Technical Paper No. 498

Clam Reintroduction in Chenega, Alaska: A Mixed-Methods Approach to Recovery

by

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Alaska Department of Fish and Game **Division of Subsistence**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz Hz	
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly-accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly-accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures) first three letters	(Jan,...,Dec)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance:	
population	Var
sample	var

TECHNICAL PAPER NO. 498

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ABSTRACT

Clams are an important part of the subsistence seasonal round for residents of the Prince William Sound (PWS) community of Chenega, Alaska, but local shellfish populations throughout the sound have been in decline. The ultimate goal of this project was to inform a shellfish management plan with baseline information focused on identifying suitable beaches for clam reintroduction; collecting environmental data on beaches identified as potential quality clam habitat; documenting spawning behavior, recruitment, growth, and survival of clams in a shellfish sanctuary; and complementing biological information with traditional ecological knowledge of clam habitat and harvest practices. This was a multidisciplinary effort by staff from Chugach Regional Resources Commission's Alutiiq Pride Marine Institute, the Alaska Department of Fish and Game Division of Subsistence, the Chenega Indian Reorganization Act (IRA) Council, and community members. Together, the project team documented traditional ecological knowledge (TEK) from key respondents about clams and habitat near Chenega and mapped clam harvest areas, created a Habitat Suitability Index (HSI) model for clam habitat in western PWS, introduced hatchery-reared clams to a local shellfish sanctuary site, and collected environmental data to inform future shellfish management. Results demonstrate the ongoing importance of clams to Chenega residents, the potential of incorporating TEK into HSI models, challenges with predator control with clam reintroduction efforts, and the success of hatchery-reared clam production.

Key words: Butter clams, *Saxidomus gigantea*, Littleneck clams, *Leukoma staminea*, Habitat Suitability Index model, Traditional Ecological Knowledge, Shellfish sanctuaries

1. INTRODUCTION

Shellfish, including Pacific littleneck and butter clams, are a traditional food resource and important cultural component of subsistence ways of life for Alaska Natives in the Chugach region, including the Alaska Native community of Chenega (population of 59 in 2020, 67% Alaska Native according to the U.S. Census[1]) (Figure 1-1). The Native Village of Chenega, represented by the Chenega Indian Reorganization Act (IRA) Council, is a federally recognized tribe. In response to a sharp decline in local shellfish populations, in 2020 the Chenega IRA Council submitted a proposal to the U.S. Fish and Wildlife Service Tribal Wildlife Grants program that requested funds for a project supporting shellfish populations. The successfully funded project, awarded in November 2020, enlisted support from the Chugach Regional Resources Commission to have its subsidiary, the Alutiiq Pride Marine Institute, collect clam broodstock and establish a shellfish sanctuary near Chenega to study reintroduction efforts. To incorporate traditional ecological knowledge (TEK) and document the importance of clams to subsistence ways of life, the project also included funding for the Alaska Department of Fish and Game (ADF&G) Division of Subsistence to compile existing clam harvest and use data, conduct key respondent interviews and clam harvest area mapping, and produce a Habitat Suitability Index model to describe the degree to which various locations near Chenega are suitable habitat for clams.

This report presents methods, quantitative summaries from compiled historical harvest and use data, new qualitative findings from ethnographic key respondent interviews and harvest area mapping conducted with Chenega residents, the Habitat Suitability Index model, and results of efforts to establish a shellfish sanctuary (including hatchery rearing and clam reintroduction). Together, findings demonstrate that clams remain an important subsistence resource for Chenega residents, and refined hatchery rearing techniques have the potential to be a critical aspect of clam reintroduction efforts.

Project Background

This project was driven by Chenega tribal members' concern regarding the availability of local food sources and addresses both biological and social research needs for shellfish in the region. Chenega is one of the seven tribes of the Chugach region that established the Chugach Regional Resources Commission (CRRC) in 1984 to address environmental and natural resources issues of concern to tribal members. CRRC's Board of Directors recently identified the loss of shellfish resources as a priority for recovery efforts in the Chugach region. As a result, the Chenega IRA Council applied for funding in 2020 and facilitated this project in collaboration with CRRC and its subsidiary marine research facility, the Alutiiq Pride Marine Institute (APMI), and the ADF&G Division of Subsistence (Appendix A). CRRC originally created APMI after the *Exxon Valdez* oil spill to produce shellfish resources for rehabilitation of oiled beaches near Chugach Native communities. APMI now serves entities across the state in a variety of ways, including shellfish population enhancement, mariculture research and development, and research on ocean acidification and harmful algal blooms. Both the Chenega IRA Council and CRRC have a long history of collaborating with the ADF&G Division of Subsistence, whose mission is to scientifically gather, quantify, evaluate, and report information about customary and traditional uses of Alaska's fish and wildlife resources (AS 16.05.094). Table 1-1 lists staff from the collaborating organizations who participated in the project. Together, the project team was able to address a wide range of interdisciplinary research needs.

Biologically, shellfish populations are considered a tidal zone keystone species that play a key role in cycling nutrients and stabilizing beaches. The absence of shellfish affects the complex nutrient cycling of beaches, diminishing the basic productivity of beaches in general (Filippini et al. 2023; Gallardi 2014). A notable decline in endemic shellfish populations across Southcentral Alaska in recent decades is associated with changes in the subtidal marine environments where residents of Prince William Sound gather traditional foods (Fukuyama et al. 2014). It is unlikely that shellfish populations will recover in the near

1. "2020 Census Data for Redistricting," Alaska Department of Labor and Workforce Development Research and Analysis, accessed August 3, 2023, https://live.laborstats.alaska.gov/census-data/redistrict?value%5B0%5D=4650.

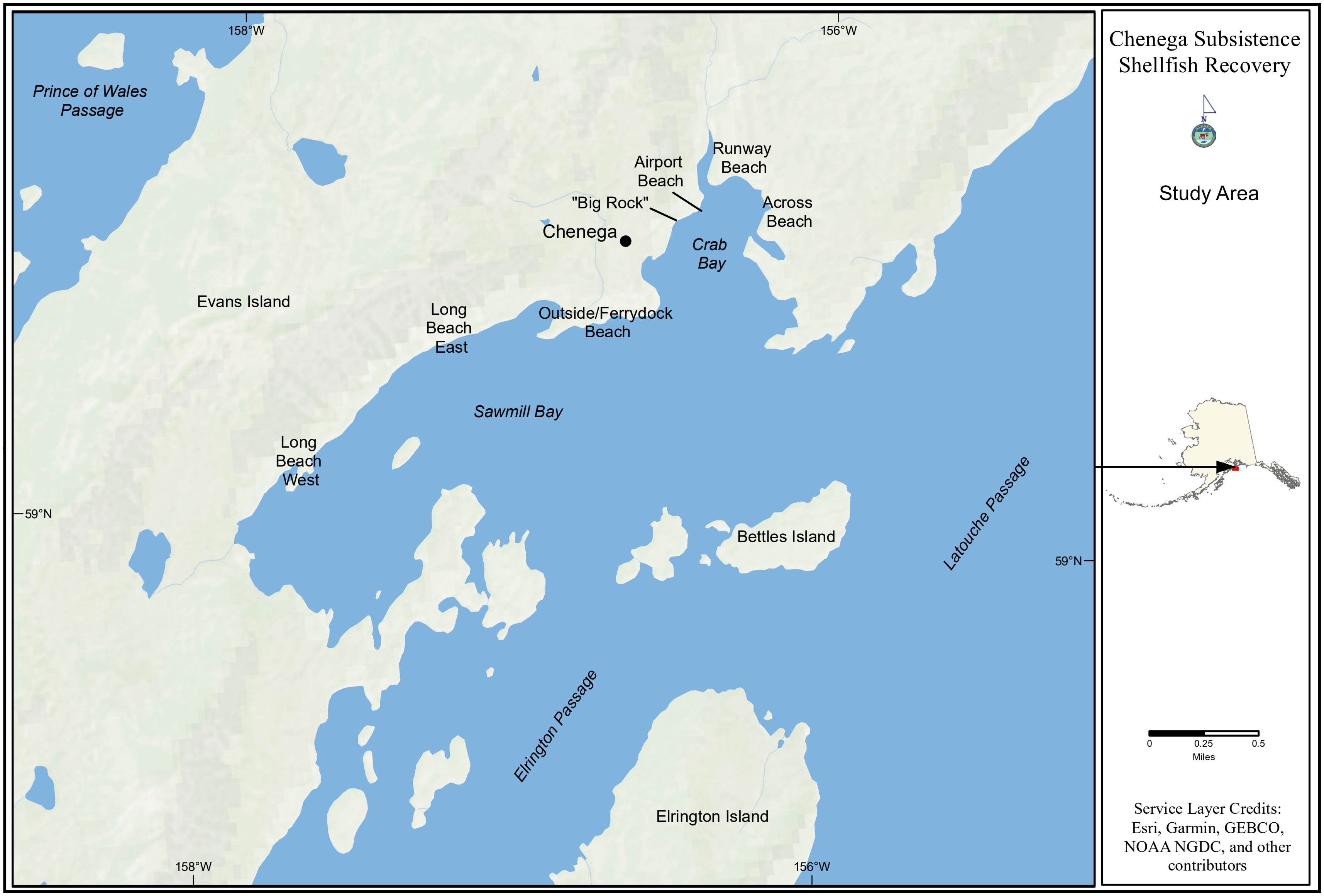

Figure 1-1.–Map of Chenega, Alaska, community study area within Prince William Sound.

Table 1-1.–Project staff.

Task	Name	Organization
Southern Regional Program Manager	Robin Dublin	ADF&G Division of Subsistence
Principal Investigator	Jacqueline Keating	ADF&G Division of Subsistence
Principal Investigator	Jeff Hetrick	Alutiiq Pride Marine Institute
Administrative support	Pam Amundson	ADF&G Division of Subsistence
	Tamsen Coursey-Willis	ADF&G Division of Subsistence
	Cheryl Park	ADF&G Division of Subsistence
Data Management Lead	David Koster	ADF&G Division of Subsistence
Qualitative data entry and analysis	Devin Anderson	ADF&G Division of Subsistence
	Jacqueline M. Keating	ADF&G Division of Subsistence
Spatial modeling and analysis	Gayle P. Neufeld	ADF&G Division of Subsistence
Hatchery Production Manager	Michael Mahmood	Alutiiq Pride Marine Institute
Hatchery Technician	Jennifer Wells	Alutiiq Pride Marine Institute
Cartography	Gayle P. Neufeld	ADF&G Division of Subsistence
Editorial Review Lead	Mary Lamb	ADF&G Division of Subsistence
Production Lead	Mary Lamb	ADF&G Division of Subsistence
Field research staff	Jacqueline M. Keating	ADF&G Division of Subsistence
	Lisa Hutchinson-Scarbrough	ADF&G Division of Subsistence
	Annette Jarosz	Alutiiq Pride Marine Institute
	Emily Mailman	Alutiiq Pride Marine Institute
	Case Estes	Alutiiq Pride Marine Institute
Local reasearch assistants	Tyler Zacher	Native Village of Chenega
	Raven Parry	Chenega/hatchery volunteer

future without intervention. APMI has been developing hatchery rearing techniques to produce juvenile clams for seeding local beaches, and has worked to establish shellfish sanctuaries to better understand the life histories of shellfish and barriers to shellfish recovery. APMI staff addressed the biological needs of this study by developing and refining hatchery culture techniques for butter (*Saxidomus gigantea*) and Pacific littleneck (*Leukoma staminea*) clams and reintroducing them to shellfish sanctuary beach areas near Chenega. Throughout this study, APMI collected environmental data and baseline information on beach areas suitable for clams near Chenega, and data about the recruitment, growth, and survival of juvenile clams reared in the hatchery and reintroduced to local beach areas. In support of the Chenega IRA Council's project obligations, APMI applied for and received permits from ADF&G for broodstock collection and transportation, hatchery spawning, and outplanting activities (see Aquatic Resource Permits in Appendix B).

The decline in shellfish populations has had a notable effect on food security for Alaska Native communities whose residents rely on shellfish as an integral part of their diet and traditional ways of life. While clam harvests fluctuate annually, the percentage of households harvesting clams has generally declined in recent decades based on household surveys conducted by the Division of Subsistence. For example, while 88% of Chenega households harvested clams in 1985, only 33% harvested in 2014.[2] A recent longitudinal analysis

2. Survey data are publicly available in the online Community Subsistence Information System (CSIS) database: http://www.adfg.alaska.gov/sb/CSIS/.

of subsistence harvest data for Chenega and other communities affected by the *Exxon Valdez* oil spill in 1989 shows a decline in harvest and use diversity, or the number of types of resources used, after the 2003 study year (Keating et al. 2020). Local residents often cited access issues including lack of boats, the inability to maintain equipment, and fuel expense as reasons for greater pressure on easily accessible resources like clams (Keating et al. 2020:50–55, 58).

To complement biological research efforts around clam habitat and reintroduction monitoring, the ADF&G Division of Subsistence was responsible for ethnographic research that would document the social components of shellfish recovery and provide updated information on customary and traditional uses of clams. The division compiled existing clam harvest and use data for Chenega, conducted new ethnographic key respondent interviews to document knowledge on clam habitat and harvest techniques, and produced updated maps of clam harvest areas. Additionally, this project provided the division with the opportunity to pilot Habitat Suitability Index (HSI) modeling, which incorporates habitat and environmental data to create predictive species-specific landscape favorability models using Geographic Information Systems (GIS) (Elsäßer et al. 2013; Guisan and Zimmermann 2000; Olsson and Rogers 2009; Wilson et al. 2011a; 2011b). The division produced HSI maps with environmental data and used mapped subsistence harvest areas identified by key respondents to validate the model. Finally, there is a growing body of literature that actively incorporates TEK into HSI models to provide more precise information on useful habitat identification and animal concentration (Berkes 2004; Olsen et al. 2015), highlight areas of particular local importance (Olsen 2015), and provide more effective recovery planning for imperiled species (Polfus et al. 2014). Therefore, the division assessed pilot HSI model results and TEK to inform suggestions for more actively integrating TEK into HSI models for future research; these suggestions are presented in the final chapter of this report.

This collaborative research effort was a multi-year study that began with broodstock collection in May 2021, subsistence ethnographic fieldwork in August 2021, seeding hatchery-reared clams in May 2022, and observations of reintroduced clams in Chenega through September 2022. On August 26, 2022, project staff Jacqueline Keating (ADF&G) and Jeff Hetrick (APMI) met with Chenega IRA Council Natural Resource staff to present project progress and obtain approval to produce a full technical paper on project results. Chenega staff granted approval and agreed to review the draft technical paper prior to publication. Through a cooperative agreement with CRRC (Appendix C), the division obtained additional funds in July 2023 to coauthor this full technical paper to report project data. Staff from the ADF&G Division of Subsistence and APMI coauthored this report. An early draft report was sent to the Chenega IRA Council on September 28, 2023, but no feedback was received. A second draft was sent on January 18, 2024, and accepted by the council. CRRC, another project collaborator, reviewed an updated draft report in January 2024, and coauthors incorporated feedback to produce the final technical paper.

Regional and Community Background

Chenega is one of five communities located in Prince William Sound, an area characterized by its rugged coastline, deep fjords, coniferous rainforest at lower elevations, and the encompassing Chugach Mountains that climb up to 13,000 feet. The people of the Native Village of Chenega are part of the Alutiiq tribal family, and they have called the Prince William Sound area home for longer than 10,000 years (Simeone and Miraglia 2000). The Alaska Native language of the Chenega people is a dialect of Alutiiq, called *Suqcestun* (sooks-toon).[3] Founded before Russians arrived in the late 1700s, Chenega was the longest occupied village in Prince William Sound at the time of the 1964 earthquake and resulting tsunami. Old Chenega was primarily a fishing village located on Chenega Island, north of the community's current location on Evans Island. The tsunami destroyed most structures in the community and claimed 26 lives.[4] Survivors were first evacuated to Cordova and then Tatitlek, where most remained until the new location named Chenega

3. "The Chenega Story," Chenega Corporation, 2023, accessed September 2023, https://www.chenega.com/about/the-chenega-story/.
4. "The Chenega Story," Chenega Corporation, 2023, accessed September 2023, https://www.chenega.com/about/the-chenega-story/.

Bay was established and then occupied in 1984 on Evans Island, 42 miles southwest of Whittier (Simeone and Miraglia 2000). Shortly after this resettlement, the 1989 *Exxon Valdez* oil spill forever altered Prince William Sound and drastically affected subsistence and commercial fishing harvest opportunities. A more detailed history of Chenega and patterns of subsistence resource use can be found in Stratton and Chisum (1986).

Today, the Alaska Native village of Chenega (renamed from Chenega Bay in 2018) includes approximately 60 residents. Chenega is only accessible by water or air through the Alaska Marine Highway System, commercial charter flights from Anchorage, and personal boat travel from larger communities such as Whittier. With no local stores available, residents continue to rely heavily on locally harvested wild foods. Employment opportunities are primarily through the local school, tribal council, health clinic, and commercial fishing. The community hosts a small boat harbor, Russian Orthodox church, a post office, and a community center.

Regulatory Context

There are no bag or possession limits or closed seasons for clams in the areas surrounding Chenega in western Prince William Sound. The Alaska Board of Fisheries (BOF) made a positive customary and traditional use finding for shellfish in Prince William Sound and determined that 15,000–25,000 lb usable weight of shellfish other than shrimp and crab are reasonably necessary for subsistence uses in the Prince William Sound Area (5 AAC 02.208(c)). However, butter clams and Pacific littleneck clams have been on the decline for longer than two decades in Prince William Sound and adjacent areas (Fukuyama et al. 2014). For example, at the 2022 meeting where Cook Inlet Area shellfish proposals were considered, the BOF adopted ADF&G-sponsored proposals to close the sport and personal use harvests of hard-shell clams (Pacific littleneck and butter clams) in the Cook Inlet and North Gulf Coast districts, and to reduce the subsistence bag limit of hard-shell clams in the Cook Inlet Area from 80 to 40 clams in combination.[5] This action was taken due to substantial declines of hard-shell clams throughout Kachemak Bay. While similar harvest restrictions have not been implemented for butter and Pacific littleneck clams in Prince William Sound, subsistence harvest opportunities have diminished along with lower clam abundance. Additionally, at the time of the study no regular paralytic shellfish poisoning (PSP) testing was available in a timely manner for Chenega residents to determine if local clams were safe to eat. While PSP was less of a concern in the past, some residents thought that the risk had increased in recent decades.

Study Objectives

The ultimate goal of this project was to inform a shellfish management plan with baseline information focused on identifying suitable beaches for clam reintroduction; collecting environmental data on beaches identified as potential quality clam habitat; documenting spawning behavior, recruitment, growth, and survival of clams in a shellfish sanctuary; and complementing biological information with traditional ecological knowledge of clam habitat and harvest practices. To inform such a management plan, this project had the following objectives:

1. Collect 200 broodstock of Pacific littleneck clams and 200 of butter clams from local beaches around Chenega and transport to the APMI in Seward for producing juvenile clams. Additional adult clams will be translocated to the sanctuary area for monitoring gamete development and spawning behavior;
2. Seed production and hatchery rearing of 100,000 Pacific littleneck clams and 100,000 butter clams;

5. Michael Booz, "Press Release: New Regulations for Southcentral Shellfish Fisheries in 2022," Alaska Department of Fish and Game, April 8, 2022, https://www.adfg.alaska.gov/sf/EONR/index.cfm?ADFG=region.NR&Year=2022&NRID=3301.

3. Establish a shellfish sanctuary near Chenega to host translocated adults and for out stocking juvenile clams;
4. Seed 100,000 juvenile Pacific littleneck clams and 100,000 butter clams near Chenega;
5. Monitor adult clam populations biweekly from April–June in 2021 and 2022;
6. Produce a habitat suitability map to determine specific locations in the Chenega region that are most likely to increase the success rate of clam reintroduction;
7. Compile all available clam harvest and use data from the ADF&G Community Subsistence Information System;
8. Conduct key respondent interviews to document local knowledge and concerns about clams and habitat, and update digital maps with subsistence harvest areas.

APMI was responsible for Objectives 1–5, in close partnership and collaboration with the Chenega IRA Council. The Division of Subsistence led the research efforts for Objectives 6–8.

Final Report Organization

To contextualize the importance of clam reintroduction efforts to Chenega residents, this report presents results for project Objectives 7 and 8 (compiled subsistence clam harvest and use data, a key respondent interview summary, and harvest area maps) and Objective 6 (Habitat Suitability Index modeling) before the results for Objectives 1–5. Chapter 2 describes the research methods applied for all study objectives, beginning with subsistence data collection, harvest area mapping, and habitat suitability modeling, and ending with hatchery production and shellfish reintroduction. Chapter 3 addresses project Objectives 7 and 8 by presenting four decades of clam harvest and use data, findings from key respondent interviews conducted in 2021, and clam harvest areas documented by Chenega residents during key respondent interviews. Chapter 4 begins with an explanation of Habitat Suitability Index modeling and shows maps depicting suitable clam habitat based on criteria in the model. The remainder of Chapter 4 details clam reintroduction efforts from broodstock collection through monitoring reintroduced clams in Chenega. Chapter 5 summarizes traditional uses of clams in Chenega, discusses challenges with mapping harvest areas and clam reintroduction efforts, evaluates the HSI model produced for this study, highlights consistencies between traditional knowledge and HSI model results, and outlines implications for future research and clam reintroductions efforts in the Chugach region.

ADF&G mailed copies of the full technical paper to the Chenega IRA Council and Native Village of Chenega. A short (four-page) summary of the study findings were mailed to every household in the Chenega (Appendix D).

2. METHODS

This project used multidisciplinary research methods to address social and biological project objectives. Social science research methods included analysis of existing harvest and use data, ethnographic key respondent interviews, and harvest area mapping. Biological research methods included shellfish population enhancement activities and comparing locations of suitable habitat according to the Habitat Suitability Index model against traditional knowledge and observations of beach areas in Crab Bay. This chapter addresses ethical principles for research with human subjects and indigenous communities, followed by a description of social science research methods, biological research methods, and project team coordination.

Ethical Principles for the Conduct of Research

The project was guided by the research principles outlined in the *Alaska Federation of Natives Guidelines for Research,*[1] the *Principles for Conducting Research in the Arctic* by the U.S. Interagency Arctic Research Policy Committee,[2] and the *Ethical Principles for the Conduct of Research in the North* (ACUNS 2003), as well as the Alaska confidentiality statute (AS 16.05.815). These principles stress community approval of research designs, informed consent, anonymity or confidentiality of study participants, community review of draft study findings, and the provision of study findings to each study community upon completion of the research.

In order to protect the health and safety of researchers and community members alike and in compliance with Chenega's mandate at the time, all project staff provided proof of vaccination and a negative COVID test prior to traveling to Chenega.

Subsistence Harvest Data and Traditional Ecological Knowledge

Compiling Subsistence Harvest Data from Previous Systematic Household Surveys

All quantitative harvest and use data presented in the report are the result of previously conducted household harvest surveys in Chenega from study years 1984 through 2014. Appendix E is an example of a shellfish harvest form from a comprehensive harvest survey conducted in Chenega for the 2014 study year. Survey data are publicly available in the online Community Subsistence Information System (CSIS[3]) database, and all results are reported at the community level. Data from all existing study years in Chenega were downloaded from the CSIS as a Microsoft (MS) Excel[4] file and harvest and use data related to clams overall and individual species of clams were reviewed to assess the scope of clam species used by Chenega households. Harvest and use trends were summarized in a series of tables depicting overall clam harvest and use patterns of Chenega households, the percentage of households using clams by species, and harvest estimates (in pounds usable weight) by species for study years between 1984–2014. Of note, one adjustment of the downloaded CSIS data is presented in this report. For harvest data from the 1980s, a significant percentage of clam harvests were reported as "unspecified clams." In order to more accurately reflect the harvest of different species for the 1984 and 1985 study years, the estimated harvests of unspecified clams were proportionally apportioned among the specific species for which harvest estimates were produced from survey responses in each of those years.

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1. Alaska Federation of Natives, "Alaska Federation of Natives Guidelines for Research," Alaska Native Knowledge Network, adopted in 1993, accessed February 8, 2021, https://www.uaf.edu/ankn/indigenous-knowledge-syst/alaska-federation-of-nati/.
2. U.S. Interagency Arctic Research Policy Committee (IARPC), "Principles for Conducting Research in the Arctic," National Science Foundation, Office of Polar Programs, adopted in 2018, accessed February 8, 2021, https://www.nsf.gov/geo/opp/arctic/conduct.jsp.
3. ADF&G Community Subsistence Information System: http://www.adfg.alaska.gov/sb/CSIS/ (hereinafter cited as CSIS).
4. Product names are given because they are established standards for the State of Alaska or for scientific completeness; they do not constitute product endorsement.

Traditional Ecological Knowledge

Ethnographic Key Respondent Interviews

Prior to conducting key respondent interviews in August 2021, researchers drafted a key respondent interview protocol that was shared with CRRC and APMI staff and the Native Village of Chenega. All entities reviewed the draft and provided feedback, which was incorporated into the final interview protocol (Appendix F). Interviews were semi-structured to provide suggested topics for discussion while leaving space for participants to make unanticipated associations with clams and their habitat (Huntington 2000). ADF&G researchers worked closely with the Native Village of Chenega and CRRC to compile a list of eight Chenega residents who were active clam harvesters, or who were particularly knowledgeable about local clam habitat. To start, researchers interviewed six respondents from the original list; they then employed a snowball sampling strategy, where respondents were asked to suggest other local contacts who were particularly knowledgeable about clam harvest practices and habitat. Four additional respondents were identified through snowball sampling and interviewed for a total of seven interviews with 10 respondents. Those who agreed to participate in key respondent interviews were provided an honorarium for sharing their expertise. All interviews and mapping were conducted in the Chenega tribal hall, or in adjacent offices in the same building. CRRC also hosted a community dinner and outreach event on August 19, 2021. Key respondents were informed that, to maintain anonymity, their names would not be included in this report. Interviews were audio recorded with the permission of participants. Interviewers also took notes during interviews that were referenced when reviewing audio transcripts.

Two ADF&G staff transcribed the interviews following ADF&G Division of Subsistence transcription protocols, including assigning a numeric code to each respondent for anonymity. To ensure accuracy, each transcript was reviewed by a second staff member who listened to the interview audio recording while reading the transcript text. After discrepancies were reconciled, transcripts were uploaded to QSR International's NVivo 12 Pro for qualitative analysis. A coding structure was developed with coding nodes based on the original interview protocol and emergent themes. Coding allowed researchers to assign a topic category to a section of text, which then generated a list of relevant excerpts that address specific research questions (Campbell et al. 2013). The final codebook contained six primary nodes and 24 secondary nodes (Appendix G). Any quotes or references to information from the interviews included in this report use the unique identifier to differentiate between respondents.

Mapping Locations of Subsistence Clam Harvesting Activities

During key respondent interviews, researchers asked respondents to indicate the locations of their clam harvest activities from recent years (the last five years, 2017–2021) as well as any harvest areas respondents used in the past. Interviewers asked the respondents to indicate the species of shellfish harvested and general amounts harvested from each location (high, medium, or low).

Current and historical harvest locations were documented on iPads using the Collector application (ESRI, or Environmental Systems Research Institute) customized for Division of Subsistence data collection protocols. To mark a harvest area, a researcher drew a polygon on a U.S. Geological Survey topographic relief map downloaded on the iPad. The iPad allowed the user to zoom in and out to the appropriate scale and the ability to document harvesting activities wherever they occurred in the state of Alaska. For this project, respondents only documented clam harvest areas in the local region. Once a polygon feature was accepted, an attribute box was filled out by the researcher that noted whether the harvest area was used currently, in the past, or both; the species harvested and general amount; method of access to the resource; and the time of year of harvest. Once an interview was complete, researchers conducted a quality control exercise by matching the map data to the interview notes to ensure all map data had been documented. Once data collection was complete, the data were uploaded through ArcGIS Online to the ESRI cloud server and then downloaded to the ADF&G network for storage. Researchers also verified that the household data were logged into the server.

ADF&G researchers created custom maps to depict past and current clam harvest areas. In order to protect the confidentiality of individual household reports, all households' data were dissolved by species using the

ArcGIS Dissolve tool; additionally, the data were also dissolved by time period (historic and current). In this instance, the term "dissolved" refers to an analytical procedure of aggregating data (individual household shellfish harvest areas) into a single unit to represent a composite whole (harvest areas for Chenega). The spatial data for current and historical clam and other shellfish search and harvest areas were sorted by species to the following subcategories: butter clams, Pacific littleneck clams, and all other shellfish combined (i.e., cockles, razor clams, and unspecified clams). The harvest locations depicted on maps in this report were dissolved to the narrowest possible resource subcategories to allow publication of data from all of the households interviewed and provide confidentiality of individual household harvest areas.

Habitat Suitability Index Modeling

Habitat suitability models describe the degree to which various habitats are suitable for a given species based on an assessment that integrates different environmental variables into a single index. Following is a description of different model types to provide context about the type of model chosen for this project. Habitat suitability index models can be categorized into three different groups—empirical, analytical, and mechanistic—all of which have varying degrees of interaction between number of input criteria (generality), capturing the complexity of nature (realism), and the precision of the results (Guisan and Zimmermann 2000; Levins 1966). In general, habitat suitability models are limited by the quality of the data used to create them (Lewis et al. 2019).

Empirical models, also called statistical models, are more precise in their predictions because they utilize multivariate statistical models with environmental criteria as predictor values; these models tend to be more realistic in their representation of the complexity of nature, which makes them less general. Analytical models use simplified equations that do not represent the level of complexity of the interactions between a species and its environment; as such, these models tend to be more general and more precise, but less representative of reality. Finally, mechanistic models are more dynamic, relying on known ecosystem processes to predict a species response to environmental change; these models, while not precise, are both general and realistic. The advantage of more generalized models is that they can be used for predictions over larger geographic areas. Mechanistic models are useful because they can represent the realized cause-and-effect relationships over large geographic areas (Guisan and Zimmermann 2000). When using spatial analysis tools in a geographic information system (GIS), the development of a mechanistic Habitat Suitability Index (HSI) model combines multiple raster datasets of geospatial environmental data in such a way as to predict species occurrence and geographic distribution (Bohlen 2019). Given the project objective of determining suitable clam habitat in the Chenega area, researchers developed a mechanistic model for this project.

Natural History-Based Habitat Suitability Models

Data collection for habitat suitability models can be time-consuming: the models require environmental data to be collected alongside species inventory data over a large environmental gradient. Such gradients are gradual changes in different factors that affect where a specific organism can survive. Commonly used gradients in marine ecosystems include air and water temperature, salinity, and wave exposure. The parameters used to predict a species' distribution should be those that are believed to be the contributing factors for its distribution and abundance. In the case of marine organisms, the expense of data collection is amplified by larval dispersal, where the immature form of the organism is carried over a wide area by ocean currents, and resultant patchy settlement for attachment and metamorphosis into the adult form. Therefore, collection of these parameters can be difficult to measure (Guisan and Zimmermann 2000). These factors make habitat suitability modeling an expensive endeavor.

As an alternative to costly methods that rely solely on newly collected environmental data, Lewis et al. (2019) developed a natural history-based, mechanistic modeling framework that could be used in conjunction with a subset of species habitat data. To further decrease the cost of the model, data can be derived from existing remotely sensed datasets or digital maps, thereby eliminating the need for costly field sampling (Guisan and Zimmermann 2000).

