

Cook Inlet Razor Clam Study, 2014

by

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and

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February 2015

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Mathematics, statistics	
centimeter	cm	Alaska Administrative Code	AAC	<i>all standard mathematical signs, symbols and abbreviations</i>	
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H_A
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	e
hectare	ha	at	@	catch per unit effort	CPUE
kilogram	kg	compass directions:		coefficient of variation	CV
kilometer	km	east	E	common test statistics	(F, t, χ^2 , etc.)
liter	L	north	N	confidence interval	CI
meter	m	south	S	correlation coefficient	
milliliter	mL	west	W	(multiple)	R
millimeter	mm	copyright	©	correlation coefficient (simple)	r
		corporate suffixes:		covariance	cov
Weights and measures (English)		Company	Co.	degree (angular)	$^\circ$
cubic feet per second	ft ³ /s	Corporation	Corp.	degrees of freedom	df
foot	ft	Incorporated	Inc.	expected value	E
gallon	gal	Limited	Ltd.	greater than	>
inch	in	District of Columbia	D.C.	greater than or equal to	\geq
mile	mi	et alii (and others)	et al.	harvest per unit effort	HPUE
nautical mile	nmi	et cetera (and so forth)	etc.	less than	<
ounce	oz	exempli gratia (for example)	e.g.	less than or equal to	\leq
pound	lb	Federal Information Code	FIC	logarithm (natural)	ln
quart	qt	id est (that is)	i.e.	logarithm (base 10)	log
yard	yd	latitude or longitude	lat. or long.	logarithm (specify base)	log ₂ , etc.
		monetary symbols (U.S.)	\$, ¢	minute (angular)	'
Time and temperature		months (tables and figures): first three letters	Jan,...,Dec	not significant	NS
day	d	registered trademark	®	null hypothesis	H_0
degrees Celsius	°C	trademark	™	percent	%
degrees Fahrenheit	°F	United States (adjective)	U.S.	probability	P
degrees kelvin	K	United States of America (noun)	USA	probability of a type I error (rejection of the null hypothesis when true)	α
hour	h	U.S.C.	United States Code	probability of a type II error (acceptance of the null hypothesis when false)	β
minute	min	U.S. state	use two-letter abbreviations (e.g., AK, WA)	second (angular)	"
second	s			standard deviation	SD
Physics and chemistry				standard error	SE
all atomic symbols				variance	
alternating current	AC			population sample	Var
ampere	A			sample	var
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				

REGIONAL OPERATIONAL PLAN SF.2A.2014.12

Cook Inlet Razor Clam Study, 2014

by

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Division

February 2015

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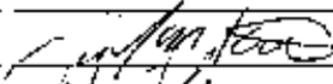
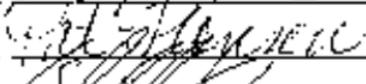
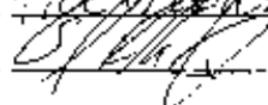
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ABSTRACT

Pacific razor clam *Siliqua patula* studies along eastern Cook Inlet will be conducted in 2014 to estimate clam digger distribution, clam harvest and relative digger success by beach, age and length composition of the harvest, and abundance at the Ninilchik South beach and Clam Gulch beaches. In 2013 and 2014 emergency orders restricted the razor clam sport and personal use fisheries on eastside beaches because of the combination of lowered abundance trends, low recruitment and reduction of the number of broods on the Ninilchik beaches.

Keywords: razor clams, Cook Inlet, eastside beaches, Ninilchik, Clam Gulch, abundance, age, length, digger success.

INTRODUCTION

Beaches along the east side of Cook Inlet (Figure 1) provide the largest sport fishery for the Pacific razor clam, *Siliqua patula* (Dixon) in Alaska. This fishery is confined primarily to an 81 km section of beach bounded by the Kasilof River to the north and the Anchor River to the south.

The Alaska Department of Fish and Game (ADF&G) began monitoring this clam population in 1965 following the 1964 earthquake that caused subsidence of beaches in the Cook Inlet Area (Nelson unpublished). Initial studies included creel surveys, digger distribution surveys, and length-at-age analyses (Nelson unpublished). Annual digger distribution and proxy length and age of harvested clams are ongoing. Since 1977, annual harvest and effort has have been estimated with the Statewide Harvest Survey (SWHS) (Mills 1979-1980, 1981a-b, 1982-1994, Howe et al. 1995, 1996, 2001 a-d, Walker et al. 2003, Jennings et al. 2004, 2006a-b, 2007, 2009 a-b, 2010 a-b and 2011 a-b; Jennings et al In prep a-b). The average annual harvest and effort from 1977 to 2012 was 797,522 and 30,527 respectively. Harvest has been apportioned by beach since 1977 using digger distribution estimates. Clam abundance was first estimated by Szarzi (1991). Szarzi estimated mean density (number per m²), total abundance, and age and length composition of the population for Clam Gulch and Ninilchik beaches, and performed a catch-age analysis (CAGEAN) for Clam Gulch with data collected in 1988 and 1989. The data required for the catch-age analysis included harvest and age composition by beach, auxiliary information such as abundance, instantaneous fishing mortality, and estimates of natural mortality (Deriso et al. 1985, 1989). Clam density and abundance and length and age composition of the population were estimated for Clam Gulch again in 1990 (Athons 1992), 1999 (Szarzi et al. 2010) and 2008 (Szarzi and Hansen 2009). Density and abundance and length and age composition of the population at Ninilchik were estimated in 1990 through 1993, 1998, 2001, 2003, 2005, 2011, 2012, and 2013 (Szarzi 1991, Athons 1992, Athons and Hasbrouck 1994, Szarzi et al. 2010, Szarzi and Hansen 2009, and Kerkvliet et al. *in prep*).

The annual participation (digger days) and razor clam harvest peaked in 1994 (Figure 2). The 2012 harvest was the lowest reported since the inception of the SWHS. The 1977-2003 average number of razor clam harvested per digger averaged approximately 29 clams dropped to a 16 clam average from 2004-2012. Use patterns since 1977 have changed; Clam Gulch received an average of 59% of the total annual effort from 1977-1985 (Athons and Hasbrouck 1994). Ninilchik has been consistently more popular than Clam Gulch since 1986, and since 2006 over 60% of the area harvest has been taken from the Ninilchik Beach (Table 1).

Shifts in effort and harvest are likely due to changes in abundance of clams among beaches and to the changes in availability of larger clams at Ninilchik (Athons 1992, Athons and

Hasbrouck 1994, Szarzi et al. 2010). The growth rate is greater in the southern beaches resulting in clams that are larger at age at Ninilchik than at Clam Gulch (Nelson unpublished, Szarzi et al. 2010). Diggers shifted south to Ninilchik to take advantage of the larger clams found there through 1995. The average size of clams in department samples at Ninilchik declined after 1994; likely the result of new year-classes recruiting to harvestable size. The smaller average size of clams at Ninilchik was probably the impetus for diggers moving back to Clam Gulch after 1995. In 2005, a new age class appeared in large numbers in the Clam Gulch beach in conjunction with a die off of older, larger-sized clams coinciding with a decline in digger effort there and an increase at Ninilchik beaches and beaches south of Ninilchik. Lower than average growth rates at beaches between Set Net Access and Coho beaches including Clam Gulch beach between 2005-2007 depressed clam sizes extending the period that diggers dug elsewhere to avoid small clams. From 2004-2012, the trend reversed again as more diggers moved from Clam Gulch back to Ninilchik and for the first time also more diggers moved south to Whiskey Gulch and Happy Valley.

Harvest estimates by beach are more precise after 1989 because more flights were conducted each year to estimate digger distribution. Harvest rates were 60% and 43% for exploitable sized clams (clams >80 mm) on the Ninilchik beach in 1989 and 1990 (Szarzi 1991), respectively, raised concerns about over-exploitation of Ninilchik clams. Harvest rate declined to 17% in 1991 (Athons 1992) and 16% for 1992 (Athons and Hasbrouck 2004) as clams in the 1988 year class grew to harvestable size. The harvest rate increased to 30% in 1998 (Szarzi et al. 2010) because the 1988 year class was no longer present on the beaches in significant numbers. The harvest rate was 26% in 2001, 14% in 2003 (Szarzi et al. 2010) and 16% in 2005 (Szarzi 2009), perhaps due to the decline in harvest coupled with the appearance of another year class in the harvestable sized population. Potential over-exploitation continued to be a concern at Ninilchik because exploitation periodically exceeded recruitment. In contrast, harvest rates on the northern beaches at Clam Gulch have been relatively low ranging from approximately 3% to 12% during the four years (1988, 1989, 1999, and 2008) when rates were estimated.

A new and very large year class from broodyear (BY) 2007 appeared in large numbers in the Ninilchik beach in 2009-2010. On November 17, 2010 large numbers of dead razor clams were reported washed up along the Ninilchik beach. In 2011 razor clam abundance was estimated on the Ninilchik North and South beach to assess impact of the recently observed die-off, through a cooperative agreement between department staff and Alaska Pacific University (APU) staff and students. In 2011, razor clam abundance was the highest on record (~1.7M) for the Ninilchik South beach and exploitation was the lowest. In 2012 and 2013, abundance was again estimated for the Ninilchik South beach and the abundance dropped to ~790K in 2012 then to ~200K in 2013. Recruitment to the Ninilchik beaches has been poor following the large recruitment event from BY2007 with most of the harvested supported by one year class. The combination of poor recruitment, drop in the number of broods on the Ninilchik beaches from an average of 9 broods from 1990-2005 to an average of 5 broods from 2006-2013, and reduced abundance has raised concerns.

