear Concerned Citizen:

The Proposed Hale Passage Salmon Aquaculture Site Draft Environmental Impact Statement is enclosed for your review. The draft summarizes the environmental impacts on the proposed site as well as the surrounding areas of Bellingham Bay, Whatcom County. The analysis examines the proposed operation of two 20x40 meter net-pen structures for the culturing of salmon intended as a source of locally produced salmon and salmon products as well three alternatives, including a no aquaculture siting option.

Your comments and views on the given information in the statement, as well as your advice on the accuracy and adequacy of the analysis, would be most helpful. The statement recognizes that salmon aquaculture and the associated impacts on local environments and wildlife are highly debated topics. Demand for salmon and other fin-fish products has increased consistently in recent years due to associated health benefits. This demand has intensified pressures on traditional wild and hatchery salmon populations and decreased socio-economic accessibility through increased prices.

Due in part to the National Aquaculture Act of 1980, aquaculture saw substantial growth in what is now known as the Salish Sea including operations in Bellingham Bay. Salmon aquaculture operations continue to the north of Bellingham Bay in British Columbia and to the south in Skagit County waters. Concerns regarding the negative environmental impacts of these operations precipitated a county-wide moratorium on further expansion of privately owned aquaculture operations. State shoreline plans adopted by Whatcom County currently list aquaculture as prohibited, but subject to exceptions.

Recently, interest in utilizing aquaculture as an economic and salmon stock enhancement tool have grown. The impacts outlined in the enclosed document are an important step in understanding the trade-offs in the use and siting of net-pen aquaculture. The intent of this assessment is to communicate likely negative environmental impacts as well as initiate discussion of plausible value in integrating aquaculture into local marine industry. We have met with professionals in government agencies and non-profit groups who have guided the data collection and creation of this document. Substantial public interest in the past and present has been useful in helping us focus on impacts most relevant to the public. By fully and explicitly stating the likely negative impacts of this siting we can more accurately assess possible future proposals for aquaculture expansion in Bellingham Bay.

Your feedback will provide key guidance in increasing accurate decision-making regarding the proposed aquaculture site and improving siting standards and requirements for future proposals and assessments. We encourage you to submit comments by emailing Jordan Wrigley at wriglej2@wwu.edu. If you do not have internet access, please mail your comments to:

Dr. Tammi J. Laninga
Environmental Studies MS 9085
530 High Street
Western Washington University
Bellingham, WA 98225

You may also deliver your comments to: Arntzen Hall 217, 530 High Street, Western Washington University, Bellingham, WA 98225 Attn: Hale Passage Aquaculture DEIS. Thank you for your time, attention and thoughts on the Proposed Hale Passage Salmon Aquaculture Operation and Structure Siting Draft Environmental Impact Statement.

Environmental Impact Assessment of Proposed Hale Passage Salmon Aquaculture Site

(Photo Credit: WA Fish Growers Association)

Prepared for:
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Disclaimer: This report represents a class project that was carried out by students at Western Washington University, Huxley College. It has not been undertaken at the request of any persons representing local government or private individuals, nor does it represent any opinions, positions, or plans by individuals from government or the private sector.

Acknowledgements

We would like to thank the following individuals who contributed to the guidance and creation of this document:

Dr. Tamara Laninga, Department of Environmental Studies, Huxley College of the Environment, WWU

Mark A. “Mak” Kaufman, Water Quality Specialist, Washington Department of Ecology

Hypothetical Proposed Hale Passage Salmon Aquaculture Site

The Hale Passage Aquaculture Operation is a hypothetical Atlantic salmon aquaculture site located within the coastal waters of the Salish Sea in Whatcom County, Washington. The proposed operation would include two 20x40 meter net pens sited within Hale Passage between Lummi Island and Lummi Nation, east-southeast of the ferry route.

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Proponent

Salmon T. Steelhead

456 Lox Street

Fintown, WP 11223

Proposed implementation: June 2017 (tentatively)

Required Permits and Approvals

State Permits: Washington State

Federal Permits: United States of America

Important Information

Draft EIS issue: December 5, 2016

DEIS Comments Due: January 4, 2017

Final EIS issue: January 15, 2017 (tentative)

Agency Action: TBD

Projected Date for action: TBD

Subsequent Environmental Review: TBD

EIS availability: Western Washington University: CEDAR database. http://cedar.wwu.edu

Fact Sheet

Project Title

Hypothetical Proposed Hale Passage Salmon Aquaculture Site

Project Description

The Hale Passage Salmon Aquaculture Site is a hypothetical Atlantic salmon aquaculture site located within the coastal waters of the Salish Sea in Whatcom County, Washington. The proposed operation would include two 20x40 meter net pens sited within Hale Passage between Lummi Island and Lummi Nation, east-southeast of the ferry route.

Proponent and Proposed Implementation Date

Salmo T. Steelhead
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Fintown, WP 11223

Proposed Implementation: June 2017 (Tentative)

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Date of Issue of the Draft EIS
December 6, 2016

Date DEIS Comments are due
January 5, 2017

Projected date of Issue of Final EIS
TBD

Agency Action and Projected date for action
TBD

Subsequent Environmental Review
TBD

EIS availability
Western Washington University: CEDAR database. http://cedar.wwu.edu

State and Federal Permitting Requirements and Agencies:

State

Washington Department of Agriculture

1) Processing Plant License (RCW 69.07)
2) Product Identification Requirements (RCW 15.85; WAC 16-603-010)
3) State noxious weed list compliance (RCW 17.10; WAC 16-750; WAC 16-752)

Washington Department of Fish and Wildlife

1) Aquatic Farm Permit and Registration, Annual renewal (RCW 77.115.040; WAC 220-76-010)
2) Disease Control (RCW 77.115; WAC 220-76-030)
3) Finfish Transport Permit (WAC 220-77-030)
4) Finfish aquaculture escape prevention, reporting, and recapture (WAC 220-76-110; WAC 220-76-120)
5) Aquaculture facility inspection authority (WAC 220-76-130)
6) Scientific Collection Permits (RCW 77-32-240; WAC 220-20-045)

Washington Department of Ecology

1) Section 401 Water Quality Certification (RCW 90.48; WAC 173-201a; WAC 173-225)
2) National Pollutant Discharge Elimination System (NPDES) Permit, Applicable to facilities with over 20,000 lbs.
3) State Waste Discharge-General Permit (WAC 176-216)
4) Coastal Zone Management Act Consistency

Washington Department of Natural Resources

1) Aquatic Use Permit and Aquatic Lands Lease (RCW 79.105)

Federal

United States Army Corps of Engineers

1) Section 10 Rivers and Harbors Act Permit (Rivers and Harbors Appropriation Act (1899))
2) Section 404 Clean Water Act Permit (Clean Water Act U.S.C 1251, Section 404)

NOAA Fisheries

1) ESA Section 7 Consultation (Endangered Species Act, Section 7)

United States Fish and Wildlife Service

2) ESA Section 7 Consultation (Endangered Species Act, Section 7)

United States Coast Guard

3) Compliance with marking of structures (Title 33: Navigation and Navigable Waters (33 CFR); Part 64: Marking of Structures, Sunken Vessels, and Other Obstructions; Part 66: Private Aids to Navigation, subparts 66.01-5)
4) Private Aids to Navigation Permit (Title 33: Navigation and Navigable Waters (33 CFR); Part 64: Marking of Structures, Sunken Vessels, and Other Obstructions; Part 66: Private Aids to Navigation, subparts 66.01-5)

List of agencies copies of this EIS were sent to

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Table of Contents

0. Glossaries

0.1. List of Acronyms

CFR	Code of Federal Regulations
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FOC	Fisheries and Oceans Canada
GIS	Geographic Information Systems
IMTA	Integrated Multi-Trophic Aquaculture
ISAV	Infectious Salmon Anemia Virus
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
NIC	Northwest Indian College
NICMERE	National Indian Center for Marine Environmental Research and Education
NIMBY	Not In My Backyard
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PHPSAS	Proposed Hale Passage Salmon Aquaculture Site
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
TMDL	Total Maximum Daily Load
WA-DNR	Washington Department of Natural Resources
WAC	Washington Administrative Code
WCFA	Whatcom Commercial Fisherman Association
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WWU	Western Washington University

0.2. List of Figures, Tables, and Maps

Tables

Maps

Figures

0.3. Technical Terms

ArcGIS	geographic information systems software
Anadromous	Species that live their adult lives in the ocean, but move into freshwater streams to reproduce or spawn (e.g., salmon).
Antifoulant	Compounds that prevent an organism from attaching to a surface.
Aquaculture	The farming of aquatic organisms in the marine environment or freshwater.
Bathymetry	The study of the "beds" or "floors" of water bodies, including the ocean, rivers, streams, and lakes
Benthic	Anything associated with or occurring on the bottom of a body of water.
Biofouling	The accumulation of unwanted biological matter on surfaces, with biofilms created by micro-organisms and macroscale biofouling created by macro-organisms.
Biogeochemistry	The study of how chemical elements flow through living systems and their physical environments.
Biota	The plant and animal life characteristics of a specific region or biosphere, or given time period.
Bivalves	A mollusk having a shell consisting of two lateral plates or valves joined together by an elastic ligament at the hinge, which is usually strengthened by prominences.
Buffer	A parcel or strip of coastline that is protects an adjacent aquatic or wetland site from upland impacts.
Copepods	Small crustaceans that become food for salmon in their fry, smolt and adult life cycle stages.
Ecosystem	A community of organism and their physical environment interacting as an ecological unit.
Endangered	Defined under the ESA as "any species which is in danger of extinction throughout all or a significant portion of its range."

Environmental impact	Possible adverse effects caused by a developmental, industrial, or infrastructural project or by the release of a substance in the environment.
Finfish	Vertebrate and cartilaginous fishery species, not including crustaceans, cephalopods, or other mollusks.
Fish Meal	Protein-rich meal derived from processing whole fish (usually small pelagic fish, and fishery bycatch) as well as residues and by products from fish processing plants (fish offal). Used mainly in agriculture feeds for poultry, pigs, and aquaculture feeds for carnivorous aquatic species.
Genetic diversity	The variation at the level of individual genes, and provides a mechanism for populations to adapt to their ever-changing environment. It refers to the differences in genetic make-up between distinct species and to genetic variations within a single species.
Geographic Information System (GIS)	A computer system for storage, analysis, and retrieval of information in which all data are spatially referenced by their geographic coordinates (latitude, longitude). In addition to primary data, such as climatic and soil characteristics, a GIS can be used to calculate derived values such as erosion hazard, forest yield class, or land suitability for specified land-use types.
Hypoxia	A condition with low or depleted oxygen in a water body that often leads to 'dead zones' - regions where life cannot be sustained. It is often associated with the overgrowth of certain species of algae, which can lead to oxygen depletion when they die, sink to the bottom, and decompose.
Infaunal	Benthic fauna living in the substrate and especially in the soft seafloor.
Juvenile	A young fish or animal that has not reached sexual maturity.
Marine	Waters that receive no freshwater input from the land and are substantially of full oceanic salinity (>30 practical salinity units (PSU) throughout the year).
Marine Mammals	Warm-blooded animals that live in marine waters and breathe air directly. These include porpoises, dolphins, whales, seals, and sea lions.