Framework to Identify Suitable Bivalve Habitat in Estuaries (FISBHE)

Estuaries are characterized by a diverse and dynamic range of environmental conditions, and the organisms inhabiting them must be able to tolerate these conditions (Thrush et al. 2003). Thus, a dense collection of biotic and abiotic information is required throughout an estuary to produce the most accurate model for locating anticipated suitable habitat. Extensive field surveys of this type are expensive, and in Alaska are subject to further constraints due to inclement weather. To explore an alternative to conducting project-specific survey efforts, Lewis et al. (2019) developed a modeling framework (Framework to Identify Suitable Bivalve Habitat in Estuaries, or FISBHE) using existing datasets collected independently from each other and natural history information retrieved from published literature. Model validation showed that the FISBHE modeling approach accurately predicted the presence of four out of five species of clams in the areas determined to be most-suitable habitat. The simplistic nature of this model approach is cost effective, and therefore of interest to agencies subject to budget constraints. However, because species occurrence data are not used in a FISBHE model, it is possible that the model will mischaracterize the suitability of the habitat for species for which there is no documented natural history information or in locations without enough existing data (Lewis et al. 2019). Thus, model results are limited by the quality of the data used.

HSI Model Criteria

Given the broad availability of geospatial data for the Prince William Sound region, division staff opted to develop a simple HSI model based on the approach of Lewis et al. (2019) to model locations that appear most likely to support a successful shellfish sanctuary.

The steps involved in creating a suitability model are as follows:

1. Determine and prepare criteria;
2. Transform the values of each criterion to a common suitability scale;
3. Weight criteria relative to one another and combine them to create a suitability map;
4. Locate the final locations that best meet pre-determined spatial requirements; and
5. Validate the model.

The following criteria were determined to be the most important for both the butter clam (*Saxidomus gigantea*) and the Pacific littleneck clam (*Leukoma staminea*) habitat in the Pacific Northwest (Lewis et al. 2019):

- Substrate
  - Since *S. gigantea* and *L. staminea* are both infaunal species, the physical makeup of the sediment is important. *S. gigantea* favors sand or sand-and-gravel beaches. *L. staminea* prefers mud, or mud-and-sand, or mud-and-gravel mixed substrates since it is a poor digger.
- Exposure
  - Both species are typically found in sheltered bays and estuaries, and not on open coasts or areas with oceanic influence, although *L. staminea* may be found in cracks of rocky outcrops in more exposed areas.
  - Researchers did not include rocky outcrop substrates in the model because it was unknown how successful seeding would be in these areas. Clam species are susceptible to desiccation when they are exposed to air during low tide, which dries out the soft tissue inside the shell. Because of this, they are typically found in the lower intertidal zone, which limits their exposure to air and lessens their chances of desiccation, or in the subtidal zone, which eliminates the risk.

- Salinity
  - Estuaries and bays are characterized by having a range of salinity depending on the freshwater input and water column mixing. The salinity level can be limiting to where a clam species can survive. Both *S. gigantea* and *L. staminea* can tolerate a broad range in salinity, from 23 practical salinity unit (PSU) to more than 32 PSU.
  - It had been expected that sufficient long-term salinity data existed to create a surface raster of Prince Wiliam Sound. However, no data were found for the southwest area of the sound, especially in the study area. Some salinity data were supplied by APMI researchers; however, it was not spatially explicit enough to generate a raster for the analysis. It is possible that the presence of eelgrass (*Zostera marina*) could be used as a proxy for salinity since it grows best in salinities over 20 parts per thousand (ppt), as do both *S. gigantea* and *L. staminea* (Lewis et al. 2019). However, *Z. marina* can also grow at lower salinities, which casts doubt on using its presence as a proxy for salinity (Biebl and McRoy 1971).
- Presence of burrowing shrimp
  - The presence of burrowing shrimp, such as the ghost shrimp (*Neotrypaea californiensis*) and the mud shrimp (*Upogebia pugettensis*) negatively affects the survivability of clams and other animals that inhabit the same substrate that the shrimp do. This is because when the shrimp burrow into the substrate it is destabilized (McGinnis 2008). It is currently unknown whether burrowing shrimp inhabit the area around Chenega.[5]
  - The eelgrass *Z. marina* inhabits the same intertidal habitat as burrowing shrimp (Berkenbusch et al. 2007). Seagrasses, with their dense root and rhizome matrix, have been shown to negatively affect the abundance of ghost shrimp, likely because the shrimp are unable to burrow into the sediment (Berkenbusch et al. 2007; Harrison 1987). Additionally, seagrasses are known to stabilize the sediment as well as slow down water movement (Duarte 2002). Thus, the presence of *Z. marina* may be used as a positive habitat criterion for shellfish species as a substitute for the negative criterion of burrowing shrimp presence. Additionally, using the presence of *Z. marina* as a proxy for absence of burrowing shrimp is advantageous in that, while burrowing shrimp are mobile and can migrate in and out of an area, the presence of continuous *Z. marina* beds is unlikely to dramatically change. By using the presence of continuous *Z. marina* beds as a positive proxy for the absence of data about burrowing shrimp presence, the only criterion that had high potential temporal variation (i.e., burrowing shrimp presence) was removed from the model. *Z. marina* locations have been mapped throughout coastal areas of Alaska by ShoreZone.

Data Sources

The Digital Elevation Model (DEM[6]), a digital depiction of the bare ground topography of earth, serves as the basis for habitat suitability modeling because it is the most accurate map available. As such, it determines the spatial resolution of the model (Guisan and Zimmermann 2000). The DEM of Prince William Sound used in this model was an 8/3 Arc-second Mean Higher High Water (MHHW) Coastal DEM created by the National Oceanic and Atmospheric Administration (NOAA). The DEM was downloaded in NetCDF file format.[7]

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5. Jay Baumer, Fishery Biologist 4, ADF&G, Anchorage, August 2023, personal communication.
6. U.S. Geological Survey, n.d., "What is a Digital Elevation Model (DEM)?" U.S. Department of the Interior, accessed January 2024, https://www.usgs.gov/faqs/what-digital-elevation-model-dem#:~:text=A%20Digital%20Elevation%20Model%20(DEM)%20is%20a%20representation%20of%20the,derived%20primarily%20from%-20topographic%20maps.
7. NOAA National Geophysical Data Center, 2009, "Prince William Sound, Alaska 8/3 Arc-second MHHW Coastal Digital Elevation Model," NOAA National Centers for Environmental Information, accessed July 22, 2021, https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ngdc.mgg.dem:735.

All other data were derived from ShoreZone data. ShoreZone is a mapping and classification system that utilized low-altitude aerial photography to map and interpret the biology and geology of the Pacific Coast from Oregon to Alaska (Harper and Morris 2014). The full Alaska geodatabase was downloaded from www.ShoreZone.org. Data for the following habitat criteria identified as important for developing a suitability model were available:

- BC Class: Coastal class or shore type of the unit. There are 35 BC classes based on substrate type, across shore width and slope.
- Exposure: Observed physical exposure based on fetch distance. There are six exposure classes ranging from very exposed to very protected. It should be noted that there are no very exposed locations within the study area (see ShoreZone appendix table A-4).
- *Zostera marina*: Presence of eelgrass observed as continuous (greater than 50% cover) or patchy (less than 50% cover). *Z. marina* is a habitat-forming organism and therefore may be used as a proxy for organisms that inhabit eelgrass beds (Schoch et al. 2014).

Data for each criterion listed above were extracted from the ShoreZone geodatabase and saved as individual polyline feature classes. Each of the feature classes were clipped to the study area. Since polyline feature classes do not have an area, they would not provide a sufficient resolution in a raster from which to conduct the analysis. Therefore, they were converted to polygons using the Buffer tool. The buffer was generated on both sides of the polyline with flat ends to prevent adjacent values from overlapping. Each buffer was dissolved on the classification field to simplify the attribute table (a table containing information about a set of geographic features). It was determined that the smallest buffer that allowed for enough resolution in the raster to run the model was 100 meters (m).

Creating the Habitat Suitability Model: ArcGIS Suitability Modeler

The habitat suitability model was created using the Suitability Modeler tools in ArcGIS Pro (3.0.0). The Suitability Modeler in ArcGIS Pro provides a framework in which to construct and evaluate a habitat suitability model based on the transformation and weight given to the input criteria.

ArcGIS Pro's Suitability Modeler requires the input data to be rasters.[8] Polygons were converted to rasters using the Polygon to Raster tool. Tables 2-1 through 2-3 describe the settings used in the conversion process to generate each criterion raster. The Prince William Sound DEM raster was reclassified so that the intertidal and subtidal zones would be separated out from the terrestrial areas while at the same time providing enough spatial overlap to ensure enough resolution for the model to run successfully (Table 2-4). Since the DEM values were floating point values, they were converted to integer values using the Int tool in the Spatial Analyst toolbox before transforming the data. All geographic data were projected into the Alaska Albers projection (NAD 83).

After transforming the criteria to a common suitability scale and assigning weights to the criteria relative to each other, the resulting model identifies the preference of each location relative to each other based on the features at a location. Using the Suitability Modeler, researchers can identify contiguous areas with the highest overall preference based on the criteria used in the model.

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8. A raster is an image that has a data value assigned to each pixel, and each pixel's value is used in spatial analytical procedures.

Table 2-1.–BC class conversions and transformations used in the model development process and analysis.

Description[a]	BC class by ShoreZone[a]	Value used in raster	Transformed value for model *Saxidomus gigantea*	Transformed value for model *Leukoma staminea*
Rock ramp–wide	1	1	1	1
Rock platform–wide	2	2	1	1
Rock cliff	3	3	1	1
Platform with sand beach–wide	4	4	1	1
Rock platform–narrow	5	5	1	1
Ramp with gravel beach–wide	6	6	1	1
Platform with gravel beach–wide	7	7	1	1
Cliff with gravel beach	8	8	1	1
Ramp with gravel beach	9	9	1	1
Platform with gravel beach	10	10	1	1
Ramp with gravel and sand beach–wide	11	11	1	1
Platform with gravel and sand beach–wide	12	12	1	1
Cliff with gravel/sand beach	13	13	1	1
Ramp with gravel/sand beach	14	14	1	1
Platform with gravel/sand beach	15	15	1	1
Ramp with sand beach–wide	16	16	1	1
Platform with sand beach–wide	17	17	1	1
Cliff with sand beach	18	18	1	1
Ramp with sand beach–narrow	19	19	1	1
Platform with sand beach–narrow	20	20	1	1
Gravel flat–wide	21	21	1	4
Gravel beach–narrow	22	22	1	4
Gravel flat or fan	23	23	1	4
Sand and gravel flat or fan	24	24	4	5
Sand and gravel beach–narrow	25	25	4	5
Sand and gravel flat or fan	26	26	4	5
Sand beach	27	27	5	1
Sand flat	28	28	5	1
Mudflat	29	29	1	5
Sand beach	30	30	5	1
Organics/fines	31	31	1	1
Manmade permeable	32	32	1	1
Manmade impermeable	33	33	1	1
Channel	34	34	1	1
Glacial ice shoreline	35	35	1	1

a. Source is ShoreZone.

Table 2-2.–Biological wave exposure conversions and transformations used in the model development process and analysis.

Description[a]	Biological wave exposure class by ShoreZone[a]	Value used in raster	Transformed value for model
Exposed	E	1	1
Semi-exposed	SE	2	1
Semi-protected	SP	3	2
Protected	P	4	5
Very protected	VP	5	5

a. Source is ShoreZone.

Table 2-3.–*Zostera marina* conversions and transformations used in the model development process and analysis.

Description[a]	*Z. marina* distribution class by ShoreZone[a]	Value used in raster	Transformed value for model
No *Z. marina* observed	–	1	1
Visible in less than one-half of the along-shore unit length	Patchy	2	1
Visible in more than one-half of the unit's along-shore length	Continuous	3	4

a. Source is ShoreZone.

Note "–" indicates ShoreZone did not have a description for "no *Z. marina* observed"; this description was added to assign a value for the raster.

Table 2-4.–Digital Elevation Model classification and transformations used in the model development process and analysis.

Description	Elevation (meter)[a]	Value from raster[a]	Transformed value for model
Subtidal	< 0	< 0	5
Intertidal	0–5	0–5	5
Terrestrial	> 5	> 5	1

a. Source is the Digital Elevation Model; see NOAA National Geophysical Data Center, 2009, "Prince William Sound, Alaska 8/3 Arc-second MHHW Coastal Digital Elevation Model," NOAA National Centers for Environmental Information, accessed July 22, 2021, https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ngdc.mgg.dem:735.

Table 2-5.–Weight assigned to criterion rasters used in the model development process and analysis.

Criterion raster	Assigned weight
BC Class	1.75
Biological wave exposure	1.25
Z. marina distribution	1
Prince William Sound elevation (DEM)	2

Transformed Values and Weights

Before running the model, all values in rasters were transformed to a common suitability scale, spanning from 1 (least suitable) to 5 (most suitable) as shown in tables 2-1 through 2-4. Common suitability scale assignments were based on the habitat requirements of the clams; habitat tends to be suitable or not, therefore few midrange values were assigned. A weight was assigned to each raster relative to the other rasters (Table 2-5). The transformed criteria were then multiplied by their weighted value and added together. After the model is produced, the Locate tool may be used to identify the best locations based on specific conditions entered by the user. Because three of the four input criteria set the spatial constraints to the narrow intertidal zone, it was unnecessary to set these constraints in the Locate tool. Additionally, the patchy nature of the intertidal zone substrate created difficulties with setting minimum size constraints and distances between regions. Thus, the Locate tool was unable to be utilized. Instead, the raster cell values returned in the model results had to be interpreted using a different method. This model used the sum of the highest value of each input criterion except for the Digital Elevation Model (DEM), with the determination that sums ranging from 14–18 were suitable habitat, sums greater than 18 were most suitable, and sums lower than 14 were unsuitable. The ranges of values for habitat suitability type were the same for both species of clams. The model produced a band of results ranging from 6–30.

Final Map Layout

For a smoother look to the final maps published in this report, the resulting model raster was converted back to a polyline feature. Because the model raster was a floating-point raster, it was converted to an integer raster using the Int tool in the Spatial Analyst toolbox. The resulting integer raster was converted to a polyline feature class using the Raster to Polyline tool, with the raster value assigned as the attribute field for the polyline. The background value was set to 0, so all raster cells with negative values, as well as no data, were considered background cells and not shown as a line. The lines were simplified for a smoother appearance. The model results were overlaid on a map and exported as a PDF file for inclusion in this report, as well as to present to APMI.

Establishing a Shellfish Sanctuary

The first step toward establishing a shellfish sanctuary was for APMI to work with the Native Village of Chenega to identify local individuals interested in assisting with choosing and surveying the sanctuary beach site, collecting adult clams, and enhancement activities. Selected local residents received training support from APMI staff on how to collect broodstock, outplant hatchery juveniles, collect and measure water quality parameters, and handle shellfish according to safety and sanitation best practices. This section summarizes various steps involved with the effort to establish a productive shellfish sanctuary for Pacific littleneck and butter clam populations within the harvest area used by the community of Chenega. Of note, Habitat Suitability Index modeling was useful for assessing select habitat characteristics of the sanctuary site but, as a new research method conducted by the Division of Subsistence, was not used to determine the sanctuary site location.

APMI Experience with Seed Production and Rearing

APMI has been developing hatchery culture techniques to produce juvenile Pacific littleneck clams and butter clams for decades. Pacific Littleneck clams and butter clams have been produced by APMI for the aquatic farm industry and other enhancement projects since 1993, including population recovery projects in Port Graham, Nanwalek, Tatitlek, Chenega, and Cordova from 1993–1997 that were funded by the *Exxon Valdez* Oil Spill Trustees Council.

A component of this project was to test a new hatchery technique to produce 2 mm–5 mm butter clams in less than 12 months. Historically, APMI collected broodstock in the spring and kept the progeny over winter and into the following late summer until reaching an adequate size of 2 mm–5 mm before they could be outplanted. APMI has recently developed new culture techniques to increase growth rates to achieve the size range goal in just 12 months rather than 16 months. APMI accomplished this significant growth increase by rearing juveniles in heated water and by increasing feed frequency and diversity. Before this project, APMI was culturing juvenile clams in ambient water temperature (4°C–10°C) and only feeding the clams two different species of phytoplankton (*Chaetoceros calcitrans* and *Isochrysis galbana*) at a density of $4x10^4$ cells per mL, twice a day. During this project, the water was heated to 12°C–18°C to increase metabolism and growth in juvenile clams. Additionally, APMI increased the number of species of feed phytoplankton to four (*Chaetoceros muelleri*, *Isochrysis galbana*, *Tisochrysis lutea*, and *Rhodomonas salina*) and increased feed frequency from twice a day to 12 times a day at a cell density of $2x10^4$ cells per mL.

Site Selection

Potential locations were identified near Chenega through conversations with local clam harvesters. The site was carefully chosen based on local subsistence harvesters identifying the site best able to meet the needs of the residents' subsistence way of life and providing the best level of easy access from the community to the site. Chenega is situated along the western shore of Crab Bay and the coastline along the entire bay is referred to as "Airport Beach" by local residents. Various project activities were conducted in a large expanse of the coast of Crab Bay; Figure 1-1 depicts names for different portions of the Crab Bay coast to help differentiate what parts of the study area were accessed for specific activities. The shellfish sanctuary area was located at Airport Beach (60° 4' 13.2132" N, 148° 0' 9.0756" W) (see Figure 1-1). Additional criteria were evaluated with a beach survey—assessing beach slope, protection from storms, presence and evidence of predators, and proper substrate—to confirm the selected location in August 2021. As depicted in Figure 2-1, the substrate was sampled using 0.25 m quadrats at even intervals across four transects at tidal heights 1.5 ft, 0 ft, -0.6 ft, and -1.4 ft and evaluated for gravel size and distribution using the "Wentworth scale," a scale for classifying and describing sediments by grain size (Wentworth 1992). Risk of clam predation was assessed by surveying the sanctuary area for the presence and abundance of sea otter foraging pits, after which APMI staff determined the presence of predators was high (Plate 2-1). As will be discussed later, based on this assessment, predator control measures were implemented in the sanctuary to reduce predation of seeded juvenile clams. The risk of storm surges disrupting seeded juvenile clams was determined to be low by observing that Airport Beach fronts a protected bay, reducing risk of storm surge the likes of which open ocean beaches experience. Finally, the beach slope was calculated based on measurements collected at the sanctuary beach site. These beach survey data were collected in a Rite in the Rain field book. Recorded data were input in MS Excel spreadsheets and final trip reports; this process was conducted following internal APMI quality assurance procedures for data entry. These spreadsheets and reports are housed on the CRRC SharePoint site.

Collecting Broodstock and Adult Clams for Translocation

APMI staff and local technicians from Chenega dug at local beaches in Crab Bay to collect adult broodstock for transport to APMI in Seward to produce juvenile clams. Clams were stored in plastic bags or in a bucket filled with fresh seawater before transport to APMI in Seward. Below is a summary of when and where adult clams were collected in both 2021 and 2022.

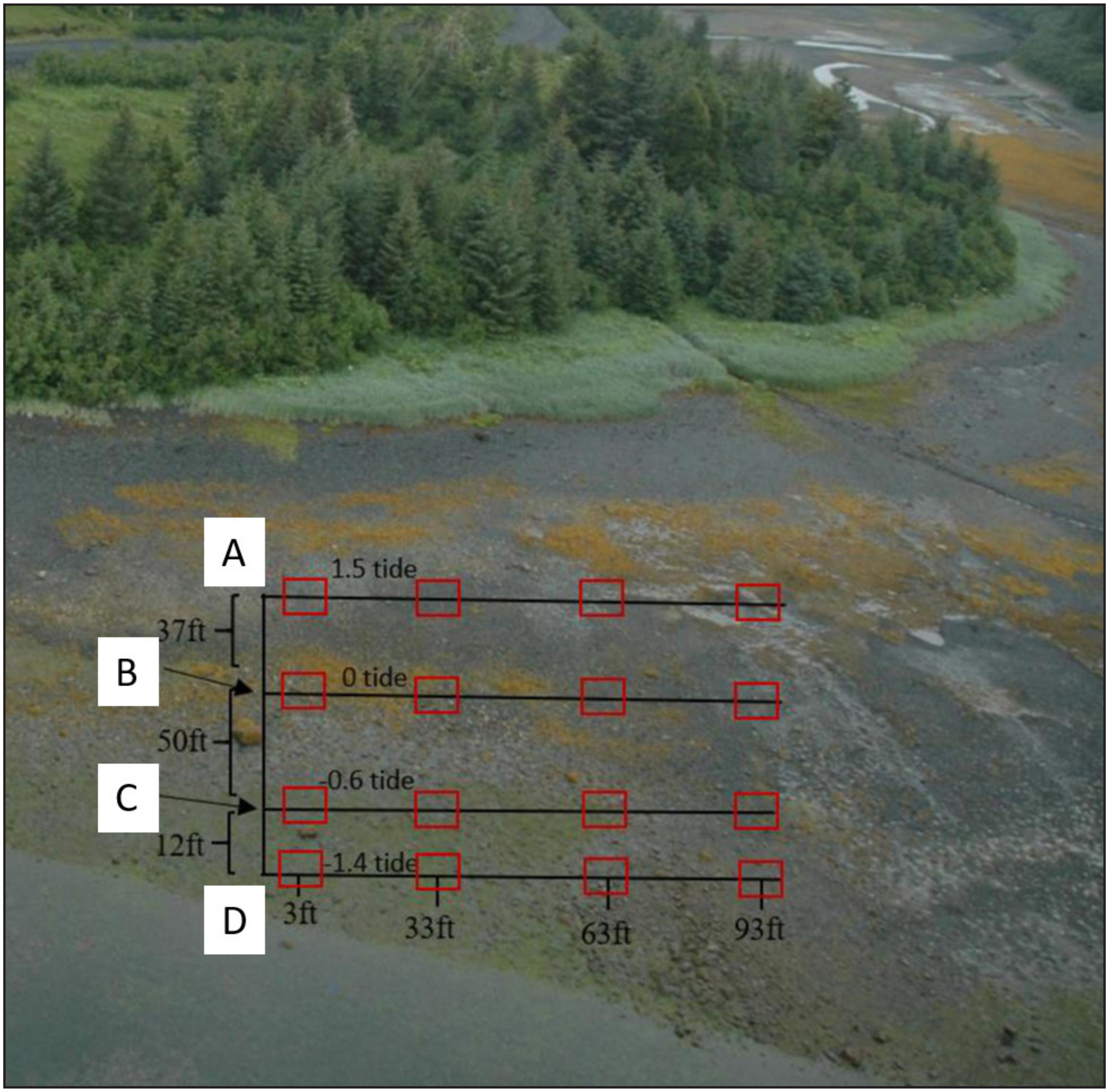


Photo by ShoreZone

Figure 2-1.–Transect diagram overlaid on Airport Beach photograph.

Photo by Jeff Hetrick, APMI

Plate 2-1.–Sea otter foraging pits at Airport Beach, May 16, 2022

2021

Project staff Willow Hetrick (CRRC) and Jeff Hetrick (APMI) traveled to Chenega on May 26–28, 2021. On May 27–28, W. Hetrick, J. Hetrick, and Tyler Zacher, an employee of the Native Village of Chenega, collected 115 clam broodstock and Zacher received monitoring and observational training.

Two clam species were collected under the 2021 permit P-21-009 issued by ADF&G (Appendix B); collection efforts were also approved by the U.S. Fish and Wildlife Service (National Historic Preservation Act Section 106 Review). The collection took place on May 27, 2021, at Airport Beach via hand digging.

2022

APMI employees J. Hetrick, Annette Jarosz, Emily Mailman, and Case Estes traveled to Chenega for fieldwork on June 15–16, 2022. Under approval by the U.S. Fish and Wildlife Service (National Historic Preservation Act Section 106 Review) and as permitted by ADF&G (permit P-22-019; see Appendix B), APMI staff and an Armin F. Koernig (AFK) Hatchery volunteer, Raven Parry, dug at Airport Beach, Across Beach (60° 4’ 9.0516”’ N, 147° 59’ 37.6794” W), and Runway Beach (60° 4’ 19.0704” N, 147° 59’ 42.36” W) to collect adult clams (see Figure 1-1). The additional beaches were added to the collection area because there was not sufficient numbers of adult Pacific littleneck and butter clams found at Airport Beach. It took two days to collect 83 adult clams.

Seed Production and Hatchery Rearing

Broodstock collected on May 27, 2021, were transferred to APMI and slowly acclimated to a water temperature of 12°C. The clams were fed a mixture of diatoms and flagellates, which were supplemented with concentrated algae paste. To induce spawning, the clams were fed heavily while raising the water temperature to 15°C–18°C. The Pacific littleneck clams spawned on June 19, 2021, and the butter clams spawned on July 19, 2021. The eggs were mixed with sperm from multiple males to ensure a genetic mix. Once the eggs were fertilized, they were placed in 1,200-liter tanks at 3 larvae per mL until they reached the veliger D-stage. On their last planktonic life stage, right before shell formation, the larvae were transferred to screens in downweller tanks. They were then fed at a rate of 20,000 algal cells per mL until the 21- to 24-day larval stage was completed and the clams set. Larvae samples were measured 2–4 times a month using a ruler imbedded in a microscope.

The juvenile clams were set on 100-micron screens and sprinkled with sifted 700-micron sand. The juvenile clams were fed a daily ration of 20,000 cells per mL 12 times a day. Once they reached 500-micron in size and were fully developed juveniles, the tanks were switched to upwell mode. The tanks were frequently rinsed and cleaned. The clams were cultured with warm water (18°C) and experienced rapid growth.

Throughout the year, the juvenile clams were measured for length 2–4 times a month. An APMI technician collected a random sample of 20 clams out of each species tank and used an electronic caliper tool to measure shell length. The shell length is used to determine growth rate of the juvenile clams and is a key indicator as to when juvenile clams are ready to be seeded at a sanctuary.

All larval and juvenile measurement data were collected on paper spreadsheets and, at the end of both the 2021 and 2022 rearing cycles, the spreadsheets were digitized and uploaded to the CRRC SharePoint site for storage following internal APMI quality assurance practices for transferring records from paper to electronic format.

In 2022, the same methods were followed for spawning and rearing juvenile clams produced from the broodstock that was collected on June 15 and 16, 2022. The broodstock Pacific littleneck and butter clams were successfully spawned on June 27 and June 29, 2022, respectively.

Seeding and Monitoring Juvenile Clams at the Sanctuary

While juvenile clams were produced at APMI from broodstock collected in both 2021 and 2022, only the juveniles produced from 2021 broodstock were outplanted because the juvenile clams from 2022 broodstock did not reach adequate size before the end of this project. Clams from the 2021 broodstock were outplanted in May, June, and September, 2022, between a 0 ft and a -2.5 ft tidal level to minimize the possibility of freezing during the winter and to slow bird and starfish predation while still allowing access by harvesters at low tide sequences. Prior to seeding, the substrate was raked to allow clams to burrow easily on an incoming tide. Each species of clam was seeded at a density of 500 clams per m^2 or planted in an enclosed predator control structure. Predator control structures and markers were used to protect and locate planted clams. Biodegradable cups (12 ounces), recruitment boxes (referred to as Beal boxes[9]), and 4-inch diameter PVC (polyvinyl chloride) pipes were used for predator control to deter predation by sea otters and large invertebrates. The site was well marked with flagging, global positioning system (GPS) coordinates were logged, and the sites were photographed. Following is a description of when clams were seeded and monitored. Outplanted juvenile clams were monitored during the daylight tide sequence, when samples of clams were collected, measured, photographed, and then replaced at their sites.

On May 16, 2022, APMI employees J. Hetrick, A. Jarosz, and E. Mailman traveled to Chenega. The team, comprising APMI staff and R. Parry from the AFK hatchery, surveyed the beach to document beach slope and marked tide lines. Once the beach was delineated, the team put out two Beal boxes to encourage natural settling and recruitment of clams and positioned a line of 21 PVC pipes at the -0.5 ft tide line as predator protection for outplanted clams. Due to COVID concerns and limited time, the APMI team did not enter the village of Chenega or meet with any of the community members.

On June 15 and 16, 2022, using the same markers left from the May 2022 trip as guides, biodegradable cups and PVC pipes were placed for predator control at the -1 ft tide line to protect newly outplanted clams. Additionally, the Beal boxes were assessed for clam recruitment and multiple PVC pipes that were placed on May 16, 2022, were dug up and analyzed for clam survival and growth rates. These monitoring efforts were completed by team members from APMI, J. Hetrick, A. Jarosz. E. Mailman, and C. Estes, and also R. Parry from the AFK hatchery. During this trip, project staff documented observations of evidence of clam recruitment or pockets of adult clams to help identify good candidate sites for additional enhancement efforts at Airport Beach and surrounding local beaches, such as Runway Beach and Across Beach.

9. A Beal box is a large wooden box with mesh on both the top and bottom that is used for predator exclusion to increase clam settling and survival rates.

Photo by Jacqueline M. Keating, ADF&G

Plate 2-2.–Translocated broodstock placed in mesh bags at Airport Beach, August 19, 2021.

On September 13 and 14, 2022, J. Hetrick and A. Jarosz traveled to Chenega on the OMC[10] to monitor the growth and survival of juveniles and outplant remaining juveniles that were left from broodstock year 2021. PVC pipes from the May 2022 trip were collected and analyzed and juveniles were outplanted by being scattered under large mesh netting that was fixed into the substrate with metal stakes.

On October 3, 2022, J. Hetrick returned to Chenega and pulled all remaining predator control structures (PVC pipes and Beal boxes) to prevent inclement winter weather from destroying and removing the structures.

Seeding and Monitoring Translocated Adult Clams at the Sanctuary

Due to the low population of adult clams in Crab Bay, the sanctuary was stocked with the surviving broodstock of 50 adult butter clams and 50 adult Pacific littleneck clams on August 19, 2021. The adult animals were placed in mesh bags that were anchored down with rebar, marked with flags, and photographed for recordkeeping (Plate 2-2). According to the project study objectives, the intention was to place translocated clams that were unspawned adults at the sanctuary beach area at the same time that broodstock clams were collected, and then monitor translocated clams for formation of gametes in April–June. However, since the adults that were translocated had already spawned at the hatchery and were translocated in August 2021, no monitoring was needed for 2021, although seeding and monitoring translocated adult clams in spring 2022 was planned. As will be discussed later in Chapter 4, no adult clams were translocated to the sanctuary area in 2022 and no monitoring for gamete development occurred throughout this study. Monitoring of translocated adult clams was limited to retrieving mesh bags in June 2022 and counting the clams that remained.

Research Team Coordination

Members of the research team from APMI and ADF&G met quarterly throughout the project. APMI staff provided updates on trips to Chenega, monitoring efforts, and biological data collection. ADF&G staff proactively shared ethnographic interview and mapping information that might have implications for the shellfish sanctuary and consulted with APMI staff when identifying variables to include in HSI models.

Community Review

CRRC, APMI, and ADF&G staff hosted a dinner in the community hall on August 18, 2021, and shared the project proposal and plans. CRRC and APMI staff returned to Chenega on November 30, 2021, and shared project updates and early results of hatchery rearing and reintroduction efforts. Finally, APMI and ADF&G presented preliminary results to Native Village of Chenega staff in September 2022, and shared draft papers for input in September 2023 and January 2024.

10. OMC, Old Man Charley, is the Chenega Corporation's landing craft, named in honor of Chief Charles William Selanoff.

3. SUBSISTENCE USES OF CLAMS IN CHENEGA

Clams have a long history of being an important component of subsistence ways of life in Chenega. This chapter integrates existing clam harvest and use data for Chenega from comprehensive household surveys conducted by the Division of Subsistence from 1984 through 2014 with new qualitative data and harvest area mapping from interviews conducted in 2021. Full results of each survey effort are available on the Community Subsistence Information System[1] and the technical paper series (Fall 1997; 2006; Fall et al. 1996; Fall and Utermohle 1999; 1995; Fall and Zimpelman 2016; Stratton and Chisum 1986). Table 3-1 displays the 10 study years for which comprehensive household harvest surveys occurred for Chenega, and the percentage of households sampled each year based on the number of households surveyed and the total number of occupied households during each study year. The percentage of households sampled ranged from 71% (12 out of 17 households) in 2014 to 100% (16 out of 16 households) in 1984. At least 80% of households were surveyed in every study year except for 1997 and 2014.