In 2013, trends of lowered abundances coupled with low recruitment and reduction of the number of broods on the Ninilchik beaches prompted managers to reduce the bag and possession limit to the first 25 clams for all eastside beaches beginning May 23, 2013 by emergency order (EO). During the 2013 fishery, interview data and anecdotal reports

indicated reduction in razor clam abundance may be occurring along all eastside Cook Inlet beaches, though most pronounced on the Ninilchik beaches. Also aerial surveys flown to estimate digger effort among all eastside beaches did not detect a shift in effort from Ninilchik to the other beaches. As a result, in 2014 an EO was issued that closed the Ninilchik beaches to the harvest and clams and the bag and possession limit was set to the first 25 clams dug for the remaining eastside beaches.

The trends observed for Ninilchik beaches has prompted managers to expand abundance sampling to include Clam Gulch. Furthermore, harvest success surveys will be conducted to provide a method for apportioning harvest between eastside beaches.

OBJECTIVES

1. Estimate the proportion of digger effort and the number of razor clams harvested at five beaches such that the estimates by beach are within the levels of precision give below 95% of the time:

Beach	Relative Precision (%)	
	Effort	Harvest
Whiskey Gulch	9	25
Happy Valley	4	23
Ninilchik	CLOSED	
Oil Pad	7	24
Clam Gulch	6	16
Cohoe	9	25

2. Estimate the harvest of razor clams by age at Cohoe, Clam Gulch, and Oil Pad Access such that absolute precision of the estimated harvest for any age on any beach is within 2,800 clams 90% of the time.
3. Estimate the age composition of razor clams on Ninilchik Beach such that estimates are within 5 percentage points of the true value 92.5% of the time.
4. Estimate the abundance of razor clams on a section of the Ninilchik South Beach such that the estimate is within 32% of the true value 90% of the time.
5. Estimate the abundance of razor clams on a section of the Clam Gulch Beach such that the estimate is within 20% of the true value 90% of the time.
6. Estimate relative digger success at Cohoe, Clam Gulch, Set Net Access, Happy Valley, and Whiskey Gulch.

TASKS

1. Estimate mean length-at-age for the major age classes.
2. Collect 150 ageable clams from Deep Creek and Whisky Gulch beach.
3. Assess spatial distribution and abundance of razor clams using ArcGIS mapping software for Ninilchik South Beach and Clam Gulch Beach (north and south).

STUDY DESIGN

ESTIMATED HARVEST BY BEACH

Five beaches along the east side of the Kenai Peninsula will be sampled for this project: Whiskey Gulch, Happy Valley, Ninilchik, Oil Pad Access, Clam Gulch, and Cohoe (Figure 1). Although the Ninilchik beach is closed to harvest, sampling will continue for age composition. Clam Gulch is divided into three sub-beaches: Tower to Bluff, Bluff to A-frame, and A-frame to South Extension, for a total of ten sampling sites. The Ninilchik Bar is located off the main beach between Deep Creek and the Ninilchik River and is only available to diggers on foot when the tide is lower than minus three feet. Lehman's is the first set of set net cabins that are located approximately 5.2 km north of the Ninilchik River. A beach access road is also present at this location. Set Net Access refers to a beach access road, located approximately 13.7 km south of the Clam Gulch access road. The Clam Gulch Tower is a communications tower, which is located on the bluff above the beach approximately 3.2 km south of the Clam Gulch Access Road. Bluff refers to a section of non-vegetated bluff located approximately 0.4 km south of Clam Gulch. The A-Frame is a set net cabin located approximately 1.6 km north of Clam Gulch. Southern Extension refers to where the southern extension of Cohoe Loop Road turns inland away from the bluff approximately 6.4 km north of Clam Gulch.

Harvest by beach will be estimated using total harvest from the Statewide Harvest Survey, apportioned to beach using relative numbers of diggers per beach. Digger counts will be adjusted by a relative digger success rate for each beach based on the estimates derived from digger interview survey conducted in 2014. Estimates will be calculated for each of two tidal strata and then combined. The first strata will include tides ranging from -1.0 to -2.9 feet and the second will include tides of -3.0 feet and lower. In 2014, between April 1 and late August 15, 40 tides will be from -1.0 through -2.9 ft and 24 tides will be -3.0 ft or lower. A total of 14 flights will be made in 2013: 7 flights with tides of -1.0 through -2.9 ft and 7 flights with tides of -3.0 ft and lower (Table 2, Appendix A). Therefore, a digger count will be scheduled for approximately every $40/7 = 6^{\text{th}}$ tide ranging from -1.0 through -2.9 ft and every $24/7 = 3.4$ (3^{rd} or 4^{th}) tide of -3.0 ft and lower. Within each stratum, the tides selected for surveys will be over the entire season including shoulder (April and August) and peak (May-July) seasons and will include both weekday and weekend surveys. Although there are additional groupings of surveys within each stratum, only the tide strata will be used to apportion harvest by beach.

Data from aerial surveys of beaches in 2013 and overall estimates of razor clam harvest from 2012 (Jennings et al. 2009 a-b, 2010 a-b, 2011 a-b and in prep) were used to calculate expected levels of precision for 2014 (Table 2). Estimates are expected to meet the precision criteria in Objective 1.

Age composition has been estimated since 1977 on the east side beaches (Nelson unpublished). Six beaches will be sampled for age composition in 2014: Cohoe, Clam Gulch, Oil Pad Access, and Ninilchik, Deep Creek, and Whisky Gulch. Assuming 14 aerial counts will be conducted; sampling a minimum of 300 ageable clams per beach will achieve the absolute precision levels specified in Objective 2 and Objective 3 (Table 3). Szarzi (1991) recommended 300 clams be sampled per beach to estimate age composition and mean length-at-age for the major age classes with adequate precision for use in catch-age analysis, should such an analysis be conducted.

ESTIMATED ABUNDANCE - NINILCHIK SOUTH BEACH

The Ninilchik South beach study area begins at the southern edge of the Ninilchik River mouth and extends 1.6 km south and is bounded by the gravel's edge at the top (east) and Cook Inlet at the bottom (west). The study area is divided into a 5x26 grid with 5 locations running north to south (perpendicular to the water line) and 26 stratum running east to west (parallel to the water line, Figure 3). Sample sites are located within each of the 130 grid cells. The sample sites are rectangular areas 5.53 m long by 0.79 m wide and within a site there are 7 possible 0.5 m² circular plots.

Abundance will be estimated independently for each stratum using a two-stage sampling design. The primary units are sites and the secondary units are plots within a site (Figure 3).

The first sample site, located within Location 1, Stratum 1, will be chosen randomly, all subsequent samples will be chosen systematically. Randomization for the first site will take place both parallel and perpendicular to the shoreline. Starting in the NW corner of the study area, the location of the first site will be determined by the intersection of two randomly chosen points; the first being a randomly chosen point along a 278 m line parallel to the shoreline and the second being a randomly chosen point along a 15.2 m line perpendicular to the shoreline. Subsequent samples will be taken systematically every 227 m along the line parallel to the beach (north to south) and every 15.2 m perpendicular to the beach (west to east).

At least three and up to seven 0.5 m² circular plots will be sampled at each sampling site. The number of plots sampled per site will depend on the tidal range, the rate at which the tide falls, and the beach substrate.

A systematic random sample will be used instead of a random sample because of the sampling time limitations due to tides and difficulty moving the pump long distances. The assumption is made that the systematic random sample can be treated as a simple random sample for the calculation of variance.

This same sample design was used to estimate abundance of razor clams from 2011-2013. Data collected in 2011 and 2012 was used to estimate the number of sites per stratum needed to meet the objective criteria of the razor clam abundance estimate. In 2011, 3 sites were sampled per stratum and the abundance and relative precision of the abundance estimate for the south beach was estimated to be 28%. A Monte Carlo simulation was used to add sites to each stratum and the abundance and relative precision was recalculated after each addition. Using this method we estimated that sampling 5 sites per stratum on Ninilchik South beach (maximum of 130 total sites, 390 – 910 total plots) would give an estimate with a relative precision of 20%, but in reality the relative precision was higher (23%). When the 2012 data collected by ADF&G was combined with the data collected by APU, the abundance estimate, having sampled 10 sites per stratum, had a relative precision of 17%. In 2013, ADF&G and APU again sampled 10 sites, but relative precision increased to 23%. The increase is attributed to the combination of low abundances and patchy distribution of razor clams.

In 2014, we expect the relative precision to be similar to 2013 using 5 sites. ArcGIS® will be used to assess spatial distribution and abundance of razor clams on Ninilchik South beach. This assessment will allow for possible post stratification of the sampling to improve the abundance estimate and its variance.

ESTIMATED ABUNDANCE - CLAM GULCH BEACH

The Clam Gulch beach study area will encompass the aerial survey Clam Gulch north (A-Frame at Lat. 60° 15.699 N to the Bluffs at 60° 14.405 N) and south (Bluffs at 60° 14.405 N to Clam Gulch Tower 60° 13.020 N) beach sections. Methods will be identical to those described above for the Ninilchik South Beach.

ESTIMATED DIGGER SUCCESS

Digger success is not the same among all five beaches along the east side of the Kenai Peninsula. When apportioning out the harvest based on effort this variation in digger success among beaches must be considered. Digger interviews will be used to estimate digger success. On a single day (July 14) several technicians will be sent to each of the five beaches approximately 1 hour before low tide. Technicians will attempt to interview every exiting digger. The interview will consist of 3 questions:

1. Were you digging clams?

If the answer to question 1 was yes then the following two questions will also be asked:

2. How many clams did you dig?
3. How long did you spend digging?

The estimate of relative success (among beaches) assumes that success does not change through time.

Before 2009, digger success was not estimated but was based on biological intuition and was considered a constant. Digger success was estimated in 2009 and 2013 (Table 4)

DATA COLLECTION

ESTIMATED HARVEST BY BEACH:

Aerial counts of clam diggers will be used to estimate proportion of diggers by beach following the project schedule (Appendix A). Since the Ninilchik beaches are closed, no diggers are expected to be counted in this area; however, if diggers are observed they will be counted and harvest estimated. Days when flights cannot be made will be rescheduled on a similar tide level. Counts will be made of the specific beach areas as outlined in the aerial survey data sheet (Appendix B). The count will originate at Anchor River within ± 15 minutes of low water at Deep Creek/Ninilchik and proceed north. As it is impossible to distinguish diggers from non-diggers, all persons associated with digging activity will be included in the count, even those traveling along the beach on all-terrain vehicles. Persons in highway vehicles and those associated with commercial fishing activities will not be included.