Marine Mammal Protection Act (MMPA)	The MMPA prohibits the harvest or harassment of marine mammals, although permits for incidental take of marine mammals while commercial fishing may be issued subject to regulation.
Native Species	A local species that has not been introduced.
Net-pen	A system that confines fish or shellfish in a mesh enclosure.
Nutrient loading/pollution	The process where too many nutrients, mainly nitrogen and phosphorus, are added to bodies of water.
Pathogens	Disease causing organisms such as bacteria, viruses, and other parasites.
Point-source	A source of sediment, nutrients, or contaminants into a water body that comes from one discharge location.
Population	The number of individuals of a particular species that live within a defined area.
Predation	Relationship between two species of animals in which one (the predator) actively hunts and lives off the meat and other parts of the other (the prey).
Run	Seasonal migration undertaken by fish, usually as part of their life history.
Salmonid	A fish belonging to family Salmonidae, which includes salmon, trout, chars, whitefish and grayling.
Significant wave height	The average height (trough to crest) of the one-third highest waves valid for the indicated 12-hour period.
Socio-Economic	Pertaining to the combination or interaction of social and economic factors and involves topics such as distributional issues, labor market structure, social and opportunity costs, community dynamics, and decision-making processes.
Spawning	Release of ova, fertilized or to be fertilized.
Species	Group of animals or plants having common characteristics, able to breed together to produce fertile (capable of reproducing) offspring, and maintaining their "separateness" from other groups.

Species richness	The distribution of the number of species and the number of individuals of each species in a community.
Stock	A part of a fish population usually with a particular migration pattern, specific spawning grounds, and subject to a distinct fishery
Triploidy	The cells of the individual has three sets of chromosomes as compared to the normal two sets
Trophic Level	Classification of natural communities or organisms according to their place in the food chain. Green plants (producers) can be roughly distinguished from herbivores (consumers) and carnivores (secondary Syn: Trophic group consumers); 2. Group of organisms eating resources from a similar level in the energy cycle; 3. Position in food chain determined by the number of energy-transfer steps to that level. Plant producers constitute the lowest level, followed by herbivores and a series of carnivores at the higher levels.
Turbidity	The condition resulting from the presence of suspended particles in the water column which attenuate or reduce light penetration.
View-shed	The natural environment that is visible from one or more viewing points.
Water Column	The vertical column of seawater that extends from the surface to the bottom.
Wild Salmon	Salmon are considered "wild" if they have spent their entire life cycle in the wild and originate from parents that were also produced by natural spawning and continuously lived in the wild.
Wind fetch	The unobstructed distance that wind can travel over water in a constant direction.

Executive Summary

The Hale Passage Salmon Aquaculture Site (HPSAS) Environmental Impact Statement (EIS) has been prepared according to Washington State Environmental Policy Act (SEPA) guidelines. *The Environmental Checklist* (SEPA, WAC 197-11-960) defines the scope of the assessment and identifies the factors to be considered within the EIS. These factors are mainly water quality, native wildlife, marine navigation, and aesthetics. Also considered were socio-economic impacts such as job growth and secondary environmental impacts such as reduction of harvest pressures on wild native salmon stocks.

The purpose of the EIS is to provide information about the proposed salmon aquaculture operation and site, to identify potential impacts of the original proposal and alternative actions, and to describe mitigation measures to reduce potential negative impacts.

Proposed Action and Alternatives

The original action was proposed by Salmon T. Steelhead. The proposer is a private individual wishing to begin salmon farming as a small business and provide locally produced Atlantic salmon (*Salmo salar*) products in regional markets. Atlantic salmon have been chosen by the proposer due to available technical research and the likely reduction of impact on native Pacific salmon (*Oncorhynchus*) species. The proposal includes two 20x40 meter net-pen structures sited in Whatcom County waters near or in Bellingham Bay. The structures will be anchored to the marine floor and would float at the marine surface using a structure of flotation buoys. The site will require 1,600 sq. meters as minimum. Direct access to the site from shore via boat as well as appropriate shore buildings are also required. The proposer seeks to produce an annual average of 200,000 salmon by 2022. The proposer was also willing to consider alternatives. In addition to the proposed action, three alternatives were considered:

Alternative 1:
“Reduced site” - a single 20x40 meter net-pen rather than the two originally proposed.

Alternative 2:
“Sablefish” - farming operation using two 20x40 meter net-pens rather than the originally proposed Atlantic salmon farming operation.

Alternative 3:
“No Action” - alternative wherein no aquaculture siting would take place.

Probationary Period

In addition to these alternatives, a probationary period of a single production cycle (5-6 years) is reserved. The purpose of this blanket probationary period is to fully assess the impacts of the recommended action that remain unclear. At the end of the period, the decision to extend or termination the site under the recommended action or any alternative will be the responsibility of the permitting agencies.

Site Selection
Site selection was carried out by a marine geographic information systems (GIS) consultant, Dan Ashley. The selected site was chosen by the proponent from zones included in the original proposal (Maps 2 and 3) using GIS software, ArcGIS, and available data (see Appendix A, Data Sources). Assessments of the impacts of the original proposal and each alternative were based in Site 2.1 (see Map 1). Greater information and a report by the consultant can be found in Appendix A. All maps of the site referenced in this document are also in this appendix.

Significant Impacts of Proposed Action
Assessment of the original proposal showed significant impacts to water quality conditions, wildlife, and plants. Increased nutrient loading, chemical leaching, and turbidity decreases water quality, negatively affecting benthic, infaunal, and plant communities. Native fin-fish populations are depressed due to competition as well as disease and lice transmission. Marine mammal and bird attraction to net-pens likely results in entanglement and injury.

In consideration of the built environment with the proposed action, significant impacts would affect the aesthetics of the surrounding area, boaters navigating Hale Passage, and Lummi tribal activities and water use. Surrounding communities could be influenced by the view-shed and emitted odor from the site. Lummi Nation plays a large role in the implementation of this operation, because the site is located within Lummi waters. Current tribal aquaculture and fishing practices in the area could be impacted and therefore opposition from Lummi Nation could ensue.

Socio-economic research indicates this action would bring a new type of salmon production into the area with possible direct and indirect job creation and tax benefits as well as increased success to salmon products through lower prices. This could also create competition with local catch fisheries to their detriment.

Alternative 1: Reduced Site
In terms of the natural environment, including water quality and plants and wildlife, assessment of the reduced site alternative showed the same impacts as the proposed action, but at a reduced magnitude.

Assessment of the reduced site alternative results in lower impacts to the aesthetics of the surrounding area. Potential hazard to boaters navigating Hale Passage remain the same. Lummi nation may be more inclined to approve a smaller, experimental operation.

The socio-economic impacts of this alternative would also be similar to the proposed action, but reduced. This reduction may make possible positive impacts such as job creation and tax revenue. This alternative would also compete less with catch fisheries by producing less.

Alternative 2: Sablefish
Assessment of the sablefish alternative showed similar impacts as the proposed action, but with variation to impacts on turbidity and native fin-fish. Sablefish contribute less to turbidity than Atlantic salmon. It is relatively unknown, but likely that sablefish will depress native fin-fish populations in much the same way as farmed Atlantic salmon. However, the most at risk fish populations will more likely be sablefish and other deep sea bottom-dwelling fin-fish rather than salmonids.

In terms of the built environment, assessment of the sablefish, the alternative showed similar impacts to the proposed action with possible unknown increase or decrease in odor. This alternative would also result in a lower impact on tribal fishing practices and the local fish market.

The socio-economic impacts of this alternative would be very reduced in comparison to a salmon operation due to the lack of market for sablefish. Research indicates the market for this type of operation is mostly in exporting the raw product.

Alternative 3: No Action
Assessment of the no action alternative showed no significant impacts on water quality, wildlife or plants. However, this alternative would diminish any chance of removing pressure from wild fished salmon stocks by integrating an alternative production source into salmon markets.

Assessment of the no action alternative showed no significant impacts on the built environment.

In terms of socio-economic impacts, this action would result in no completion wild catch fisheries through markets as well as no positive impacts such as access, job creation, and tax, revenue.

Recommend Action: Alternative 1 with Probationary Cycle
The alternative of a reduced site with a probationary period of one production cycle is recommended. The recommended action was chosen in part due to a lack of current information and literature regarding the impacts the proposal would have environmentally, economically, and socially. This action will allow the progress and testing of such a site under regulated circumstances. A reduced site will make for smaller environmental impacts and increase the effectiveness of mitigation measures. This alternative will also reduce conflicts and impacts on the build environment until determination of their extent and severity. Lastly, a reduced site alternative will allow for the measurement of positive socio-economic impacts to more fully address the trade-offs that may be face in further expansion of the same or similar operations.

Decision Matrix

	Original Proposal	#2 Reduced site	#3 Sablefish	#4 No Action
Water Quality				
Feed				
Waste				
Antifoulants				
Turbidity				
Plants and Wildlife				
Marine and Shore Birds				
Marine Mammals				
Fin-fish			Uncertain	
Benthic/Infaunal				
Flora				
Built Environment				
Aethetics				
Viewshed				
Odor				
Noise				
Commercial Fishing				
Tribal				
Socio-Economic				
Jobs/Employment				
Tax Revenue				
Local Salmon Production		Low		
Consistent Production				
Access to Salmon		Low		

Key:

	= High impact
	= Some Impact
	= Low Impact
	= Positive Impact
	= No Impact

1. Introduction

1.1. Objective, Extent and Purpose

The Hale Passage Salmon Aquaculture Site (HPSAS) Environmental Impact Statement (EIS) has been prepared according to Washington State Environmental Policy Act (SEPA) guidelines. The Environmental Checklist (SEPA, WAC 197-11-960) defines the scope of the assessment and identifies the factors to be considered within the EIS. These factors are mainly water quality, native wildlife, marine navigation, and aesthetics. Also considered were socio-economic impacts such as job growth and secondary environmental impacts such as reduction of harvest pressures on wild native salmon stocks.

The purpose of the EIS is to provide information about the proposed salmon aquaculture operation and site, to identify potential impacts of the original proposal and alternative actions, and to describe mitigation measures to reduce potential negative impacts.

1.2. Proposed Action and Alternatives

The original action was proposed by Salmon T. Steelhead. The proposer is a private individual wishing to begin salmon farming as a small business and provide locally produced Atlantic salmon (*Salmo salar*) products in regional markets. Atlantic salmon have been chosen by the proposer due to available technical research and the likely reduction of impact on native Pacific salmon (*Oncorhynchus*) species. The proposal includes two 20x40 meter net-pen structures sited in Whatcom County waters near or in Bellingham Bay. The structures will be anchored to the marine floor and would float at the marine surface using a structure of flotation buoys. The site will require 1,600 sq. meters as minimum. Direct access to the site from shore via boat as well as appropriate shore buildings are also required. The proposer seeks to produce an annual average of 200,000 salmon by 2022. The proposer was also willing to consider alternatives. In addition to the proposed action, three alternatives were considered:

Alternative 1:
: "Reduced site" - a single 20x40 meter net-pen rather than the two originally proposed.

Alternative 2:
: "Sablefish" - farming operation using two 20x40 meter net-pens rather than the originally proposed Atlantic salmon farming operation.

Alternative 3:
: "No Action" - alternative wherein no aquaculture siting would take place.

1.3. Probationary Period

In addition to these alternatives, a probationary period of a single production cycle (5-6 years) is reserved. The purpose of this blanket probationary period is to fully assess the impacts of the recommended action that remain unclear. At the end of the period, the decision to extend or termination the site under the recommended action or any alternative will be the responsibility of the permitting agencies and regional governments.

1.4. Site Selection

Site selection was carried out by a marine geographic information systems (GIS) consultant, Dan Ashley. The selected site was chosen by the proponent from zones included in the original proposal (Maps 2 and 3) using GIS software, ArcGIS, and available data (see Appendix A, Data Sources). Assessments of the impacts of the original proposal and each alternative were based in this site (Map 1). Greater information and a report by the consultant can be found in Appendix A. All maps of the site referenced in this document are also in this appendix.