Ethnographic Key Respondent Interviews

In fulfillment of project Objective 8 and to add context to harvest and use data, the Division of Subsistence conducted key respondent interviews and harvest area mapping with Chenega residents. Division researchers Jacqueline Keating and Lisa Hutchinson-Scarbrough traveled to Chenega from August 18–20, 2021, with CRRC Executive Director Willow Hetrick and APMI Hatchery Director Jeff Hetrick. In addition to assisting J. Hetrick with beach sampling and clam reintroduction efforts, J. Keating and L. Hutchinson-Scarbrough conducted seven key respondent interviews with 10 Chenega residents, nine of whom were Alaska Native. Two interviews included couples, and one interview included a mother and her son who was a youth and an avid clam harvester. Respondents comprised seven males and three females and ranged in age from 11 to 49, with an average age of 31.7. While few elders lived in the community or were available for interviews, most respondents were direct relatives who could speak to the knowledge that was transferred from older generations. Excerpts from interviews appear throughout the remainder of this chapter to contextualize quantitative findings, harvest areas, and clam reintroduction efforts.

While some respondents were more engaged in regular clam harvest activities than others, all consistently attested to the importance of clams and other wild foods to the way of life in Chenega. As described in Chapter 1, Chenega is isolated with limited amenities, resulting in a community of resourceful individuals who play a variety of roles in the village. As one lifelong resident described: “I’m the water plant operator and make sure that the water’s good. I also partially help out with the power plant. I help get mail out on the mail plane. I help plow snow in the winter. So, all around, a little bit of everything” (NCN04). Multiple respondents described younger generations helping other residents as a key part of life in Chenega. One younger respondent described himself as “just local kid who helps out everybody. If they need help, you go help them” (NCN08). Consistent with this local value is the harvesting and sharing of wild foods.

Most respondents had been gathering clams since they were children. One learned how to gather clams from his father, and said he started: “When I was really little. So, like 5 or 6. We would do it as a family” (NCN03). A respondent who grew up in Chenega described learning from elders who lived there when she was a 5- or 6-year-old, and then she taught her son to harvest clams when he was 4 years old. As her son explained, “They kind of just told me I was going to go clam digging and I just do it” (NCN09b). A lifelong resident of Chenega described the familial nature of harvesting clams:

1. ADF&G Community Subsistence Information System: http://www.adfg.alaska.gov/sb/CSIS/ (hereinafter cited as CSIS).

Table 3-1.–Percentage of households surveyed, Chenega, 1984–1985, 1989-1993, 1997, 2003, and 2014.

Study year	Sampled households	Total households	Percentage sampled
1984	16	16	100.0%
1985	16	17	94.1%
1989	18	21	85.7%
1990	18	21	85.7%
1991	18	22	81.8%
1992	23	26	88.5%
1993	23	28	82.1%
1997	15	21	71.4%
2003	16	20	80.0%
2014	12	17	70.6%

Source ADF&G Division of Subsistence Community Information System database (accessed September 2023).

Table 3-2.–Percentage of households using, attempting, harvesting, receiving, and giving away clams, Chenega, 1984–1985, 1989-1993, 1997, 2003, and 2014.

	Percentage of households				
Study year	Using	Attempting harvest	Harvesting	Receiving	Giving away
1984	68.8%	50.0%	43.8%	31.3%	25.0%
1985	87.5%	87.5%	87.5%	0.0%	6.3%
1989	5.6%	0.0%	0.0%	5.6%	0.0%
1990	38.9%	22.2%	22.2%	16.7%	11.1%
1991	27.8%	27.8%	27.8%	5.6%	11.1%
1992	65.2%	47.8%	47.8%	47.8%	34.8%
1993	65.2%	52.2%	52.2%	39.1%	30.4%
1997	73.3%	66.7%	66.7%	53.3%	46.7%
2003	81.3%	56.3%	50.0%	68.8%	43.8%
2014	41.7%	33.3%	33.3%	8.3%	8.3%

Source ADF&G Division of Subsistence Community Information System database (accessed September 2023).

> The whole family used to go out for them in the morning, big minus tide, get a bucket of clams. I don't know maybe 10, 13 [age] area. We did it for a long time. … Family's always done it and we'll have a big pig-out of just clams for lunch a couple days in a row. It's just something to do in the summertime. (NCN08)

The importance of clams to Chenega residents is also reflected in the quantitative harvest data.

Household Harvest and Use of Clams

Household survey data demonstrate the long-term use of clams over four decades in Chenega. Table 3-2 outlines the harvest and use characteristics for all species of clams combined, including the percentage of households using, attempting to harvest, harvesting, receiving, and giving away clams. With the exception of the three years immediately following the 1989 *Exxon Valdez* oil spill and the 2014 study year, at least 65% of Chenega households used clams in every study year. Additionally, at least one-third of households harvested clams in every year outside of 1989–1991. Harvest participation was highest in 1985, when 88% of Chenega households harvested and used clams. Lastly, there were only two years when the percentage of households attempting to harvest clams was greater than the percentage that harvested. This demonstrates that clam harvesting efforts have a high chance of success, which was also evident when respondents spoke about the simplicity of harvesting methods.

Clam Harvest and Processing Methods

Many key respondents spoke fondly of how clam harvesting was an accessible activity that did not require specialized equipment, although items such as clam guns and narrow clam shovels are designed for clam harvesting. As one resident stated: "We use our hands and sometimes clam diggers. Most of the time clam diggers but, I like to use my hand" (NCN09). Multiple respondents spoke of using a pronged garden tool called a cultivator: "A garden tool, little claw. The three-pronged claw. Just lift the rocks up and dig where we see a tongue or the squirt" (NCN013), "The three-pronged garden rake, the short one" (NCN12), "Yep, or the triple-pronged little garden claw deal" (NCN10); or a shovel, "Just a shovel" (NCN03), "We sometimes use those little shorthand shovels like you'd use for gardening" (NCN04). Many expressed the importance of clamming at large minus tides: "Yeah, you usually just go [at] crazy minus tides so you can at least get a decent amount" (NCN08). Harvesters typically look for small holes in the sand: "Certain size holes. Not the really big ones, those are the worms … and then the smaller ones with the more rectangular shape" (NCN03), or sometimes watch for air bubbles or water: "We look for those holes and we'll stab near it. We see water coming out and it's like, 'Yeah, there's a clam right there'" (NCN04). Many used buckets to collect clams: "We don't bring that big of a bucket. We have little ice cream containers, those gallon ones with the little handle. We just save those" (NCN09).

When asked about how many clams people gathered in one attempt, harvest numbers ranged from about 15 to 60 clams. One respondent helped articulate what harvesters might classify as low, medium, and high levels of harvest during one effort: "I'd say low is like, 15 clams. Medium, 25. And high, 50 or 45" (NCN03). Another explained how many clams they typically tried to gather in one outing: "So, when it's just us going, we'll maybe do 20 or 30. And then, if we know other people are here, like some elders, we'll get … well, sometimes we'll bring the big bucket for elders" (NCN09). Multiple harvesters spoke of gathering additional clams for elders. As another put it, "Thirty, 40 at the most. If I can get more and I know it's not too late, I'll go and pull more for the elders" (NCN013).

Once clams are dug out of the sand, one harvester described how to store them: "My dad likes to use potato sacks that have the little mesh. We put them in there and keep them in water. Spit out the sand, so you're not eating sand" (NCN03). Another harvester described cleaning her clams, and some of the ways her family liked to prepare them: "We clean them with water, cold water. We fry them in some flour and butters, or we steam them with just water. Or clam chowder. We'd steam them first, for clam chowder" (NCN12). None of the respondents ever froze or preserved clams to use at a later time: "We eat them right away. Eat them right away, with the clams" (NCN04), "I've never heard of anyone freezing or saving them for later" (NCN08), "Yeah, there's never a lot to freeze, we just prepare them" (NCN10). There were a variety of preferred preparation methods from raw to steaming and frying:

- I also like to eat them raw. (NCN09b)
- If they're a little small, make a broth. Kids love the broth. (NCN013)
- Steam them, fry 'em, make soup. (NCN03)
- I think I'd have to go with fried. The local guys here use bread batter. (NCN09)
- Probably in pasta, like a linguini. Butter, water, garlic. Try to share a bunch. (NCN10)
- Steamed. Get a mess of them, put them in a pot, and steam it up. A little tabasco sauce, some salt. Big pile for everybody. (NCN08)

Sharing Clams and Trends in Use

In addition to harvesting for personal consumption, many respondents attested to the importance of sharing clams with others. Figure 3-1 displays the percentage of Chenega households (on the x-axis) using any species of clams (dark blue), harvesting clams (orange), and receiving clams (gray) against the total pounds of clams harvested (on the y-axis) for each study year indicated by the yellow line. As is typical with subsistence harvest and use data, the percentage of households using clams is consistently higher than the percentage harvesting due to harvesters sharing with other households. As one lifelong resident put it:

> We also give some to elders. Because either they can't go themselves, or they don't want to ask the younger members to go. So, it's always nice just to check in – 'Do you need something? Got you these.' (NCN09)

Figure 3-1 also shows a clear recovery in clam harvest and use activities following the 1989 oil spill, although there is a noticeable drop in harvest, use, and receiving clams in the 2014 study year. With a community as small as Chenega where only 12 households (71%) were surveyed for 2014, it is possible that one or more high harvesting households did not participate in the survey, thus creating the appearance of decline in harvesting. However, it is also possible that the decline in estimated harvest corresponds with the decline in local clam populations that served as the impetus for this project. As one respondent explained:

> The population [of clams] may have died down and mostly other things are prioritized. Halibut fishing and seal and going to get deer. And shrimp pots, long lines, other things. (NCN04)

While updated household survey data would help contextualize the lower harvest numbers in 2014, it remains critical to view harvest activities in the context of available resources and the health of local clam populations. To understand the decline and recovery of clams and the environments they thrive in, it is helpful to learn about the different local species available near Chenega.

Clam Species Harvested and Local Names

Household harvest data over four decades show a regular harvest of butter clams (*Saxidomus gigantea*) and Pacific littleneck clams (*Leukoma staminea*) among Chenega households. It is important to note that household harvest data encompass any harvesting that a household did during that study year, including traveling to harvest resources in places other than Chenega. Therefore, clam harvest data for Chenega households also includes horse clams and razor clams even though neither species is prevalent in the immediate vicinity. Lastly, cockles are locally available and actively harvested by residents while searching for clams. Due to the project's focus on butter and Pacific littleneck clams, the household survey data summary focuses on harvest of those species, but razor clams are also included in these summaries due to the volume of harvest.

While the previous table and figure displayed clam harvest and use for all clam species combined, Table 3-3 shows the percentage of households harvesting clams by species. For harvest data from the 1980s, a significant percentage of clam harvests were reported as "unspecified clams." In order to more accurately reflect the use of different species, the estimated harvests of unspecified clams were proportionately apportioned among specific species reported as harvested from survey responses in each of those years. Again, no households harvested clams the year of the *Exxon Valdez* oil spill in 1989, and the years immediately following the spill show lower percentages of households harvesting clams.

Figure 3-2 displays the percentage of households harvesting butter clams (dark blue), Pacific littleneck clams (orange), and razor clams (gray) for each study year. Butter clams were harvested by the greatest percentage of households in six out of the nine study years that clam harvests took place. No households reported harvesting Pacific littleneck clams in 1985 and 1990, and no razor clam harvests were reported in 2014. The percentage of households harvesting razor clams is notably high in 1985 and is likely attributed to Chenega residents harvesting razor clams near Cordova due to ongoing ties to the community from residents being displaced after the 1964 earthquake and settled in Cordova, or in conjunction with

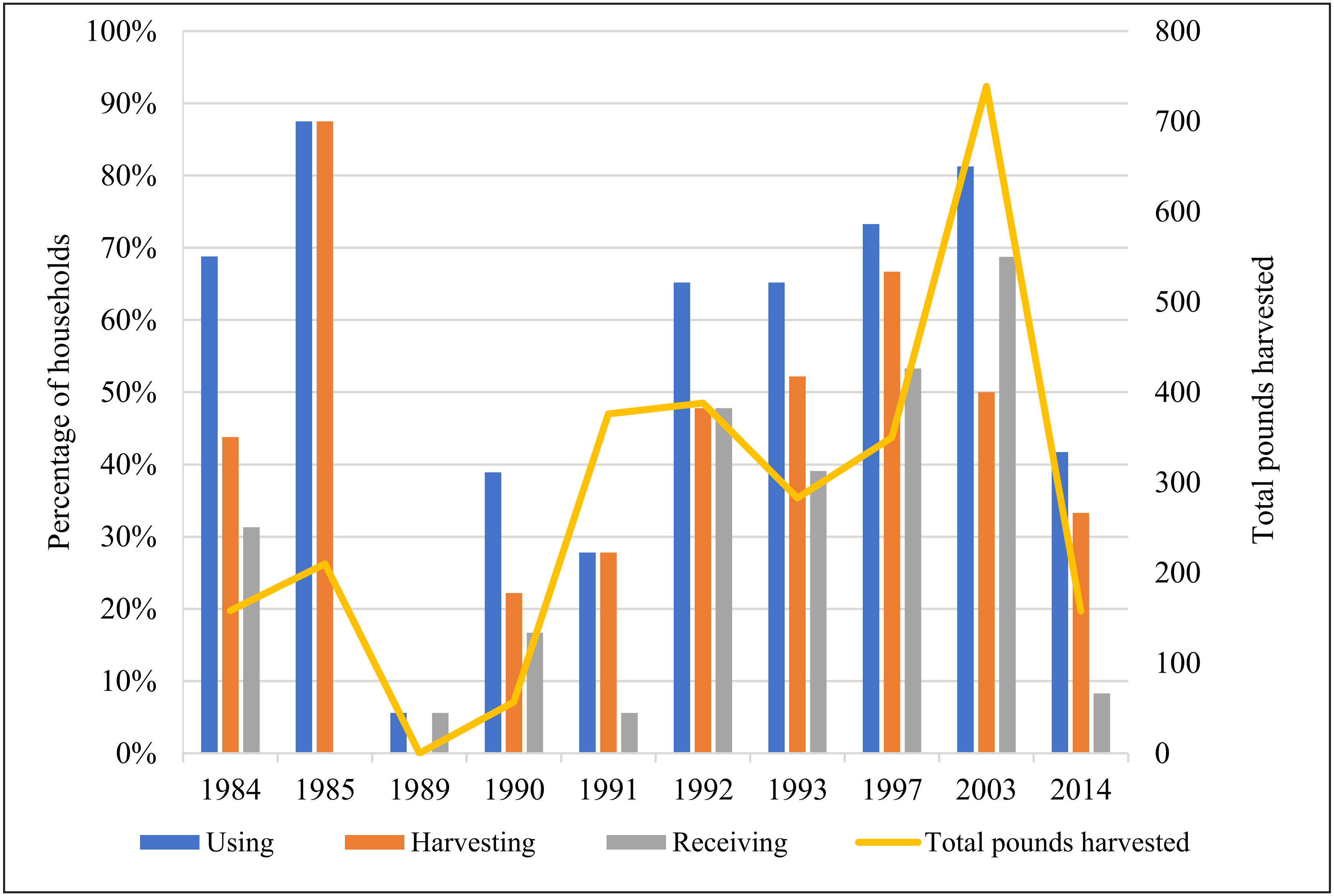


Figure 3-1.–Percentage of households using, harvesting, and receiving clams and total pounds harvested, Chenega, 1984–1985, 1989-1993, 1997, 2003, and 2014.

Table 3-3.–Percentage of households harvesting butter clams, Pacific littleneck clams, and razor clams, Chenega, 1984–1985, 1989-1993, 1997, 2003, and 2014.

	Percentage of households harvesting		
Study year	Butter clams	Pacific littleneck clams (steamers)	Razor clams
1984[a]	25.1%	8.4%	16.7%
1985[a]	41.7%	0.0%	83.3%
1989	0.0%	0.0%	0.0%
1990	11.1%	0.0%	11.1%
1991	27.8%	5.6%	5.6%
1992	39.1%	17.4%	26.1%
1993	30.4%	17.4%	13.0%
1997	60.0%	53.3%	26.7%
2003	43.8%	50.0%	12.5%
2014	33.3%	16.7%	0.0%

Source ADF&G Division of Subsistence Community Information System database (accessed September 2023).

a. Reports of harvest of unspecified clams were apportioned among specific reported species harvested.

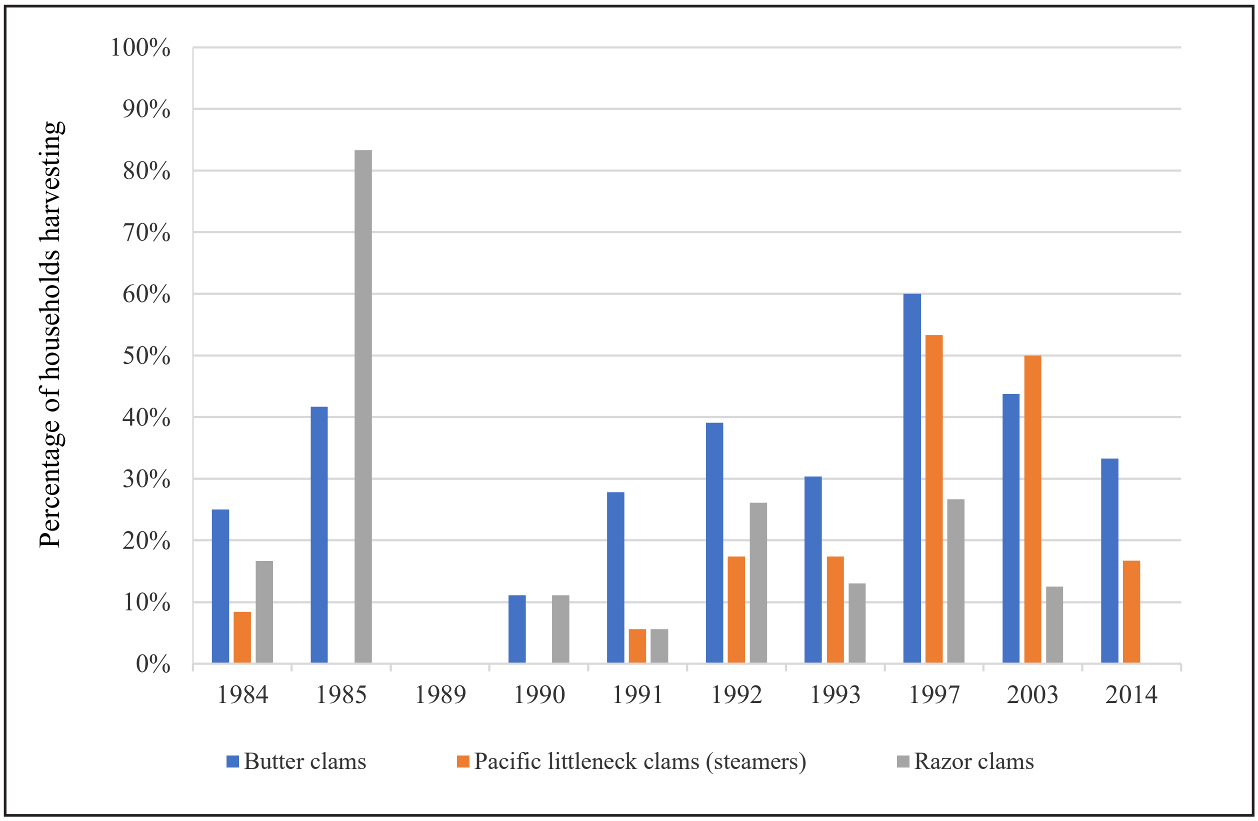


Figure 3-2.–Percentage of households harvesting butter clams, Pacific littleneck clams, and razor clams, Chenega, 1984–1985, 1989–1993, 1997, 2003, and 2014.

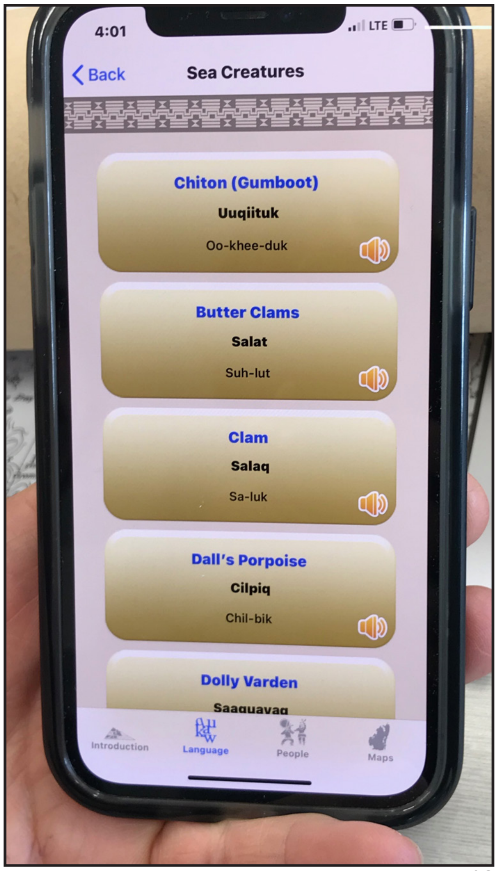


Photo by Jacqueline M. Keating, ADF&G

Plate 3-1.–Alaska Native language phone application displaying names for clams.

commercial fishing activities in the area. Many Chenega families were living in Cordova until the new village site was established in 1985, so some families were likely harvesting in the Cordova area during that study year. Additionally, razor clams were abundant in Cordova at the time. From the inception of the commercial razor clam fishery in Alaska in 1916 until the 1964 earthquake, razor clams in the Cordova area were exceedingly plentiful and generally supported a profitable commercial fishery (Nickerson 1975). Even following the 1964 earthquake when the population began to decline, subsistence harvest opportunities of razor clams around Cordova remained.

Consistent with the quantitative data depicting a greater percentage of households engaged in butter clam harvest, multiple interview respondents spoke of a preference for butter clams: "Butter. We always put the long tongue [steamers] back, we never eat them" (NCN12). Some were less familiar with the names, but indicated butter clams by their color: "I don't know the local name, but it's that regular general white one. I forgot what those are called but, we mainly get those" (NCN04). While none of the respondents referred to butter clams with any local names, one pulled up an Aleut language app on their phone and shared that butter clams were named *Salat*, pronounced "Suh-lut," while clams in general were named *Salaq* ("Sa-luk") (Plate 3-1). Also consistent with harvest data, Pacific littleneck clams were popular among other respondents. Many residents referred to Pacific littleneck clams exclusively as steamers: "The steamers are the one you're going to get the most" (NCN10). One resident who moved to Chenega later in his life said he preferred to harvest Pacific littleneck clams: "Just the littlenecks, the little ones" (NCN13). However, many respondents said they would harvest any kind of clam they found, even if there was a preference for one over the other. Finally, some respondents spoke about razor clams even though they are not immediately available near Chenega: "Razors are more in just, your sandy areas. We have more rocky, heavy duty rocky stuff [around Chenega]" (NCN10). One discussed how razor clams were the only other kind he ate outside of butter and Pacific littleneck clams: "I don't think I've ever ventured off [to other kinds]. Except razor clams, but those are off Montague and whatnot, and we don't usually go out that far anyways" (NCN08).

Finally, Table 3-4 shows the total estimated pounds harvested for each clam species across study years. Again, estimates of harvests of unspecified clams were apportioned among specific reported species in 1984 and 1985, and no reported clam harvests occurred around the 1989 *Exxon Valdez* oil spill. Figure 3-3 displays these same data to illustrate the composition of clam harvests for each study year and changes in the harvests of butter clams (blue), Pacific littleneck clams (orange), razor clams (gray), and horse clams (yellow) over time. In later years, razor clams consistently made up less of the total harvest weight, while Pacific littleneck clams came to compose a greater percentage of total harvest weight. Again, it is likely that higher razor clam harvests in earlier study years are associated with ties to Cordova, and more abundant harvest opportunities there.

Table 3-4.–Estimated clam harvests in pounds usable weight, by species, Chenega, 1984–1985, 1989–1993, 1997, 2003, and 2014.

	Estimated harvest weight (lb)					
Study year	All clams	Butter clams	Pacific littleneck clams (steamers)	Razor clams	Horse clams (gaper)	Unknown clams
1984[a]	158	89	9	61	0	0
1985[a]	210	62	0	149	0	0
1989	0	0	0	0	0	0
1990	57	36	0	21	0	0
1991	376	122	9	244	0	0
1992	388	146	36	206	0	0
1993	283	130	44	110	0	0
1997	350	151	113	76	10	0
2003	739	195	300	131	113	0
2014	158	26	108	0	23	0

Source ADF&G Division of Subsistence Community Information System database (accessed September 2023).

a. Reports of harvest of unspecified clams were apportioned among specific reported species harvested.

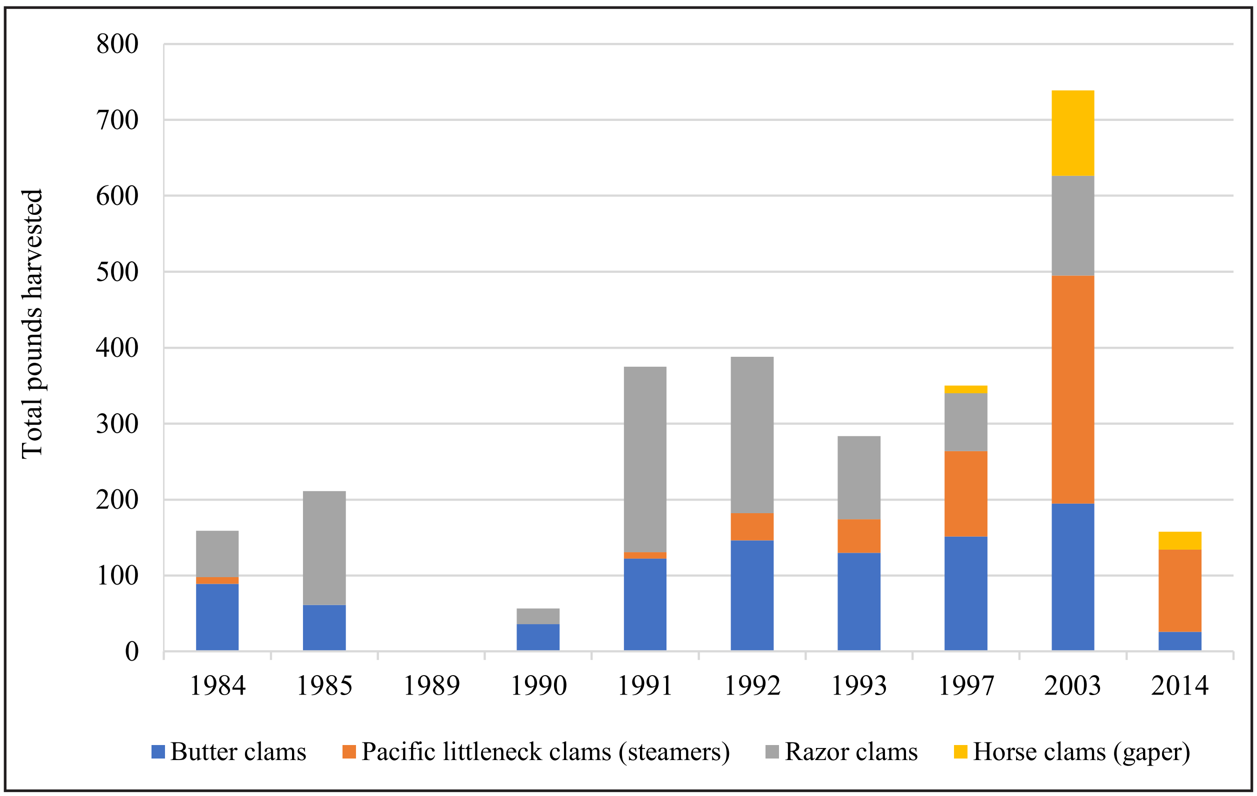


Figure 3-3.–Comparison of clam harvest composition, in pounds usable weight, Chenega, 1984–1985, 1989–1993, 1997, 2003, and 2014.

Clam Harvest Areas and Habitat

Descriptions of Suitable Habitat

When asked to describe what habitat is best for clams, most respondents discussed the abundance of rocks on beaches around Chenega: "If you walk down the beach, it's very rocky down there. You have to really get down to get to the fine stuff" (NCN013). While the rocky environment could be challenging for harvesters, many felt that it was also suitable habitat for local clams: "Well, beaches similar to the Ferry Dock Beach. The sand and the rocks" (NCN12). One respondent described the type of substrate that seemed ideal:

> Something without a lot of boulders. Real gravel-y. I don't know if that's how you would describe a beach. Dirt? Gravel-y dirt [laughter]. No boulders that you would have to flip and push around all day … just a beach. Sandy beach, gravel-y beach. (NCN08)

Another harvester shared a similar sentiment:

> I'm just thinking about the rocks. Because sometimes, like I said, down here it can be pretty rocky. And big rocks, before you can actually get to digging. So, more sandy or gravel-y rocks. Not big ol' huge things. (NCN09)

Documentation of Harvest Areas

Figure 3-4 displays current (within the last five years) shellfish harvesting areas that respondents used for butter and Pacific littleneck clams (pink) and other shellfish (orange), which included unspecified clams and cockles. Figure 3-5 displays shellfish harvest areas that respondents documented as past harvest areas. Current and past harvest areas documented during key respondent interviews are largely consistent with one minor exception: the map of current harvest areas shows clam harvest on a beach on Evans Island directly south of Long Beach West, and the map of harvest areas used in the past shows clam harvesting further south on Elrington Island, across Elrington Passage. Figure 3-6 displays current clam harvest areas that were specifically documented for butter clams (pink) and Pacific littleneck clams (yellow). While respondents did report harvesting clams in the Airport Beach area, all harvests were documented as unspecified clams, and therefore do not appear on Figure 3-6 despite the likelihood that both butter and Pacific littleneck clams were harvested there. The remainder of this section focuses on the three primary beaches that are easily accessible to the community for harvesting clams.

First, respondents reported using Long Beach for gathering both butter and Pacific littleneck clams. Long Beach is located on the west end of the village, as one harvester described: "At the very end of this road, if you just keep following this one and there's that little 'T' there. You go down that way and keep going down to the end and then you get to Long Beach" (NCN09). Many respondents spoke about Long Beach being an easier location for walking and harvesting clams due to the substrate: "Sandy, and that's why we went to Long Beach, because it's a lot more friendly with us and our kids" (NCN10). In general, people spoke about this location as having an abundance of clams: "The beach down at the end of the village there, that's still the same. Chock-full of clams all year long" (NCN08). When asked about any changes to habitat at that location, one respondent discussed how the slope of the beach was changing as a result of taking gravel from the beach to put on the village roads in the winter:

> Long Beach … we used to get gravel down there in wintertime to put on the roads when it's icy. So it used to be a lot more shallow but since we took out the gravel, it's gotten a lot steeper. And I'm happy we stopped doing that because it has gotten a lot steeper. (NCN09)

Because beaches with a more gradual slope tend to increase the area that falls within the tideline range inhabited by clams, it is possible that the changes in slope on Long Beach affected clam abundance as well as access to clams. For example, another respondent spoke of only harvesting at Long Beach at low tides so they could go out farther: "We go to Long Beach, at the very end [of the beach] where the rocks poke out of the water. But we hardly go there because we only go when it's really low tide" (NCN12).

Directly south of the community is another beach that many residents referred to as Ferry Dock Beach, although some referred to it by the name of people who lived close to it: "People would try to call it Ferry Dock Beach, but we just call it Minnie's Beach because that's where she would go" (NCN09). Like Long Beach, respondents harvest butter and Pacific littleneck clams at this location. However, most agreed that the beach had a different composition than sandy Long Beach: "The Ferry Dock Beach has more rocks, black sand. Very big rocks" (NCN12). Despite being rockier, many respondents expressed appreciation for the accessible location. As one explained: "It's ideal because of the setting. Easy access. Readily available. Whether you're young, whether you're old" (NCN10). One concern was the amount of otters in the area. When discussing Ferry Dock Beach, one respondent explained: "Yeah, the beach that we dig out in front of the village is pretty bare because of all the sea otters and everything digging down there" (NCN03). Finally, some respondents also used the inlet to the east of the village that was commonly referred to as Airport Beach given its proximity to the end of the runway (Figure 3-4). As stated earlier, there was no specific documented harvest of butter or Pacific littleneck clams during interviews, although multiple respondents reported harvesting unspecified clams. One respondent explained why she rarely harvested clams there: "I didn't go there very often. Terrain's a little tougher to get through (NCN10b)."