Age and size composition will be estimated from clams hand dug from the six specified beaches. Samplers will walk throughout the beach area in a manner that mimics an average clam digger, rather than sampling from a relatively small specific area of beach. All clams dug will be retained regardless of size or condition, in compliance with State regulation.

Samples will be dug at Clam Gulch Beach between one quarter mile south to one half mile north of the access road. Oil Pad Access Beach will be sampled with half of the specimens obtained from the northern end and the other half obtained from the southern end of the beach. Half of the Ninilchik Beach sample will be dug south of the Ninilchik River. The

second half of the Ninilchik sample will be dug north of the Ninilchik River. Additional clams will be taken from the Ninilchik Bar. Clams will be sampled from the northern end of Deep Creek beach within 2 miles of the Deep Creek access. Whisky Gulch samples will be dug 1 mile south of Stariski Creek.

A total of 350 clams will be dug at each beach to estimate age, total length, and length-at-age. At the Ninilchik Bar a total of 175 clams will be taken; at Coho, Deep Creek and Whisky Gulch beaches a total of 150 clams will be taken. Clams dug on the subsections of beach will be kept separate (Appendix C). This level of sampling will ensure that the target of 300 samples will be met by compensating for breakage in processing. As only one shell is required from each clam for measuring and aging, a clam with one unbroken shell can be utilized. Total length will be measured as closely as possible from clams that are broken and not ageable. Clams will be processed by removing the body from the shell, separating the two halves of the shell, retaining one half for aging and measuring, and bleaching the specimens to remove the periostracum to facilitate aging. Shells will be soaked in a 25% or 50% household bleach solution depending on shell size until most of the periostracum is removed but the heavy layers along the annuli remain. Shells less than 80 mm will be soaked in the weaker solution to prevent over bleaching. The bleach solution will then be poured off, the shells rinsed in water and dried for aging and measuring. Bags with clam shells for aging will be labeled with date collected, beach location, and number of shells. Overall length and length at each annulus will be measured to the nearest 0.01 mm and input directly into an Excel spreadsheet using Mitutoyo Digimatic Calipers.

Aging of each shell will follow methods described by Nelson (unpublished) following the recommendations of Coggins (1994). Three “expert” agers have established a training set of 150 razor clam shells collected in 2000 from Clam Gulch Beach and Ninilchik Beach. That age set has been supplemented with clams aged by experts in 2002 and 2003. The training set was aged three times by each expert to determine the modal age of the clam for each reader. Once a neophyte ager attains an 80% repeatability on the training set (Coggins 1994:19), the shells collected in 2014 will be aged by a veteran ager.

Age will be determined for by the veteran ager. Because ages have been consistent for the veteran ager, fifty percent of the shells (every other clam) will be aged at least two times. In the event a new ager is identified all shells will be re-aged. Each reading of each shell will be independent: after determining age for the entire sample, the shells will be rearranged and age determined again so that the ager has no idea of the age assigned to any shell during a previous examination. Any previous age determination will be unknown to the ager each time a sample is aged. The age of a clam will be considered final when the ages from two independent readings agree and the measurements of the annuli for each of the two readings are within ± 2 mm of one another.

Time permitting, the technician that initially aged the shells in the training set will re-age the shells in the training set following the procedure detailed here. This approach will allow minimizing between-reader variability in comparing age composition with that of previous agers and evaluation of within-reader variability. Age composition will be estimated by using the age of each sample from the two readings. If two readings of the shell aren't the same, those shells will be aged again.

ESTIMATED ABUNDANCE BY BEACH:

Sampling to estimate abundance of razor clams at the Ninilchik South Beach and Clam Gulch Beach (north and south) will occur on days listed in Appendix D1. On a given day of sampling, all sites within a location will be sampled. Locations will be numbered from north to south and the order in which they are sampled will be scheduled to ensure that different tide height across the entire sample area (Figure 5; Appendix D1). The first sample site for a given survey beach, located within Location 1, Stratum 1, will be chosen randomly and all subsequent samples will be taken systematically (Appendix D2). After sampling 3-7 plots at the first site in Location 1, Stratum 1, the remaining sites within Location 1 (stratum 2–26) will be sampled every 15.2 m perpendicular to the beach (west to east). For all subsequent sampling days the location all sample sites will be 227 m south of the previous sample. If a sample site falls within a known coal seam with no razor clam habitat, the site will be moved approximately 100 m further south. On each sampling day the first sampling site will be located using a GPS and the coordinates listed in Appendix D2. Data will be entered on the data sheets in Appendix D3. Existing state equipment will be used to sample 3 locations on the Ninilchik South Beach and 7 locations on the Clam Gulch Beach (Figure 6; Appendix D1)

In addition to the sampling planned by the Department, students and staff from APU will provide additional sampling. Alaska Pacific University equipment will be used to sample 2 location on the Ninilchik South Beach and 3 locations on the Clam Gulch Beach (Appendix D2).

Both ADF&G and APU sampling equipment will consist of a 4-cycle Honda pump with 30 m of firehose on the inlet (output) side and 12 m of stiff plastic hose on the outlet (intake) side (Figure 3). The outlet hose has a metal tube or "wand" attached to direct the flow of water into the substrate enclosed by a 0.5 m² sampling ring. This sampling equipment is described in greater detail by Szarzi (1991).

A 0.5 m² sampling ring will be used to define the sample area for each plot. For each plot, substrate will be assessed for presence or absence of coal, clay, and/or gravel. The wand will be used to evaluate compaction using the following method. At full water pressure the wand will be balanced vertically on the beach, without any downward pressure at the center of the plot for 5 seconds to allow water from the wand to dig a hole that wand will drop into. The depth that the wand sinks will be measured to the nearest 10 cm (start depth). Once the plot is emulsified, the depth of the probe will again be measured to the nearest 10 cm (end depth). Compaction will be estimated as the difference between start depth and end depth.

The wand will be repeatedly inserted into the substrate inside the sample ring as far as the wand will penetrate. The substrate enclosed in the ring will be loosened such that all clams within the ring (sample area) will be flushed to the surface. Sampling will cease when the entire area within the ring is fluid and no clams have surfaced for approximately one minute. A hand-held net with 2 mm mesh will be used to strain the loosened substrate to search for small clams not readily visible. All clams encountered inside the ring will be measured and then released. An attempt will be made to sample seven plots at each sample site before moving 15.2 m to the next site. A marker stake or flag will be placed at each site where less than seven plots were obtained with remaining plots sampled as the incoming tide floods the beach. The length of each clam captured from each plot will be recorded onto the datasheets.

A survey grade GPS (Trimble[®] AG132) will be used to collect GPS coordinates of the Ninilchik South Study area and the Clam Gulch study area and at each sampled site. To define the study area, GPS coordinates will be collected along the transition from gravel to sand (starting side of study area) and along the water's line during slack tide of each survey. GPS coordinates will also be collected along the along the water's line during slack tide of the most extreme minus tides (-5.6 ft) of the season on May 7 and June 5. Additionally any areas that are not suitable razor clam habitat (large coal seams or areas with mostly gravel) will be surveyed, mapped and potentially removed from the sample area.

ESTIMATED DIGGER SUCCESS

Sampling to estimate digger success will occur on July 14, 2014 (Appendix D1). Several technicians will be sent to each of the five beaches approximately 1 hour before low tide. Technicians will attempt to interview every exiting digger. The interview will consist of 3 questions:

1. Were you digging clams?

If the answer to question 1 was yes then the following two questions will also be asked:

2. How many clams did you dig?
3. How long did you spend digging?

All data will be recorded in field notebooks.

DATA REDUCTION

Digger counts will be recorded on an Aerial Survey Form (Appendix B1), entered into an Excel workbook file, and converted to the angler count format in Appendix E for archiving. The survey form will be inspected for completeness and legibility after the completion of each flight. A clearly legible digger count should be recorded for each beach or sub-beach, including a zero for any beach or sub-beach where no diggers were observed. Counts key-punched into the workbook file will be compared to those on the survey form to edit any errors and note any counts that seem extraordinarily small or large. Counts in the workbook and mark-sense files will be compared to ensure all count data was properly converted into mark-sense format.

Age and length data will be directly recorded into an Access database containing the historical data and stored in three tables with the information detailed in the column headings in Appendix E for analysis.

Abundance data will be recorded on water proof data sheets (Appendix D3). Data collected for each Location will be recorded separately. After sampling the data will be proofed and entered into an Excel workbook.

The project biologist will examine each file for completeness (e.g., total length and length for each age – annulus – are recorded). Age data will be summarized by beach or sub-beach to detect any aberrant ages (e.g., < 0 , ≥ 15). Minimum and maximum length by age will also be inspected for each beach or sub-beach to find any errors.

All count, age, length and digger success data along with an explanation of file structures will be archived on the Sport Fish network hard drive at O:\DSF\SprotF\Clam\razor clams\2014.

Field notebooks and data sheets will be stored in the Homer office until final data analysis and archiving is complete.

All GPS data will be recorded directly into a handheld data logger and post processed in the Homer ADF&G office immediately after the survey is complete. Data will imported into ArcGIS and proofed against already collected GPS data. All GPS point data for the study area will be used to develop a polygon layer for the study. The estimate of area for Ninilchik South Beach will be produced from the polygon layer in ArcGIS. The GPS point data for the sampled sites will be converted into a point layer within ArcGIS and will include other sampling data such as number of sampled plots, number of clams found, and habitat information.