2. Proposed Actions and Alternatives

2.1. Proposed Action

The proposed action consists of two 40x20m net-pens, and expected to produce 200,000lbs of Atlantic salmon annually after initial growth period of 5-6 years, which may have an associated impact on the surrounding quality of water and the plants and wildlife. Site 2.1 is described as being well flushed and contains optimal conditions for rearing mature salmon.

2.2. Alternative 1: Reduced Site

The first alternative to the proposed action is to install a smaller scale operation. There the operation would consist of a single 40x20m net-pen, which would produce about 100,000 salmon annually.

2.3. Alternative 2: Sablefish

The second alternative to the proposed action is to raise the experimental fin-fish species sablefish. British Columbia has sablefish aquaculture operations, but this is a relatively new practice and the amount of research on the effects of these operations is limited.

2.4. Alternative 3: No Action

The third alternative is to take no action for the development of an aquaculture site.

3. Affected Environment

The affected environmental elements that will be analyzed are water, plants and wildlife. These are the elements that have been identified as experiencing significant impacts from the proposed Hale Passage Salmon Aquaculture Site.

4. Water Quality

4.1. Existing Conditions

The proposed location occupies an area within Hale Passage near Gooseberry Point (Map 1). Due to the Lummi Island Ferry and general boat traffic this area is contaminated with heavy metals (RH2 Engineering Inc., 2009). Based on WA Department of Ecology's Water Quality Assessment categories, this area has been designated as a Category 5: polluted waters (Water Resources Division, 2011). The Environmental Protection Agency (EPA) requires a Total Maximum Daily Load (TMDL) report, which describes the pollutants and the amount being discharged into the affected water body.

4.2. Significant Impacts

Significant impacts to water quality are discussed for the proposed action, the alternatives, and a no action alternative.

4.3. Proposed Action

The proposed action consists of installing two 40x20m Atlantic salmon net-pens at Site 2.1, and would produce about 200,000 salmon annually.

4.3.1. <u>Feed and Waste</u>

Fish farms are point-sources of pollution due to the fallout of excess dissolved and particulate feed as well as fish waste. This causes increased levels of nitrogen and phosphorous in the water column around fish-farm sites (Price et al., 2015).

A study in the Bay of Fundy, Canada, showed that for each metric ton of fish fed with dry pellet feed, 35-78kg of nitrogen and 4.9kg of phosphorus are released into the environment (Ackefors et al., 1994). Using this conversion, the proposed double net-pen system will release an estimated amount of 3,177-7,089kg of nitrogen and 445kg of dissolved phosphorus.

4.3.2. <u>Antifoulants</u>

Antifoulants are chemical coatings used to prevent organisms like anemones and barnacles from attaching to net-pens. Without antifoulants there is reduced water exchange, structural fatigue, and disease risk to the farmed salmon (Nikolau et at., 2014). Studies in Norway have shown that the amount of biofouling that can occur on 50m net-pens can reach 2-7 metric tonnes (Floerl et al., 2016).

However, it is common for antifoulants to contain copper compounds as part of their primary biocidal compounds. This factor increases the risk of having copper compounds leach into the water column and compromise the water quality (Floerl et al., 2016). These compounds also accumulate in the sediment below farm sites.

4.3.3. <u>Turbidity</u>

Atlantic salmon commonly swim at depths less than the proposed 30m - 50m depth of the net-pens (Johansson et al., 2009). This behavior may cause increased turbidity of the water column due to fish waste, excess feed, and swimming behavior, but the research concerning the effects of turbidity on the water column of open-ocean net-pens is limited (Price & Morris, 2013).

4.4. Alternative 1: Reduced Site

Alternative 1 consists of installing one 40x20m Atlantic salmon net-pen at Site 2.1 and would produce 100,000 whole salmon annually.

4.4.1. Feed and Waste

A smaller operation will either not change the amount of fish feed and waste or cut it by half, resulting in a potential reduction of water quality impacts.

4.4.2. Antifoulants

A smaller operation will either not change the amount antifoulants used or it will decrease the amount of by half, resulting in potential reduction of water quality impacts.

4.4.3. Turbidity

A smaller operation will either not change the turbidity levels or it will cause turbidity to decrease, therefore lessening the impacts of water quality as predicted for the proposed action.

4.5. Alternative 2: Sablefish

Alternative 2 consists of installing two 40x20m sablefish net-pens at Site 2.1, and would produce about 200,000 whole sablefish annually.

4.5.1. Feed and Waste

There is no significant change in the water quality effects from feed and fish waste between the original proposal and a sablefish alternative.

4.5.2. Antifoulants

There is no significant change in the water quality effects of antifoulants between the original proposal and a sablefish alternative.

4.5.3. Turbidity

Turbidity of the water column is decreased to some extent in comparison to Atlantic salmon, based on the tendencies for sablefish to swim around the lower and bottom areas of the net-pens. Thereby, reducing the amount of fecal matter and particulate food waste being mixed into the water column. The wastes are able to be expelled from the nets more quickly due to swimming behavior (Brager et al., 2015).

4.6. Alternative 3: No Action

Alternative 3 is to take no action for the development of an aquaculture site.

4.6.1. Feed and Waste

A no action alternative will have no changes to the amounts of feed and waste in the water.

4.6.2. Antifoulants

A no action alternative will have no changes to the amount of antifoulants in the water.

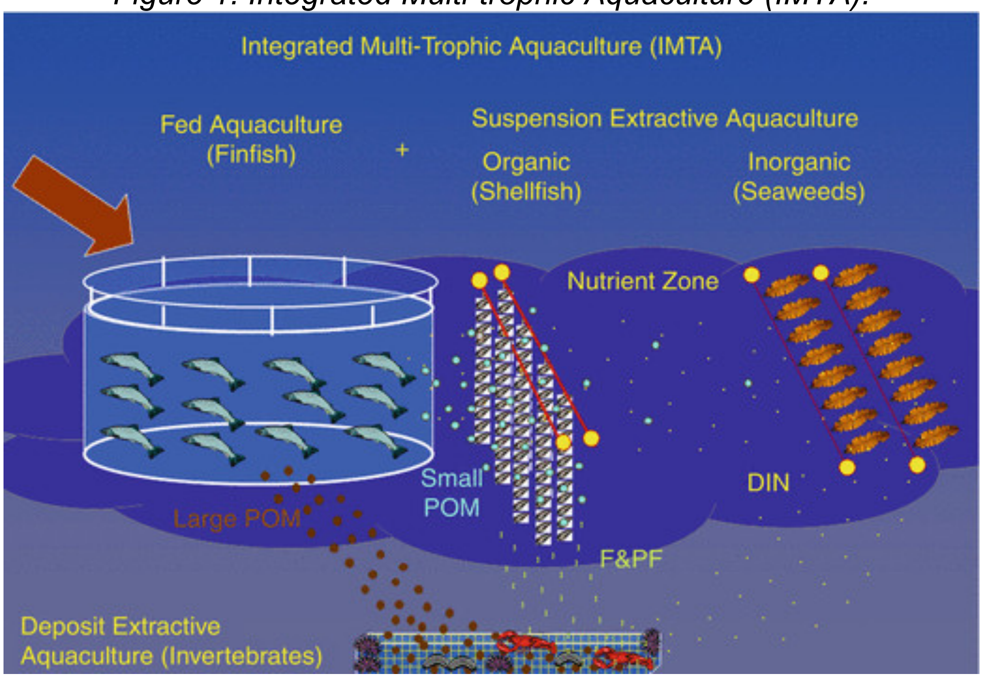
4.6.3. Turbidity

A no action alternative will have no significant impacts on the current water turbidity conditions.

4.7. Mitigation measures

There are mitigation measures that can be taken to limit water quality impacts for the proposed action, the alternatives, and the no action. One approach is integrated multi-trophic aquaculture (IMTA) that utilizes species from different trophic levels with complementary ecosystem functions (Chopin et al., 2012). It allows for one species' uneaten feed and waste, to be recaptured and utilized by another species, taking advantage of the synergistic interactions between species (Figure 1). This approach to aquaculture removes the focus on monospecific technological solutions and mitigates multiple impacts simultaneously.

Figure 1: Integrated Multi-trophic Aquaculture (IMTA).



Other mitigation approaches to reduce water quality pollution are using plant-based feed and closed system contaminant technologies. According to recent studies, nutrient discharge from net pens is significantly lower when plant-based feed ingredients are substituted for fish-meal feed (Naylor and Burke, 2005). Closed system contaminant structures such as closed-wall sea pens also potentially minimize effluent discharge from farms (Naylor and Burke, 2005).

5. Plants and Wildlife

5.1. Existing Conditions

Several plants and animals existing in the Salish Sea. The species of plants and wildlife considered include: marine and shore birds, marine mammals, fin-fish, benthic and infaunal species, and marine plants.

5.1.1. Marine and Shore Birds

Thirty-four species of marine and shore birds use Hale Passage for at least part of the year (Lummi, 2010) (Appendix B1 for full species list). Washington State recognizes four of the birds as species of concern. The marbled murrelet (*Brachyramphus marmoratus*) is federally recognized as threatened under the Endangered Species Act (ESA). The proposed location is within one of the marbled murrelet conservation zones, as delineated by the Northwest Forest Plan (WDFW). Washington State classifies the western grebe (*Aechmophorus occidentalis*) and common loon (*Gavia immer*) as sensitive species. They are in decline or expected to decline due to destruction of habitat, overuse, disease, predation, inadequate regulation, or other factors and are being monitored to determine the necessity of threatened or endangered status. Finally, the bald eagle (*Haliaeetus leucocephalus*), which is large enough to prey upon aquaculture fin-fish, is recognized by Washington State as a sensitive species, and by the federal government as a species of concern.

5.1.2. Marine Mammals

Three species of marine mammals, the harbor seal (*Phoca vitulina)*, the steller sea lion (*Eumetopias jubatus)*, and the California sea lion *(Zalophus californianus)* have habitat within the proposed site area. All three species are managed under the Marine Mammal Protection Act. The Steller sea lion is listed as threatened under the ESA, however it has been recommended for de-listment in Washington State.

5.1.3. Fin-fish

Twenty species of fin-fish use the proposed site area for habitat or migration routes for at least part of the year (see Appendix B3). These include three species of salmon: chinook (*Oncorhynchus keta*), chum (*Oncorhynchus kisutch*), and pink (*Oncorhynchus gorbuscha*). These also include salmonids such as steelhead trout (*Oncorhynchus mykiss*).

5.1.4. Benthic and Infaunal

Seventy benthic and infaunal species have habitat within the proposed site (see Appendix B4 for full species list). These include clams, cockles, limpets, anemones, shrimp, and crabs.

5.1.5. Plants

Eleven species of plants have been identified within the proposed site (see Appendix B5 for full species list). These include eelgrass and several types of kelp. Eelgrass beds and kelp forests are critical nesting, resting, and feeding habitats for many fish, birds, and mammals.

Kelp forests and beds provide growing space for many plants and animals as well. They also protect other nearby sensitive environments from erosion and disturbance by heavy currents.

Eelgrass provides essential productivity and nutrient services for the coastal marine zone. They make up the backbone of the grazing food web while simultaneously being an important habitat for migratory birds protected under the Migratory Bird Treaty Act (Parks, 2008).

5.2. Significant Impacts

Significant impacts to plants and animals are discussed for the proposed action, the alternatives, and a no action alternative.

5.3. Proposed Action

The proposed action consists of installing two 40x20m Atlantic salmon net-pens at Site 2.1.

5.3.1. Marine and Shore Birds

Net-pens can attract large numbers of marine and shore birds, particularly those who prey upon fin-fish. This can lead to changed behavior patterns and changes in food sources for these birds. Birds attracted to the net-pens are also at risk of predation by marine mammals that are also attracted to the pens.