Discussion

In conclusion, many Chenega residents spoke fondly of harvesting clams and sharing them throughout the community. The knowledge passed down from older generations on where to look for clams and how to prepare them for consumption came across through discussions with residents. Both key respondent interviews and other casual conversations with community members were critical to helping ADF&G and APMI staff understand local clam habitat and sites suitable for establishing a shellfish sanctuary. The following chapters explain how this knowledge was utilized in Habitat Suitability Index model validation, and when identifying challenges to establishing a productive shellfish sanctuary site.

Figure 3-4.–Current shellfish harvest areas, Chenega.

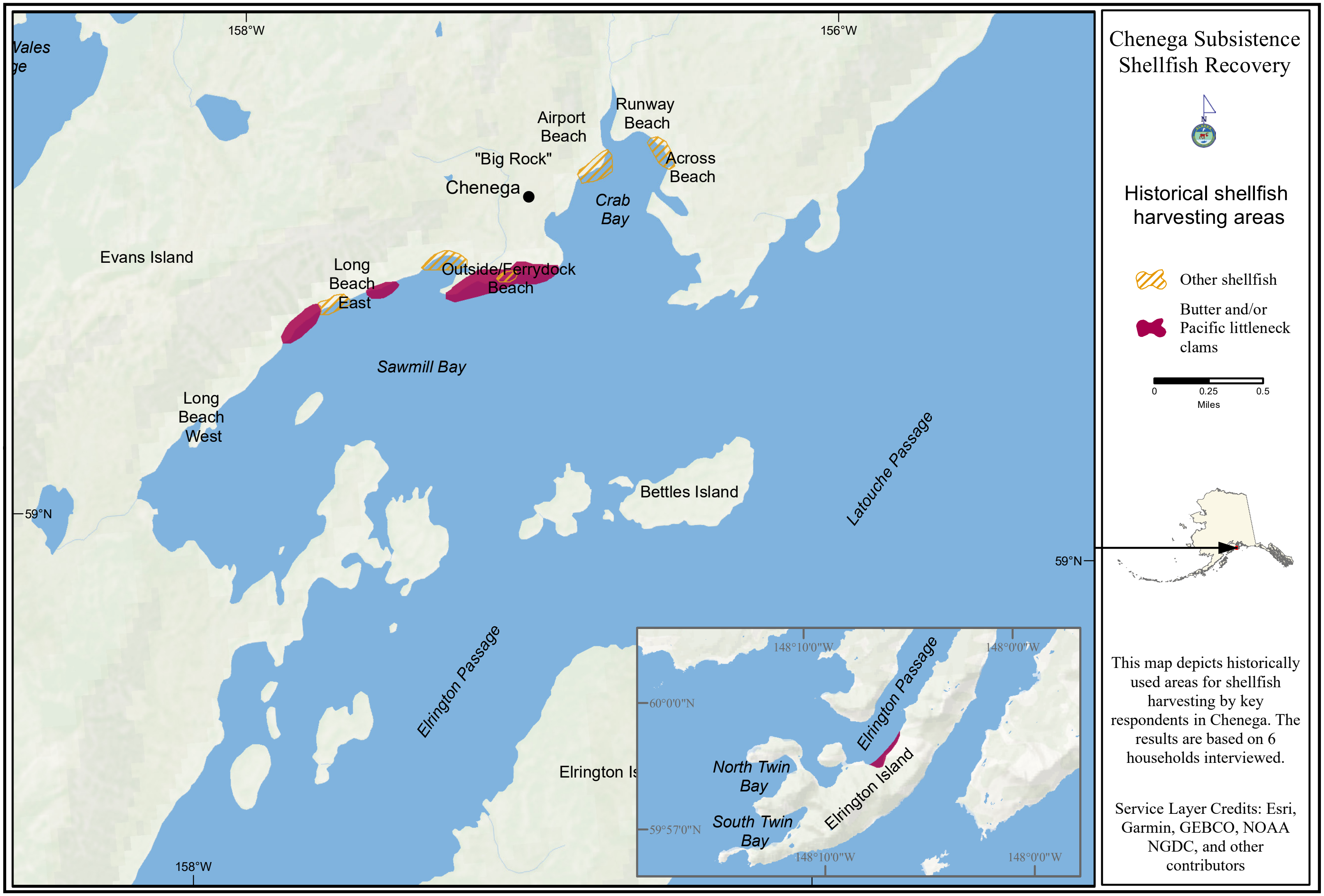


Figure 3-5.–Historical shellfish harvest areas, Chenega.

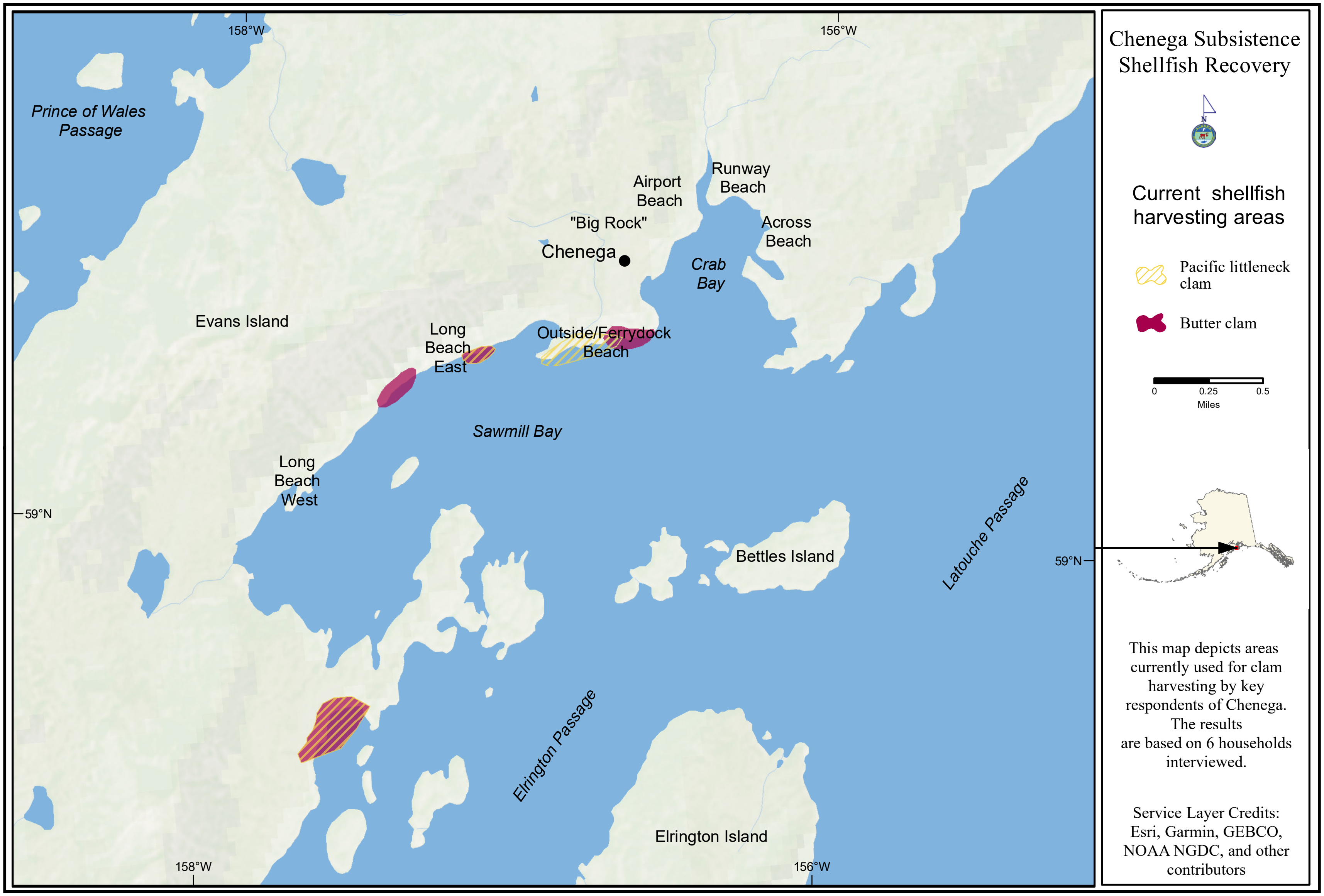


Figure 3-6.–Current harvest areas, Pacific littleneck and butter clams, Chenega.

4. IDENTIFYING SUITABLE CLAM HABITAT AND ESTABLISHING A SHELLFISH SANCTUARY

This chapter presents results for project Objectives 1–6. As stated earlier, results of Objective 6, Habitat Suitability Index modeling, are presented first to contextualize results of sanctuary site selection and clam reintroduction efforts. The location of the shellfish sanctuary was determined based on input from local residents who identified a beach area that had both a history of healthy clam populations, and reasonable access for residents to harvest clams. The selected site was assessed through the creation of the Habitat Suitability Index model and observations of beach characteristics that are important for supporting clam populations. Results of the HSI modeling (Objective 6) are presented first and include a summary about validating the model results using harvest location information from key respondents. Beach survey data collected during field activities for Objectives 1–5 are then presented, followed by a summary of the results for collecting broodstock, spawning clams, and planting shellfish at the sanctuary location.

Habitat Suitability Index Modeling

Butter Clams

Habitat suitable for butter clams is prevalent throughout the study area, with unsuitable areas found only in the most exposed locations (Figure 4-1). The model returned a total of 600.1 kilometers (km) of shoreline modeled for butter clam habitat. Of this, 535.3 km (89%) were considered suitable habitat for butter clams, with 110.1 km (18%) of this being highly suitable based on the model parameters. The modeled shoreline included 39.8 km from within Sawmill Bay and the immediate area outside of it (Figure 4-2). For this area, 100% was considered suitable habitat for butter clams, with 29% being highly suitable based on model parameters.

Pacific Littleneck Clams

Habitat suitable for Pacific littleneck clams is prevalent throughout the study area, although unsuitable habitat is also present even within more sheltered areas (Figure 4-3). The model returned a total of 592.7 km of shoreline modeled for Pacific littleneck clam habitat. Of this, 372.6 km (63%) were considered suitable habitat for Pacific littleneck clams, with 202.2 km (34%) of this being highly suitable based on the model parameters. The modeled shoreline included 39.1 km from within Sawmill Bay and the immediate area outside of it (Figure 4-4). For this area, 81.1% was considered suitable habitat for Pacific littleneck clams, with 33.2% being highly suitable based on model parameters.

HSI Model Validation Against Harvest Area Maps

Habitat suitability model results are dependent upon the input criteria used and the assigned weight of each criterion in relation to each other. The addition or removal of any criteria, or a change in their assigned weight, can change the results of the model. Therefore, HSI models are useful in that they allow researchers to narrow down areas of interest, but groundtruthing is still essential in determining if clams are present. In creating this model without salinity data, and because the model does not consider interactions among habitat variables, it is possible that the model did not achieve spatially specific desired results (Lewis et al. 2019). Further, information about the presence of burrowing shrimp in Prince William Sound is lacking, but to develop the HSI model for this project, it was possible to use the presence of continuous areas of *Z. marina* as a positive criterion for clam habitat. When running versions of the model without using the presence of *Z. marina* as a criterion, the results showed no suitable habitat in the study area; this outcome emphasized the importance of groundtruthing clam presence. For this project, comparisons between known harvest areas and modeled suitable habitat was one metric for confirming clam presence.

When overlaying the past and present areas of both butter clam and Pacific littleneck clam harvests, the maps show that harvests are taking place in areas shown by the model to be suitable habitat. For butter clams, this is to be expected because 100% of Sawmill Bay was determined as suitable habitat based on the criteria used in the model (Figure 4-5). For Pacific littleneck clams, the map shows that harvests are taking place in areas shown by the model to be both suitable and highly suitable habitat (Figure 4-6). Although, there is also some overlap showing harvests in areas assessed to be unsuitable habitat, which is most likely a result of dissolving the harvest areas into larger polygons or the resolution of the technique involved in substrate determination used in the ShoreZone datasets (see Chapter 2). As mentioned in the previous chapter, Figure 2-4 depicts current harvesting areas, including Airport Beach in Crab Bay, for unspecified clams, which likely includes both butter and Pacific littleneck clams. Of note, part of the Crab Bay shoreline was determined to be highly suitable habitat for both butter and Pacific littleneck clams and this is where unspecified clams are harvested (see figures 4-5, 4-6, and 2-4).

Establishing a Shellfish Sanctuary

Site Selection

As described in Chapter 2, the selection of a location for the shellfish sanctuary was first informed by local knowledge that Chenega residents shared. It was important to reintroduce clams in a location that was both accessible to local residents for harvesting and suitable habitat for clams. Although HSI modeling was not conducted until reintroduction efforts were already underway, as depicted in Figures 4-2 and 4-4, model results show that for both butter and Pacific littleneck clams, the beaches in Crab Bay were determined to be suitable habitat, with much of the shoreline determined by the model to be highly suitable for both species. For Pacific littleneck clams, 83% of the shoreline was determined by the model to be suitable habitat, with 77% of this being most suitable. For butter clams, 100% of the shoreline was determined to be suitable, with 44% being most suitable. No area was determined to be unsuitable habitat for butter clams based on the parameters of the model, whereas 17% of the area was determined to be unsuitable habitat for littleneck clams.

To complement local knowledge and the HSI model results, APMI conducted additional assessments and measurements of Airport Beach on August 18–19, 2021 to document overall beach characteristics such as presence and absence observations of seaweed, shellfish predators, and shellfish species. Salinity and temperature were measured at different points during the assessment to denote changes during incoming tides and at different locations on the beach to determine freshwater influence from O'Brian Creek. Lastly, the beach slope and substrate were analyzed at each transect (see Figure 2-1).

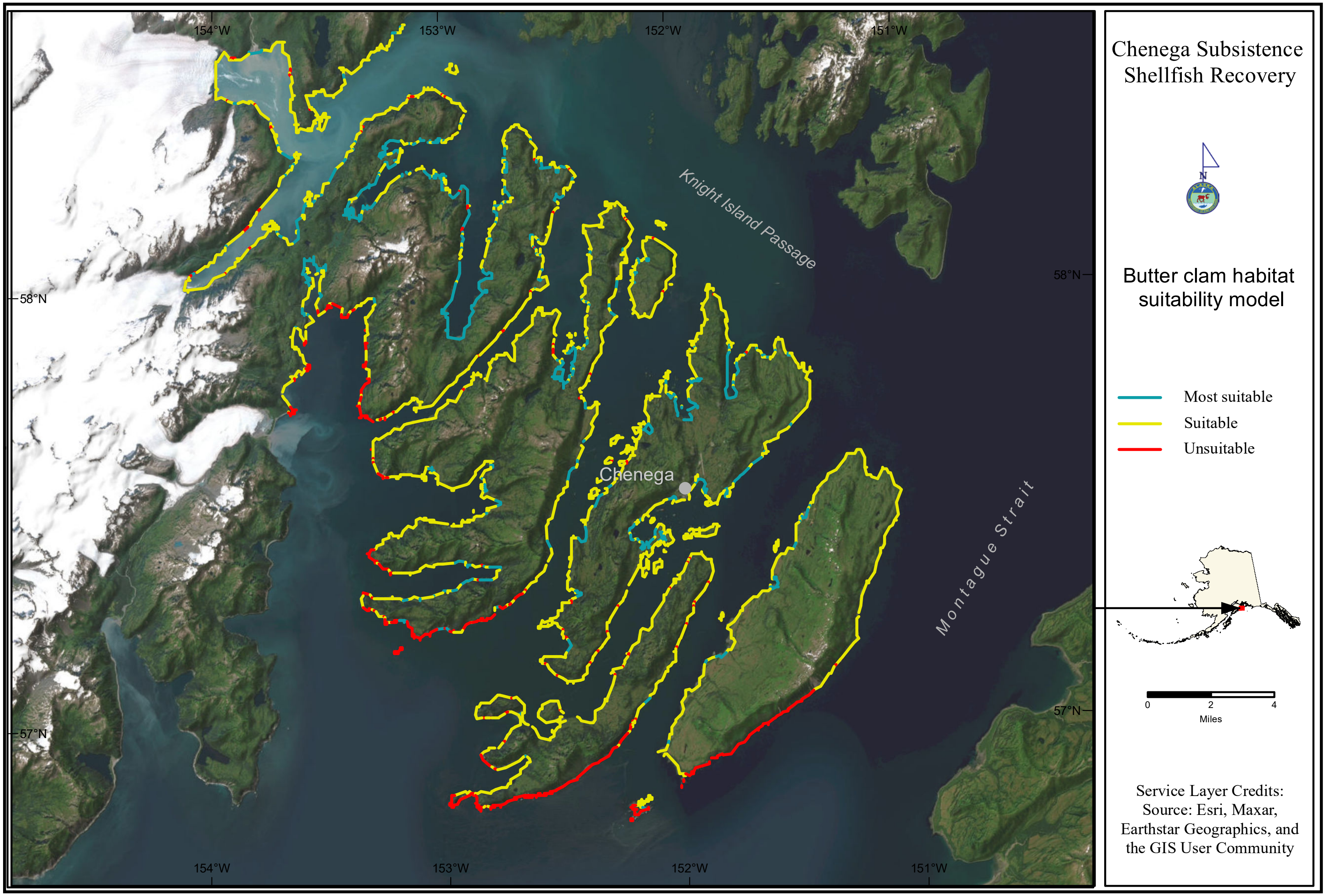


Figure 4-1.–HSI model results showing habitat suitability classifications, butter clams.

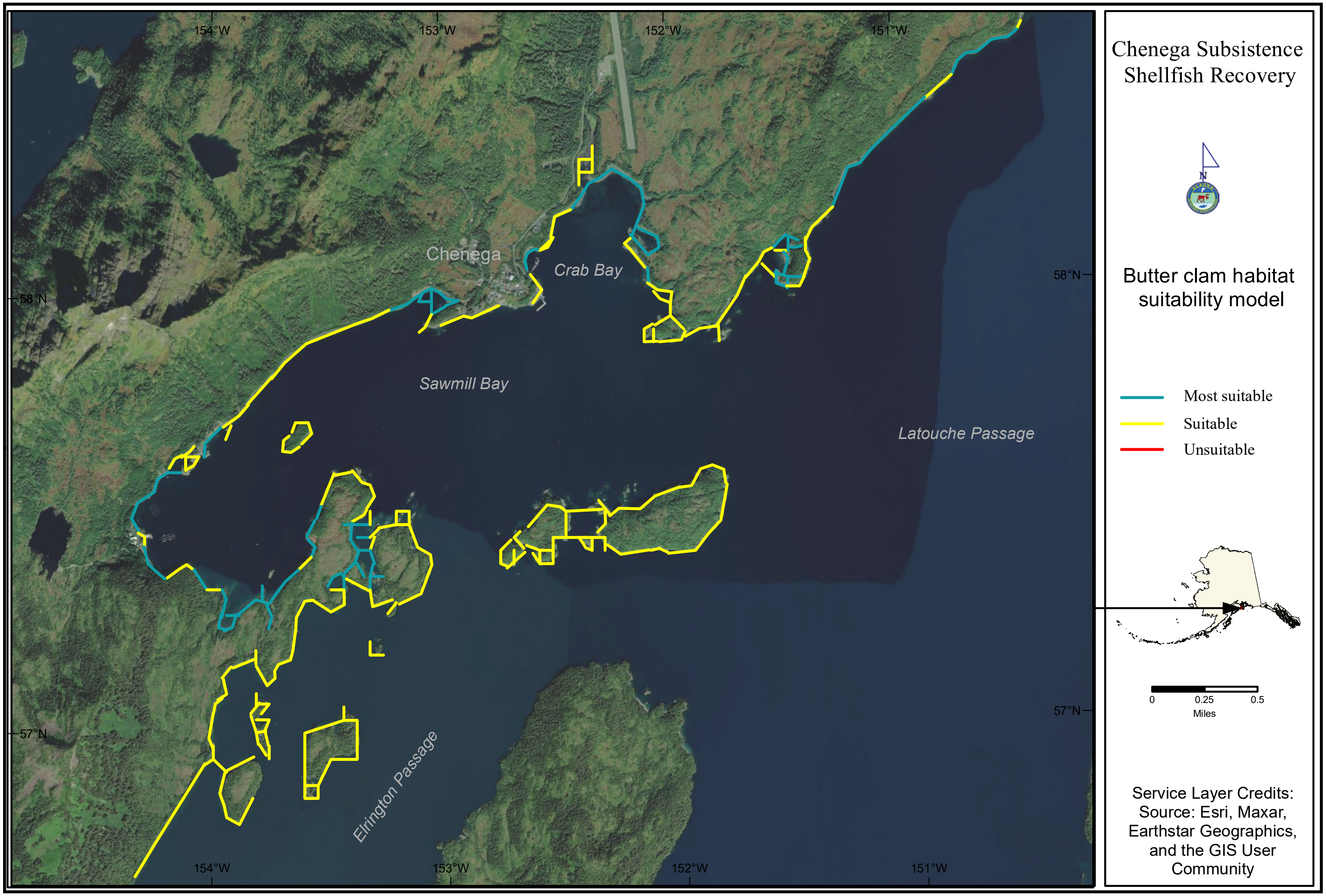


Figure 4-2.–HSI model results showing habitat suitability in Sawmill Bay area, butter clams.

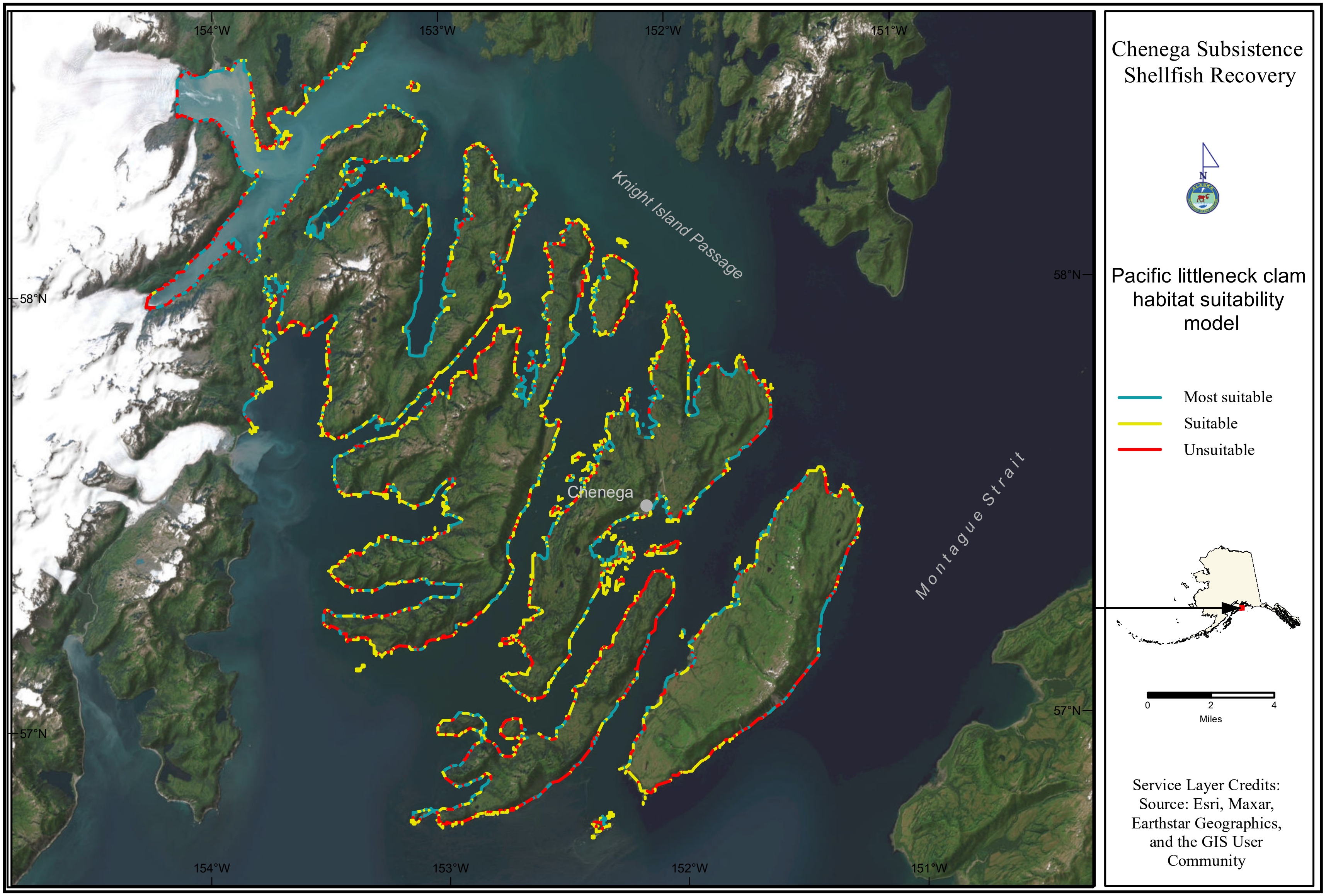


Figure 4-3.–HSI model results showing habitat suitability classifications, Pacific littleneck clams.

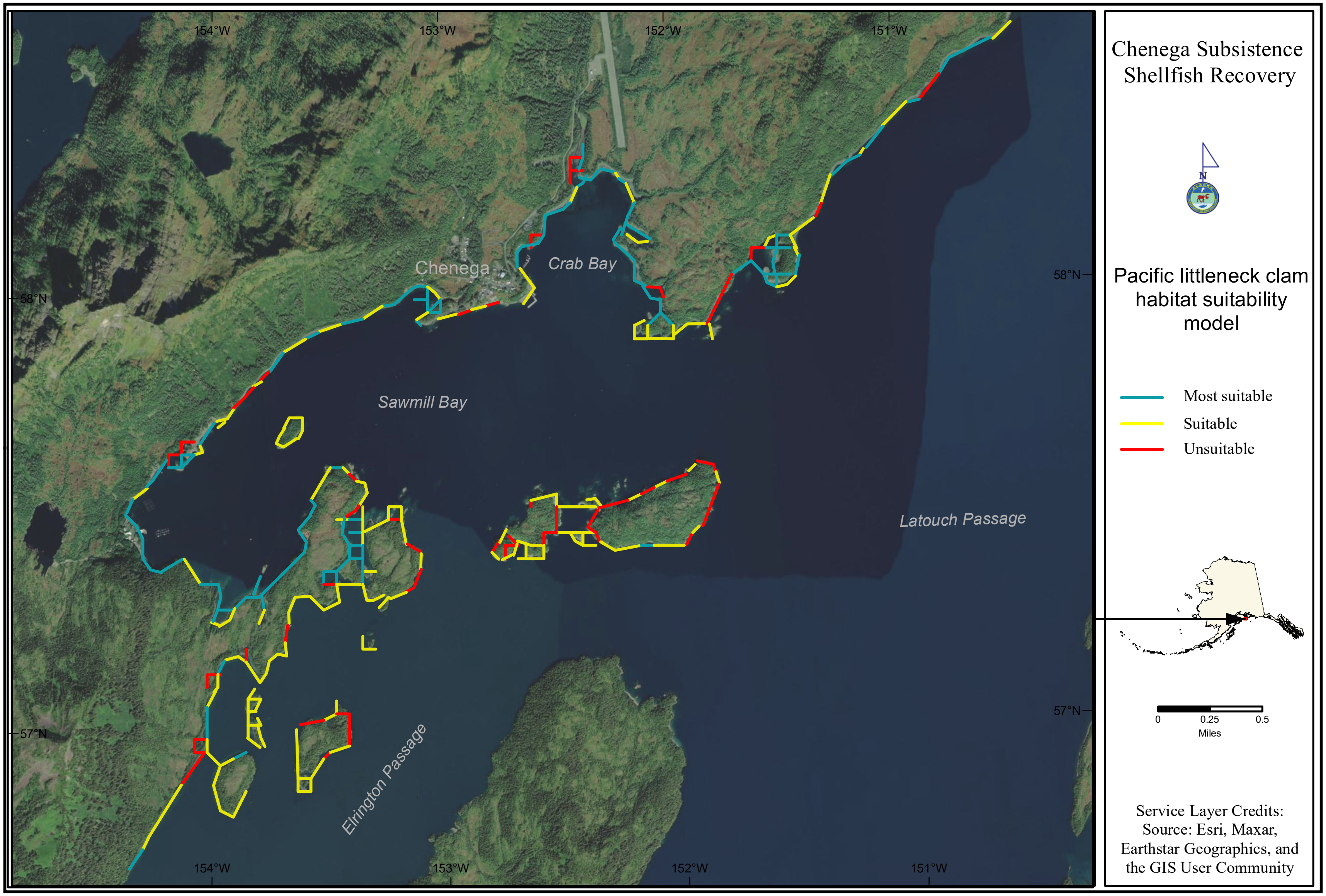


Figure 4-4.–HSI model results showing habitat suitability in Sawmill Bay area, Pacific littleneck clams.

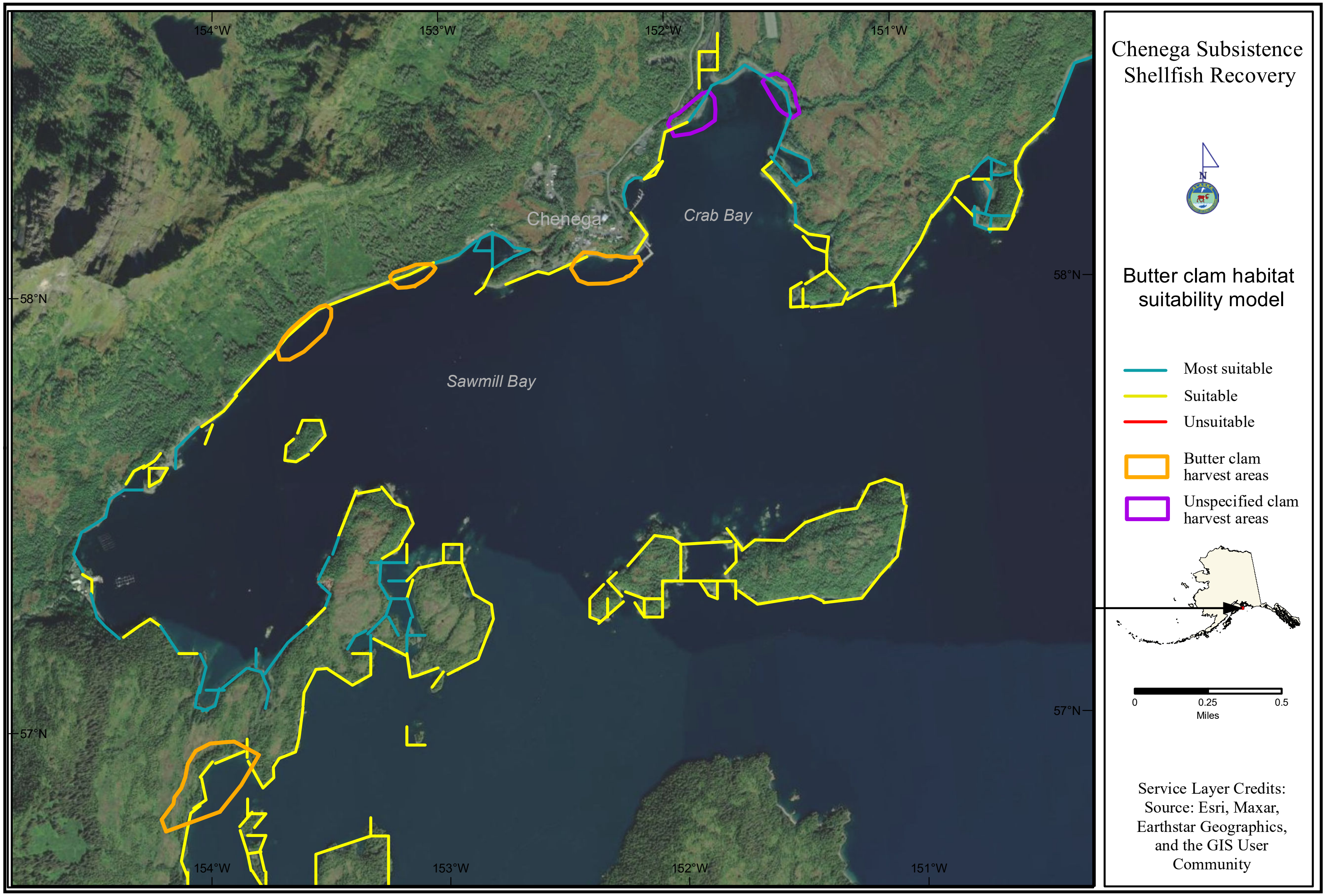


Figure 4-5.–HSI model results showing habitat suitability in Sawmill Bay area and harvest areas, butter clams.