DATA ANALYSIS

ESTIMATED HARVEST BY BEACH:

Harvest by beach will be estimated by apportioning the total harvest estimate from the Statewide Harvest Survey. Aerial counts of diggers will be collected as a stratified, two-stage sampling design with high-low tides (-1.0 to -2.9 ft) and low-low tides (-3.0 ft and lower) as the two strata, flights as the primary units, and diggers as the secondary units. Since the Ninilchik beach is closed to harvest, theoretically no diggers should be counted; however, if diggers are observed the data will be included for analysis. Primary units (flight days) will not be chosen randomly, but will be spread out systematically through time.

Success rate of diggers varies by beach, so a crude adjustment for success rate will be made to estimate harvest by beach. Digger counts for each beach will be multiplied by the relative digger success rate (\hat{I}_b) estimated for each beach based on digger interviews conducted in 2014 (Appendix F) to give adjusted digger counts.

$$d_{tbk} = \hat{I}_b A_{tbk} ; \tag{1}$$

where:

d_{tbk} = the adjusted digger count during flight k on beach b in tidal stratum t ;

\hat{I}_b = the harvest success rate for beach b ; and

A_{tbk} = the number of diggers counted during flight k on beach b in tidal stratum t .

The relative harvest on beach b during flight k of tidal stratum t will be estimated by:

$$r_{tbk} = \frac{d_{tbk}}{d_{tk}} ; \tag{2}$$

where:

d_{tk} = the total adjusted digger count during flight k in tidal stratum t ;

$$= \sum_{b=1}^n d_{tbk} ; \text{ and}$$

n = the total number of beaches.

The average relative harvest on beach b in tidal stratum t (\bar{r}_{tb}) will be estimated, incorporating the sample weights (w_{tk}) that adjust the proportions for different total numbers of diggers during different flights:

$$\bar{r}_{tb} = \frac{\sum_{k=1}^{c_t} w_{tk} r_{tbk}}{c_t}; \quad (3)$$

where:

w_{tk} = the sample weight of flight k in tidal stratum t ,

$$= \frac{d_{tk}}{\bar{d}_t};$$

$$\bar{d}_t = \frac{\sum_{k=1}^{c_t} d_{tk}}{c_t}; \text{ and,}$$

c_t = the number of flights taken in tidal stratum t .

The number of diggers is probably related to the size of the minus tide. Since heights of tides run in cycles and selection of flights is not random, but "pseudo-systematic", number of diggers (sample weights) are probably cyclic. Therefore a successive difference estimator (Wolter 1985) will be used to estimate the variance of \bar{r}_{tb} :

$$\hat{V}[\bar{r}_{tb}] = \left\{ 1 - \frac{c_t}{m_t} \right\} \left\{ \frac{\sum_{k=2}^{c_t} (w_{tk} r_{tbk} - w_{tb(k-1)} r_{tb(k-1)})^2}{2c_t(c_t - 1)} \right\}; \quad (4)$$

where:

m_t = the number of tides in tidal stratum t .

The average relative harvest on beach b (\bar{r}_b) will then be estimated, incorporating stratum weights (W_t) that adjust the proportions for different numbers of tides and different average numbers of diggers in each tidal stratum:

$$\bar{r}_b = \sum_{t=1}^2 W_t \bar{r}_{tb}; \quad (5)$$

where:

\hat{W}_t = the weight for tidal stratum t ,

$$= \frac{m_t \bar{d}_t}{\sum_{t=1}^2 m_t \bar{d}_t}.$$

The estimated harvest for beach b (\hat{H}_b) is:

$$\hat{H}_b = \bar{r}_b \hat{H}; \quad (6)$$

where:

\hat{H} is the estimate of harvest of razor clams between Kasilof and Anchor Point from the 2014 Statewide Harvest Survey.

Its variance is estimated following Goodman (1960):

$$\hat{V}[\hat{H}_b] = \bar{r}_b^2 \hat{V}[\hat{H}] + \hat{H}^2 \hat{V}[\bar{r}_b] - \hat{V}[\hat{H}] \hat{V}[\bar{r}_b]; \quad (7)$$

where:

$\hat{V}[\hat{H}]$ is the variance of the Statewide Harvest Survey estimate; and

$$\hat{V}[\bar{r}_b] = \sum_{t=1}^2 \hat{W}_t^2 \hat{V}[\bar{r}_{tb}]. \quad (8)$$

To estimate the harvest by age class, the proportion of clams in age class i on beach b will be estimated by:

$$\hat{p}_{bi} = \frac{n_{bi}}{n_b}; \quad (9)$$

where:

n_{bi} = the number of clams sampled of age class i from beach b ; and

n_b = the total number of ageable clams in the sample from beach b .

The variance of the proportion will be estimated by (Cochran 1977):

$$\hat{V}[\hat{p}_{bi}] = \frac{\hat{p}_{bi}(1 - \hat{p}_{bi})}{n_b - 1}. \quad (10)$$

Harvest of age class i on beach b will be estimated by:

$$\hat{H}_{bi} = \hat{p}_{bi} \hat{H}_b; \quad (11)$$

with variance (Goodman 1960):

$$\hat{V}[\hat{H}_{bi}] = \hat{p}_{bi}^2 \hat{V}[\hat{H}_b] + \hat{H}_b^2 \hat{V}[\hat{p}_{bi}] - \hat{V}[\hat{p}_{bi}] \hat{V}[\hat{H}_b]. \quad (12)$$

Currently the variance around the relative digger success rate (\hat{I}_b) is ignored. This will cause an underestimate in the variances of all calculations that use, or are derived from, the relative digger success rate. An attempt will be made to incorporate a closed form estimate of the

$V(\hat{I}_b)$ where appropriate. If no closed form estimate can be found, bootstrapping and/or simulations will be used to estimate the variance. The age composition of razor clams for the Ninilchik Beach closed area will be estimated using formulas 9 and 10.

ESTIMATED ABUNDANCE BY BEACH:

The number of clams ≥ 80 mm in each stratum will be estimated as:

$$\hat{N}_b = S_b \hat{\bar{N}}_b \quad (13)$$

where:

$S_b =$ the number of possible sites in area stratum b ,

$\hat{\bar{N}}_b =$ mean estimated abundance of sites in area stratum b ,

$$\hat{\bar{N}}_b = \frac{\sum_{i=1}^{s_b} \hat{N}_{bi}}{s_b} \quad (14)$$

$s_b =$ the number of sites sampled in area stratum b ,

$\hat{N}_{bi} =$ the estimated abundance of clams in site i , area stratum b ,

$$\hat{N}_{bi} = P_{bi} \hat{\bar{N}}_{bi} \quad (15)$$

$P_{bi} =$ the number of possible plots at site i in area stratum b

$\hat{\bar{N}}_{bi} =$ mean estimated abundance of plots in site i , area stratum b ,

$$\hat{\bar{N}}_{bi} = \frac{\sum_{j=1}^{p_{bi}} \hat{N}_{bij}}{p_{bi}} \quad (16)$$

$\hat{N}_{bij} =$ the estimated abundance in plot j , site i , area stratum b ,

$p_{bi} =$ the number of plots sampled at site i in area stratum b

with variance:

$$Var[\hat{N}_b] = (1 - f_{1b}) S_b^2 \frac{s_{1b}^2}{s_b} + f_{1b}^{-1} P_{bi}^2 \sum_{i=1}^{s_b} \left[(1 - f_{2bi}) \frac{s_{2bi}^2}{P_{bi}} \right] \quad (17)$$

where:

$$s_{1b}^2 = \frac{\sum_{i=1}^{s_b} (\hat{N}_{bi} - \hat{\bar{N}}_b)^2}{s_b - 1} \text{ the variance among sites,}$$

$$s_{2bi}^2 = \frac{\sum_{j=1}^{p_{bi}} (\hat{N}_{bij} - \hat{N}_{bi(j-1)})^2}{p_{bi} - 1} \text{ the variance among plots within a site,}$$

$$f_{1b} = \frac{S_b}{S_b} \text{ the number of sites sampled in a stratum relative to the total possible sites, and}$$

$$f_{2bi} = \frac{p_{bi}}{P_{bi}} \text{ the number of plots sampled in a site relative to the total possible plots.}$$

The abundance of clams on the entire south beach will be the sum of the number of clams in each stratum:

$$\hat{N}_a = \sum_{b=1}^B \hat{N}_b \quad (18)$$

The variance of abundance of clams on the south beach will be estimated by:

$$V(\hat{N}_a) = \sum_{b=1}^B V(\hat{N}_b). \quad (19)$$

Adjacent strata with similar clam densities may be combined to reduce the variance of the overall abundance estimate. Evaluation to determine if strata should be combined will include testing for differences in mean clams per site between strata (2-sample t-test) and examination of changes in the abundance estimate.

ANNUAL EXPLOITATION RATE

Annual exploitation will be computed by dividing the total estimate of harvest of the abundance sample area by the total estimate of abundance for this same area. Survey estimates of exploitation rates will be converted to instantaneous fishing mortality by solving the Baranov catch equation (Deriso et al. 1989) for fishing mortality using abundance estimates from the density samples.

ESTIMATED DIGGER SUCCESS

Relative digger success for each beach (\hat{I}_b) will be estimated by dividing the average harvest on July 14, 2014 of each beach by the average harvest on July 14, 2014 of the most successful beach:

$$\hat{I}_b = \frac{\bar{x}_b}{\max_b(\bar{x}_b)} \quad (20)$$

where:

\bar{x}_b = the harvest on July 14, 2014 on beach b

$$= \frac{\sum_{i=1}^{f_b} x_{bi}}{f_b}$$

where:

x_{bi} = the number of clams harvested on July 14 by digger i on beach b , and
 f_b = the number of diggers interviewed on beach b .

SCHEDULES AND REPORTS

A schedule for conducting digger counts and collecting shells for age and length data appears in Appendix A. Processing and aging shells will occur inseason as time permits and during August. A report summarizing the results of data collected in 2009 - 2014 will be completed by March, 2015 and published in the ADF&G Sport Fishery Data Series.