5.3.2. Marine Mammals

Net pens attract marine mammals, leading to conflict with operation staff and owners. Marine mammals such as seals and sea lions have been known to frequently prey on salmon net-pens, resulting in them being shot by aquaculturists (Naylor, 2010). Entanglement of marine mammals also occurs in net-pens as a result of attempted predation (Wursig, 2002). This can lead to net damage, and be potentially fatal for the marine mammal.

5.3.3. Fin-fish

Across the globe, wild salmon runs in rivers with salmon farms are less productive compared with those in comparable rivers without salmon farms (Ford, 2008). The average decline in returning salmon in such rivers was 25%, 5%, and 60% for coho, chum, and pink salmon respectively. This decline is attributed mainly to sea lice, competition, reduction of genetic diversity due to interaction between escaped and wild individuals, and physical hazards from net pens. Competition includes both habitat and food sources (Naylor, 2005). Atlantic salmon can outcompete steelhead trout for territory, due to earlier hatching times (Volpe, 2001). However, Atlantic salmon are known to be less competitive in the proposed area than in other areas of the globe, so lesser effects are to be expected.

Diseases and pathogens can be easily transmitted from farmed fish to wild fish. This can cause severe alterations to wild community structures and population depression. Diseases and pathogens can affect both salmon and other wild fin-fish. Transmission can occur at hatchery sites, within net-pen plumes, or from escaped fish (Naylor, 2005).

Stress to farmed fish due to predation attempts and entanglement can increase rates of disease which are then passed on to wild stocks (Nash, 2000).

Another source of impacts on wild fin-fish populations is lice. When juvenile salmon are exposed to lice during their first trip to the ocean, it can result in 16-97% mortality rates (Krkosek, 2007). Juvenile salmon emerging from streams without fish farms had few instances of lice, suggesting that close contact between pens and wild stocks is needed to transport the lice (Krkosek, 2007). The location of this proposed aquaculture site is away from the mouths of salmon-bearing rivers in Bellingham Bay, which may lead to a lesser risk from lice.

Permanent runs established by escaped salmon have been verified across the globe, particularly in the Atlantic Ocean. These runs compete with wild salmon for habitat and food. However, the risk of a permanent Atlantic salmon run being established by escapees from this farm is low, due to low numbers of farmed salmon relative to wild populations, low reproductive rates, and unsuitability of the environment (Naylor, 2005). Still, escaped salmon do pose a risk to wild salmon populations in other ways. Disturbance of wild eggs by spawning farmed salmon can lower the reproductive rate of the wild stocks (Naylor, 2005). Genetic depression due to inbreeding can also lower the productivity of wild stocks. Stress is a factor stemming from competition and also depresses wild populations, even if the escaped salmon never breed successfully.

5.3.4. Benthic and Infaunal

Changes in water quality conditions from the presence of aquaculture operations can cause significant impacts to benthic and infaunal organisms. Uneaten feed and fish waste results in nutrient pollution in the water near net-pens. In particular, nitrogen waste can cause algal blooms resulting in hypoxia, which drives away or kills native plants and fauna (Bouwman et al. 2013).

Nutrient loading can also alter the biogeochemistry of nearby benthic communities (Naylor, 2005). However, nutrients can also enrich benthic communities, depending on the specifics of the site and the local water flow (NOAA, 2001).

The biological effects of aquaculture waste on benthic infauna have been well documented. Brooks et al (2002) found significant reductions in the species richness within 45m of a farm during peak production. Any changes or decreases in the benthic communities also affects organisms who rely on these communities for food, including marine mammals (Wursig, 2002).

Antibiotics are commonly used in aquaculture operations, leading to antibiotic residue in the local environment. Accumulation of antibiotics in sediments can interfere with microbial communities and alter their rates and mechanisms of crucial processes such as mineralization of organic waste (Champeau, 2013).

5.3.5. Plants

Changes in the water column and in sediment properties from increasing nutrients released from an aquaculture site impacts the surrounding plants. Studies on

Mediterranean seagrasses observed the grass to disappear under fish cages and to be significantly degraded in surrounding areas (Ruiz et al., 2001). However, the extent of this impact is highly variable depending on the hydrodynamics of the area. The proposed site is well flushed so the impact won't be significant.

5.4. Alternative 1: Reduced Site

Alternative 1 consists of installing one 40x20m Atlantic salmon net-pen at Site 2.1.

5.4.1. Marine and Shore Birds

A decreased operation will lead to a decreased attraction to marine and shore birds, resulting in similar but lessened impacts as in the original proposal.

5.4.2. Marine Mammals

A decreased operation will lead to a decreased attraction to marine mammals, resulting in similar but lessened impacts as in the original proposal.

5.4.3. Fin-fish

A decreased operation will lead to decreased impacts on wild fin-fish, resulting in similar but lessened impacts as in the original proposal.

5.4.4. Benthic and Infaunal

A decreased operation will lead to decreased amounts of fish feed, antibiotics, and waste entering the local environment, resulting in similar but lessened impacts on benthic and infaunal communities as in the original proposal.

5.4.5. Plants

A decreased operation will lead to decreased amounts of fish feed, antibiotics, and waste entering the local environment, resulting in similar but lessened impacts on plants as in the original proposal.

5.5. Alternative 2: Sablefish

Alternative 2 consists of installing two 40x20m sablefish net-pens at Site 2.1.

5.5.1. Marine and Shore Birds

A sablefish operation will have the same significant impacts on marine and shore birds as in the original proposal.

5.5.2. Marine Mammals

A sablefish operation will have the same significant impacts on marine mammals as in the original proposal.

5.5.3. Fin-fish

A sablefish operation will have lessened impacts on wild salmon populations and greater impacts on wild sablefish populations compared to the original proposal. Sablefish are not direct competitors with wild salmon, so any escapees would not have a large negative effect on wild salmon populations. Sablefish exist naturally as deep-water bottom-dwelling species. Salmon spend their time mid water column. This means that these two species would not be directly competing for habitat, food, or spawning grounds. Sablefish are not a known carrier of salmon lice, and thus would not cause the high levels of juvenile salmon mortality.

There are very large amounts of uncertainty about the effects of sablefish aquaculture operations. There are few sablefish farms in existence and their impacts on the surrounding ecosystems have not been widely studied or well understood. Unknown diseases and parasites could pose a significant risk to wild salmon, wild sablefish, or other populations.

Sablefish are native to the north Pacific Ocean, and thus the potential for permanent colonization and inbreeding is very high in the event of an escapement. Sablefish are also a very long lived fish compared to salmon, so the ecological effects of escaped fish have the potential to be more long lasting.

Sablefish do not spawn in streams and thus would not have the potential to disrupt the breeding of stream-spawning anadromous fish.

5.5.4. Benthic and Infaunal

A sablefish operation will have the same significant impacts on benthic and infaunal organisms as in the original proposal.

5.5.5. Plants

A sablefish operation will have the same significant impacts on plants as in the original proposal.

5.6. Alternative 3: No Action

Alternative 3 is to take no action for the development of an aquaculture site.

5.6.1. Marine and Shore Birds

A no action alternative will have no significant impacts on marine or shore birds.

5.6.2. Marine Mammals

A no action alternative will have no significant impacts on marine mammals.

5.6.3. Fin-fish

A no action alternative will have no significant impacts on fin-fish.

5.6.4. Benthic and Infaunal

A no action alternative will have no significant impacts on benthic and infaunal organisms.

5.6.5. Plants

A no action alternative will have no significant impacts on plants.

5.7. Mitigation Measures

There are several possible mitigation measures that can be applied to the proposed action and any of the alternatives to decrease environmental impacts by escapement, diseases, and lice.

Preventing damage to net-pens by marine mammals is one way to prevent fish escapes. This can be done in several ways. Options include tensioning net pens with steel spars in the nets, installing outer predator nets, and using more efficient deterrents around the floats (Nash et al., 2000).

Recapturing escapees from the wild will also minimize impacts. However, the feasibility and cost of this option is questionable (Bridger and Garber, 2002).

Mitigation measures to reduce the transmission of diseases and sea lice will also minimize the impacts on wild fish stocks. Blue mussels have been shown to inactivate the infectious salmon anemia virus (ISAV) (Chopin et al., 2012). Blue mussels and other shellfish (i.e. scallops) can ingest sea lice in their planktonic and infectious stage as copepods. Installing bivalves around the fish cages could result in biological control of pathogen and parasite outbreaks (Chopin et al., 2012).

Removing farmed fish from their pens during the time of juvenile migration to the ocean can significantly lower the mortality due to lice by nearly 100% (Krkosek 2007, Morton 2004).

Inducing triploidy in farmed Atlantic salmon stocks makes them infertile, and thus incapable of genetically affecting wild salmon upon escapement. However, they currently have a slightly lower survival rate than non-triploid fish making them slightly less economically favorable (Benfey, 2001).

6. The Built Environment

The built environment encompasses the area in which human activity and man-made structures exist prior to the proposal of a project. This pre-existing infrastructure and area usage can heavily influence and even dictate what new structures or activities are allowed to take place. Assessment of the built environment should consider community opinions, local and traditional activities, and the effects the proposed operation may have on existing structures and activities. Because the proposed location is within Lummi waters and close to the Lummi Nation boundary, we must carefully account for the history and opinions of the Lummi people.

6.1. Existing Conditions

A number of existing conditions in the built environment are considered, including: aesthetics, commercial fishing, tribal use, and marine pathways.

6.1.1. Aesthetics

Aesthetics are an important consideration in an aquaculture operation because the public plays a significant role in community decisions. The public's perceptions of aquaculture tend to be negative and associated with pollution issues (Ertor, 2015). There are several aesthetic components to an aquaculture operation that are likely to stir up complaints from the community. The most significant of these complaints being view-shed, light, and odor.

6.1.2. Commercial Fishing

The Whatcom Commercial Fishermen Association (WCFA) supplies fresh caught seafood to the greater Whatcom area. Commercial fishing from the Port of Bellingham contributes to the local economy with 1781 direct jobs and 870 indirect jobs (Port of Bellingham, 2016).

6.1.3. Tribal Use

The Lummi tribe was included in the Treaty of Point Elliott, signed in 1855. This treaty protects the natural resources within Lummi Island, including the surrounding waters. The Lummi Nation is heavily reliant on the surrounding water for food, transport, and livelihood. This treaty gives Lummi Nation a large role in the proposed operation because it will directly impact their natural resources. However, Lummi has had previous experience with fin fish aquaculture and has expressed great interest in implementing the practice within their waters again. The main concern of Lummi Nation is that each individual should be a greater steward of the ocean, which means having minimal environmental impact on the ocean. There is less concern regarding the aesthetic of the operation and more concern regarding its environmental implications (Hillaire, 2012).

In 1969, the Lummi Nation started The Aquaculture Project, in an attempt to continue their traditional reliance on coastal ecosystems. This operation continues to provide a valuable supply of fish and shellfish, income for the tribe, and a possible resource for aquaculture research through Northwest Indian College programs (Hillaire, 2012). Lummi Nation has its own offshore shellfish hatchery, which produces oysters and Manila clams.

6.1.4. Marine Pathways

The Whatcom Chief Ferry route is located in close proximity to the proposed site; see Map 1.

6.2. Significant Impacts

Significant impacts to the built environment are discussed for the proposed action, the alternatives, and a no action alternative.

6.3. Proposed Action

The proposed action consists of installing two 40x20m Atlantic salmon net-pens at Site 2.1.