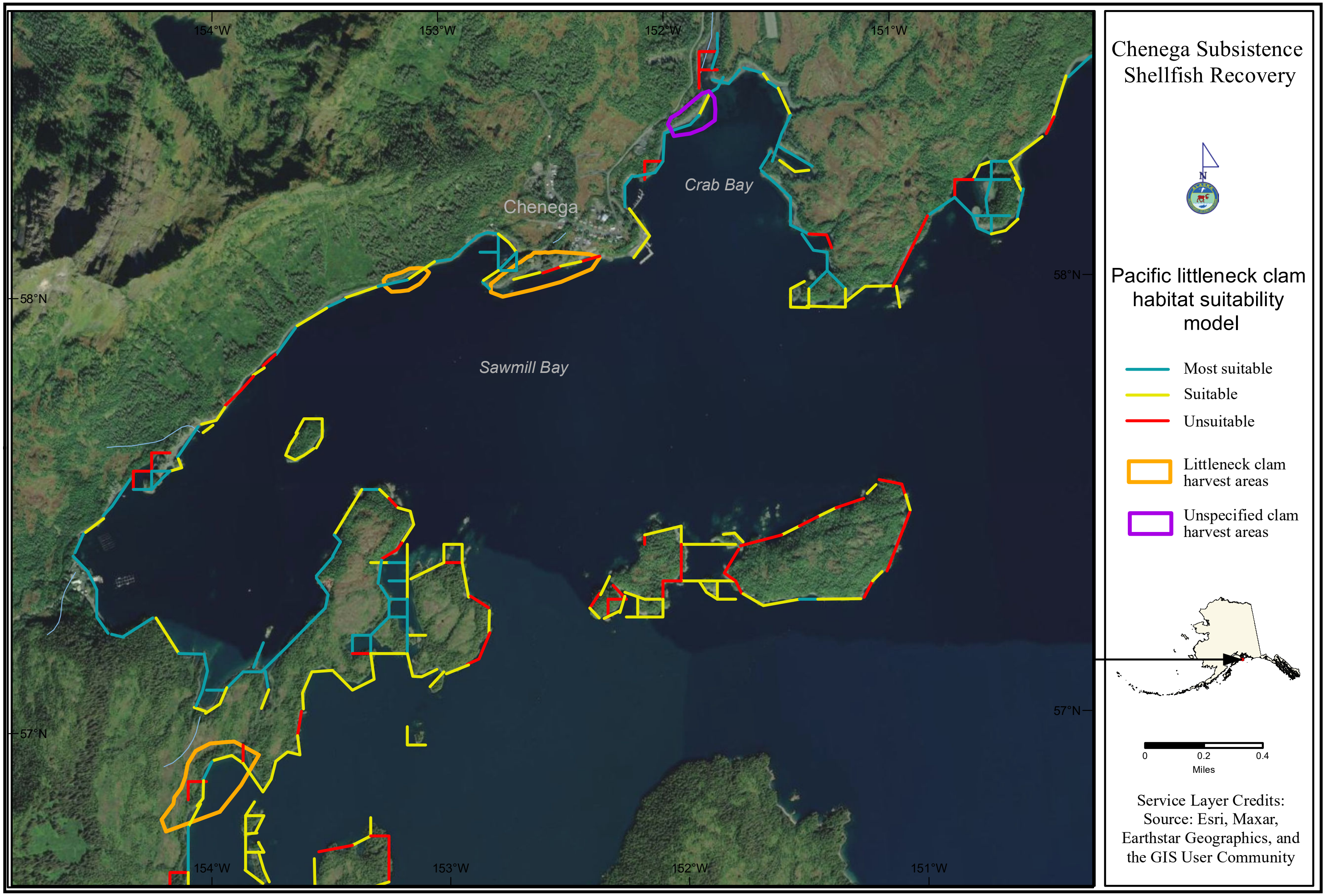


Figure 4-6.–HSI model results showing habitat suitability in Sawmill Bay area and harvest areas, Pacific littleneck clams.

Beach Characteristics

The beach study site represented several distinct habitat types. Silt and eelgrass (*Zostera marina)* and more typical sand/gravel mixture dominated the minus tide level extending to the 1 ft tide level, which was dominated by popweed (*Fucus gardeneri*) and blue mussels (*Mytilus edulis*). At the higher tide level (1.5 ft to 2.2 ft) barnacles (*Balanus glandula*) were found attached to the cobble and rock, which were the predominant substrate at that tidal height.

The beach was rich in biological activity with the common taxa listed above present. The beach was covered with empty clam shells: mostly butter clams, a few Pacific littleneck clams, and cockles were mixed in. There was a small mussel patch on a rock outcropping and the beach had patches of popweed and sea lettuce (*Ulva* spp.).

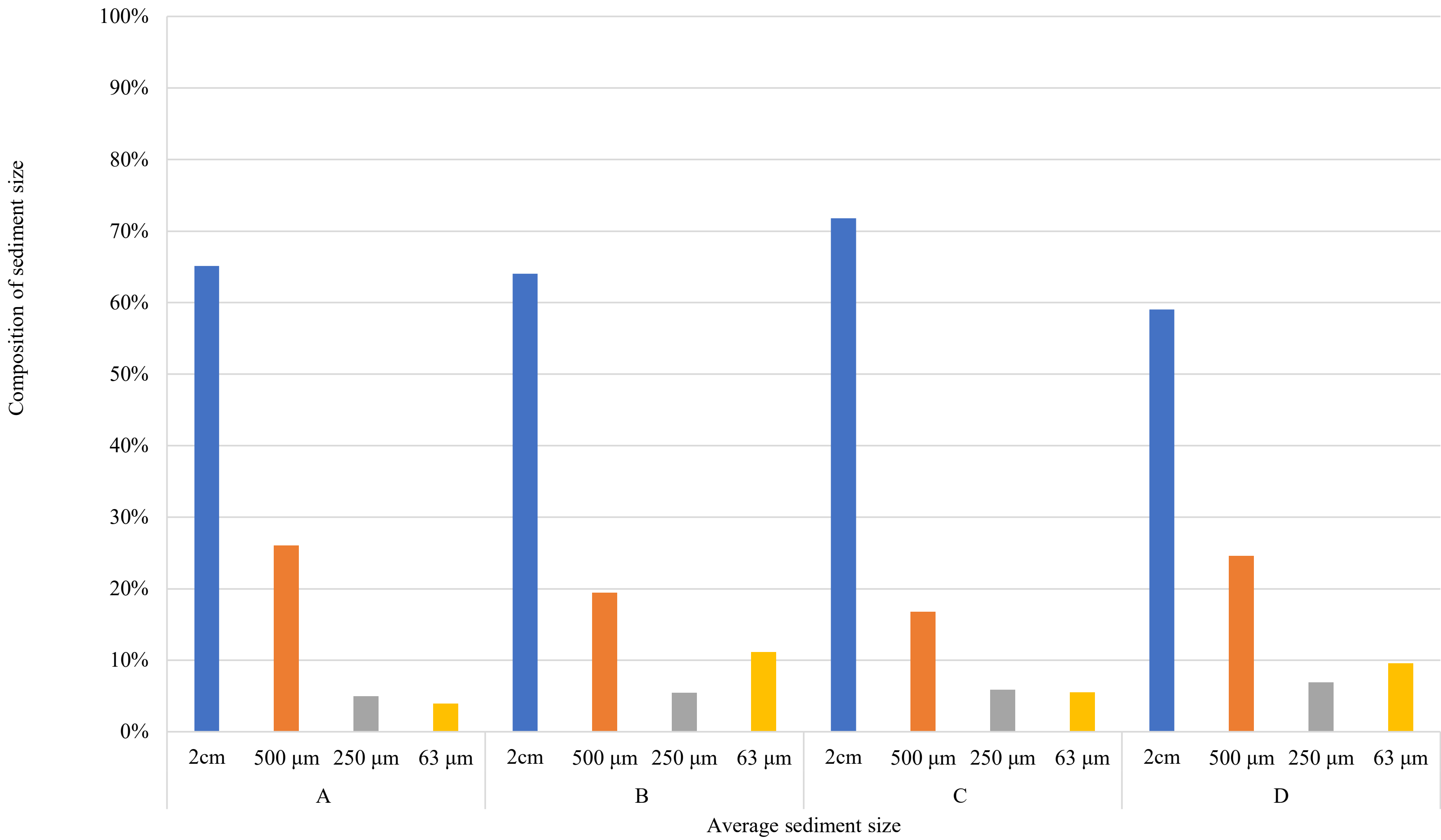
The area was influenced by O'Brien Creek flowing into the area from the northeast. Despite a strong salinity gradient at a low tide, the area was continuous in its species composition. The fresh water is feeding nutrients into the area. The entire beach, including the smaller portion of the study area, was covered with sea otter foraging pits. At the time of the survey, there were six sea otters in or near Crab Bay. Some sea stars (*Pyncnopodia helianthoides*) were also observed. While the sampling focused on butter and Pacific littleneck clams, the samplers also noted several basket cockles (*Clinocardium nuttallii*) and the soft-shell clams *Mya arenaria* and *Mya truncate*. The beach also had a healthy population of polychaetes (*Nereis* spp.) and peanut worms (*Sipunculid* spp.).

Temperature and Salinity

The water temperature was 13.6°C both mornings in August 2021 at the Airport Beach study site (see Figure 2-1) and at the Chenega community dock. The temperature in the substrate at the minus and zero tidal heights at the Airport Beach study site was also 13.6 °C but was 15.2°C at the 1.5 ft tide line. Given salinity is an important environmental parameter for habitat suitability, several measurements were taken to document the freshwater influence of O'Brien Creek. The salinity at the Airport Beach study site was 18 parts per thousand (ppt) during low tide and was 15 ppt at a location 150 feet northeast toward O'Brien Creek, and 25 ppt at a location 100 feet in the other direction (southwest) toward the community dock. The creek influenced the salinity with the incoming freshwater during a low tide, although the salinity increased to 33 ppt at high tide at the Airport Beach study site.

Substrate Analysis

The substrate was sampled using 0.25 m quadrats at even intervals across four intersects at tidal heights 1.5 ft (Line A), 0 ft (Line B), -0.6 ft (Line C), and -1.4 ft (Line D) (see Figure 2-1). The analysis showed a relatively consistent ratio of coarse-to-fine sediments from higher tide lines (1.5 ft) to lower tide lines (-1.4 ft) (Figure 4-7). All transects had a majority composition (>50%) of gravel (+2 cm) and low rates (<12%) of fine sand (63 µm). Butter clams prefer majority gravel and coarse sand (+2 cm–500 µm) substrate compositions with only small amounts of medium-to-fine sand (250 µm–63 µm) (Paul and Feder 1976; Rodnick and Li 1983). Pacific littleneck clams prefer a slightly higher ratio of fine substrate to coarse substrate. The beach survey results show that all transect areas are suitable for Pacific littleneck and butter clam survival with a slight preference toward butter clams due to low fine-sediment rates.



Note For sediment size, "cm" is centimeter and "µm" is micrometer.

Figure 4-7.–Substrate size ratio per transect line at tidal heights 1.5 ft (Line A), 0 ft (Line B), -0.6 ft (Line C), and -1.4 ft (Line D).


Photo by Teal and Marques Hall, Southern Dipper Productions, courtesy of APMI

Plate 4-1.–Broodstock Pacific littleneck clams located at APMI hatchery.

Collecting Broodstock and Adult Clams for Translocation

On May 27, 2021, 115 total collected clams were retained as broodstock and transported to APMI in Seward for producing juvenile clams: 64 Pacific littleneck clams and 51 butter clams, all of which were greater than 5 cm in length (Table 4-1) (Plate 4-1). On August 19, 2021, 50 adult butter clams and 50 adult Pacific littleneck clams from the surviving broodstock were translocated back to Airport Beach and placed in mesh bag that were staked down with rebar at the 0 ft tide level. In 2022, due to low abundance of clams of desirable shell size (5 cm or larger), all 83 collected clams (36 Pacific littleneck and 47 butter clams) were retained as broodstock and remained at the hatchery and not subsequently translocated to the sanctuary site. As depicted in Table 4-2, in 2022, the clam collection effort took two days and required searching several beach areas to collect broodstock.

Seed Production and Hatchery Rearing

2021

An estimated 20,000,000 eggs resulted from the spawning event of Pacific littleneck clam broodstock on June 19, 2021; 11,000,000 survived through the first three days to the D-veliger stage. Next, 7,500,000 larvae survived through the settling stage but were culled to 900,000 at the juvenile stage so that the final culture density did not exceed a density of 1 clam/mL. The Pacific littleneck clams were cultured with warm water (15°C–19°C) and subsequently experienced exceptional growth, resulting in the majority reaching the target size goal of 4 mm–7 mm by February 2022 (Figure 4-8).

Table 4-1.–Broodstock collected, 2021.

Date	Location	Latitude	Longitude	Collection method	Species	Life stage	Size	Number collected
May 27, 2021	Airport Beach	60.0703	-148.0025	Hand digging	*Leukoma staminea*	Adult	>5cm	64
May 27, 2021	Airport Beach	60.0703	-148.0025	Hand digging	*Saxidomus gigantea*	Adult	>5cm	51

Table 4-2.–Broodstock collected, 2022.

Date	Location	Latitude	Longitude	Collection method	Species	Life stage	Size	Number collected
June 15, 2022	Airport Beach	60.0703	-148.0025	Hand digging	*Leukoma staminea*	Adult	>5cm	
June 16, 2022	Across Beach	60.0692	-147.9938	Hand digging	*Leukoma staminea*	Adult	>5cm	36
June 16, 2022	Runway Beach	60.072	-147.9951	Hand digging	*Leukoma staminea*	Adult	>5cm	
June 15, 2022	Airport Beach	60.0703	-148.0025	Hand digging	*Saxidomus gigantea*	Adult	>5cm	
June 16, 2022	Across Beach	60.0692	-147.9938	Hand digging	*Saxidomus gigantea*	Adult	>5cm	47
June 16, 2022	Runway Beach	60.072	-147.9951	Hand digging	*Saxidomus gigantea*	Adult	>5cm	

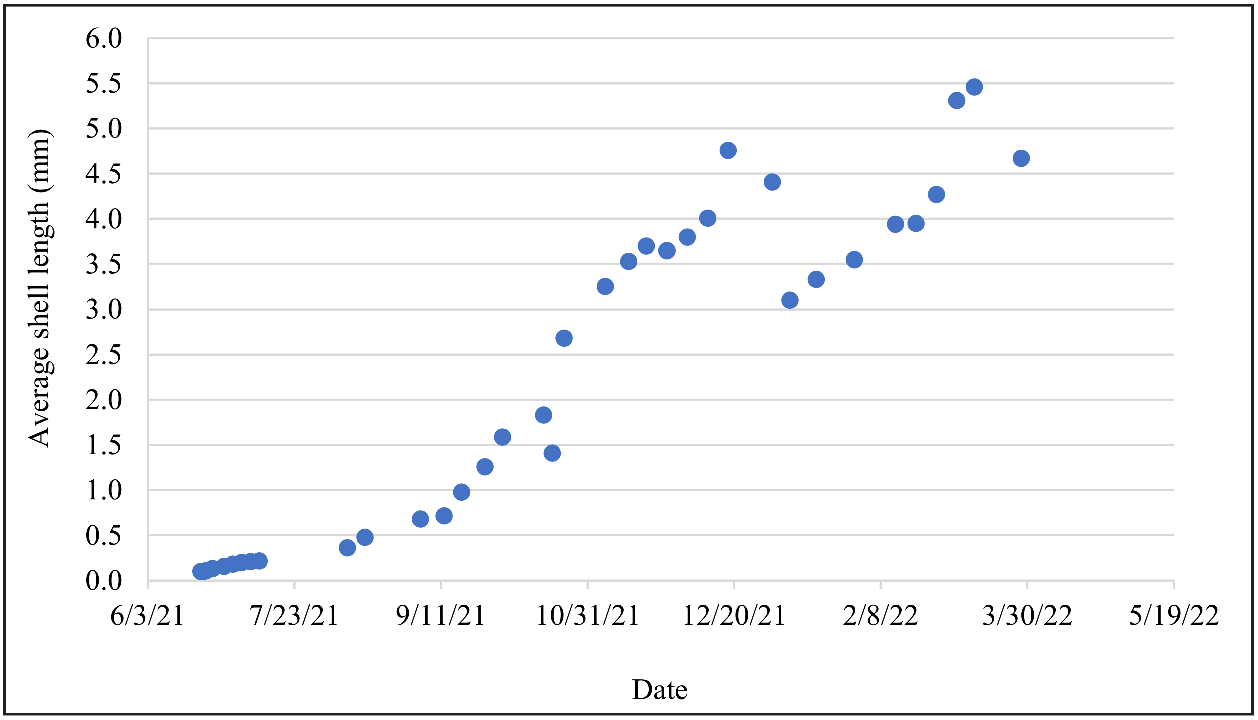


Figure 4-8.–Average shell length of juvenile Pacific littleneck clams born from broodstock in 2021, measurements spanning June 21, 2021–March 28, 2022.

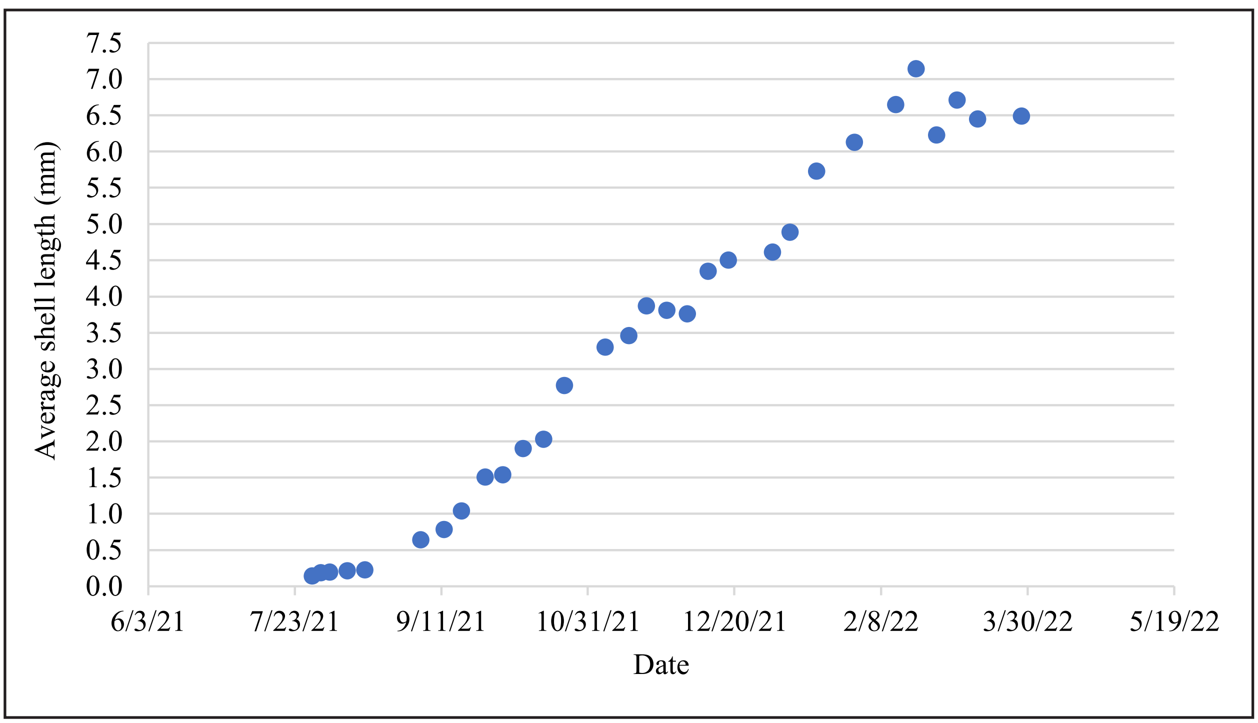


Figure 4-9.–Average shell length of juvenile butter clams born from broodstock in 2021, measurements spanning July 29, 2021–March 28, 2022.

On January 8, 2022, the Pacific littleneck clam juveniles were sorted by size into three separate tanks to prevent larger clams from outcompeting the smaller clams for food (Plate 4-2; Plate 4-3). Clams in bin 1 had an average shell length size of 1.21 mm, clams in bin 2 had an average shell length size of 2.70 mm, and clams in bin 3 had an average shell length size of 5.40 mm. Average shell lengths were taken from all three bins to track growth per bin and then averaged together to document average growth for the overall hatchery population.

The butter clams did not spawn under the typical conditions (15°C–19°C water temperature); rather, a "stress spawn," caused by stimulating gamete release with very high water temperature (22°C), was prompted: the spawn occurred on July 19, 2021. An estimated 7,750,000 eggs were fertilized with only 2,000,000 making it through the first three days to the D-veliger stage. Due to the stress spawn, which causes a high mortality rate, the population estimate at the setting stage was only 210,000; therefore, no culling was necessary. The majority of butter clams reached the target size goal of 5 mm–8 mm by January 2022 (Figure 4-9). This was the only stress spawn that occurred during the project.

Due to low density of butter clams, the juveniles did not need to be sorted by size for hatchery growth or sorted by size for outplanting.

2022

The Pacific littleneck clams were cultured with warm water (15°C–19°C) and spawned on June 27, 2022. An estimated 30,000,000 fertilized eggs resulted from the spawn; 7,500,000 survived through the first three days to the D-veliger stage. The final density was 4,000,000 at the settled larvae stage but was culled to 815,000. The majority of Pacific littleneck clams reached the target size goal of 4 mm–7 mm by May 2023 (Figure 4-10).

The butter clams were cultured with warm water (15°C–19°C) and spawned on June 29, 2022, resulting in an estimated 21,000,000 fertilized eggs, with only 6,620,000 making it through the first three days to the D-veliger stage. The final density was 3,260,000 at the settled larvae stage but was culled to 688,000. On the trip to Chenega in September 2022, a small number of exceptionally fast-growing butter clams (3 mm) were taken and outplanted in addition to the clams produced in 2021. The majority of the butter clams reached the target size goal of 5 mm–8mm by May 2023, which was after the project timeline so these juveniles were not outplanted for this study (Figure 4-11).

Seeding and Monitoring Juvenile Clams at the Sanctuary

2021

The spawn of both clam species born from broodstock year 2021 clams did not grow to a sufficient size for outplanting before the last field work trip in August 2021. Therefore, no seeding of juvenile clams occurred in 2021.

2022

Below is a summary of the outplanting and monitoring activities in 2022. Juveniles born from 2021 broodstock were of sufficient size for outplanting in this project year, as well as a small number of fast-growing juveniles from 2022 broodstock. There were three outplanting events (May 16, June 15–16, and September 13–14) that employed traditional beach seeding protocols as well as placement of multiple types of predator control structures: PVC pipes, biodegradable cups, Beal boxes, and mesh netting. On the last outplanting event (September 13–14), APMI examined a portion of the PVC pipes outplanted on May 16 for the purpose of monitoring growth and mortality in the juvenile clams.

May 16, 2022: First Outplanting

APMI staff traveled to Airport Beach and planted three Beal boxes (boxes that are designed to protect settled clams from predators) within the marked square delineating tidal markings: two of the boxes only contained sand and one was planted with hatchery-raised Pacific littleneck clams (see Figure 2-1; Plate 4-4). The Beal boxes that were only filled with sand were buried to reduce predation risk for naturally settled

Photo by Teal and Marques Hall, Southern Dipper Productions, courtesy of APMI

Plate 4-2.–Close view of downweller tanks containing progeny produced by broodstock.

Photo by Teal and Marques Hall, Southern Dipper Productions, courtesy of APMI

Plate 4-3.–High view of downweller tanks containing juvenile clams sorted by shell size.

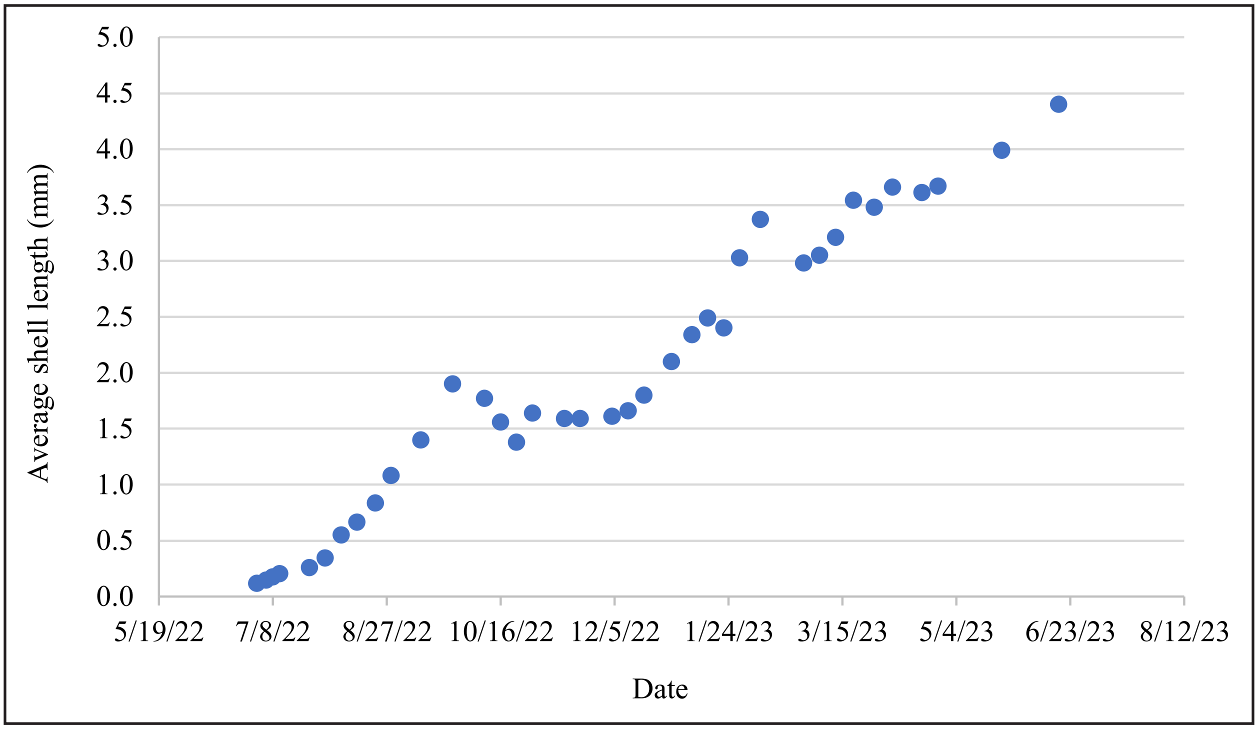


Figure 4-10.–Average shell length of juvenile Pacific littleneck clams born from broodstock in 2022, measurements spanning July 1, 2022–June 18, 2023.

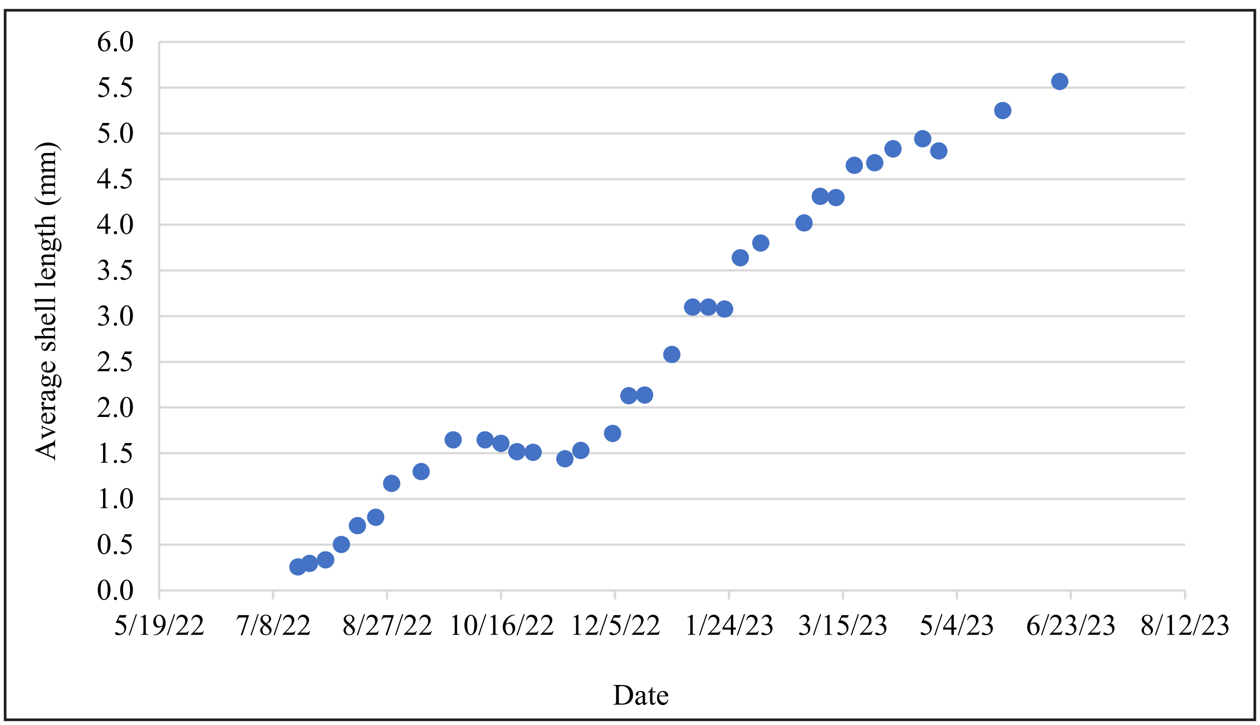


Figure 4-11.–Average shell length of juvenile Pacific littleneck clams born from broodstock in 2022, measurements spanning July 7, 2022–June 18, 2023.

Photo by Annette Jarosz, APMI

Plate 4-4.–Beal box predator control structure buried at Airport Beach.

clams and the other Beal box was intended to provide protected habitat for outplanted hatchery-grown clams. One sand-only Beal box was placed at approximately the -2.3 ft tide level on the east side of the "Big Rock." Another sand-only box was placed west at the -2.0 ft tide level, also on the east side of the Big Rock. The last Beal box was filled with an estimated 300 Pacific littleneck clams and placed at the -1.5 ft tide level; an additional 3,000 Pacific littleneck clams were planted in a racked 10 ft-by-10 ft plot east of the last Beal box.

Next, staff dug a trench to plant 21 PVC pipes for housing juvenile clams: 15 held Pacific littleneck clams and 6 of the PVC pipes held butter clams (Figure 4-12). The Pacific littleneck clams were sorted into three groups based on size ranges. One group was labeled "Big littleneck clams" with an average length of 12.8 mm, the next was labeled "Medium littleneck clams" with an average length of 8.6 mm, and the last group was labeled "Little littleneck clams" and the average length was 5.9 mm. The butter clams were an average length of 7 mm and labeled "Butter clams." Each PVC unit was filled with 20 juveniles from their respective size and species group.