RESPONSIBILITIES

List of Personnel and Duties:

1. Carol Kerkvliet, Assistant Area Management Biologist, ADF&G
Duties: Project leader. Overall project supervision. Will prepare operational plan, administer the project budget, hire seasonal field staff, assist with field sampling, conduct digger counts, and write the report.
2. Patricia Hansen, Biometrician, ADF&G
Duties: Technically reviews study design, sampling methods, and data analysis of operational plan, and reviews report. Will provide assistance in drafting operational plan and technical assistance inseason should changes in the design be necessary.
3. Michael Booz, Fisheries Biologist I, Project Assistant, ADF&G
Duties: Assist with operational planning, train project technicians, participate in project activities and assist with data analysis, summarization and reporting.
4. Tim Blackmon, Fisheries Technician III
Duties: Crew leader. Oversee and participate in the collection of field data as outlined in operational plan, including biological sampling and specimen processing. Responsible for maintenance and repair of sampling equipment.
5. Brad Harris PhD, Assistant Professor of Marine Biology
Duties: Schedule Alaska Pacific University students to assist area staff with five days of field sampling. Responsible for insuring that the students collect the field data as outlined in the operational plan, including biological sampling and specimen processing.
6. Other assisting personnel
Duties: Will collect field data as outlined in operational plan, including biological sampling and specimen processing. Responsible for maintenance and repair of sampling equipment.

BUDGET

Line Item	Category	Budget (\$K)
100	Personal Services	0.0
200	Travel	0.0
300	Contractual Services	4.0
400	Commodities	0.0

500	Equipment	0.0
Total		4.0

Budget Manager: Carol Kerkvliet

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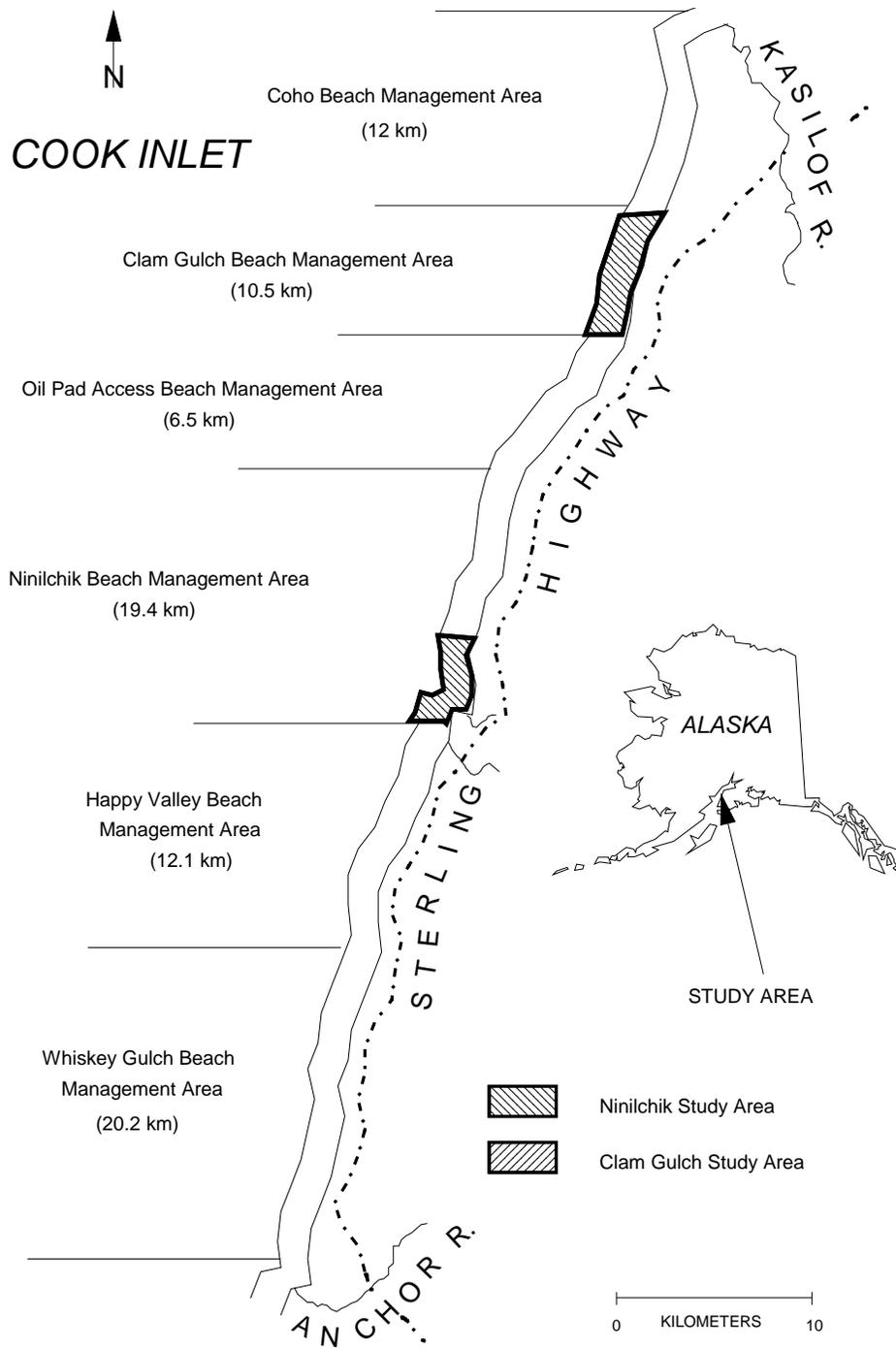


Figure 1.—Map of Kenai Peninsula showing Eastside beaches.

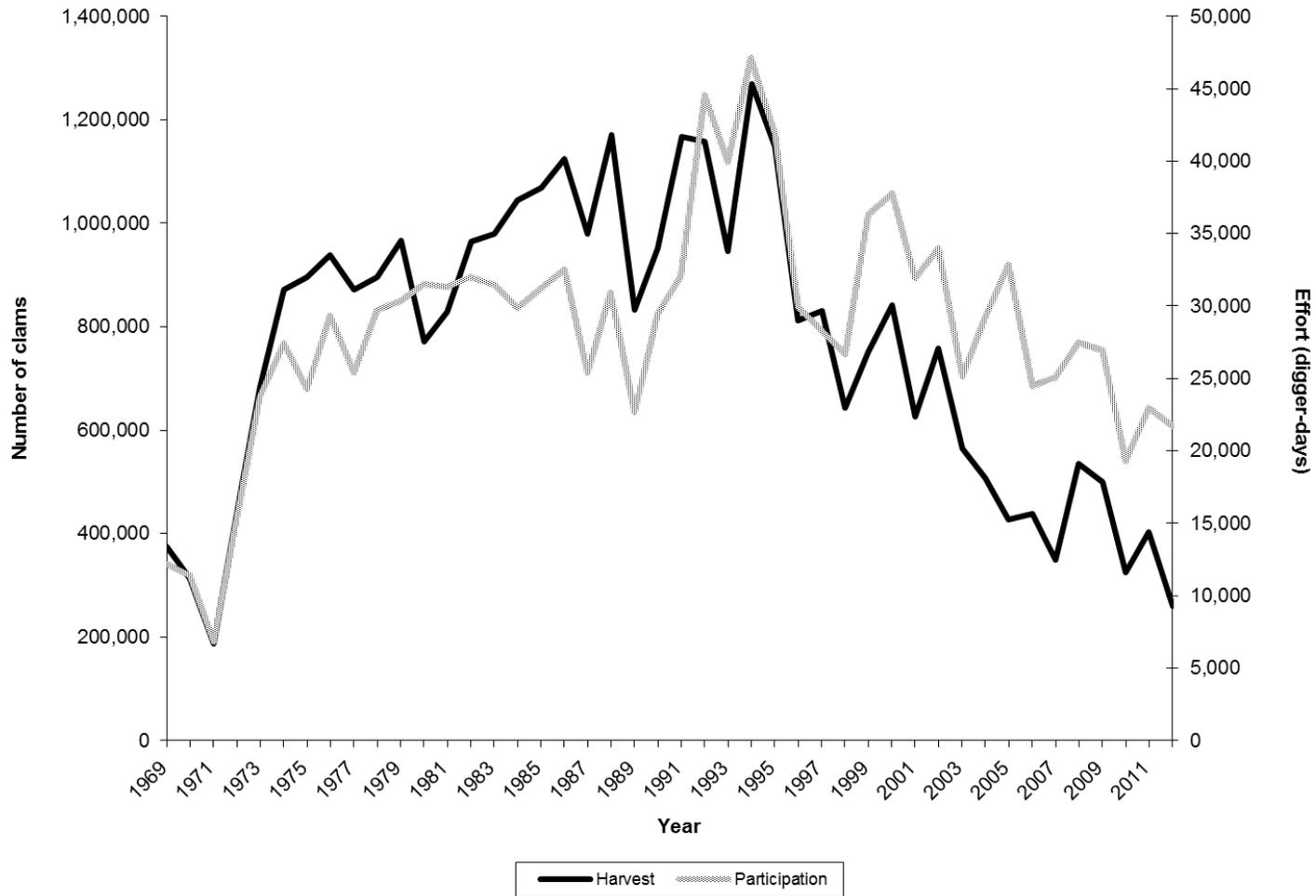


Figure 2.—Harvest and participation in the recreational razor clam fishery on eastside Cook Inlet beaches, 1969-2012.