6.3.1. Aesthetics

Many fin-fish aquaculture operations in Europe have run into issues relating to Not in My Backyard (NIMBY) complaints from residents in surrounding areas (Ertor, 2015). Residents reject the idea of having aquaculture within the direct view-shed of their neighborhoods because they do not think it is aesthetically pleasing. It is a possibility that these types of issues could arise as a result of the proposed fin-fish operation here in Whatcom County. However, the site is far enough from shore to create a relatively small view-shed. It is important to address these complaints in a political framework to satisfy important stakeholders and prevent the creations of a major block to the proposal.

Salmon aquaculture produces odors that often permeate the general area as well as produce an "off" flavor in the fish product. This odor is created by plankton and bacterial compounds that feed off the food and feces of farmed fish (Schrader, 2008). Aquaculture pens create a condensed feeding ground for this kind of biota. Odor is often measured by two factors; strength and offensiveness.

Noise should not be too significant of an issue regarding the aesthetics of the operation, and should result in few complaints. The operation involves very little industrial machinery and thus would not have a significant noise impact on the surrounding area. The proposed location is also far enough offshore to prevent noise pollution from reaching the land.

Depending on the size of an aquaculture operation, emitted light from the site of the net-pens could have an impact on the surrounding population. Because the proposed site is offshore, more light is required in order to illuminate the area in order for boat traffic to identify the site as an obstacle (Washington State Department of Ecology). This light pollution has potential to disturb wild fish populations, but would not likely cause disturbance to the surrounding neighborhoods.

6.3.2. Commercial Fishing

The proposed action would create a more competitive local market for salmon. Farmed salmon can be sold at a lower price than wild caught salmon, which in turn drives down the price of wild fish products. This affects the livelihoods of local fisherman as well as the entire commercial fishing industry and the economy surrounding it.

There are also issues associated with tribal commercial fishing.

6.3.3. Tribal Use

The proposed operation could compete with traditional tribal methods of fishing, potentially creating significant cultural and economic impacts. Although the product of this operation would not be sold within Lummi Nation, the proposed site may impede upon traditional fishing grounds. In the case of fish escapement, Atlantic salmon could potentially have an impact on the local catch (see Section 5, Plants and Wildlife).

6.3.4. Marine Pathways

The Whatcom Chief ferry route could have a potential impact on the operation when considering the disturbance of the surrounding waters. Waves produced by the moving ferry could reach the location of the operation and possibly cause damage to the net-pens.

The proposed net-pens could provide a navigational hazard to any and all boaters utilizing Hale Passage.

6.4. Alternative 1: Reduced Site

Alternative 1 consists of installing one 40x20m Atlantic salmon net-pen at Site 2.1.

6.4.1. Aesthetics

In Alternative 1, the net-pen area would be half the original size. Although, the amount of accessory structure needing to be built, such as a dock and a processing facility would likely still be the same. Need for access to the site and processing equipment required would remain unchanged.

Alternative 1 has a smaller view-shed, but could still be easily viewed by neighborhoods nested above the shorelines. It is the fact of existence in the field of view, rather than the actual size, which is objectionable to the community. The difference in the perceived view-shed alteration would likely be very small between the original proposal and this alternative.

A decreased operation will result in decreased amounts of noise. With less noise being produced within the site, there is a higher chance that recreation could take place within the area, and a lower chance of disturbance to the community.

With a smaller operation, less light would be required to illuminate structures, meaning there would be a lower light pollution impact.

A decreased operation will result in decreased amounts of odor. So, with less odor being produced within the site, there is a higher chance that recreation could take place within the area, and a lower chance of disturbance to the community.

6.4.2. Commercial Fishing

Reducing the size of the proposed operation by 50% turns an already small operation into a relatively unthreatening one regarding competition with the local commercial fishing industry. This operation would be small enough to be considered more experimental than a means to produce a large enough amount of product to create competition.

6.4.3. Tribal Use

A decreased operation would not have a significant impact on tribal fishing. Having 800m more space to potentially use for fishing practice, especially in such close proximity to a salmon net-pen, would not effectively change much.

6.4.4. Marine Pathways

A smaller operation would still receive the same level of disturbance from potential marine traffic.

A smaller operation would still be a hazard to boaters.

6.5. Alternative 2: Sablefish

Alternative 2 consists of installing two 40x20m sablefish net-pens at Site 2.1.

6.5.1. Aesthetics

The impact on view-shed, noise, and light of a sablefish operation would be the same as the proposed action.

There is a potential difference in odor between a salmon and a sablefish operation, which may result in more or less disturbance to the local community.

6.5.2. Commercial Fishing

The local market for sablefish is very small, with most wild-caught sablefish being sold in Japan. A sablefish operation would drive down the price of wild-caught salmon, negatively affecting local commercial fishermen, without providing cheaper product to local markets. (See Section 7.4 Local Salmon Production)

6.5.3. Tribal Use

Because traditional tribal fishing methods rely on local fish species that are wild-caught, only in the event of escapement would this practice be interfered with. Because sablefish populations are only local to the North Pacific and not to Hale Passage waters, there would be no breeding interference with wild populations of Sablefish.

6.5.4. Marine Pathways

This alternative's effect on marine pathways does not differ from the proposed action.

6.6. Alternative 3: No action

Alternative 3 is to take no action for the development of an aquaculture site.

6.6.1. Aesthetics

There would be no impacts on view-shed, noise, light or odor in the no-action alternative.

6.6.2. Commercial Fishing

Local commercial fishing practices would have no competition from farmed salmon and the market would stay the same.

6.6.3. Tribal Use

Traditional tribal fishing practices would not be disrupted or have any competition from the proposed action. The proposed site (Map 1) would leave space for Lummi Nation to potentially start their own net-pen aquaculture operation, or use the space for other traditional fishing methods. However, without the funding the proposed operation would provide, they would be left to finance a potential operation on their own.

In the event that no action is taken, Lummi Nation would still likely continue their own use and research of aquaculture. However, without the funding and resources of the proposed action, it would be a lot harder for them to reinstate a new net-pen operation. Without the proposed aquaculture operation, The National Indian Center for Marine Environmental Research and Education would not have a new resource for the students to study (Hillaire, 2012).

6.6.4. Marine Pathways

The marine passage where the proposed site is would be fully open to large boats to pass and would remain the same for its current use.

6.7. Mitigation Measures

Reduction of these factors would entail diluting odorants or modifying the emission of existing odorants. Diluting the odors would imply that one must use a chemical such as ammonia that could harshly impact the environment, where modifying the emission of odorants would be a very difficult task (McCrory, 2000). So far, in existing aquaculture practice only short term methods of masking odor have been achieved.

In order to have minimal interference with tribal land and practices it is pertinent that Lummi Nation is on board with this proposal. In order to cooperate with Lummi, we could offer a potential collaboration throughout the extent of the implementation of this aquaculture operation.

7. Socio-Economic Impacts

This section covers the possible socio-economic impacts of the proposed action. These include aspects of the installation, initial operation, and eventual development of the proposal. We will discuss job creation, tax revenue, local salmon production, consistent supply, and socio-economic access.

7.1. Existing Conditions

Presently, Whatcom Country has several catch fisheries based communities in Blaine and Bellingham (Norman, United States. National Marine Fisheries Service, and Northwest Fisheries Science Center 2007). However, the local market supply for salmon is minimal with very few and often very expensive wild-caught salmon products in local grocery store fish departments. Much of the caught salmon product available comes from Bristol Bay and other Alaskan fisheries. Other fish products are imported from international and often aquaculture-origin sources.

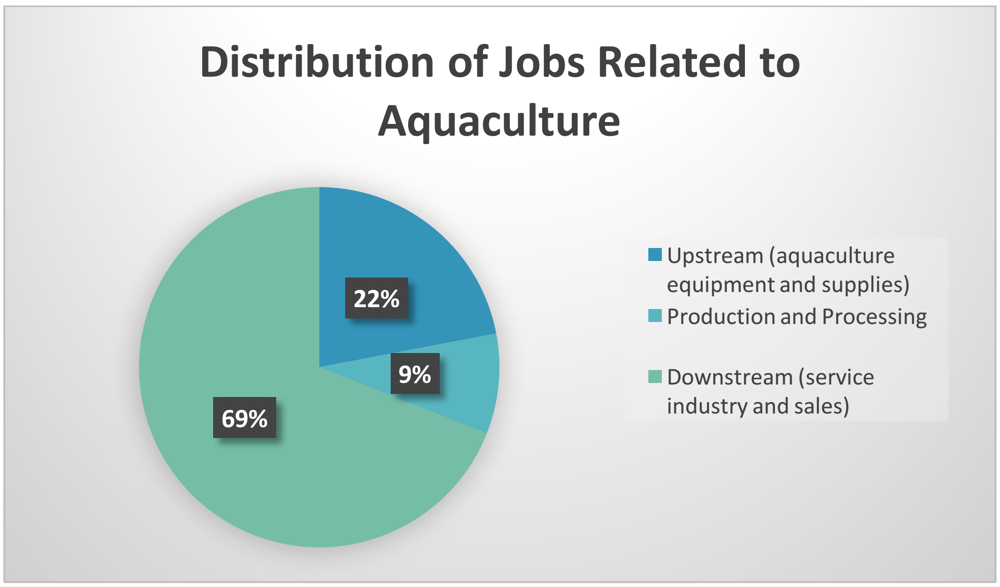
Although aquaculture has existed in the past in Whatcom and Bellingham Bay, there is not present operations. Therefore, there is no job direct or indirect job markets in this industry in Whatcom County.

7.2. Job Creation

7.2.1. Proposed Action

Job creation is a benefit of natural resource utilization. Development of this proposal will create employment opportunities directly as well as upstream (ex. aquaculture suppliers and equipment) and downstream (ex. processors, retail, and service). Downstream industries would present the largest growth and benefit as shown in Figure 2 (Dicks, McHugh, and Webb 1996). Installation of the proposal will include substantial contracting in skilled and industry focused labor from local sources. Employment at the proposed operation itself would likely be minimal after installation.

Figure 2: Distribution of Jobs Related to Aquaculture by Percentage



7.2.2. Alternative 1: Reduced Site

The halved site and operation alternative, will result in less job creation as a result of reduced initial installation jobs as well as reduced production numbers.

7.2.3. Alternative 2: Sablefish

The sablefish alternative, would support somewhat lower levels of job creation than the salmon operation. There would be fewer downstream jobs for selling and marketing sablefish, since most of the product is exported.

7.2.4. Alternative 3: No Action

The no action alternative, will result in no jobs being added to regional marine seafood production sectors.

7.3. Tax Revenue from Fish Market Economy

7.3.1. Alternative 1: Reduced Site

Canadian salmon farms have added to tax revenues through local and exported products. However, this increase is variable and inconsistent over years. A single operation of two net-pens will affect the Washington State revenues in any great way but may have an effect on local and county revenues.

7.3.2. Alternative 2: Sablefish

The sablefish alternative would likely economically depress the area (Phillips, 2005). Farming fish drives down the prices of both the farmed fish and the wild caught, due to flooding of the market. This can be beneficial to the local population, and result in higher demand if the buyers are local. However, the vast majority of the buyers of sablefish are Japanese. This means that the lower prices will benefit Japanese economy while harming local fishermen (Sumaila, 2007).

7.3.3. Alternative 3: No Action

However, Sumaila et al. (2007) note that at very low levels there can be economic benefits from sablefish farming, but that these benefits disappear quickly as the production increases. It is possible that this operation could remain within the economic gain range.