June 15–16, 2022: Second Outplanting

APMI staff planted Pacific littleneck clams and butter clams in two different predator control structures. Forty biodegradable cups, with the bottom cut out, were used for the first method of predator control and were planted in a horizontal line parallel to the ocean at the -1.5 ft tide line. Ten cups held "Big butter clams" (7 mm–8 mm in length), 10 cups held "Big littleneck clams" (7 mm–8 mm in length), 10 cups held "Medium butter clams" (2 mm–3 mm in length), and 10 cups held "Medium littleneck clams" (2 mm–3 mm in length). Each of the 40 cups contained 10 individual clams (Figure 4-13, see top portion "A"). Additionally, 10 PVC pipes, planted in a horizontal line parallel to the ocean at the -2.0 ft tide line, were also used as predator control structures (Plate 4-5). Five of the PVC pipes were filled with 10 butter clams per pipe (labeled "Big butter clams") and the remaining five pipes each contained 10 Pacific littleneck clams (labeled "Big littleneck clams) (Figure 4-13, see lower portion "B"). Lastly, APMI staff raked two 15 ft-by-15 ft plots to the east of the PVC line and planted 55,000 Pacific littleneck clams and 30,000 butter clams.

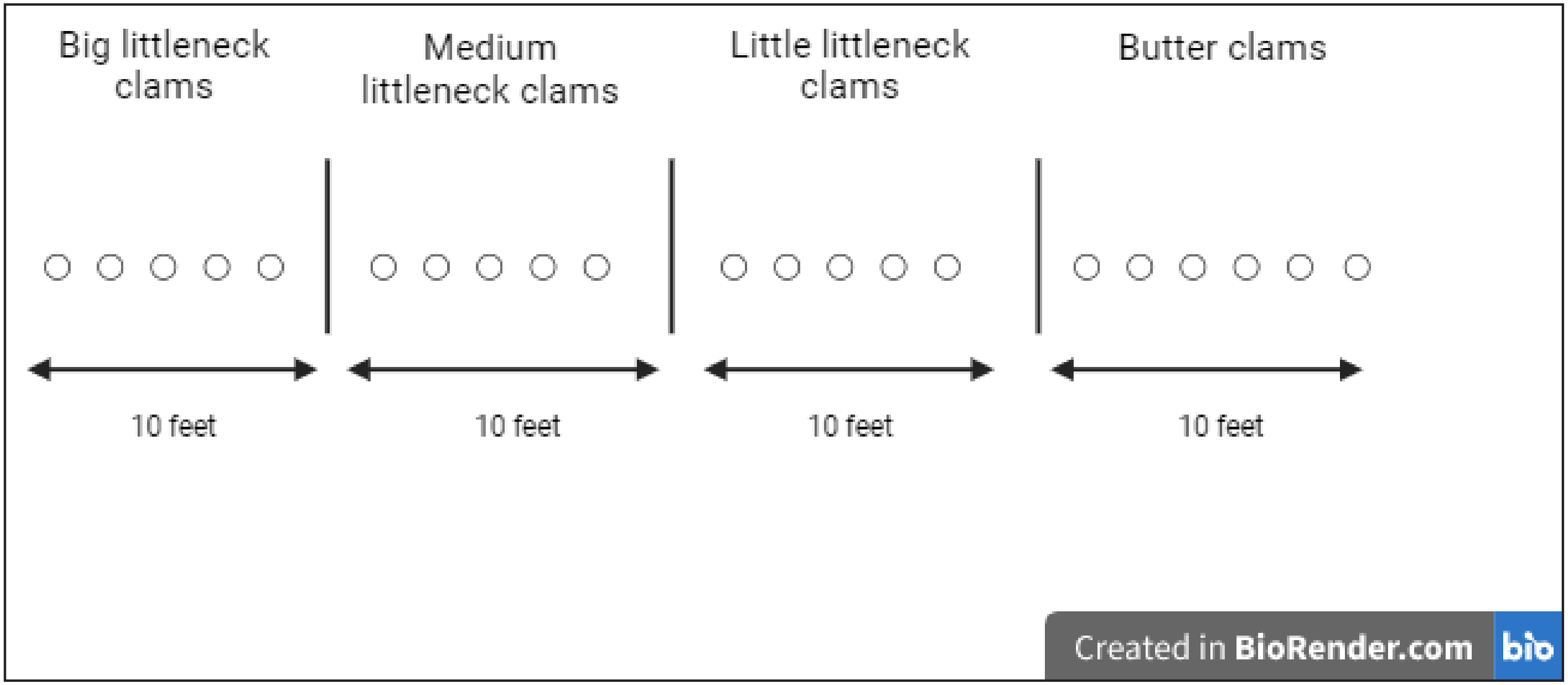


Figure 4-12.–Diagram depicting the layout of the 21 PVC pipe placed on the -1.5 ft tide line.

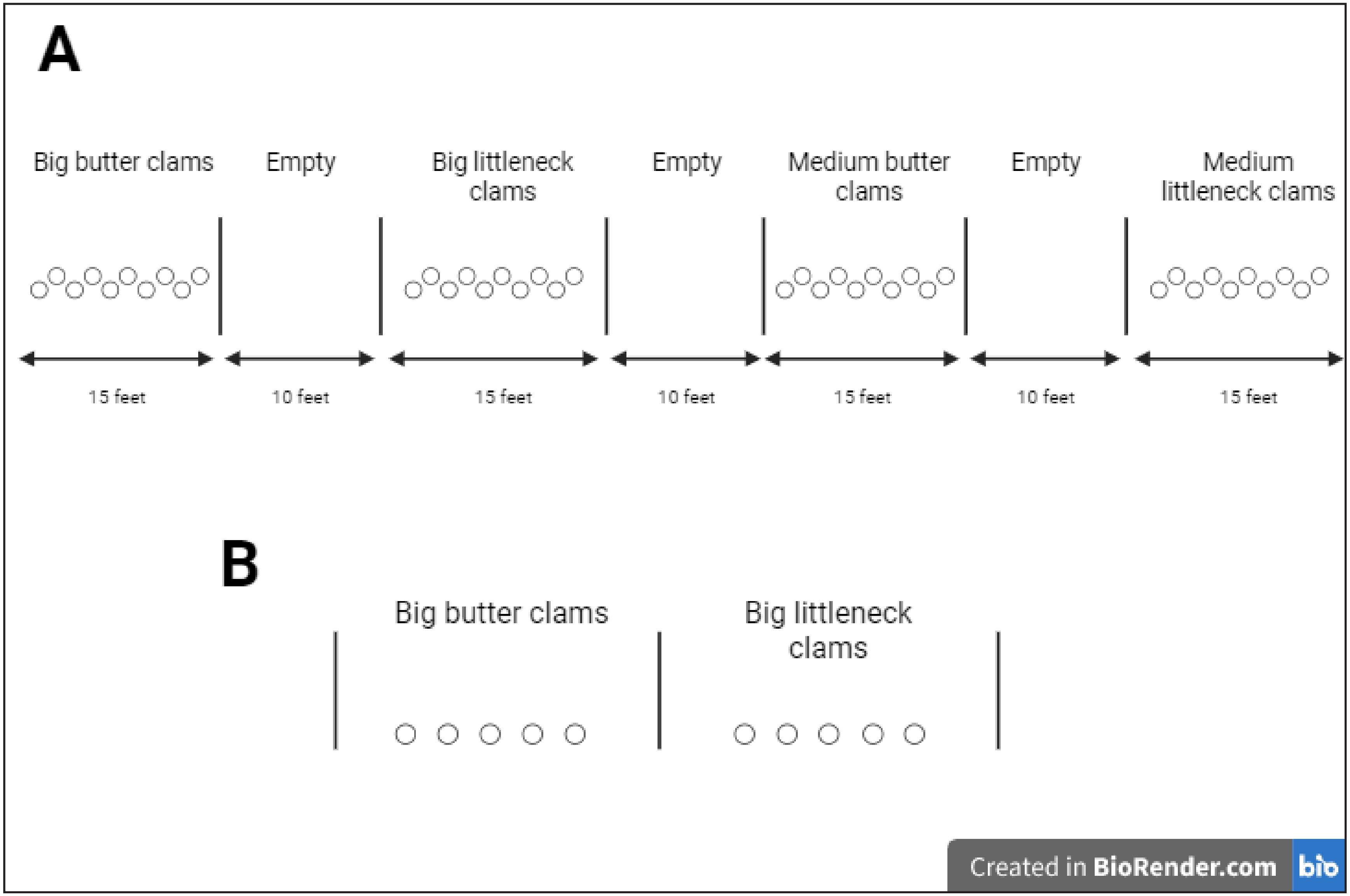


Figure 4-13.–Diagram depicting the layout of the A) 40 biodegradable cups planted on the -1.5 ft tide line and B) 10 PVC pipes planted on the -2.0 ft tide line.

Photo by Annette Jarosz, APMI

Plate 4-5.–PVC pipes planted on transect line at Airport Beach.

September 13–14, 2022: Monitoring and Third Outplanting

APMI staff traveled to Chenega to monitor the growth and survival of the clams that were planted in PVC pipes in May 2022. Staff collected one PVC tube from each of the four groups of clams ("Big littleneck clams," "Medium littleneck clams," "Little littleneck clams," and "Butter clams") (Plate 4-6). APMI staff found one macoma clam (*Macoma balthica*) (13 cm) and one Pacific littleneck clam (12 cm) in the first PVC pipe ("Big littleneck clams"). Unfortunately, most of the sand was spilled when pulling up the pipe, so it is likely that most of the clams were lost with the spilled sand. The second PVC pipe ("Medium littleneck clams") had 20 Pacific littleneck clams that had an average length of 14.7 mm, which is an average increase of 71%, or about 1.5 mm growth per month. The third PVC pipe ("Little littleneck clams") had 17 Pacific littleneck clams with an average length of 14.2 mm, which is an average increase of 140%, or about 2.1 mm growth per month. Lastly, the fourth PVC had 18 butter clams with an average length of 11.9 mm, which is an average increase of 70%, or about 1.2 mm per month. If the first spilled PVC is excluded, the average survival rate was 88% (Pate 4-7; Plate 4-8). Juvenile mortality could be caused by a myriad of reasons. One of the highest risks of mortality is predation from smaller invertebrates, such as moon snails, small sea stars, and small crabs, that could fit in the PVC pipes. Other causes of mortality could be temperature shock and damage of the shell from being outplanted. It is too difficult to predict which of these factors was the reason for the 88% survival rate, especially because once clams die, their lightweight, empty shell is often carried away by the tide, effectively removing evidence of cause of death.

In addition to monitoring, APMI staff outplanted the last of the juveniles produced in 2021, as well as the small number of exceptionally fast-growing butter clams (3 mm) produced from 2022 broodstock. APMI raked two 15 ft-by-15 ft sections of Airport Beach and spread out 30,000 Pacific littleneck clams and 20,000 butter clams evenly between the two. The juveniles were spread under large mesh netting that was fixed into the substrate with metal stakes.

Photo by Dayne Buddo, Georgia Aquarium

Plate 4-6.–APMI staff collecting clams from PVC pipe predator control structure, September 2023.

Monitoring Translocated Adult Clams

June 15–16, 2022

The work area surveyed in 2021 on Airport Beach was identified by a metal rebar stake at the 1 ft tide line. The mesh bags containing the translocated butter clams were recovered with only four surviving butter clams and the mesh bags containing the Pacific littleneck clams were recovered at the 2 ft tide height and none of the Pacific littleneck clams survived.

Photo by Annette Jarosz, APMI

Plate 4-7.–Outplanted juvenile clams retrieved from PVC pipes and measured, September 2023.

Photo by Annette Jarosz, APMI

Plate 4-8.–APMI staff sorting clams retrieved from PVC pipes.

5. DISCUSSION AND CONCLUSIONS

This project addresses Chenega residents' concerns about the local availability of wild foods by informing a future shellfish management plan with baseline information on clam habitat and results of clam reintroduction efforts. This project's mixed-methods research approach included documenting local knowledge to understand local clam habitat and uses of clams in the community, mapping clam harvest areas, and exploring the potential of Habitat Suitability Index (HSI) models to complement local traditional knowledge when identifying clam reintroduction areas. Additionally, a core focus of the project was introducing hatchery-spawned clams to assess the potential of a shellfish sanctuary near Chenega that could increase harvest opportunities for residents. This chapter reviews key findings, challenges, and implications for future research and clam reintroduction efforts.

Traditional Ecological Knowledge of Harvest Practices and Habitat

Key respondent interviews with Chenega residents documented traditional clam harvest methods and uses, and informed clam reintroduction efforts by documenting harvest areas and providing qualitative information about clam habitat. Compiled harvest data from 1984–2014 demonstrated that clams were regularly harvested and shared by Chenega households. Ethnographic interviews provided context for clam harvest activities by sharing clam harvest methods, describing the wide range of ways to prepare and consume clams, describing the different types of clams used near Chenega, and discussing suitable clam habitat proximal to Chenega where harvesters could more easily access clams. Descriptions of suitable clam habitat included beaches that had a combination of sand and smaller rocks, and shallow beaches that have sandy areas for digging at low tide. Interviews also involved mapping clam harvest areas and describing modes of access, species harvested at each location, and local names for harvest areas. The remainder of this section evaluates harvest area mapping efforts, and implications for clam reintroduction efforts.

Harvest Area Mapping

Harvest area mapping documented past and present harvest areas for clams around Chenega and informed reintroduction efforts by providing a visual representation of accessible local habitat where different clam species were successfully harvested. Mapped harvest areas also created an additional metric to validate the HSI model for the existence of different clam species at a variety of locations. Harvest area mapping in this study is limited by the fact that key respondents were not a representative sample of the whole community since multiple known clam harvesters were never successfully contacted to participate in the project. Additionally, many past residents who used to harvest clams no longer live in Chenega or have passed away. Therefore, similar to other mapping efforts that the division has recently conducted (Neufeld et al. 2021:49; Van Lanen et al. 2018:14), it is impossible for maps in this project to be a complete representation of all possible current and past clam harvesting areas used by Chenega residents. Nevertheless, small samples of purposefully selected resource users can yield meaningful results and informed map products (Polfus et al. 2014).

There are multiple ways that mapping can be improved in future research. First, respondents were asked to indicate harvest areas that they used in the past, but they were not asked to indicate discrete periods of time. As a result, there is no mechanism to observe the specific years when areas were utilized, which might have provided context for timeframes of clam health and abundance. Future mapping efforts could benefit from identifying discrete harvest time periods. Second, the Division of Subsistence collected geospatial data in previous comprehensive survey years that could have been used to identify additional past harvest areas for clams. However, in those study years, geospatial data were collected for all marine invertebrates combined rather than individual species. As such, there is no way to directly compare prior clam harvest areas against locations identified by key respondents who participated in this study. Therefore, when possible, mapping by species is valuable for contributing to a longitudinal dataset. Finally, based on previous research on subsistence harvest areas (Neufeld et al. 2021:53), researchers asked respondents to indicate whether the harvest area was a low, medium, or high area of use. While this has potential for indicating areas that are especially important for harvesting, the applicability for this study was limited by the small number of respondents and the subjective nature of the question. Respondents were instructed to classify their level of use of an area using their own definition for each level, so the classifications of low, medium, and high harvest areas do not have a direct correlation with the number of clams in the area nor other respondents' assessments. Future efforts should supply clear parameters for low, medium, and high use of areas.

Despite ways that mapping can be improved in future studies, harvest area mapping remained an important step in identifying locations that might be successful for a shellfish sanctuary, understanding which areas would be used by Chenega residents, and validating the HSI model.

Habitat Suitability Index Model Validation

Model validation is important in that it increases confidence in the model results (Power 1993; Roberts et al. 2017). Standard model validation methods include normalizing clam presence/absence data and using a binary logistic regression model to determine if there was a correspondence between HSI classes and predicted clam presence probabilities for each species in the study (Lewis et al. 2019). However, a growing body of literature calls for utilizing TEK in conjunction with Western scientific models to validate results with local observations (Olsen et al. 2015:11866; Polfus et al. 2014). Creating a dataset for presence/absence data requires a high density of sample points throughout the study area, which was not possible for the scope of this study due to funding and project timeline constraints, and the lack of robust butter clam and Pacific littleneck clam populations in Prince William Sound. As an alternative, polygons representing past and present harvest areas that were delineated during key respondent interviews were overlaid on the maps showing HSI model results. The resulting maps show that harvests are taking place in areas shown by the model to be both suitable and highly suitable habitat for both species of clams (Figure 4-5; Figure 4-6). Although there is some overlap in areas shown to be unsuitable habitat for the Pacific littleneck clam (Figure 4-6), this is most likely a result of the spatial resolution of the harvest area data as well as the patchy nature of the intertidal zone. Groundtruthing provided additional validation of results: staff from APMI reviewed the model results and found species presence at Crab Bay, Outer Beach, and Bingo Beach. While harvest areas documented during key respondent interviews were a useful validation tool for the HSI model in this study, there is much potential for actively integrating TEK into HSI models in future studies. The following sections briefly describe the existing research on TEK-informed HSI models and consider implications for future research of this type.

Traditional Ecological Knowledge–HSI Models

The literature on TEK-informed HSI models is recent and growing. Polfus et al. (2014:113) argued that HSI models predict habitat quality based on expert opinion, and thus are a natural fit for integrating traditional ecological knowledge. To test overlap between standard HSI model results and TEK–HSI models, Polfus et al. (2014) developed two independent models for woodland caribou in British Columbia. One HSI model used only Western science inputs with resource selection functions (RSF), which statistically assess the probability of an animal using a resource in proportion to the availability of that resource. The other model relied on TEK collected from mapping interviews with eight First Nation hunters and knowledge holders. This HSI model incorporated TEK information about caribou food resources, seasonal use areas, and documented animal locations. Based on comparisons with global positioning system (GPS) locations of caribou, both models accurately predicted that caribou selected low elevation pine forests in the winter and alpine habitats in the summer. However, the TEK-based model captured some nuanced differences in winter habitat by indicating a large burn area as low habitat quality, therefore capturing a habitat relationship that the RSF model had not (Polfus et al. 2014:117).

Olsen et al. (2015) created HSI maps for marine mammals in Arctic environments by converting TEK data to polygons representing presence/absence data. Researchers interviewed expert hunters in Bering Strait villages and produced seasonal maps of important hunting and search areas, areas where bearded seals concentrate, and environmental characteristics of areas considered important for hunting success. Inputs from TEK data were used to create classifications for additional potential seal habitat. Analysis of mapped areas helped narrow limited Western science predictions of seal habitat to specific areas that were likely critical habitat zones for bearded seals, especially amidst rapid environmental changes.

Tendeng et al. (2017) evaluated HSI models for moose in Quebec, Canada, with TEK from 16 interviews with First Nation hunters in the local Algonquin community. Respondents indicated spots on a map where moose habitat was high, good, low, or null. Contour lines were quantified in ArcGIS to produce TEK–HSI models, and the suitability rating for each 5 km grid was evaluated against other HSI models using Cohen's[1] kappa (k). Results found moderate to strong statistical agreement between the TEK-based and the other HSI models. Suggestions for improving accuracy of standard HSI models include accounting for local factors like lakes, rivers, and unproductive sites or wetlands that the TEK-informed model was able to delineate due to TEK about the area.

Existing literature clearly demonstrates that TEK is able to capture critical habitat relationships that are not always quantified in Western science models, allowing TEK–HSI models to account for more nuanced variables within wider areas (Polfus et al. 2014; Tendeng et al. 2017). Additionally, testing of TEK-based models demonstrated high predictive performance when evaluated with caribou location data, moose habitat quality, and bearded seal presence (Olsen et al. 2015; Polfus et al. 2014:117; Tendeng et al. 2017). These findings are consistent with recent division research that demonstrated the accuracy and complementary nature of traditional knowledge and mapping in conjunction with Western scientific methods for caribou abundance and habitat (Van Lanen et al. 2018). Together, this growing body of literature demonstrates that the utility of standard HSI models can only be improved with information shared by local experts who possess a deep knowledge of their lands passed through generations and rooted in experiences. The inconsistencies that can arise when comparing this rooted knowledge to other scientific findings can lead to new insights (Huntington et al. 2011); and, in this case, more powerful HSI models. There are numerous opportunities to apply TEK-informed HSI models in future research, which will be discussed in the next section of this chapter.

Implications for Future Research

Climate Change

Various habitat suitability models have been developed that attempt to predict the effects of environmental change on the suitability of a habitat and future species distribution (Beamer et al. 2020; Garcia et al. 2013; del Río et al. 2021; Whannou et al. 2022). However, FISBHE habitat suitability models are created using current environmental conditions and do not predict the suitability of locations in future environmental conditions (Thuiller and Münkemüller 2010). The scope of this project was to locate a suitable shellfish sanctuary area for this project's clam restoration effort and not to develop a model that could help predict habitat suitability in the future. Long-term concerns include threats to intertidal organisms resulting from increased water and air temperature, decreased salinity and, in the case of clams, ocean acidification. It is recommended to continue monitoring the parameters used in this study's HSI model for updated suitability information.

The bathymetric depth at which an intertidal species is found is indicative of its tolerance to temperature gradients. Organisms that survive in the upper intertidal zone spend more time exposed to ambient air temperatures, which subjects the organisms to a wider seasonal temperature gradient than those organisms found in the lower intertidal zone (Bernard 1983). Bivalve species such as clams that burrow in the sediment can mitigate the effects of extreme temperatures further by avoiding exposure to air temperature and resultant desiccation (Zwarts and Wanink 1989). The lack of available salinity data for this region of Prince William Sound makes it difficult to predict future salinity levels. Increased air temperatures leading to increased runoff from glaciers, rivers, and snow melt will likely lead to seasonally decreased salinity levels at near-surface depths, although this could be mitigated by a reduction in the seasonal mixed layer

1. See Cohen (1960) for more information about Cohen's kappa for measuring agreement between two dependent categorical samples.

depth (Campbell 2018). Implications of extended periods of low salinity is limiting to bivalve species (Dethier et al. 2012; Gaumer and McCrae 1990; Lauzier et al. 1998).

While predicting the effects of climate change on the success of a shellfish sanctuary was beyond the scope of this project, it is important to realize that other sources of environmental change also affect shellfish survival. For example, the March 1964 earthquake measured 9.2 on the Richter scale and resulted in drastic changes in the coastline; in Prince William Sound the coastline was generally uplifted, resulting in intertidal communities being abruptly trapped above sea level (Stanley 1968). The result was catastrophic to bivalve populations.

Informing HSI Models with Traditional Ecological Knowledge

TEK–HSI models have many potential applications in future research efforts. First, other Southcentral Alaska coastal communities with an interest in establishing shellfish sanctuaries could start with mapping interviews about habitat quality and characteristics to inform an HSI model for the local region. Mapping for this study was limited to clam harvest areas close to Chenega, which is common of TEK-informed HSI models that tend to be concentrated in areas near settlements where hunters and knowledge holders live (Olsen et al. 2015). However, the geographic scope can be expanded through incorporating other communities and identifying knowledge holders who have experience in a wider area, such as fishers and hunters who may have an intimate knowledge of beaches in areas farther away from their communities. Second, TEK-informed HSI models have applications for other wildlife species being stressed by climate change in coastal Alaska. For example, residents of the Chugach communities of Port Graham and Nanwalek have noted challenges with accessing moose traditionally relied on for subsistence due to changes in moose population abundance and the vegetation moose rely on. HSI models could provide updated information on critical moose habitat by integrating TEK of localized habitat characteristics, weather patterns, as well as other local knowledge of moose landscape use (Mackenzie et al. 2017). Importantly, TEK-informed models should inform site selection for other shellfish sanctuaries, but, more broadly, they should be a useful tool for communities by providing formal documentation of critical habitat areas for clams and other subsistence resources important to the long-term sustainability of subsistence ways of life.

Evaluation of Clam Reintroduction Efforts

Airport Beach proved to be an ideal location for clam reintroduction efforts. The beach area was indicative of an area with high biological functions: it was rich in flora and fauna and had permeable substrate with interstitial space for gradual draining of tidal flow. Based on past APMI research efforts, beaches with the proper slope and drainage where water is retained for a period of time are often the most suitable habitat for clams. The most obvious factor when looking for a suitable beach for clams is the presence and evidence of shells that indicate at least at some point in time clams resided in the area. A second critical factor, which was also supported in key respondent interviews, is a substrate that can be easily dug and has pore water (water contained in the gaps of sediments) flowing through the substrate. The retention of pore water allows for the temperature to heat up in the winter and retain food during outgoing tides and also rinses the beach to prevent freezing in the winter. An interesting characteristic of Airport Beach is the presence of O'Brien Creek, which influences the tidal area. It is dynamic in that there are berms and rerouting but the drainage is small. The salinity gradient at a low tide along the 300-foot beach ranges from 15 ppt to 26 ppt in a relatively short distance. The low flow of fresh water from the creek is easily overcome with the large, full-strength saltwater tidal influence. The fresh water does not appear to affect the shellfish populations and may be beneficial as a source of terrestrial nutrients.

While numerous aspects of Airport Beach were promising for clam reintroduction, sea otter predation posed a serious challenge, especially for finding broodstock. Due to the low number of adult clams found when broodstock collection occurred each spring, APMI was unable to complete study Objective 1 to place adult clams in a sanctuary and monitor their spawning behavior and observe gamete development. To troubleshoot this impediment, APMI established the sanctuary in late summer 2021 using the surviving 2021 broodstock after they spawned at the hatchery. Unfortunately, when APMI staff returned in 2022 to check on the adults, only four surviving butter clams were found. Based on finding even fewer adults in

2022 for broodstock and low survivorship for the outplanted 2021 adults, APMI decided not to outplant adults into the shellfish sanctuary in 2022.

Finally, one of the challenges that APMI consistently faces is understanding how well juveniles survive and grow once placed into the wild. For this effort, predator control methods were needed to prevent large invertebrates (i.e., sea stars and moon snails) and sea otters from predating on the juvenile and adult clams in the sanctuary, and to identify hatchery shellfish from wild shellfish. It is difficult to differentiate between hatchery and wild shellfish because there are no physical features to discern between hatchery-raised and wild shellfish. The predator control structures provided a unique opportunity to outplant hatchery shellfish and allow researchers to return and quantify survivability and growth. Use of these structures provided one of the first times APMI has been able to understand and compare natural wild growth to growth in an artificial hatchery environment. Unfortunately, while the structures provided a way for researchers to identify hatchery shellfish, they did not provide a realistic and true understanding of predation and growth outside of an artificial structure; the vast majority of outplanted juveniles were not in predator control structures and therefore are expected to have had different mortality rates. In future projects, APMI plans to conduct experiments using calcein, a fluorescent dye that has been used as a non-toxic and non-invasive method to mark and track various aquatic organisms, as a way to mark shellfish and identify hatchery shellfish without the use of artificial structures.

Otter predation is the largest factor in the paucity of clams. Predator exclusion devices such as those used in this project—PVC pipes, biodegradable cups, and Beal boxes—have proven to be effective ways to reduce predation and create a viable sanctuary for juvenile shellfish. Larger predator exclusion devices, such as large mesh netting, can be deployed over large sections of beach and provide protection for adult shellfish. In past shellfish enhancement efforts, APMI has successfully used large predator control netting at Port Graham and Tatitlek, which were successful in preventing otters from predating on adult clams and were maintained for longer than a decade (Brooks et al. 2001).

In conclusion, due to high otter activity, Chenega could benefit from employing larger-scale predator control netting on areas with the highest abundance of adult shellfish. This type of netting is low maintenance and easy to find on the beach. The predator control structures used in this project (PVC pipes, Beal boxes, and biodegradable cups) were effective for protecting juvenile clams and tracking growth rate and survival rate of juveniles in small quantities, while larger netting that can protect adults would be more effective for long-term conservation. Similar netting has been used in the Chugach region communities of Tatitlek and in Port Graham with great success. The netting prevents otters from predating on the shellfish but has a wide enough gauge to allow for normal shellfish feeding and spawning activity. This provides a protected pool of adult shellfish that can help repopulate the beach each season. In addition to predator control netting, APMI can continue to provide juvenile shellfish to help increase and reestablish local shellfish populations. Creating shellfish sanctuaries with predator control netting is important for long-term conservation but a sanctuary would remain vulnerable to inclement weather and changing ocean conditions such as ocean acidification and warming water. These conditions may not necessarily affect adult populations but can greatly affect the success of spawn events each year. Continued juvenile outplanting can help buffer poor spawning years and provide stability across population age classes.

Conclusion

As coastal climates and ecosystems continue to change, ongoing access to subsistence foods remains of the utmost importance. The reintroduction of juvenile shellfish is one possible solution to working toward sustainable populations of local wild foods. This study demonstrates the importance of working with local knowledge holders to identify suitable habitats for clam reintroduction, including variables like accessibility to local residents and challenges with predation. Habitat Suitability Index models for broader regional planning for all subsistence resources should actively incorporate traditional ecological knowledge to encompass the depth of information that can only be understood by extensive time on the land and waters of the Chugach region. The study team would like to thank the residents of Chenega who welcomed researchers to their community, shared a wealth of knowledge, and made invaluable contributions to this research.

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APPENDIX A: COOPERATIVE AGREEMENT (21-076)

Alaska Department of Fish and Game
Division of Administrative Services
P.O. Box 115526
Juneau, AK 99811-5526

Cooperative Agreement Number 21-076
Title: Understanding the Bottleneck for Recovery of Native Clams in Chenega's Subsistence Shellfish Use Areas

Between:
Alaska Department of Fish and Game
Division of Subsistence
and
Chenega IRA Council

I. AUTHORITY:

This agreement is entered into by and between the Alaska Department of Fish and Game, Division of Subsistence (hereinafter referred to as the "ADF&G" or the "Department") and the Chenega IRA Council.

This agreement is entered into under the authority of AS 36.30.850.b(20)

II. PURPOSE OF THE AGREEMENT:

This is a cooperative agreement between the Alaska Department of Fish and Game (ADF&G) Division of Subsistence and the Chenega IRA Council. The agreement outlines the Subsistence Division's responsibilities for the project "Understanding the Bottlenecks for Recovery of Native Clams in Chenega's Subsistence Shellfish Use Areas," funded by the U.S. Fish and Wildlife Service Tribal Wildlife Grants Program. The Chenega IRA Council is working on this project with the non-profit organization in the Chugach region that provides government-like natural resource services to the people of the region: the Chugach Regional Resources Commission (CRRC) and their Alutiiq Pride Shellfish Hatchery (APSH), as well as the ADF&G Division of Subsistence.

The Chenega IRA Council, CRRC and ADF&G are committed to developing a successful clam recovery program at Chenega. Project funding will support this work for three years: one year (2021) to conduct site selection, create a shellfish sanctuary, and analyze existing harvest data, and two years (2022 and 2023) of seeding and monitoring clams and collecting new qualitative customary and traditional use data from Chenega residents. The results of the initial field work will be used as the foundation for developing a shellfish management plan for the community. The process developed for Chenega can then be applied to other coastal, Tribal communities in Prince Williams Sound and other areas of Alaska that are dependent on shellfish as a traditional, subsistence food source.

ADF&G Subsistence staff have traveled to Chenega to conduct numerous subsistence surveys over the past four decades, and they are familiar with the community and residents. The Division's contribution to this project will include compiling existing subsistence clam harvest data, conducting qualitative research on the customary and traditional uses of clams in Chenega, assisting with habitat suitability mapping, and disseminating subsistence use information to the community of Chenega.

III. PROJECT OBJECTIVES:

The project objectives for ADF&G Division of Subsistence are related to project tasks 6 and 7. For project task 6, traditional knowledge and harvest mapping, ADF&G will assist with documenting traditional knowledge about clams and updating maps of harvest areas. For project task 7, habitat suitability mapping, the Division will create a habitat suitability index map to determine specific locations in the Chenega region that are most likely to increase the success rate of clam reintroduction.