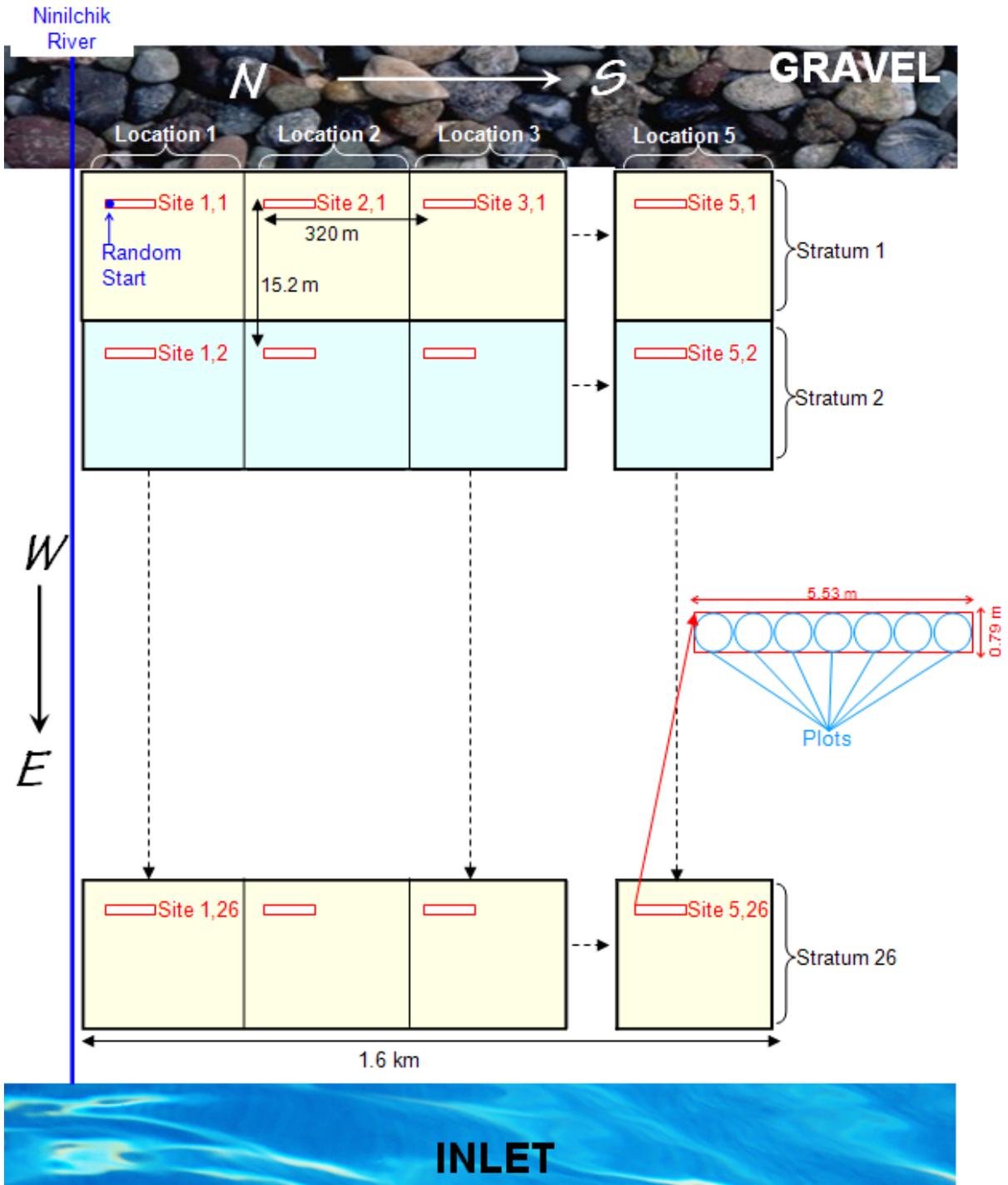


Figure 3.–Diagram of density pump plot/site/stratum sample design (not to scale).

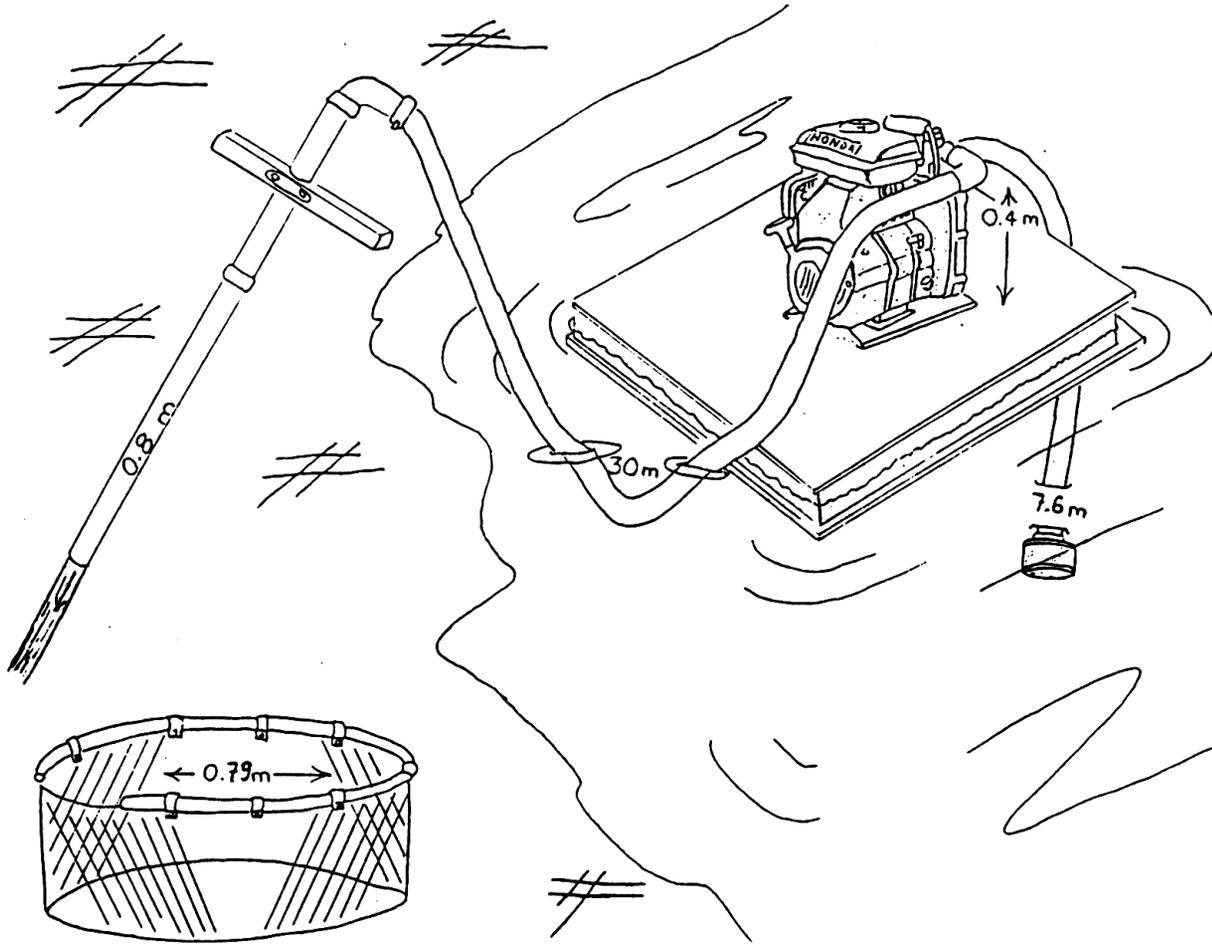


Figure 4.—Diagram of density pump generator and sample ring.

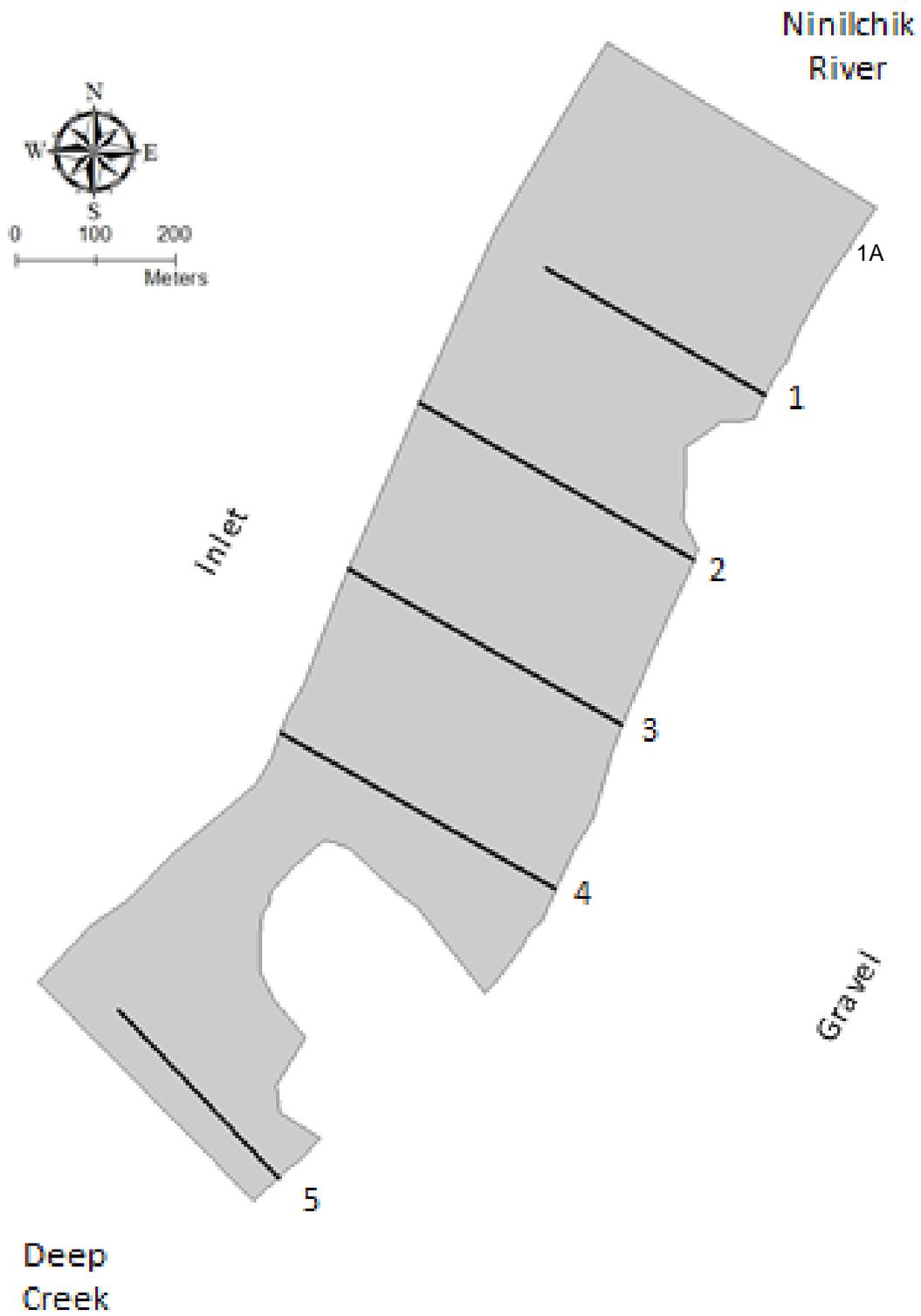


Figure 5.–Ninilchik South Beach sampling locations.