7.4. Local salmon production

7.4.1. Proposed Action

Within Whatcom County, consumption of local products is heavily emphasized. The demand for local food is growing. However, local seafood products remain minimal in regional grocery stores. Currently, 90% of seafood consumed in the U.S. is imported. Although these products largely exist in a cycle wherein U.S. caught or produced seafoods are exported for processing and re-imported for retail and consumption (NOAA, 2012). Locally controlled and operated aquaculture may impact this by integrating locally produced salmon products into regional markets. However, this is largely dependant on the demand for and willingness to buy farmed salmon by regional consumers. Due to extensive poor perceptions of farmed salmon production and products this is questionable. Lack of demand may result in the addition of local aquaculture-produced salmon to existing export/import cycles.

Aquaculture produced salmon may also impact and compete with traditional salmon fisheries in regional markets. This may negatively affect sale prices of caught-salmon and the incomes of salmon fishers. In global markets, Alaskan fishers have experienced substantial decreases in market for caught-salmon due to increased saturation of product via farmed salmon (Eagle, Naylor, and Smith 2004). The impacts of this at a local scale are less clear.

7.4.2. Alternative 1: Reduced Site

A halved operation would likely be subject to similar considerations at a reduced production rate.

7.4.3. Alternative 2: Sablefish

A sablefish operation would be more intensely subject to these considerations. Consumer demand and recognition of sablefish in regional markets is drastically lower than salmon. This would make substantial exportation of produced fish highly likely without the intentional creation of demand through marketing and outreach.

7.4.4. Alternative 3: No Action

Sablefish would also have reduced impact on caught-salmon markets as sablefish products would not compete directly with salmon markets or fishermen. However, it would likely compete with caught-sablefish fisheries in markets, decreasing prices overall as suggested by research on farmed-caught compilation in British Columbia, Canada (Liu, Volpe, and Sumaila 2014).

7.5. Consistent supply

This site may also have economic impacts in terms of providing a consistent supply of salmon products into markets. Traditional fisheries are often affected by regulations, seasons, climate, and other factors that may increase or decrease landings annually. This impact provides that the proposed site would be operated year-round; a provision that may be dictated by the structures' limitations and regulations placed on the operation. Additionally, the site may be subject to issues such as disease outbreak and predation described in sections 5.3, lowering this consistency should stock lost occur as a result.

7.5.1. Alternative 1: Reduced Site

A halved operation size would produce half the amount of salmon consistently, unless affected by the issues described in section 5.3.3. It should also be noted that a full operation (two 20x40m structures) would allow for the continuation of one structure in the event of failure of one structure. A full operation could also be controlled to run on one structure for the first half of the year and the other structure for the second half. This is a possible mitigation measure as well.

7.5.2. Alternative 2: Sablefish

A sablefish operation would also likely be consistent, but also subject to environmental climates, predation, and disease affecting consistency of production.

7.5.3. Alternative 3: No Action

The no action alternative would not concern supply other than to have no effect on current supplies.

7.6. Socio-economic access

Delgado et al. (2003) point out that fish products are often out of the reach of the poor due to rising prices. A possible economic impact of the proposed aquaculture operation is increased access to salmon products and the associated health benefits for the regional poor and food-insecure. Aquaculture produced salmon is often sold at cheaper prices than caught-salmon due to consumer preferences for the latter (Eagle, Naylor, and Smith 2004). Integration of cheaper aquaculture salmon into regional markets may balance access to salmon health benefits.

7.6.1. Alternative 1: Reduced Site

A halved operation would have similar but smaller impact if any.

7.6.2. Alternative 2: Sablefish

A sablefish operation may similarly impact access to fish products with comparable health benefits (Wander and Patton 1991). This impact may be less focused as sablefish are one of a variety of white fish meat options on the market, diffusing the demand. The addition of a locally produced aquaculture product would remain as an impact.

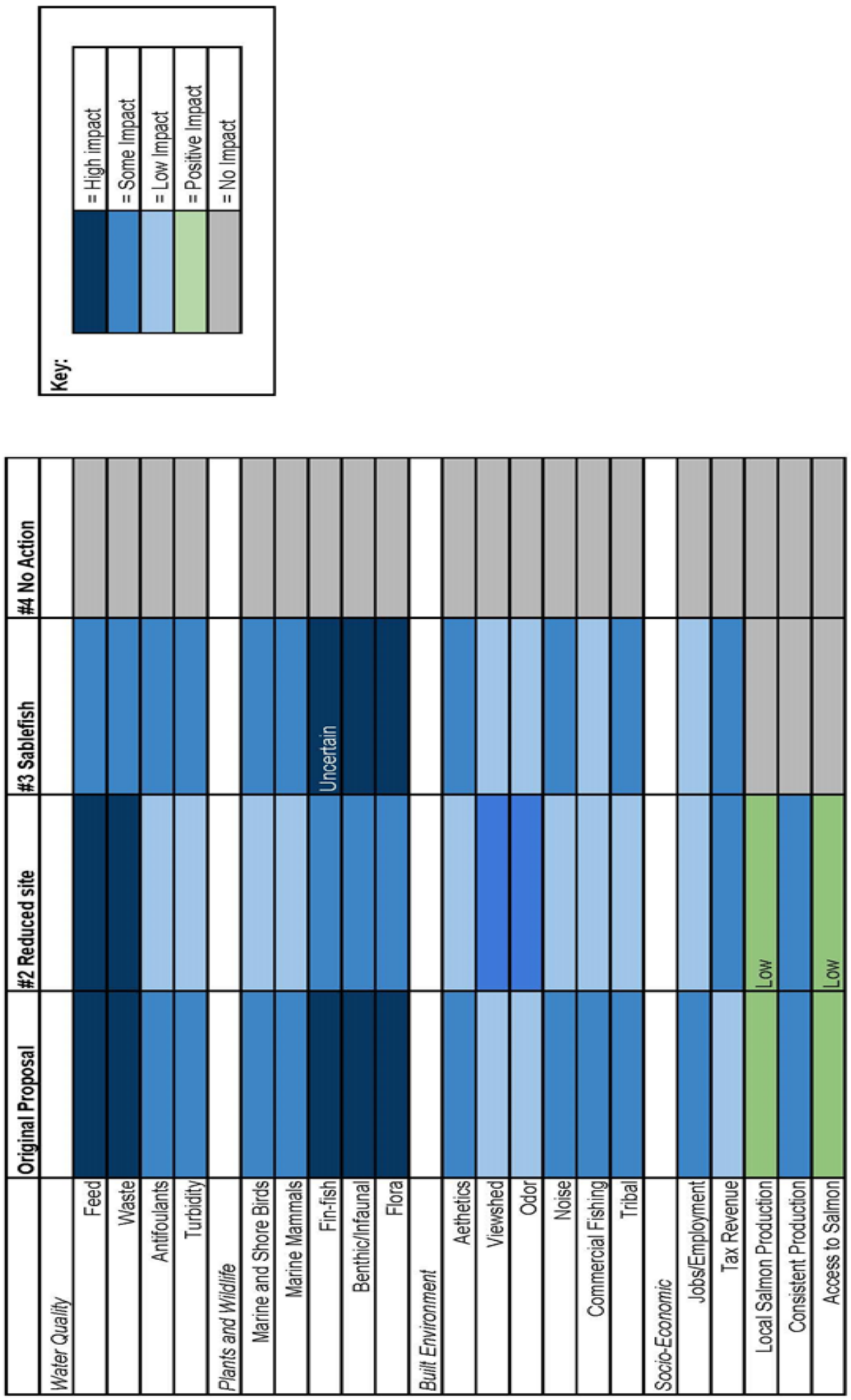
7.6.3. Alternative 3: No Action

The no action alternative would not concern access other than to have no effect on the current accessibility which is limited to high priced salmon products and unconventional market through fishing friend and family.

8. Recommended Action

The alternative of a reduced site with a probationary period of one production cycle is recommended. The recommended action was chosen in part due to a lack of current information and literature regarding the impacts the proposal would have environmentally, economically, and socially. This action will allow the progress and testing of such a site under regulated circumstances. A reduced site will make for smaller environmental impacts and increase the effectiveness of mitigation measures (see Figure 3). This alternative will also reduce conflicts and impacts on the build environment until determination of their extent and severity. Lastly, a reduced site alternative will allow for the measurement of positive socio-economic impacts to more fully address the trade-offs that may be face in further expansion of the same or similar operations.

Figure 3: Decision Matrix



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Appendices

Appendix A: Site Selection Consultation Report and Maps

<u>A GIS-based Aquaculture Site Selection in Whatcom County, Washington</u>

Dan Ashley; December 3, 2016
Western Washington University

Introduction

The site selection analysis was conducted in support of an environmental impact statement being prepared regarding a hypothetical proposed salmon aquaculture site in Whatcom County, Washington. The site selection was based on eight physical parameters adopted from an open ocean aquaculture site selection study to conduct a multi-criteria site selection for the proposed aquaculture site using geographic information systems (GIS). This site selection yielded three potential sites located within Hale Passage in the Salish Sea and provides a single recommended site location for the proposed aquaculture operation. The recommended site was utilized by the lead agency for the purpose of evaluating the environmental impacts of the proposed aquaculture operation in an environmental impact statement.

Methods

<u>Physical Parameters</u>

Benetti et al. (2010) outlined a detailed list of site selection parameters to consider in the selection of open ocean cage aquaculture sites. Physical parameters that were applicable to a coastal location were applied to this site selection. The adopted physical parameters include:

1. Saltwater location in Whatcom County, Washington
2. Minimum Area: 1,600 square meters
3. Depth: 30-meters to 50-meters
4. Distance from shore: 100-meters to 1,000-meters
5. Preferred single-entity management
6. Significant wave height: < 3-meters
7. Current Velocity: Between 0.2 and 1.5 knots
8. Wind Fetch: Minimal

A minimum area parameter was added to the evaluation due to the proposed size of the operation having previously been established as two 20-meter by 40-meter net-pens, which would require a minimum area of 1,600 square meters. Several of the adopted parameters, such as significant wave height, current velocity, and wind fetch play a less significant role in a coastal regime than the open ocean, but were still considered to some degree in this evaluation.

<u>Data</u>

This site selection was conducted using ArcGIS software. Bathymetry data was sourced from Western Washington University's Spatial Analysis Lab but was based on an original dataset provided by the Washington State Department of Fish and Wildlife. Data relating to the boundaries of Lummi Nation were sourced from the Lummi Nation GIS department. Miscellaneous data relating to the analysis was gathered from Washington State department of Natural Resources and Washington State Department of Ecology. Finally, current and tide data was sources from the National Oceanic and Atmospheric Administration.

Selection of Site

The site selection evaluation began by using a bathymetry dataset[1] to isolate saltwater locations within Whatcom County, Washington that were of suitable depths for aquaculture with consideration of the tidal fluctuations. The suitable area was then refined to a 100 to 1,000-meter coastal[2] buffer which offered approximately 9.5 square kilometers of the Salish Sea that was suitable for aquaculture within Whatcom County. The 9.5 square kilometers of suitable area was divided into six more manageable *zones* to allow for a visual refinement based on the remaining parameters, all the original zones are shown on Maps 2 and 3 in the “Process Maps” section. With consideration to the remaining physical parameters, such as wind fetch, significant wave height and current velocity, Hale Passage (Zone II) was determined to be the most suitable zone for the proposed aquaculture operation. Once the site selection had been refined down to one zone (also shown in the Process Maps section) the minimum area parameter was applied which isolated three potential sites for aquaculture development. The three sites were ranked according to the remaining physical parameters as shown in the decision matrix in Table 1. The final result was the selection of Site 2.1 as the recommended site for the operation.