IV. TERM OF THE AGREEMENT:

This Agreement shall begin May 1, 2021 and shall remain in effect through May 31, 2023.

V. COVENANTS OF THE ALASKA DEPARTMENT OF FISH AND GAME:

Task 6 of the project-ADF&G responsibility– Traditional knowledge and harvest mapping- The ADF&G Division of Subsistence will assist with documenting traditional knowledge about clams and updating maps of harvest areas using three methods: (1) compiling all available years of Chenega clam harvest data from the Community Subsistence Information System (CSIS - ttp://www.adfg.alaska.gov/sb/CSIS/), (2) conducting a series of key respondent interviews to document local knowledge and concerns about clams and habitat, and (3) updating digital maps with subsistence harvest areas.

The project timeline for task 6 is from May 2021- May 2022.

Products: (1) The Division of Subsistence will produce extracted clam harvest data for all available study years, and complete a single document that includes simple summary figures and narration. (2) Recorded key respondent interviews will be transcribed and provided to the Chenega IRA Council. Transcripts will be coded and summarized in a separate document to be incorporated in the final project report. (3) The Division will produce updated harvest area maps and provide digital copies.

Task 7 of the project-ADF&G responsibility – Habitat Suitability Mapping- The ADF&G Division of Subsistence will create a habitat suitability index map to determine specific locations in the Chenega region that are most likely to increase the success rate of clam reintroduction. Habitat suitability mapping is often used to determine species habitat requirements (Olsson and Rogers, 2009; Wilson et al, 2010; Elsaesser et al, 2012; Guisan and Zimmerman, 2000; Wilson et. Al. 2011). Habitat and environmental data are incorporated to create predictive species-specific landscape favorability models using Geographic Information Systems (GIS).

Timeline: The project timeline for task 7 is from May 2021- May 2023.

Measurables: A researcher will use GIS to incorporate temperature, salinity, water quality, and other relevant monitoring data collected on the beaches used for subsistence by Chenega residents.

Products: Using advanced spatial analysis techniques, the final Habitat Suitability Map will display color coded areas in the Chenega region that depict the level of suitability for clam reintroduction.

VI. COVENANTS OF CHENEGA IRA COUNCIL:

The Chenega IRA Council will assist with facilitating local and traditional knowledge interviews in Chenega. Additionally, CRRC will assist with travel logistics, planning and providing funding for the Local Research Assistants to help with the key respondent interviews and mapping, elder honorariums for the final report and community summaries.

VII. FINANCIAL CONSIDERATIONS:

Budget Table

Category	Task 6 Cost	Task 7 Cost	Total Budget
Personnel	$16,116.26	$9,957.02	$26,073.28
Travel	$0.00	$0.00	$0.00
Services	$0.00	$0.00	$0.00
Commodities	$0.00	$0.00	$0.00
Total Direct	$16,116.26	$9,957.02	$26,073.28
Indirect Rate - 22.01%	$3,547.19	$2,191.53	$5,738.72
Total Project	$19,663.45	$12,148.55	$31,812.00

Task 6 timeline: 5/1/21 to 5/31/22, 2022; Task 7 timeline: 5/1/21-5/31/23.
Any funds remaining from Task 6 will be used for Task 7.
Indirect is calculated on personnel services only.
The total amount of this agreement will total not more than $31,812.00

VIII. GENERAL PROVISIONS

1. Nothing in this agreement shall obligate any party in the expenditure of funds, or for future payments of money, in excess of appropriations authorized by law.

2. Each party agrees that it will be responsible for its own acts and omissions including those of its officers, agents, and employees for damages to property or injury to persons occasioned by each party's own acts or omissions in connection with the terms of this agreement.

3. Both parties agree to comply with all applicable federal or State laws regulating ethical conduct of public officers and employees.

4. Each party will comply with all applicable laws, regulations, and executive orders relative to Equal Employment Opportunity.

5. Nothing herein is intended to conflict with federal, state, or local laws or regulations. If there are conflicts, this agreement will be amended at the first opportunity to bring it into conformance with conflicting laws or regulations.

6. Policy and position announcements relating specifically to this cooperative program may be made only by mutual consent of the agencies.

7. The effective date of this agreement shall be May 1, 2021.

8. The termination date of this agreement shall be May 31, 2023. However, either party may terminate its participation in this agreement by providing to the other party notice in writing 30 days in advance of the date on which its termination becomes effective.

9. A free exchange of research and assessment data among agencies is encouraged and is necessary to ensure the success of these cooperative studies.

10. Chenega IRA Council and any agents or employees act in an independent capacity and not as officers, employees, or agents of the State in performance under this agreement.

11. This agreement may be amended by mutual written consent of the parties.

12. Chenega IRA Council, by signing this agreement, certifies that neither it, nor its principals or subcontractors, is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from federal financial assistance programs or activities.

13. Force Majeure: The parties to this contract are not liable for the consequences of any failure to perform, or default in performing, any of their obligations under this Agreement, if that failure or default is caused by any unforeseeable Force Majeure, beyond the control of, and without the fault or negligence of, the respective party. For the purposes of this Agreement, Force Majeure will mean war (whether declared or not); revolution; invasion; insurrection; riot; civil commotion; sabotage; military or usurped power; lightning; explosion; fire; storm; drought; flood; earthquake; epidemic; quarantine; strikes; acts or restraints of governmental authorities affecting the project or directly or indirectly prohibiting or restricting the furnishing or use of materials or labor required; inability to secure materials, machinery, equipment or labor because of priority, allocation or other regulations of any governmental authorities.

IX. APPROVING SIGNATURES

IN WITNESS WHEREOF, the parties hereto have caused this Cooperative Agreement to be executed as of the date of last signature below.

CHENEGA IRA COUNCIL

Buell Russell, GM

Buell Russell

3/17/21

Date

ALASKA DEPARTMENT OF FISH AND GAME

Lisa E. Olson

Lisa Olson, Division Operations Manager
Division of Subsistence

3-17-21

Date

Melissa Hill

Melissa Hill, Division Operations Manager
Division of Administrative Services

3/19/2021

Date

APPENDIX B: PERMITS (P-21-009, P-22-019)

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME

P.O. Box 115526
JUNEAU, ALASKA 99811-5526

Permit No. **P-21-009**

Expires: **8/30/2022**

AQUATIC RESOURCE PERMIT
(For Propagative/Research and Bioenhancement/Release Purposes)

This permit authorizes: **Jeff Hetrick**
(whose signature is required on page 3 for permit validation)
of
Alutiiq Pride Marine Institute
P.O. Box 369, Seward, AK 99631
(907)224-5181 jjh@seward.net

to conduct the following activities from **May 24, 2021** to **August 30, 2022** in accordance with AS 16.05.930, AS 16.05.340(b) and 5 AAC 41.600.

Purpose: This project is to conduct bioenhancement research to create a shellfish sanctuary. Broodstock will be collected in 2021, transported to Alutiiq Pride Marine Institute (APMI) and spawned. Juveniles will be planted in 2021-2023. Broodstock will be transplanted to sanctuary beach site after spawning.

Collection Location: Sawmill Bay within 20 miles of Crab Bay

Out-planting Location: Crab Bay

Species:

Species	Number and Life Stage	Destination	Release Number
Butter Clams	100 Adult	APMI for spawning/ Crab Bay for planting	100 adult and 100,000 Juveniles 5+ mm
	100 Adult	Crab Bay for planting	100 Adult
Littleneck Clams	100 Adult	APMI for spawning/ Crab Bay for planting	100 adult and 100,000 Juveniles 5+ mm
	100 Adult	Crab Bay for planting	100 Adult

Method of Collection: Hand collection

Disposition: Broodstock will be spawned and transferred to Crab Bay, sacrificed or donated to another permitted facility with adequate quarantine measures. Juveniles will be planted in Crab Bay. Any adults or juveniles remaining alive at the end of the permit effective period will be held under a subsequent permit, if issued, or destroyed as directed. See **Stipulations** section.

A COLLECTION REPORT IS DUE August 1, 2022 and a **COMPLETION REPORT IS DUE March 30, 2023**. See **Stipulations** section for more information. Data from such reports are considered public information. Reports must be submitted to the Alaska Department of Fish and Game, Division of Commercial Fisheries, PO Box 115526, Juneau, AK 99811-5526, attention Michelle Morris (907-465-4724; dfg.fmpd.permitcoordinator@alaska.gov). A report is required whether or not collecting activities were undertaken.

GENERAL CONDITIONS, EXCEPTIONS AND RESTRICTIONS

1. This permit must be carried by person(s) specified during approved activities who shall show it on request to persons authorized to enforce Alaska's fish and game laws. This permit is nontransferable and will be revoked or renewal denied by the Commissioner of Fish and Game if the permittee violates any of its conditions, exceptions or restrictions. No redelegation of authority may be allowed under this permit unless specifically noted.
2. This permit is for propagative research that requires maintaining live specimens for some amount of time after capture.
3. No specimens taken under authority hereof may be sold, bartered, or consumed. All specimens must be deposited in a public museum or a public scientific or educational institution unless otherwise stated herein. Subpermittees shall not retain possession of live animals or other specimens.
4. The permittee shall keep records of all activities conducted under authority of this permit, available for inspection at all reasonable hours upon request of any authorized state enforcement officer.
5. Permits will not be renewed until detailed reports, as specified in the Stipulation section, have been received by the department.

Permittee Initial ________x

<u>P-21-009</u> *continued (page 2 of 3)*

6. UNLESS SPECIFICALLY STATED HEREIN, THIS PERMIT DOES NOT AUTHORIZE the exportation of specimens or the taking of specimens in areas otherwise closed to hunting and fishing; without appropriate licenses required by state regulations; during closed seasons; or in any manner, by any means, at any time not permitted by those regulations.

<u>Authorization</u>:

Tom Taube 5/20/21	*Peter Bangs 5/24/21*
Deputy Director **Division of Sport Fish**	**Deputy or Assistant Director** **Division of Commercial Fisheries**

<u>Authorized Personnel</u>: The following personnel may participate in collecting activities under terms of this permit:

Jeff Hetrick, Lloyd Kompkoff, Boyd Kompkoff, Timmy Selanof Larry Evanoff, Maile Branson, Willow Hetrick-Price and Rodger Painter.

Employees and volunteers under the direct supervision of, and in the presence of, one of the authorized personnel listed above may participate in collecting activities under terms of this permit.

<u>Stipulations</u>:

1. **Ethan Ford** (Division of Commercial Fisheries, Homer, (907)235-8191, ethan.ford@alaska.gov) must be notified **prior** to you engaging in collecting or release activities. Division of Commercial Fisheries management biologists have the authority to specify methods for collecting, as well as limiting the collections of any species, and the number of specimens collected by time and area.

2. Permits will indicate the number of specimens that may be taken by species and life stage. Sampling or collecting activities must stop when the maximum allowable number of specimens is obtained. All live fish, shellfish, and aquatic plants collected in excess of the number specified on the permit must be released immediately and unharmed at the capture location, unless otherwise specified in the permit. All unintended mortalities must be recorded and returned to capture site waters.

3. Specimens collected under the authority of this permit are ONLY to be used for the purposes outlined in this permit.

4. Adult and juvenile holding tanks for this project must be clearly labeled and kept separate from any hatchery or farm stocks at APMI.

5. The permit number must be displayed on the holding tanks. All aquarium systems (open and closed) may be inspected by an ADF&G Fish Health Services Pathologist.

6. Any adults or juveniles in the Alutiiq Pride Marine Institute that have the possibility of being released in Crab Bay near Chenega must have their intake water filtered through a sand filter to reduce the possibility of incoming pathogens that may be released into a different area with transport.

7. The quarantine procedures listed must be followed at the Alutiiq Pride Marine Institute:
    a. Disinfection of transport containers with 100-ppm iodophor or 200-ppm bleach.
    b. Controlled access to the tanks either by separate room or visqueen barrier.
    c. Use of disinfectant footbath in the controlled access corridor (i.e., in the entryway).
    d. Use of separate utensils for clams.
    e. Disinfection of the effluent with ozone, bromine, or chlorine.

8. **Before release of juveniles, at least 30 clams must be submitted to the ADF&G Pathology lab for disease screening. Please contact the Fish Pathology Lab ((907)465-3577) for additional information.**

9. All unattended research gear must be labeled with the permittee's name, telephone number, and permit number. Any study gear must be installed and anchored sufficiently to withstand oceanographic conditions and monitored and maintained during the study period.

10. The establishment of structures beyond 14 days on state owned lands, including uplands, tidelands and submerged lands, requires an authorization from the Department of Natural Resources, Division of Mining, Land and Water (DMLW). Prior to the establishment of any rearing or testing structures please contact DMLW at (907) 269-8503 to discuss the authorization types and requirements.

Permittee Initial ________x

P-21-009 ***continued (page 3 of 3)***

11. Any specimens remaining alive at the end of the permit effective period will continue to be reared under subsequent ARPs, if issued, or destroyed as directed. Clams may be transferred to other permitted facilities with adequate quarantine measures in place.

12. Destroyed specimens must be double-bagged and placed in a sanitary landfill.

13. A copy of this permit, including any amendments, must be made available at all field collection sites and project sites for inspection upon request by a representative of the department or a law enforcement officer.

14. Issuance of this permit does not absolve the permittee from compliance in full with any and all other applicable federal, state, or local laws regulations, or ordinances.

15. **A report of collecting activities, referencing this aquatic resource permit, must be submitted 30 days before the expiration of this permit.** This report must summarize the number of all specimens, including bycatch, captured by date, location, depth of capture, species, size (weight and length where appropriate), age (where appropriate), sex, numbers, and the fate of those specimens. A report is required whether or not collecting activities were undertaken.

16. **A report of research activities, referencing this aquatic resource permit, must be submitted within 6 months after the expiration of this permit.** This report should present the research conducted in a format similar to a scientific paper including the following: introduction (objective of the study plan and hypothesis), methods, and results. The report is ad-hoc and intended to show that the specimens were used in a scientific method and allows for the evaluation of potential cumulative effects from multiple projects in the same area, but is not intended to be a full peer-reviewed scientific paper.

17. **Failure to comply with any of the above listed stipulations may result in the loss of all current and future permitting privileges.**

18. PERMIT VALIDATION requires permittee's signature and initial on all pages agreeing to abide by permit conditions before beginning collecting activities:

Annette Jarosz
Signature of Permittee

ecc: Ethan Ford, Matt Miller, Ted Meyers, Chris Habicht
CF Division Files
Alaska Wildlife Troopers– Chenega

Permittee Initial ________x

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
P.O. Box 115526
JUNEAU, ALASKA 99811-5526

Permit No. **P-22-019**

Expires: **9/30/2023**

AQUATIC RESOURCE PERMIT
(For Propagative/Research and Bioenhancement Purposes)

This permit authorizes:

Annette Jarosz
(whose signature is required on page 2 for permit validation)
of
Alutiiq Pride Marine Institute
P.O. Box 369, Seward, AK 99664
(443)878-0159 annette@alutiiqprideak.org

to conduct the following activities from **July 8, 2022** to **September 30, 2023** in accordance with AS 16.05.930, AS 16.05.340(b) and 5 AAC 41.600.

Purpose: This project is to develop hatchery techniques and continue bioenhancement research with hardshell clams in Chenega. Broodstock will be collected in 2022, transported to Alutiiq Pride Marine Institute (APMI) and spawned. Juveniles will be outplanted in fall 2022 through fall 2023 and monitored for survival.

Species: 200 adult littleneck clams (*Protothaqca staminea*), 200 adult cockles (*Clinocardium nuttallii*), 200 adult butter clams (*Saxidomus gigantea*) and out planting of 200,000 juveniles (3-5 mm) per species

Location: Chenega, Evan Island

Method of Collection: Hand collection.

Disposition: Broodstock will be sacrificed or donated to another permitted facility with adequate quarantine measures. Juveniles will be planted at Evan Island. Any adults or juveniles remaining alive at the end of the permit effective period will be held under a subsequent permit, if issued, or destroyed as directed. See **Stipulations** section.

A COLLECTION REPORT IS DUE September 1, 2023 and a **COMPLETION REPORT IS DUE March 30, 2024**. See **stipulations** section for more information. Data from such reports are considered public information. Reports must be submitted to the Alaska Department of Fish and Game, Division of Commercial Fisheries, PO Box 115526, Juneau, AK 99811-5526, attention Permit Coordinator (907-465-4724; dfg.fmpd.permitcoordinator@alaska.gov). A report is required whether or not collecting activities were undertaken.

GENERAL CONDITIONS, EXCEPTIONS AND RESTRICTIONS

1. This permit must be carried by person(s) specified during approved activities who shall show it on request to persons authorized to enforce Alaska's fish and game laws. This permit is nontransferable and will be revoked or renewal denied by the Commissioner of Fish and Game if the permittee violates any of its conditions, exceptions or restrictions. No redelegation of authority may be allowed under this permit unless specifically noted.
2. This permit is for propagative research that requires maintaining live specimens for some amount of time after capture.
3. No specimens taken under authority hereof may be sold, bartered, or consumed. All specimens must be deposited in a public museum or a public scientific or educational institution unless otherwise stated herein. Subpermittees shall not retain possession of live animals or other specimens.
4. The permittee shall keep records of all activities conducted under authority of this permit, available for inspection at all reasonable hours upon request of any authorized state enforcement officer.
5. Permits will not be renewed until detailed reports, as specified in the Stipulation section, have been received by the department.
6. UNLESS SPECIFICALLY STATED HEREIN, THIS PERMIT DOES NOT AUTHORIZE the exportation of specimens or the taking of specimens in areas otherwise closed to hunting and fishing; without appropriate licenses required by state regulations; during closed seasons; or in any manner, by any means, at any time not permitted by those regulations.

Tom Taube 7/8/2022	Peter Bangs 7/7/2022
Deputy Director	**Deputy or Assistant Director**
Division of Sport Fish	**Division of Commercial Fisheries**

P-22-019 ***continued (page 2 of 3)***

Authorized Personnel: The following personnel may participate in collecting activities under terms of this permit:

Annette Jarosz, Emily Mailman, Jeff Hetrick, Jaqueline Ramsey, Jennifer Wells, Maile Branson and Michael Mahmood.

Employees and volunteers under the direct supervision of, and in the presence of, one of the authorized personnel listed above may participate in collecting activities under terms of this permit.

Stipulations:

1. **Ethan Ford** (Division of Commercial Fisheries, Homer, (907)235-8191, ethan.ford@alaska.gov) must be notified **prior** to you engaging in collecting and release activities. Division of Commercial Fisheries management biologists have the authority to specify methods for collecting, as well as limiting the collections of any species, and the number of specimens collected by time and area.

2. Permits will indicate the number of specimens that may be taken by species and life stage. Sampling or collecting activities must stop when the maximum allowable number of specimens is obtained. All live fish, shellfish, and aquatic plants collected in excess of the number specified on the permit must be released immediately and unharmed at the capture location, unless otherwise specified in the permit. All unintended mortalities must be recorded and returned to capture site waters.

3. Specimens collected under the authority of this permit are ONLY to be used for the purposes outlined in this permit.

4. The permit number must be displayed on the holding tanks. All aquarium systems (open and closed) may be inspected by an ADF&G Fish Health Services Pathologist.

5. The quarantine procedures listed must be followed at the Alutiiq Pride Marine Institute:
    a) Disinfection of transport containers with 100-ppm iodophor or 200-ppm bleach.
    b) Controlled access to the tanks either by separate room or visqueen barrier.
    c) Use of disinfectant footbath in the controlled access corridor (i.e., in the entryway).
    d) Use of separate utensils for species.
    e) Disinfection of the effluent with ozone, bromine, or chlorine.

6. Any adults or juveniles in the Alutiiq Pride Marine Institute that have the possibility of being released at Evan Island near Chenega must have their intake water filtered through a sand filter to reduce the possibility of incoming pathogens that may be released into a different area with transport.

7. **Before release of juveniles, at least 30 clams must be submitted to the ADF&G Pathology lab for disease screening. Please contact the Fish Pathology Lab ((907)465-3577) for additional information.**

8. The permit number must be displayed on the holding tanks. All aquarium systems (open and closed) may be inspected by an ADF&G Fish Health Services Pathologist. Adult and juvenile holding tanks for this project must be clearly labeled and kept separate from any hatchery or farm stocks.

9. Any specimens remaining alive at the end of the permit effective period will continue to be reared under subsequent ARPs, if issued, or destroyed as directed. The permit holder must apply for an ARP by September 1, 2023 if there are plans to continue to hold live specimens. Specimens may be transferred to other permitted facilities with adequate quarantine measures.

10. Destroyed specimens must be double-bagged and placed in a sanitary landfill.

11. The establishment of structures beyond 14 days on state owned lands, including uplands, tidelands and submerged lands, may require authorization from the Department of Natural Resources, Division of Mining, Land and Water (DMLW). Prior to the establishment of any rearing or testing structures please contact DMLW at (907) 269-8503 to discuss the authorization types and requirements.

12. A copy of this permit, including any amendments, must be made available at all field collection sites and project sites for inspection upon request by a representative of the department or a law enforcement officer.

13. Issuance of this permit does not absolve the permittee from compliance in full with any and all other applicable federal, state, or local laws regulations, or ordinances.

<u>P-22-019</u> *continued (page 3 of 3)*

14. **A report of collecting activities, referencing this aquatic resource permit, must be submitted 30 days before the expiration of this permit.** This report must summarize the number of all specimens, including bycatch, captured by date, location, depth of capture, species, size (weight and length where appropriate), age (where appropriate), sex, numbers, and the fate of those specimens. A report is required whether or not collecting activities were undertaken.

15. **A report of research activities, referencing this aquatic resource permit, must be submitted within 6 months after the expiration of this permit.** This report should present the research conducted in a format similar to a scientific paper including the following: introduction (objective of the study plan and hypothesis), methods, and results. The report is ad-hoc and intended to show that the specimens were used in a scientific method and allows for the evaluation of potential cumulative effects from multiple projects in the same area, but is not intended to be a full peer-reviewed scientific paper.

16. **Failure to comply with any of the above listed stipulations may result in the loss of all current and future permitting privileges.**

17. PERMIT VALIDATION requires permittee's signature agreeing to abide by permit conditions before beginning collecting activities:

Annette Jarosz

Signature of Permittee

ecc: Ethan Ford, Matt Miller, Ted Meyers, Chris Habicht
CF Division Files
Alaska Wildlife Troopers – Seward

APPENDIX C: COOPERATIVE AGREEMENT (22-110)

Alaska Department of Fish and Game
Division of Administrative Services
P.O. Box 115526
Juneau, AK 99811-5526

Cooperative Agreement Number 22-110
Title: Chenega Shellfish Recovery: Joint Publication by ADF&G and CRRC

Between:
Alaska Department of Fish and Game
Division of Subsistence
and
Chugach Regional Resource Commission

I. AUTHORITY:

This agreement is entered into by and between the Alaska Department of Fish and Game, Division of Subsistence (hereinafter referred to as the “ADF&G” or the “Department”) and the Chugach Regional Resource Commission (hereinafter referred to as “CRRC”).

ADF&G enters into this agreement under the authority of AS 36.30.850.d.

II. PURPOSE OF THE AGREEMENT:

The Chugach Regional Resources Commission (CRRC) and Alaska Department of Fish and Game (ADF&G) Division of Subsistence have been working with the Chenega IRA Council on a project titled "Understanding the Bottlenecks for Recovery of Native Clams in Chenega's Subsistence Shellfish Use Areas." The original project was funded by the U.S. Fish and Wildlife Service Tribal Wildlife Grants Program. Due to the scope of habitat, mapping, and ethnographic work, CRRC and ADF&G determined it was necessary to publish a larger technical paper for the project than was budgeted in the original project proposal. CRRC is able to provide funding for ADF&G to publish a full technical paper and project summary on shellfish recovery in Chenega, where ADF&G staff will serve as lead authors and publications specialists, while CRRC staff will contribute as coauthors. The resulting technical paper will serve as the final project report (due January 28, 2024) and an ADF&G Technical Paper that will be publicly available through the ADF&G publications database.

III. PROJECT OBJECTIVES:

The sole objective for the scope of this agreement is to produce a full technical paper and corresponding summary that outlines methods, results, and conclusions for the project "Understanding the Bottlenecks for Recovery of Native Clams in Chenega's Subsistence Shellfish Use Areas." The original project objectives that will be detailed in the final technical paper are:

(1) Compile existing clam harvest data to understand changes in clam harvest and use;
(2) Document traditional knowledge about clams among Chenega residents, and compile existing TEK on clams;
(3) Produce maps of clam harvest areas near Chenega, including current harvest areas, and a habitat suitability index map to determine locations most likely to support successful clam reintroduction; and
(4) Develop and refine hatchery culture and shellfish sanctuary techniques for butter and littleneck clams.

IV. TERM OF THE AGREEMENT:

This Agreement shall begin on the date of the final signature, and shall remain in effect through January 31, 2024.

V. COVENANTS OF THE ALASKA DEPARTMENT OF FISH AND GAME:

The ADF&G Division of Subsistence will serve at the lead author on this joint publication, and facilitate regular discussions among coauthors to assist with writing, formatting, and formalizing joint conclusions. An ADF&G publications specialist will ensure that tables, figures, and writing are standardized and meet ADF&G publications standards. The ADF&G Division of Subsistence research director will review the publication for technical merit. Finally, the ADF&G publications specialist will also facilitate report and project summary printing and distribution.

VI. COVENANTS OF CHUGACH REGIONAL RESOURCES COMMISSION:

CRRC staff member Jeff Hetrick will serve as second author on the paper and contribute to all sections related to clam reintroduction in Chenega, as well as the joint introduction and conclusion sections. CRRC executive director Willow Hetrick will assist with reviewing drafts of the publication, and with distributing final results.

VII. PROJECT POINTS OF CONTACT:

ADF&G, Div. of Subsistence:

Cheryl Park, Administrative Officer II
1300 College Rd., Fairbanks, AK 99701
Phone: 907-459-7321
Email: Cheryl.Park@alaska.gov

Jacqueline Keating, Subsistence Resource Specialist III
333 Raspberry Rd., Anchorage, AK 99518
Phone: 907-267-2368
Email: Jacqueline.Keating@alaska.gov

CRRC:

Willow Hetrick, Executive Director
PO Box 111686, Anchorage, AK 99511
Phone: 907-224-5181
Email: willow@crrcalaska.org

Jeff Hetrick, Mariculture Director
101 Railway Ave., Seward, AK 99664
Phone: 907-224-5181
Email: jjh@seward.net

VIII. FINANCIAL CONSIDERATIONS:

CRRC will remit a one-time payment totaling $23,887.00 to ADF&G as per the below budget table. Payment shall be made within 30 days of the final signature on this agreement.

STATE FISCAL YEAR:				FY24	July 1, 2023 - June 30, 2024				
PERSONAL SERVICES									
Employee Name	*PCN*	*Job Class*	*Location*	*Months-Inc OT*	*Months w/20% Hol/Lv*	*Monthly Salary*	*Monthly Benefits*	*Monthly Cost*	*Total Salary + Benefits*
Keating, Jackie	11-0413	SRS III	Anchorage	0.25	**0.30**	$5,837	$3,586	$9,423	**$2,827**
Neufeld, Gayle	11-0401	RA III	Anchorage	0.25	**0.30**	$6,836	$3,932	$10,768	**$3,230**
Lamb, Mary	11-0433	PUB TECH II	Anchorage	1	**1.20**	$5,003	$3,297	$8,300	**$9,960**
Brown, Caroline	11-0435	RPM	Fairbanks	0.15	**0.20**	$9,710	$4,926	$14,636	**$2,927**
TOTAL SALARIES & BENEFITS:								FY24	**$18,945**

CONTRACTUAL	FY24	July 1, 2023 - June 30, 2024				
All unit costs are linked to those in row G		0			N/A	
Description	***Quantity***	***Unit Cost***	***Total***	***Quantity***	***Unit Cost***	***Total***
Stipends:						
Local Key Respondent (LKR) interviews		$100	**$0**		$100	**$0**
Local Research Assistant (LRA)-LKR assistance		$25	**$0**	0	$25	**$0**
LRA surveys		$50	**$0**		$50	**$0**
LRA training/meetings		$200	**$0**		$200	**$0**
Local translator services		$200	**$0**		$200	**$0**
Printing:						
4-page summary	30	$3	**$90**		$3	**$0**
Community summaries						
Reports	6	$25	**$150**			
Other:						
ATV rental		$200	**$0**		$200	**$0**
Space rental		$200	**$0**		$200	**$0**
Non-cash reward fund (incentive) drawing		$100	**$0**		$100	**$0**
Subcontract:			**$0**			**$0**
			$0			**$0**
TOTAL:			**$240**			**$0**
TOTAL CONTRACTUAL:						**$240**

SUPPLIES	FY24					
		0			N/A	
Description	***Quantity***	***Unit Cost***	***Total***	***Quantity***	***Unit Cost***	***Total***
Office and field supplies	0	$25	**$0**		$100	**$0**
Fuel:ATVs and participant observation		$250	**$0**		$250	**$0**
Food/Beverages for meetings		$50	**$0**		$50	**$0**
			$0			**$0**
			$0			**$0**
TOTAL			**$0**			**$0**
TOTAL SUPPLIES:						**$0**

TOTALS	FY24
TOTAL PERSONAL SERVICES ONLY:	**$18,945**
TOTAL NON-PERSONAL SERVICES:	**$240**
TOTAL DIRECT CHARGES:	**$19,185**
TOTAL INDIRECT: RATE: 24.82%	**$4,702**
YEARLY TOTAL (DIRECT + INDIRECT):	**$23,887**
	$23,647

IX. GENERAL PROVISIONS

1. Nothing in this agreement shall obligate any party in the expenditure of funds, or for future payments of money, in excess of appropriations authorized by law.

2. Each party agrees that it will be responsible for its own acts and omissions including those of its officers, agents, and employees for damages to property or injury to persons occasioned by each party's own acts or omissions in connection with the terms of this agreement.

3. Both parties agree to comply with all applicable federal or State laws regulating ethical conduct of public officers and employees.

4. Each party will comply with all applicable laws, regulations, and executive orders relative to Equal Employment Opportunity.

5. Nothing herein is intended to conflict with federal, state, or local laws or regulations. If there are conflicts, this agreement will be amended at the first opportunity to bring it into conformance with conflicting laws or regulations.

6. Policy and position announcements relating specifically to this cooperative program may be made only by mutual consent of the agencies.

7. The effective date of this agreement shall be the date of the final signature.

8. The termination date of this agreement shall be January 31, 2024. However, either party may terminate its participation in this agreement by providing to the other party notice in writing 30 days in advance of the date on which its termination becomes effective.

9. A free exchange of research and assessment data among agencies is encouraged and is necessary to ensure the success of these cooperative studies.

10. CRRC and any agents or employees act in an independent capacity and not as officers, employees, or agents of the State in performance under this agreement.

11. This agreement may be amended by mutual written consent of the parties.

12. CRRC by signing this agreement, certifies that neither it, nor its principals or subcontractors, is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from federal financial assistance programs or activities.

13. Force Majeure: The parties to this contract are not liable for the consequences of any failure to perform, or default in performing, any of their obligations under this Agreement, if that failure or default is caused by any unforeseeable Force Majeure, beyond the control of, and without the fault or negligence of, the respective party. For the purposes of this Agreement, Force Majeure will mean war (whether declared or not); revolution; invasion; insurrection; riot; civil commotion; sabotage; military or usurped power; lightning; explosion; fire; storm; drought; flood; earthquake; epidemic; quarantine; strikes; acts or restraints of governmental authorities affecting the project or directly or indirectly prohibiting or restricting the furnishing or use of materials or labor required; inability to secure materials, machinery, equipment or labor because of priority, allocation or other regulations of any governmental authorities.

X. APPROVING SIGNATURES

IN WITNESS WHEREOF, the parties hereto have caused this Cooperative Agreement to be executed as of the date of last signature below.