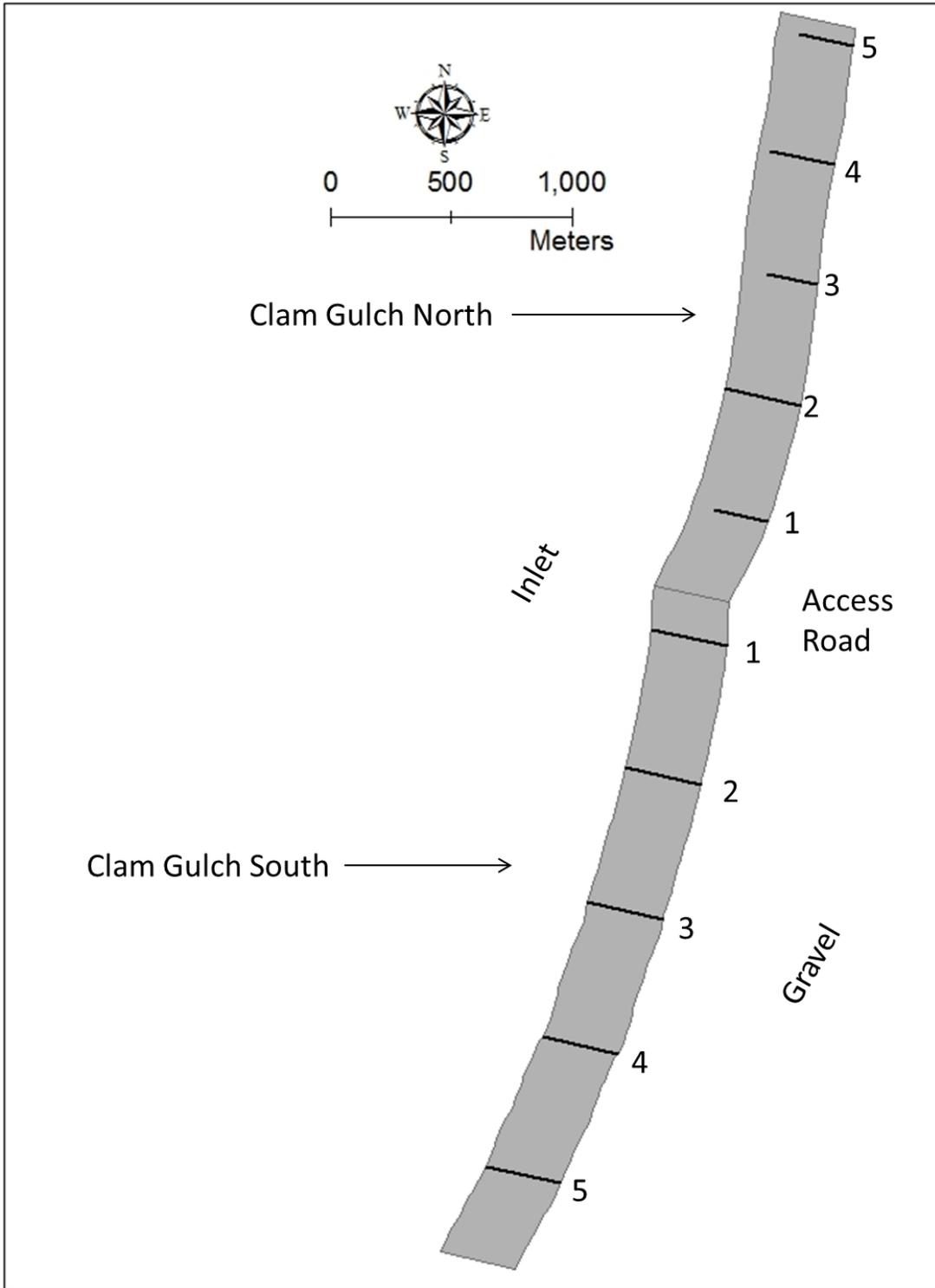


Figure 6.–Clam Gulch Beach (north and south) sampling locations.

Table 1.—Percentage of razor clam harvest by beach in the eastside Cook Inlet adjusted for relative success rate, 2004-2013.

Year	No. of surveys	Beach					
		Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch
2004	12	1.2	30.5	16.2	44.8	5.1	2.3
2005	13	0.9	26.4	10.0	53.2	6.3	3.3
2006	14	0.3	18.1	7.4	62.9	6.7	4.6
2007	14	0.5	12.2	3.5	68.1	9.8	6.0
2008	15	0.3	12.7	4.2	68.0	10.6	4.2
2009	12	0.7	5.9	4.3	74.5	11.1	3.4
2010	12	1.1	10.6	7.5	60.0	12.5	8.2
2011	13	1.1	8.4	4.1	75.0	9.4	2.0
2012	14	1.8	9.4	4.8	73.5	8.8	1.8
Average	13	0.9	14.9	6.9	64.4	8.9	4.0

Table 2.—Expected estimate, standard error (SE), and percent relative precision (RP) of relative digger effort (R_b) and razor clam harvest (H_b) by beach based on number of aerial counts of diggers during two tidal strata in 2013.

Beach	Number aerial counts ^a		Effort			Harvest ^b		
	-1.0 to -2.9	≤ -3.0	R_b	SE	RP ^c	H_b	SE	RP ^c
1. Whiskey Gulch	7	7	0.0257	0.0011	9	4,227	529	25
2. Happy Valley			0.3861	0.0077	4	63,437	7,545	23
3. Oil Pad Access			0.1770	0.0061	7	29,084	3,553	24
4A. Tower to Bluff			0.1410	0.0055	8	23,164	2,862	24
4B. Bluff to A-frame			0.1134	0.0064	11	18,628	2,421	25
4C. A-frame to S. Extension			0.0470	0.0042	18	7,718	1,137	29
4. Clam Gulch total			0.3014	0.0094	6	49,510	3,917	16
5. Cohoe			0.1098	0.0052	9	18,042	2,277	25

^a Tidal stratum of tides between -1.0 to -2.9 (n = 7 in 2014) and those of -3.0 and lower (n = 7 in 2014).

^b Based on the 2012 estimated harvest and variance at the beaches listed above plus half of the estimated harvest at Ninilchik beach (68,864 + 95,436 = 164,300 razor clams)

^c Relative precision of both estimates based on a 95% confidence interval.

Table 3.—Expected estimates, variances, and precision of harvest of razor clams by age and beach in 2014.

Beach	Hb ^a	Var(H ^b)	2013 data ^b			Expected 2014 Estimates						
			Age	n _{bi}	Prop	Age	p _{bi}	Var(p _{bi})	H _{bi}	Var(H _{bi})	RP ^c	AP ^d
Ninilchik (not including Bar)												
	0	0	1	90	0.28	1	0.28	0.00068	0	0		
			2	5	0.02	2	0.27	0.00066	0	0		
			3	39	0.12	3	0.01	0.00004	0	0		
			4	7	0.02	4	0.09	0.00027	0	0		
			5	175	0.55	5	0.02	0.00005	0	0		
			6	0	0.00	6	0.40	0.00080	0	0		
			7	1	0.00	7	0.00	0.00000	0	0		
			8	0	0.00	8	0.00	0.00001	0	0		
			9	0	0.00	9	0.00	0.00000	0	0		
			10+	0	0.00	10+	0.00	0.00000	0	0		
			Sum	317	1.00			1.07				
Oil Pad Access (North and South)												
	29,084	12,624,591	1	17	0.05	1	0.05	0.00017	1,531	173,925	0.45	686
			2	10	0.03	2	0.05	0.00016	1,450	163,412	0.46	665
			3	126	0.39	3	0.03	0.00010	853	90,201	0.58	494
			4	24	0.07	4	0.37	0.00078	10,748	2,373,497	0.24	2,534
			5	134	0.41	5	0.07	0.00022	2,047	244,917	0.40	814
			6	9	0.03	6	0.39	0.00080	11,431	2,614,920	0.23	2,660
			7	1	0.00	7	0.03	0.00009	768	80,419	0.61	466
			8	1	0.00	8	0.00	0.00001	85	8,258	1.75	149
			9	1	0.00	9	0.00	0.00001	85	8,258	1.75	149
			10+	0	0.00	10+	0.00	0.00001	85	8,258	1.75	149
			Sum	323	1.00			1.00				
Clam Gulch (Tower to A-frame)												
	41,792	14,049,269	1	0	0.00	1	0.00	0.00000	0	0		
			2	0	0.00	2	0.00	0.00000	0	0		
			3	113	0.34	3	0.34	0.00075	14,267	2,940,226	0.20	2,821
			4	29	0.09	4	0.22	0.00058	9,397	1,720,146	0.23	2,157
			5	98	0.30	5	0.06	0.00018	2,412	361,839	0.41	990
			6	67	0.20	6	0.19	0.00052	8,149	1,443,765	0.24	1,977
			7	15	0.05	7	0.13	0.00039	5,571	919,183	0.28	1,577
			8	8	0.02	8	0.03	0.00010	1,247	180,295	0.56	698
			9	1	0.00	9	0.02	0.00005	665	94,327	0.76	505
			10+	0	0.00	10+	0.00	0.00001	83	11,562	2.13	177
			Sum	331	1.00			1.00				
Cohoe												
	18,042	5,185,913	1	0	0.00	1	0.00	0.00000	0	0		
			2	11	0.07	2	0.07	0.00044	1,272	166,689	0.53	672
			3	85	0.54	3	0.07	0.00041	1,182	153,945	0.55	645
			4	14	0.09	4	0.51	0.00168	9,137	1,867,527	0.25	2,248
			5	37	0.24	5	0.08	0.00051	1,505	200,457	0.49	737
			6	8	0.05	6	0.22	0.00115	3,977	621,503	0.33	1,297
			7	1	0.01	7	0.05	0.00030	860	109,374	0.63	544
			8	0	0.00	8	0.01	0.00004	107	12,917	1.74	187
			9	0	0.00	9	0.00	0.00000	0	0		
			10+	0	0.00	10+	0.00	0.00000	0	0		
			Sum	156	1.00			1.00				

^a Expected razor clam harvest and variance assuming 7 aerial counts during tides between -1.0 and -2.9 feet and 7 counts during tides of -3 feet and lower.