Table 1: Site Selection Matrix

Parameter	Ideal	Site 2.1	Site 2.2	Site 2.3
Whatcom County	True	x	x	x
Saltwater	True	x	x	x
Area	≥ 1,600 sq. meters	9,981.20	482,359.04	15,222.76
Depth (Mean)	30-50 meters	30.36	33.34	30.56
Distance to Shore (Minimum)	100-1,000 meters	634.69	213.50	868.38
Management Entity	Single-Entity	WA-DNR	WA-DNR	WA-DNR
Significant Wave Height	< 3 meters	N/A	N/A	N/A
Current Velocity	0.2 - 1.5 knots	0.34	0.34	0.34
Wind Fetch (North) (meters)	Minimal	857	330	9,400
Wind Fetch (South) (meters)	Minimal	1,815	650	4,975
Wind Fetch (East) (meters)	Minimal	701	8,293	5,934
Wind Fetch (West) (meters)	Minimal	1,018	500	1,062

Site Selection decision matrix for three sites located within Zone II: Hale Passage. All three of the sites meet the physical parameters outlined in the site selection. Site 2.1 was selected as the recommended site for the operation due to its geographic location centered within Hale Passage.

[1] Washington Department of Fish and Wildlife, 2010

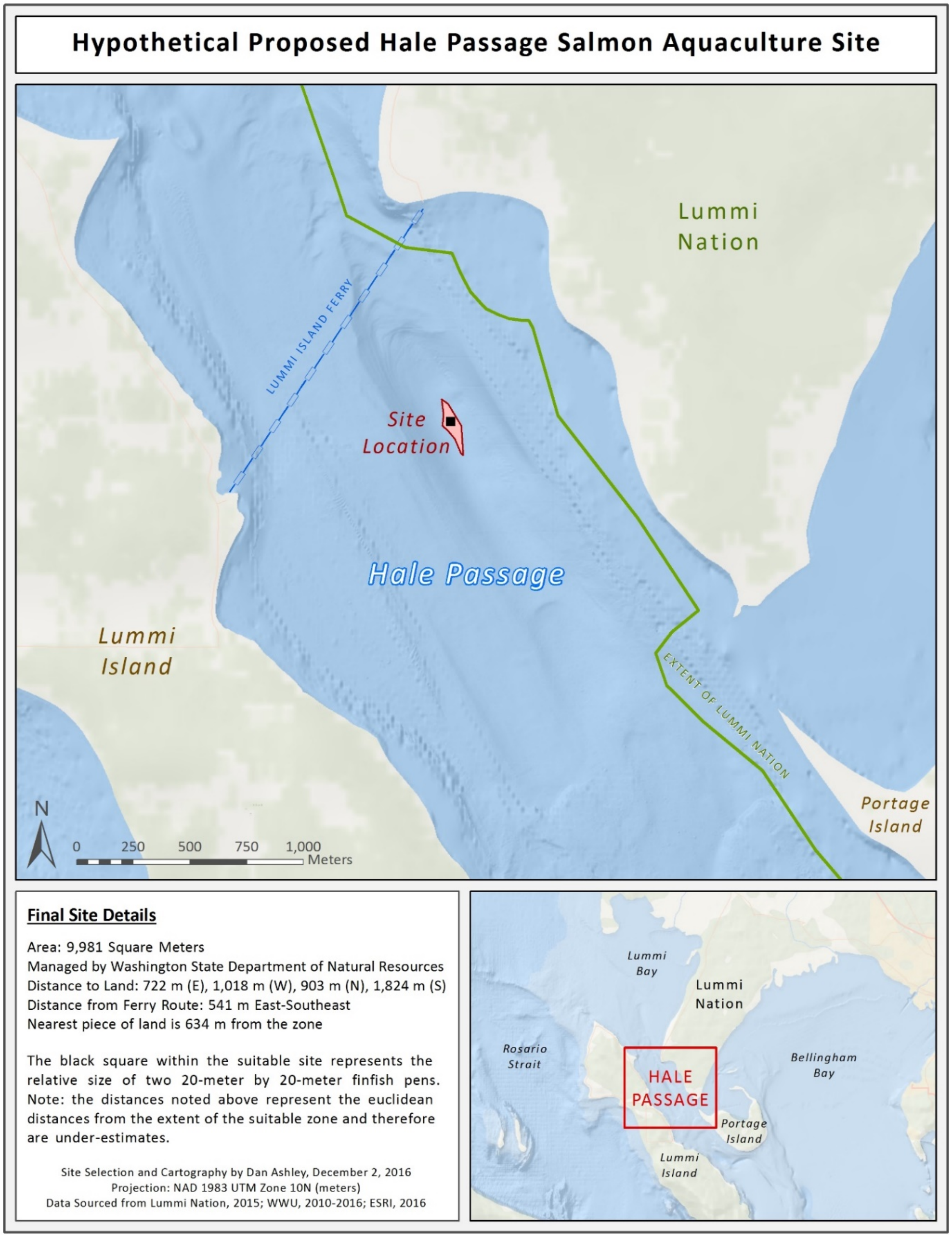
[2] At mean lower low water (MLLW)

Results

Site 2.1 is recommended as the most suitable site for the proposed fin-fish aquaculture operation in Whatcom County as shown in Map 1. The site is located in Hale Passage, covers 9,981.20 square meters and falls under the management authority of Washington State Department of Natural Resources. The site is 634-meters offshore, at its closest point, and 541-meters east-southeast of the Lummi Island ferry route. Due to its geographic location within Hale Passage with Lummi Island to the west, wind fetch is minimal and significant wave height is minimized. The average current velocity within the Passage has not been determined, however the Cherry Point dock which is 17 kilometers to the northwest of the site has a current monitoring station[3] which experienced an annual current velocity of 0.34 knots[4] which is less than the maximum outlined in Benetti et al. (2010) of 1.5 knots however still strong enough to allow for active flushing of site byproducts into the Rosario Strait and Salish Sea.

[3] Station ID: cp.0101 (NOAA)
[4] Based on November 19, 2015- November 18, 2016 at Station cp.0101

Map 1: Proposed Site



Site 2.1 is the recommended site for the hypothetical proposed Hale Passage aquaculture operation. The site meets all of the physical parameters outlined in in Table 1 and was selected due to its sheltered geographic location within Hale Passage

Discussion

This site selection could be improved in accuracy with higher resolution data, especially high resolution bathymetry data of the study area acquired with multi-beam sonar soundings. Paired with a relative tide gauge, the accuracy of tidal fluctuations and location of shoreline would be increased. The practicality of utilizing higher-resolution data however would make sense once a probable zone for an operation had already been determined using coarser resolution data, as this analysis used due to the investment involved in attaining the data. In addition, data relevant to significant wave height within the study area would be beneficial to the resulting site selection as this study made the assumption that due to the location within a passage and sheltered by an island and presenting minimal wind fetch, the wave height would not be significant.

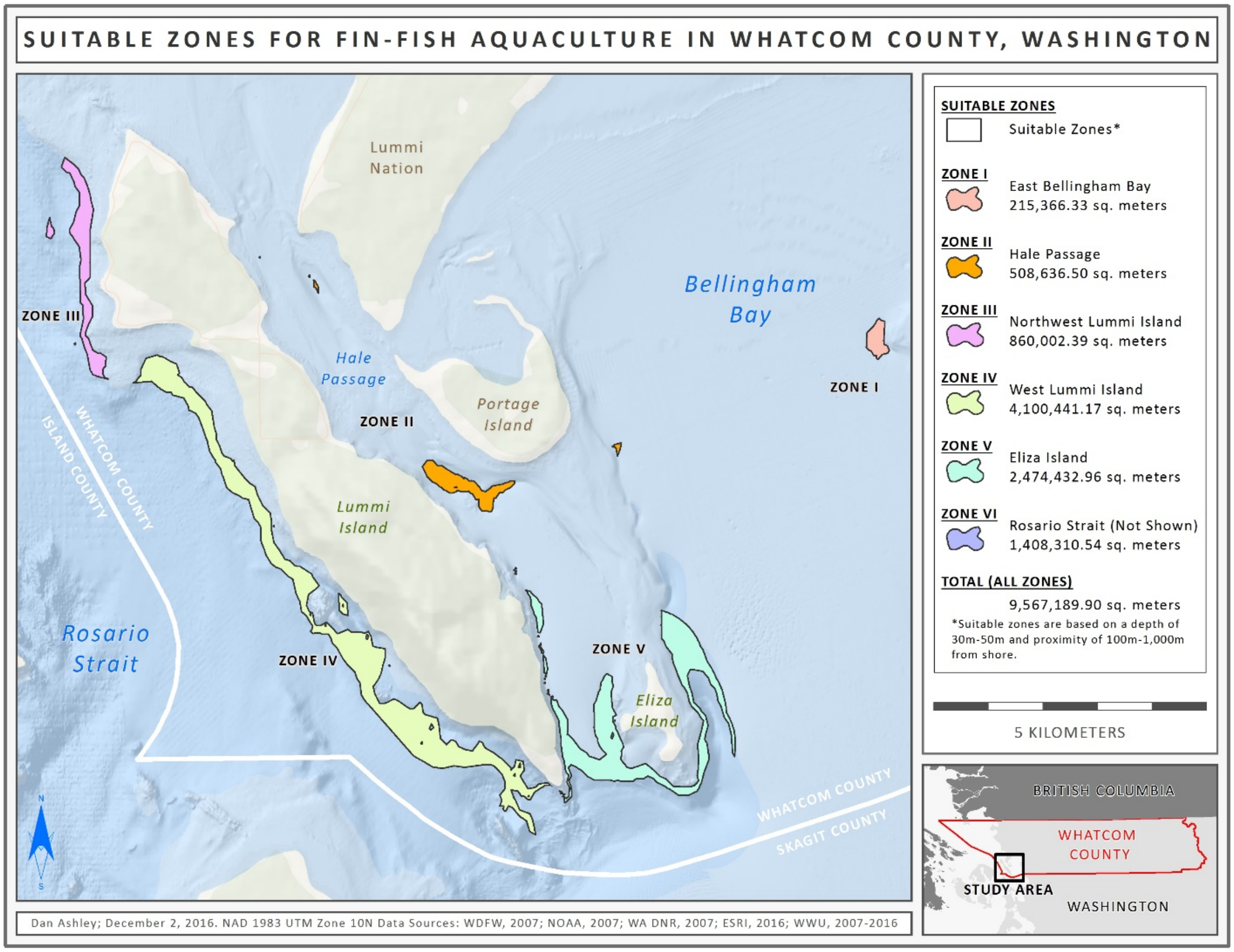
Overall, future coastal aquaculture site selections should be paired with an investment in attaining higher resolution data relevant to the selected parameters being evaluated within the spatial extent of the study area. Coarser data does result in accurate results, as shown in this site selection, however the increased accuracy granted by an investment in the collection of site specific data would be relevant to an actual aquaculture operation in selecting a suitable and sustainable site.

Conclusion

The site selection for this hypothetical proposed salmon aquaculture operation was conducted to support a draft environmental impact statement regarding a hypothetical fin-fish aquaculture operation in Whatcom County, Washington. Using 8 physical parameters adopted from an open ocean cage aquaculture site selection, the site selection was conducted within Whatcom County’s portion of the Salish Sea using ArcGIS software. The evaluation yielded three potential site locations suitable for the proposed aquaculture operation and identifies Site 2.1 as the recommended site for the hypothetical proposed fin-fish aquaculture operation. The site selection can be improved with an investment in high-resolution and site specific data once a preliminary site selection utilizing coarser data has refined potential sites to a smaller extent.