CHUGACH REGIONAL RESOURCES COMMISSION

Willow Hetrick-Price

Willow Hetrick, Executive Director

8/30/2022

Date

ALASKA DEPARTMENT OF FISH AND GAME

DocuSigned by:
Lisa Olson
06321B959A4543D...

Lisa Olson, Division Operations Manager
Division of Subsistence

8/30/2022

Date

DocuSigned by:
Melissa Hill
D2F69C89D91540F...

Melissa Hill, Deputy Director
Division of Administrative Services

8/30/2022

Date

DocuSign

Certificate Of Completion

Envelope Id: 632F288E6D95429BAE0FDC2233B7D158		Status: Completed
Subject: Please DocuSign: Coop #22-110 partly signed.pdf		
Source Envelope:		
Document Pages: 5	Signatures: 2	Envelope Originator:
Certificate Pages: 4	Initials: 0	Jed Smith
AutoNav: Enabled		PO Box 110206
EnvelopeId Stamping: Disabled		Juneau, AK 99811
Time Zone: (UTC-09:00) Alaska		jed.smith@alaska.gov
		IP Address: 136.226.55.32

Record Tracking

Status: Original 8/30/2022 9:50:38 AM	Holder: Jed Smith jed.smith@alaska.gov	Location: DocuSign
Security Appliance Status: Connected	Pool: StateLocal	
Storage Appliance Status: Connected	Pool: State of Alaska	Location: DocuSign

Signer Events	Signature	Timestamp
Lisa Olson lisa.olson@alaska.gov Security Level: Email, Account Authentication (None)	DocuSigned by: Lisa Olson 06321B959A4543D... Signature Adoption: Pre-selected Style Using IP Address: 66.58.150.13	Sent: 8/30/2022 9:51:59 AM Viewed: 8/30/2022 12:43:08 PM Signed: 8/30/2022 12:44:44 PM
Electronic Record and Signature Disclosure: Accepted: 5/9/2022 4:03:30 PM ID: 1751cd52-de7e-4b72-b157-f93cc99206cc Company Name: State of Alaska		
Melissa Hill Melissa.Hill@alaska.gov Deputy Director, Administrative Services Alaska Department of Fish & Game Security Level: Email, Account Authentication (None)	DocuSigned by: Melissa Hill D2F69C89D91540F... Signature Adoption: Uploaded Signature Image Using IP Address: 10.7.161.17	Sent: 8/30/2022 12:44:45 PM Viewed: 8/30/2022 1:35:47 PM Signed: 8/30/2022 1:35:56 PM
Electronic Record and Signature Disclosure: Accepted: 6/9/2022 9:55:54 PM ID: 17697fd9-d25d-4f7c-859e-66807ae8edc2 Company Name: State of Alaska		

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	8/30/2022 9:51:59 AM
Certified Delivered	Security Checked	8/30/2022 1:35:47 PM
Signing Complete	Security Checked	8/30/2022 1:35:56 PM
Completed	Security Checked	8/30/2022 1:35:56 PM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

Electronic Record and Signature Disclosure created on: 3/31/2020 10:41:05 PM
Parties agreed to: Lisa Olson, Melissa Hill

ELECTRONIC RECORD AND SIGNATURE DISCLOSURE

Please read this Electronic Records and Signature Disclosure (ERSD). It concerns your rights regarding electronically undertaking, and the conditions under which you and the State of Alaska agree to electronically undertake, the transaction to which it relates (the "TRANSACTION").

Consent to Electronically Undertake the TRANSACTION

You can electronically undertake the TRANSACTION only if you confirm that you meet the following requirements by selecting the box next to "I agree to use electronic records and signature" (the "AGREE BOX"):

1. you can fully access and have read this ERSD;
2. you can fully access all of the information in the other TRANSACTION records;
3. you can retain all of the TRANSACTION records in a form that you will be able to fully access for later reference;
4. you consent to undertake the TRANSACTION electronically; and
5. you are authorized to undertake the TRANSACTION. (Please note that falsely undertaking the TRANSACTION may subject you to civil liabilities and penalties and/or to criminal penalties.)

If you cannot or are not willing to confirm each of these five things, do not select the AGREE BOX.

Withdrawing Consent

If you select the AGREE BOX, you can withdraw your consent to electronically undertake the TRANSACTION at any time before you complete the TRANSACTION: simply do not finalize it. The only consequence of withdrawing your consent is that you will not finalize the TRANSACTION.

If you select the AGREE BOX, your consent will apply only to this TRANSACTION. You must separately consent to electronically undertake any other transaction with the State of Alaska.

Paper Option for Undertaking the TRANSACTION

You may undertake the TRANSACTION with the State of Alaska using paper records. (State of Alaska employees who want to undertake the TRANSACTION in paper should contact the agency responsible for the TRANSACTION.) Print the paper records on the website of the State of Alaska agency responsible for the TRANSACTION, or request them from the agency. The State of Alaska homepage is at http://alaska.gov/.

Copies of TRANSACTION Records

After completing the TRANSACTION but before closing your web browser, you should download the TRANSACTION records. Or you can download the records within 30 days after completing the TRANSACTION using the link in the DocuSign email sent to the email address you used to complete the TRANSACTION. The State of Alaska will not provide a paper copy of the TRANSACTION records as part of the TRANSACTION. Under the Alaska Public Records Act (APRA), AS 40.25.100–.295, you can request a copy from the agency responsible for the TRANSACTION, but if too much time has passed, the agency may no longer have the records when you make your request. If required under the APRA, the agency will charge a fee.

Required Hardware and Software

For the minimum system requirements to electronically undertake the TRANSACTION, including accessing and thereby retaining the TRANSACTION records, visit https://support.docusign.com/guides/signer-guide-signing-system-requirements. These requirements may change. In addition, you need access to an email account.

How to Contact the State of Alaska

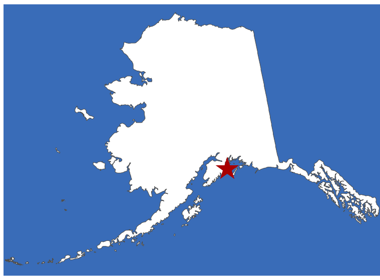
To ask a question on this ERSD or the DocuSign document generated after you complete the TRANSACTION or on using DocuSign to electronically undertake the TRANSACTION, contact the Alaska Department of Administration at either of the following addresses:

State of Alaska
Department of Administration
550 West 7th Avenue
Suite 1970
Anchorage, AK 99501
Reference: DocuSign

doa.commissioner@alaska.gov
Subject: DocuSign

To ask any other question on the TRANSACTION records or to update the information for contacting you electronically, contact the State of Alaska agency responsible for the TRANSACTION using the contact information in the TRANSACTION records or, if those records contain no contact information, using the contact information on the agency's website. Again, the State of Alaska homepage is at http://alaska.gov/.

APPENDIX D: PROJECT SUMMARY



COMMUNITY SUMMARY - Technical Paper No. 498

Chenega

Clam Reintroduction in Chenega, Alaska: A Mixed-Methods Approach to Recovery. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 498. Published 2024.

By Jacqueline M. Keating, Gayle P. Neufeld, Annette Jarosz, and Jeff Hetrick.

Project Overview

Clams are important subsistence resources for residents of the Prince William Sound (PWS) community of Chenega, but local shellfish populations throughout the sound have been in decline. The goal of this project was to inform a shellfish management plan with baseline information focused on identifying suitable beaches for clam reintroduction; collecting environmental data on beaches identified as potential quality clam habitat; documenting spawning behavior, recruitment, growth, and survival of clams in a shellfish sanctuary; and complementing biological information with traditional ecological knowledge (TEK) of clam habitat and harvest practices. This was a multidisciplinary effort by staff from Chugach Regional Resources Commission's Alutiiq Pride Marine Institute (APMI), the Alaska Department of Fish and Game Division of Subsistence, the Chenega IRA Council, and community members. Together, the project team documented TEK from key respondents about clams and habitat near Chenega and mapped harvest areas; created a Habitat Suitability Index (HSI) model for clam habitat in western PWS; placed hatchery-reared clams at a shellfish sanctuary site; and collected environmental data to inform future shellfish management. Results demonstrate the ongoing importance of clams to Chenega residents, the potential of incorporating TEK into HSI models, challenges with predator control in clam reintroduction efforts, and the success of hatchery-reared clam production.

Highlights of Clam Use and Harvest

Household survey data demonstrate the long-term use of clams over four decades in Chenega. With the exception of the three years immediately following the 1989 *Exxon Valdez* oil spill, at least 65% of Chenega households used clams in every study year except the most recent one (2014). Additionally, at least one-third of households harvested clams in every year outside of 1989–1991 (Figure 1). As is typical with subsistence harvest and use data, the percentage of households using clams is consistently higher than the percentage harvesting due to harvesters sharing with other households.

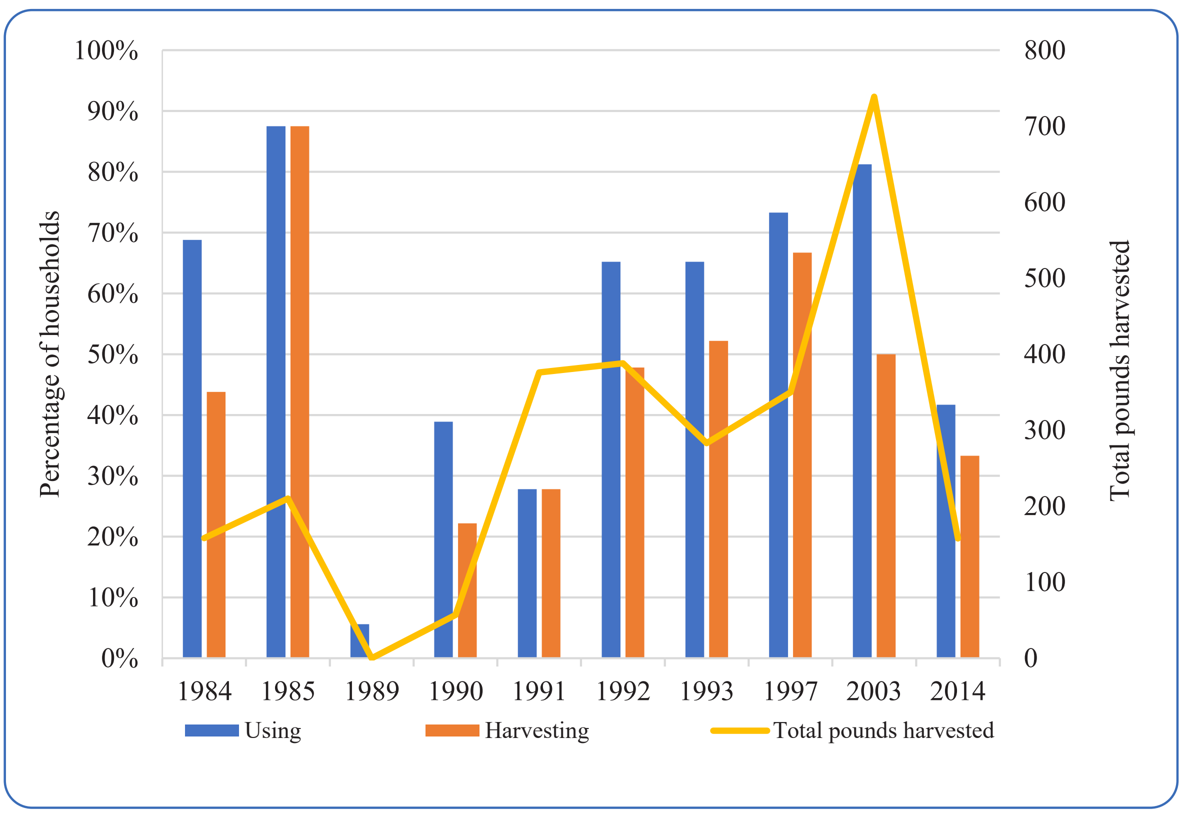


Figure 1.–Percentage of households using and harvesting clams and total pounds harvested, Chenega, 1984–1985, 1989–1993, 1997, 2003, and 2014.

> *" Usually it's just a pair of boots and a headlamp because we go at nighttime when the slack tide is like, six-plus or something. We get way down there and we dig holes all night long. "*

Traditional Ecological Knowledge (TEK) and Validating the Habitat Suitability Index (HSI) Model

During interviews to collect TEK regarding harvesting clams, many key respondents spoke fondly of how clam harvesting was an accessible activity that did not require specialized equipment. Respondents also stressed the importance of harvesting clams during large minus tides. Harvest areas were also identified on maps by key respondents. Figure 2 depicts where harvests of butter clams and unspecified species of clams have occurred in recent years as well as suitable habitat identified through creating an HSI model. Results of the model show a high level of agreement between suitable habitat and the areas used by residents of Chenega for harvesting clams.

Photo by Jacqueline M. Keating, ADF&G

Photo by Annette Jarosz, APMI

Top: Juvenile clams produced at APMI hatchery from broodstock that were large enough to be outplanted at Airport Beach.

Bottom: PVC pipes containing juvenile clams planted at Airport Beach.

Producing Clams at the Hatchery

- Due to low abundance, fewer broodstock clams were collected than desired to produce spawn at the hatchery; despite that challenge, it was determined that the goal numbers of sufficient-sized juvenile clams to outplant at the sanctuary were achieved from three out of four sets of broodstock clams (photo: top left).
- APMI successfully spawned and reared juvenile butter (*Saxidomus gigantea*) and Pacific littleneck (*Leukoma staminea*) clams in a truncated period of time (12 months) compared to past hatchery operations (16 months) by increasing water temperature and feed frequency and diversity.

Where to find the report?

The full report is available online:
www.adfg.alaska.gov/techpap/TP498.pdf

Paper copies available at
Chenega IRA Council office

Shellfish Sanctuary

The location of the shellfish sanctuary was first informed by local knowledge that Chenega residents shared. It was important to reintroduce clams in a location that was both accessible to local residents for harvesting and suitable habitat for clams. The sanctuary site was located in Crab Bay, in the area referred to as Airport Beach. For both butter and Pacific littleneck clams, the beaches in Crab Bay were determined by the HSI model to be suitable habitat, with much of the shoreline determined by the model to be highly suitable for both species. No area was determined to be unsuitable habitat for butter clams based on the parameters of the model, whereas 17% of the area was determined to be unsuitable habitat for Pacific littleneck clams.

To complement local knowledge and the HSI model results, APMI and a community member conducted additional assessments and measurements of the beach characteristics, such as observations of seaweed, shellfish predators, and presence of shellfish. Also, water temperature, salinity, and substrate measurements were gathered.

Substrate analysis showed a relatively consistent ratio of coarse-to-fine sediments from higher tide lines (1.5 ft) to lower tide lines (-1.4 ft). Each sampled transect line had a majority composition of gravel and low rates of fine sand. The beach survey results showed that all transect areas are suitable for Pacific littleneck and butter clam survival with a slight preference toward butter clams due to low fine-sediment rates.

Researchers concluded that predation risk was high at Airport Beach. Otter predation is the largest factor in the paucity of clams. Local residents were concerned that predation by otters in particular was reducing shellfish populations. Therefore, a portion of outplanted juvenile clams were contained in predator control structures: PVC pipes or Beal boxes (photo: bottom left). Whereas use of physical structures that retained hatchery shellfish in a singular location enabled APMI staff to identify hatchery clams and measure those for mortality and growth, this method was not representative of the mortality and growth rate of all the shellfish outplanted on the beach; the vast majority of outplanted juveniles were not in predator control structures and therefore are expected to have had different mortality rates. This project highlighted the need for larger-scale predator control efforts, such as netting on the beach.

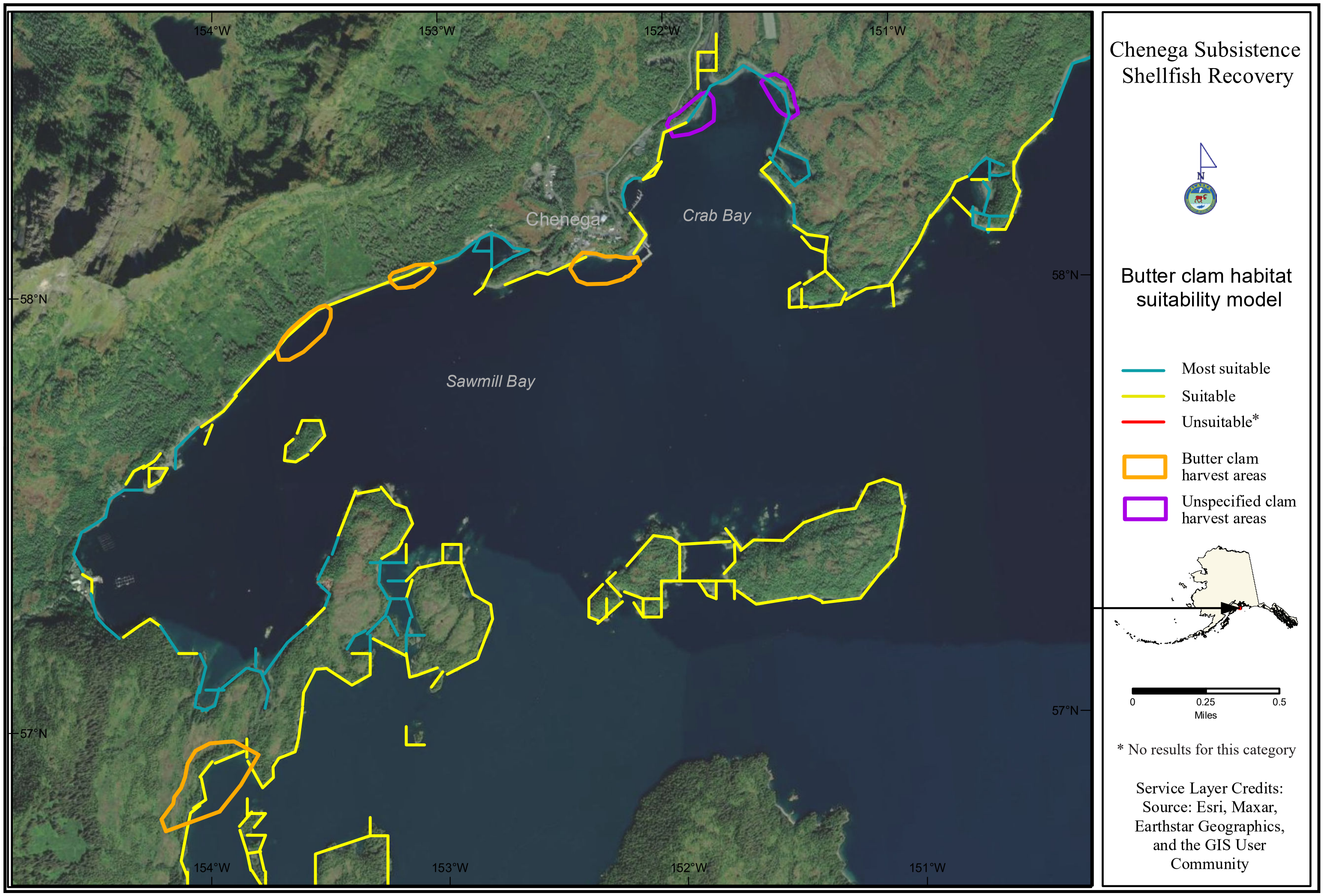


Figure 2.–HSI model results showing habitat suitability in Sawmill Bay area for butter clams, and harvest areas for butter clams and unspecified clams.

"Sometimes you'll see the tongues out or when we're just walking down, we'll see them spraying."

Photo by Jacqueline M. Keating, ADF&G

Photo by Jacqueline M. Keating, ADF&G

"We also give to elders. Because either they can't go themselves, or they don't want to ask younger members to go. So, it's always nice just to check in – 'Do you need something? Got you these.'"

ADF&G Division of Subsistence and Chugach Regional Resources Commission's Alutiiq Pride Marine Institute (APMI)

Jacqueline M. Keating
ADF&G
333 Raspberry Road
Anchorage, AK 99518
907-267-2353

Gayle P. Neufeld
ADF&G
333 Raspberry Road
Anchorage, AK 99518
907-267-2317

Annette Jarosz
APMI
101 Railway Ave.
Seward, AK 99664
907-224-5181

Jeff Hetrick
APMI
101 Railway Ave.
Seward, AK 99664
907-224-5181

ADF&G complies with OEO requirements as posted at http://www.adfg.alaska.gov/index.cfm?adfg=home.oeostatement.

APPENDIX E: SAMPLE SURVEY FORM FROM 2014 STUDY YEAR

HARVESTS: MARINE INVERTEBRATES

HOUSEHOLD ID

1. Do you or members of your household USUALLY attempt to harvest marine invertebrates?... Y N

2. During the last year (between January 1, 2014 and December 31, 2014) did you, or members of your household USE or TRY TO HARVEST marine invertebrates?... Y N

IF the answer to QUESTION 2 is NO, go to the *NEXT PAGE* .

IF the answer is *YES* , continue on this page …

Please estimate how many marine invertebrates ALL MEMBERS OF YOUR HOUSEHOLD HARVESTED in 2014. INCLUDE marine invertebrates you gave away, ate fresh, fed to dogs, lost to spoilage, or got by helping others. If harvesting with others, report ONLY YOUR SHARE of the harvest.

	In 2014 did members of your household …					In 2014 HOW MANY _____ DID YOUR HOUSEHOLD HARVEST….		
	USE?	TRY TO HARVEST?	HARVEST?	RECEIVE?	GIVE AWAY?	AMOUNT	UNITS	COMMENTS
Read names below	(circle)					(amt)	specify	(text)
BUTTER CLAMS	Y N	Y N	Y N	Y N	Y N		GAL.	
500602000								
RAZOR CLAMS	Y N	Y N	Y N	Y N	Y N		GAL.	
500612000								
LITTLENECK CLAMS	Y N	Y N	Y N	Y N	Y N		GAL.	
500608000								
PINKNECK (SURF) CLAMS	Y N	Y N	Y N	Y N	Y N		GAL.	
500610000								
HORSE CLAMS (GAPER)	Y N	Y N	Y N	Y N	Y N		GAL.	
500606000								
UNKNOWN CLAMS	Y N	Y N	Y N	Y N	Y N		GAL.	
500699000								
DUNGENESS CRAB	Y N	Y N	Y N	Y N	Y N		IND.	
501004000								
KING CRAB	Y N	Y N	Y N	Y N	Y N		IND.	
501008000								
TANNER CRAB, BAIRDI *(SNOW CRAB)*	Y N	Y N	Y N	Y N	Y N		IND.	
501012020								
UNKNOWN CRABS	Y N	Y N	Y N	Y N	Y N		IND.	
501099000								
COCKLES	Y N	Y N	Y N	Y N	Y N		GAL.	
500899000								
WEATHERVANE SCALLOPS	Y N	Y N	Y N	Y N	Y N		GAL.	
502602000								

Include ALL the marine invertebrates HARVESTED by members of this household in 2014.

MARINE INVERTEBRATES: 08 **CHENEGA BAY: 82**

HARVESTS: MARINE INVERTEBRATES

HOUSEHOLD ID

…continued from previous page

Read names below	In 2014 did members of your household … USE? (circle)	TRY TO HARVEST?	HARVEST?	RECEIVE?	GIVE AWAY?	In 2014 HOW MANY _____ DID YOUR HOUSEHOLD HARVEST…. AMOUNT (amt)	UNITS specify	COMMENTS (text)
MUSSELS 502099000	Y N	Y N	Y N	Y N	Y N		GAL.	
BLACK BIDARKIS (CHITONS) 500408000	Y N	Y N	Y N	Y N	Y N		GAL.	
RED (LARGE) BIDARKIS 500404000	Y N	Y N	Y N	Y N	Y N		GAL.	
SEA URCHIN 503200000	Y N	Y N	Y N	Y N	Y N		GAL.	
SHRIMP 503400000	Y N	Y N	Y N	Y N	Y N		LBS.	
OCTOPUS 502200000	Y N	Y N	Y N	Y N	Y N		IND.	
SNAILS 503600000	Y N	Y N	Y N	Y N	Y N		GAL.	
LIMPETS 501800000	Y N	Y N	Y N	Y N	Y N		GAL.	
SEA CUCUMBER 503099000	Y N	Y N	Y N	Y N	Y N		GAL.	
WHELK 504000000	Y N	Y N	Y N	Y N	Y N		GAL.	
	Y N	Y N	Y N	Y N	Y N			
	Y N	Y N	Y N	Y N	Y N			
	Y N	Y N	Y N	Y N	Y N			
	Y N	Y N	Y N	Y N	Y N			

Include ALL the marine invertebrates HARVESTED by members of this household in 2014.

HARVESTS: MARINE INVERTEBRATES

HOUSEHOLD ID

…continued from previous page

Read names below	In 2014 did memers of your household … USE? (circle)	TRY TO HARVEST?	HARVEST?	RECEIVE?	GIVE AWAY?	In 2014 HOW MANY _____ DID YOUR HOUSEHOLD HARVEST…. AMOUNT (amt)	UNITS specify	COMMENTS (text)
	Y N	Y N	Y N	Y N	Y N		GAL.	
	Y N	Y N	Y N	Y N	Y N		GAL.	
	Y N	Y N	Y N	Y N	Y N		GAL.	
	Y N	Y N	Y N	Y N	Y N		GAL.	
	Y N	Y N	Y N	Y N	Y N		GAL.	

Include ALL the marine invertebrates HARVESTED by members of this household in 2014.

ASSESSMENTS: MARINE INVERTEBRATES

500000000

Between January 1, 2014 and December 31, 2014…

To conclude our marine invertebrates section, I am going to ask a few general questions about marine invertebrates.

Last year…

… did your household use LESS, SAME, or MORE marine invertebrates than in recent years? ………………………………………… X L S M

IF LESS or MORE … X = do not use

WHY was your use different? ______________________ 1

______________________ 2

Last year…

…did your household GET ENOUGH marine invertebrates?……………………………………………………………………… Y N

If NO…

What KIND of marine invertebrates did you need? ______________________

How would you describe the impact to your household of not getting enough marine invertebrates last year? *… not noticable? (0)* *… minor ? (1)* *… major? (2)* *… Severe? (3)*

Think back to about ten years ago (2004). Would you say that *BIDARKIES (CHITONS)* available to harvest in this area are less, the same, or more than ten year ago? L S M

If not the same, why? ______________________ 1

______________________ 2

Do you think the *BIDARKIES (CHITONS)* from your traditional harvest areas are safe to eat?…………………………………… Y N

If NOT safe, why? ______________________ 1

______________________ 2

Think back to about ten years ago (2004). Would you say that *CLAMS* available to harvest in this area are less, the same, or more than ten year ago? L S M

If not the same, why? ______________________ 1

______________________ 2

Do you think the *CLAMS* from your traditional harvest areas are safe to eat?…………………………………………………… Y N

If NOT safe, why? ______________________ 1

______________________ 2

APPENDIX F: KEY RESPONDENT INTERVIEW PROTOCOL

Key Respondent Interview Protocol

The objective of this project is to develop and refine hatchery culture and shellfish sanctuary techniques for butter and littleneck clams, so they can be used to help population recovery to support traditional and subsistence food practices for Chenega and other villages and coastal communities throughout Alaska. The ADF&G Division of Subsistence will document traditional knowledge about clams and clam habitat by conducting key respondent interviews and updating digital maps with subsistence harvest areas.

Location of interview:

Key respondent name:

Interviewer name:

Date of interview:

Start time:

BACKGROUND INFORMATION

Year and place of birth:

Parents residence when born:

How many total years have you lived in Chenega?

-What brought you here (if applicable)

What do you do here/role in community/profession/etc.?

How old were you when you first started gathering clams for subsistence?

Who taught you how to gather clams?

LOCAL KNOWLEDGE OF CLAMS USED FOR SUBSISTENCE

What types of clams do you normally gather for subsistence? What are their local names?

What time of the year do you gather clams?

Which types of clams are most common?

Do you eat all the species you find?

What do they do with them? Consume fresh, steamed, frozen?

What is the favorite way to eat them?

How do you gather clams? What gear do you use?

What is their average harvest/catch per unit effort (# of clams for hour, or bucket in a tide)?

At what locations do you gather clams for subsistence?

-Are the clamming locations different depending on the species?

-Have your clamming locations changed over time?

Do you think clam populations have changed? Are they more abundant or less abundant?

-Are the changes you have observed isolated to specific beaches? Or is it more general?

-What do you think are the causes of these changes?

USING AND SHARING CLAMS

Do you share the subsistence clams you gather with other households?

Do other households share their subsistence clams with you?

How have levels of clam use changed over time in Chenega?

-If so, what is the most important factor that prohibits your clam harvest: Scarcity, Shellfish Safety, access, replaced with other food source?

Are younger generations continuing to participate in harvesting and processing subsistence clams?

Do you have any concerns about PSP?

-If so, would you benefit from regular PSP testing in your area?

CLAM HABITAT

How would you describe the ideal clam habitat?

Where is the best clams habitat located currently?

Has clam habitat change occurred? When? Where? Why?

Has the rate of change been slow or rapid? How many years/decades have you witnessed the changes taking place?

Have certain habitat changes increased or decreased clam abundance? Where? When?

What have you observed regarding the health of other marine resource populations and their habitats?

Have you observed any changes in the weather or climate over the years? What, when and where?

Have you observed any changes in marine water temperatures?

Have you redirected your efforts towards pursuing different resources because of any of these changes?

MAPPING

What was the level of harvest? [[Low = 0-5 gallons, medium = 6-25 gallons, high = 26 or more]

How did you access the area?

What changed?

THANK YOU FOR YOUR TIME!

STOP TIME: _______________

APPENDIX G: CODEBOOK FOR TRANSCRIBED KEY RESPONDENT INTERVIEWS

Codebook: Chenega Clam Recovery KRIs

Name	Description
Clam habitat	Comments related to clam habitat near Chenega
Changes in marine water temperatures	Observations of changes over time in marine waters and adjacent streams
Changes in weather and climate	Observations of changes in patterns over time including temperature, rain and snowfall, and wind
Clam health	Observations on health of individual clams including quality of meat and shell
Clam habitat changes	General thoughts on whether local habitat has changed over respondent's lifetime
Ideal clam habitat	Descriptions of local habitat best suitable for clams including substrate and access
Local location of best habitat	Descriptions and names of local beaches best suited for clams
Other general observations on marine resources	Including abundance and health of other marine resources including otters, salmon, nonsalmon fish, and marine mammals
Redirecting efforts due to habitat changes	Mention of changing search and harvest areas due to changes in habitat
Habitat Mapping	Comments related to GIS mapping activities
Accessing area	Context on access methods including walking, driving, and nature of access depending on season
Level of harvest	Respondents' definitions of high, medium, and low levels of harvest

Name	Description
Local name of location	Information on local names of beaches and reasons for names
Learning to Gather Clams	Comments related to learning how to gather clams
Younger generations	Comments on younger generations learning to harvest, and reasons for participation
How did you learn	Information on how respondents learned to gather, at what age, and who taught them
Local Knowledge of Clams used for Subsistence	Local and traditional knowledge of clams, habitat, harvesting, and processing
Catch per unit Effort	Comments on amounts harvested in one effort and reasons for amount
Changes in clam populations over time	General observations of changes in the number of clams around Chenega, including reasons for change
Consuming Clams	Preferred methods of preparing and consuming clams, and details on methods
Primary Clam Gathering Locations	Knowledge related to primary clams gathering locations near the village
Process for Gathering Clams	Methods for gathering clams including what to look for, tools used, tide, and processing
Time of Year for Gathering Clams	Local knowledge on time of year for gathering, and reasons
Types of Clams Gathered for Subsistence	Descriptions and local names of different clam species, including reasons for preferences between species
Role in Community	Descriptions of community life and roles respondents play

Name	Description
Using and Sharing Clams	Context on using and sharing clams throughout the community
Sharing	Comments related to sharing clams and associated values
Levels of clam use over time	Comments on trends in use of clams over times, and reasons for trends
PSP Concerns	Concern (or lack of concern) for PSP, and effects on harvest practices
PSP Testing	Thoughts or concerns related to PSP testing, and effects on harvest practices