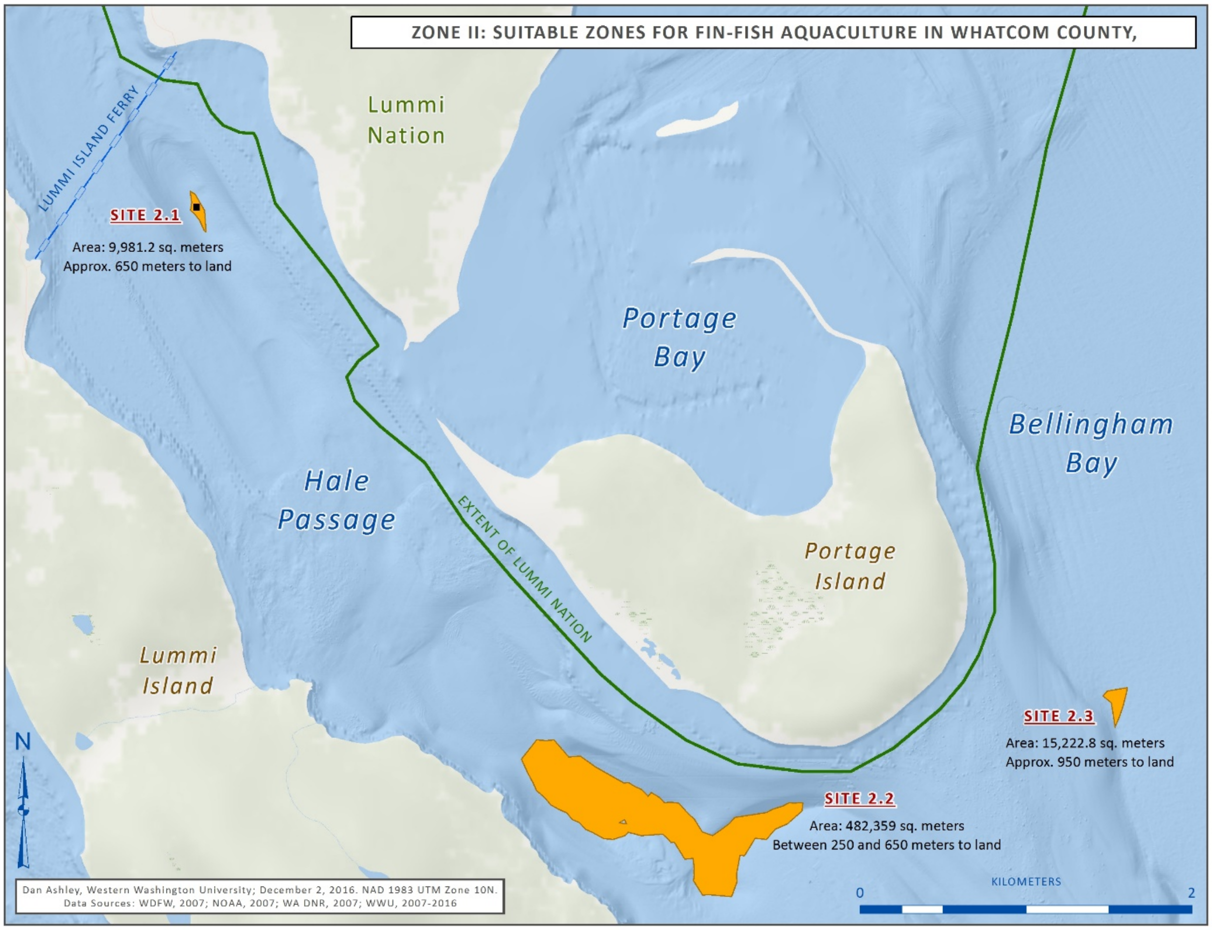
Process Maps

Map 2: Plausible Aquaculture Zones in Bellingham Bay based on Site Selection Matrix



The initial analysis utilized the suitable depth and distance from shore parameter to identify 9.5 square kilometers of suitable area for fin-fish aquaculture within Whatcom County. These areas of suitability were divided based on geographic location into six zones for further refinement. Zone II was selected as the most suitable zone for the proposed operation due to its location within Hale Passage and is shown in Map 3.

Map 3: Narrowed Sites for Aquaculture Siting in Bellingham Bay



Zone II offers three potential sites within its extent that meet the minimum area, are sited within the appropriate proximity to shore and are of suitable depth for aquaculture development. Site 2.1 was selected as the recommended site for the hypothetical proposed operation with Site 2.2 and Site 2.3 also being suitable, just more exposed to wind fetch and therefore wave action.

Data Sources

Washington Department of Natural Resources

National Oceanic and Atmospheric Administration

Western Washington University

Washington Department of Fish and Wildlife

Washington Department of Ecology

NOAA Tide and Currents

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Appendix B: Species List

B1. Common marine and shore birds identified with in Hale Passage (Lummi Intertidal Baseline Inventory, 2010).

Scientific name	Common name
Brachyramphus marmoratus	Marbled Murrelet
Cepphus columba	Pigeon Guillemot
Phalacrocorax	Double-Crested Cormorant
Corvus brachyrhynchos	American Crow
Anas americana	American Widgeon
Bucephala albeola	Barrow’s Goldeneye
Bucephala albeola	Bufflehead
Bucephala clangula	Common Goldeneye
Mergus merganser	Common Merganser
Aythya marila	Greater Scaup
Clangula hyemalis	Longtailed Duck
Anas platyrhynchos	Mallard
Anas acuta	Northern Pintail
Mergus serrator	Red-Breasted Merganser
Melanitta perspicillata	Surf Scoter
Melanitta fusca	White-Winged Scoter
Branta bernicla	Brant
Podiceps auritus	Horned Grebe
Podiceps grisegena	Red-Necked Grebe
Aechmophorus occidentalis	Western Grebe
Larus philadelphia	Bonaparte’s Gull
Larus argentatus	Herring Gull

Larus canus	Mew Gull
Larus delawarensis	Ring-Billed Gull
Ardea herodias	Great Blue Heron
Ceryle alcyon	Belted Kingfisher
Gavia immer	Common Loon
Gavia pacifica	Pacific Loon
Gavia stellata	Red-Throated Loon
Arenaria melanocephala	Black Turnstone
Charadrius vociferus	Killdeer
Haliaeetus leucocephalus	Bald Eagle
Sterna caspia	Caspian Tern

B2. Marine mammal species reported within Hale Passage (Lummi Intertidal Baseline Inventory, 2010)

Scientific name	**Common names**
Phoca vitulina	Harbor Seal
Zalophus californianus	California Sea Lion
Eumetopias jubatus	Stellar Sea Lion

B3. Fin-fish species reported in Hale Passage (Lummi Intertidal Baseline Inventory, 2010).

Scientific name	**Common names**
Citharichthys sonididus	Pacific Sanddab
Platichthys stellatus	Starry Flounder
Clupea pallasi	Pacific Herring

Ammodytes hexapterus	Sandlance
Hexagrammos stelleri	Whitespotted Greenling
Pholis laeta	Crescent Gunnel
Apodichthys flavidus	Penpoint Gunnel
Pholis omata	Saddleback Gunnel
Oncorhynchus keta	Chinook, King, Quinnat, Spring, Tyee
Oncorhynchus kisutch	Chum, Dog, Keta, Silverbrite
Oncorhynchus gorbuscha	Pink, Humpback
Oncorhynchus mykiss	Steelhead Trout
Enophrys bison	Buffalo Sculpin
Enophrys lucasi	Leister Sculpin
Gasterosteus aculeatus	Three Spine Stickleback
Rhacochilus vacca	Pile Perch
Cymatogaster aggregata	Shiner Perch
Hypomesus pretiosus	Surf Smelt
Syngnathus leptorhynchus	Bay Pipefish
Porichthys notatus	Plainfish Midshipman

B4. Infaunal/benthic species reported within Hale Passage Tidelands (Lummi Intertidal Baseline Survey, 2010).

Scientific name	**Common names**
Anthropleura artesimia	Moonglow Anemone
Urticina coriacea	Stubby Rose Anemone
Caprella species	Caprellid Amphipod
Family Corophiidae	Corophiid Amphipod
Family Gammaridae	Gammarid Amphipod

Balanus glandula	Acorn Barnacle
Blanus crenatus	Smooth Acorn Barnacle
Chthamatus dali	Tiny Brown Barnacle
Pagurus granosimanus	Grainy Hermit Crab
Pagurus hirsutiusculus	Hairy Hermit Crab
Idotea resecata	Eelgrass Isopod
Gnorimosphaeroma oregonense	Pill Bug Isopod
Idotea wosnesenskii	Rockweed Isopod
Cancer magister	Dungeness Crab
Oregonia gracilis	Graceful Decorator Crab
Pugettia producta	Kelp Crab
Telmessus cheiragonus	Hairy Helmet Crab
Hemigrapus oregonensis	Oregon Shore Crab
Pinnixa faba	Pea Crab
Hemigrapsus nudus	Purple Shore Crab
Pinnixa schmitti	Schmitt Pea Crab
Scleroplax granulata	Scleroplax granulata
Pinnixa tubicola	Tube Dwelling Pea Crab
Amphiodia species	Brittlestar Long Rayed
Ophiopholis aculeata	Red Brittlestar
Dendraster excentricus	Sand Dollar
Macoma nasuta	Bentnose Clam
Saxidomus giganteus	Butter Clam
Clinocardium nuttallli	Cockle
Cryptomya californica	Cryptomya
Parvalucina tennuisculpta	Fine Lined Lucine

Panopea abrupta	Geoduck Clam
Tresus species	Horse Clam
Solen sicarius	Jack Knife Clam
Macoma inquinata	Macoma inquinata
Macoma balthica	Macoma balthica
Macoma secta	Macoma secta
Nuttalia abscurata	Mahogany Clam
Venerupis phillipinarum	Manila Clam
Leukoma staminea	Pacific Littleneck
Mytilus trossulus	Pacific Blue Mussel
Nutricola tantilla	Purple Dwarf Venus
Mya arenaria	Softshell Clam
Tellina species	Telina Clam
Callithaca tenerrima	Thin Shelled Littleneck
Lucinoma annulatum	Western Ringed Lucine
Nearomya rugifera	Wrinkled Montacutid
Haminoea species	Bubble Snail
Lottia parallela	Eelgrass Limpet
Tectura persona	Mask Limpet
Tectura scutum	Plate Limpet
Lottia pelta	Shield Limpet
Littorina scutulata	Checkered Periwinkle
Lacuna species	Chink Shells
Batillaria attramentaria	Horn Shell
Odostomia species	Odostomia
Margarites pupillus	Puppet Margarites

Littorina sitkana	Sitka Periwinkle
Family Trochidae	Trochid Snail
Ophiodermella inermis	Turridae
Amphissa columbiana	Amphissa columbiana
Lirabuccinum dirum	Dire Whelk
Nucella lamellosa	Frilled Dogwinkle
Nassarius fraterculus	Japanese Nassa
Nucella emarignata	Ribbed Dogwinkle
Betaus harrimani	Betaus Harrimani
Family Crangonidae	Crangonid Shrimp
Neotrypaena californiensis	Ghost Shrimp
Eualus bionguis	Hippotylid Shrimp
Neomysis species	Mysid Shrimp

B5. Flora species identified on Hale Passage tidelands (Lummi Intertidal Baseline Survey, 2010)

Scientific name	**Common names**
Ulva species	Ulva
Fucus distichus	Rockweed
Saccharina latissima	Sugar Kelp
Desmarestia aculeata	Witches Hair
Prionitis species	Bleachweed
Chondrus crispus	Irish Moss
Hildenbrandia species	Rusty Rock
Chondracanthus exasperatus	Turkish Towel
Mastocarpus species	Turkish Washcloth

Zostera japonica	Japanese Eelgrass
Zostera marina	Pacific Eelgrass