^b Number and proportion of razor clams of each age class in 2013.

^c Relative precision of estimated harvest by age on each beach with a 90% confidence interval.

^d Absolute precision of the estimated harvest calculated as the product of the estimated harvest and relative precision.

Table 4.– Estimated relative success rate of diggers on eastern Cook Inlet beaches, 2009 and 2013.

	Historic Digger success	2009				2013				
		No. Interviews	No. Clams Dug	Average clam/digger	Digger Success	No. Diggers	No. Non- diggers	No. Clams Dug	Average clam/digger	Digger Success
Ninilchik	1.0	427	17,117	40.09	1.0	188	81	1,657	8.81	0.4
Set Net Access	1.0	68	1,874	27.56	0.7	47	15	635	13.51	0.6
Cohoe Beach	0.5	29	784	27.03	0.7	29	2	641	22.10	1.0
Happy Valley	0.5	161	3,265	20.28	0.5	70	16	746	10.66	0.5
Clam Gulch	1.0	155	2,631	16.97	0.4	93	16	624	6.71	0.3
Whiskey Gulch	0.5	85	928	10.92	0.3	46	12	123	2.67	0.1

Appendix A.–Razor clam sampling schedule, 2013.

Date	Day	Time	Tide (ft)	Tide Strata	Groupings		Aerial Survey	Age Length	Pump Abundance	Harvest Success
					Day	Season				
4/1	Tue	11:13 AM	-3.6	High	weekday	shoulder				
4/2	Wed	11:53 AM	-3.0	High	weekday	shoulder				
4/3	Thu	12:34 PM	-1.7	Low	weekday	shoulder				
4/14	Mon	9:44 AM	-1.0	Low	weekday	shoulder				
4/15	Tue	10:19 AM	-2.1	Low	weekday	shoulder				
4/16	Wed	10:54 AM	-2.8	Low	weekday	shoulder	x		x	
4/17	Thu	11:32 AM	-2.9	Low	weekday	shoulder			x	
4/18	Fri	12:12 PM	-2.5	Low	weekday	shoulder			x	
4/19	Sat	12:57 PM	-1.6	Low	Weekend	shoulder	x			
4/27	Sun	8:51 AM	-1.7	Low	Weekend	shoulder				
4/28	Mon	9:34 AM	-2.9	Low	weekday	shoulder			x	
4/29	Tue	10:14 AM	-3.6	High	weekday	shoulder			x	
4/30	Wed	10:53 AM	-3.6	High	weekday	shoulder			x	
5/1	Thu	11:31 AM	-3.0	High	weekday	Peak			x	
5/2	Fri	12:10 PM	-1.9	Low	weekday	Peak				
5/13	Tue	9:17 AM	-1.6	Low	weekday	Peak				
5/14	Wed	9:56 AM	-2.9	Low	weekday	Peak	x			
5/15	Thu	10:35 AM	-3.8	High	weekday	Peak				
5/16	Fri	11:16 AM	-4.1	High	weekday	Peak			x	
5/17	Sat	11:59 AM	-3.8	High	Weekend	Peak				
5/18	Sun	12:45 PM	-3.0	High	Weekend	Peak				
5/19	Mon	1:36 PM	-1.7	Low	weekday	Peak				
5/26	Mon	8:35 AM	-1.4	Low	weekday	Peak				
5/27	Tue	9:18 AM	-2.3	Low	weekday	Peak	x			
5/28	Wed	9:58 AM	-2.9	Low	weekday	Peak				
5/29	Thu	10:36 AM	-3.0	High	weekday	Peak				
5/30	Fri	11:12 AM	-2.6	Low	weekday	Peak	x			
5/31	Sat	11:49 AM	-2.0	Low	Weekend	Peak				
6/1	Sun	12:26 PM	-1.0	Low	Weekend	Peak				
6/11	Wed	8:52 AM	-1.7	Low	weekday	Peak				
6/12	Thu	9:35 AM	-3.3	High	weekday	Peak		x		
6/13	Fri	10:18 AM	-4.4	High	weekday	Peak			x	
6/14	Sat	11:01 AM	-4.9	High	Weekend	Peak	x		x	
6/15	Sun	11:46 AM	-4.8	High	Weekend	Peak	x			
6/16	Mon	12:32 PM	-4.0	High	weekday	Peak		x		
6/17	Tue	1:20 PM	-2.6	Low	weekday	Peak		x		
6/25	Wed	9:05 AM	-1.2	Low	weekday	Peak				
6/26	Thu	9:44 AM	-1.8	Low	weekday	Peak	x			
6/27	Fri	10:20 AM	-2.1	Low	weekday	Peak		x		
6/28	Sat	10:54 AM	-2.1	Low	Weekend	Peak	x	x		
6/29	Sun	11:28 AM	-1.9	Low	Weekend	Peak				
6/30	Mon	12:02 PM	-1.3	Low	weekday	Peak				

CGS - Clam Gulch South
 CGN - Clam Gulch North
 NN - Niniichik North

SN - Set Net Access
 OP - Oil Pad Access
 NS - Niniichik South

CO - Cohoe
 NB - Niniichik Bar
 DC - Deep Creek

-Continued-

Appendix A. Continued.

Date	Day	Time	Tide (ft)	Tide Strata	Groupings		Aerial Survey	Age Length	Pump Abundance	Harvest Success
					Day	Season				
7/10	Thu	8:31 AM	-1.5	Low	weekday	Peak				
7/11	Fri	9:17 AM	-3.2	High	weekday	Peak		x		
7/12	Sat	10:02 AM	-4.5	High	Weekend	Peak	x	x		
7/13	Sun	10:46 AM	-5.2	High	Weekend	Peak		x		
7/14	Mon	11:29 AM	-5.2	High	weekday	Peak	x	x		x
7/15	Tue	12:13 PM	-4.3	High	weekday	Peak		x		
7/16	Wed	12:58 PM	-2.8	Low	weekday	Peak		x		
7/26	Sat	10:02 AM	-1.2	Low	Weekend	Peak	x			
7/27	Sun	10:33 AM	-1.6	Low	Weekend	Peak				
7/28	Mon	11:04 AM	-1.6	Low	weekday	Peak				
7/29	Tue	11:35 AM	-1.3	Low	weekday	Peak				
8/8	Fri	8:11 AM	-1.0	Low	weekday	shoulder				
8/9	Sat	8:59 AM	-2.8	Low	Weekend	shoulder	x			
8/10	Sun	9:44 AM	-4.1	High	Weekend	shoulder				
8/11	Mon	10:26 AM	-4.8	High	weekday	shoulder				
8/11	Mon	10:44 PM	-1.7	Low	weekday	shoulder				
8/12	Tue	11:09 AM	-4.7	High	weekday	shoulder				
8/12	Tue	11:30 PM	-2.2	Low	weekday	shoulder				
8/13	Wed	11:51 AM	-3.7	High	weekday	shoulder				
8/14	Thu	12:16 AM	-2.0	Low	weekday	shoulder				
8/14	Thu	12:33 PM	-2.1	Low	weekday	shoulder				
8/15	Fri	1:05 AM	-1.1	Low	weekday	shoulder				

CGS - Clam Gulch South
 CGN - Clam Gulch North
 NN - Ninilchik North

SN - Set Net Access
 OP - Oil Pad Access
 NS - Ninilchik South

CO - Cohoe
 NB - Ninilchik Bar
 DC - Deep Creek

Appendix B.–Field form for razor clam digger counts.

RAZOR CLAM DIGGER COUNTS BY AREA

Date_____ Tide_____ Time_____

1	Whiskey Gulch Anchor River to Happy Creek	_____
2.	Happy Valley Happy Creek to Deep Creek	_____
3.	Ninilchik Deep Creek to Set Net Access	_____
	A. Ninilchik Bar	_____
	B. Deep Creek to Ninilchik River	_____
	C. Ninilchik River to Lehman's	_____
	D. Lehman's to Access	_____
4.	Oil Pad Access Set Net Access to Clam Gulch Tower	_____
	A. Set Net Access to A-frame	_____
	B. A frame to Clam Gulch Tower	_____
5.	Clam Gulch Tower to S. extension of Cohoe Lp. Rd.	_____
	A. Tower to bluff	_____
	B. Bluff to A frame	_____
	C. A frame to S. Ext.	_____
6.	Cohoe S. extension of Cohoe Lp. Rd to Kasilof R.	_____
Total		_____

Appendix C.–Data entry instructions for clam digger counts, length-at-age data and abundance data.

The goal is to enter each set of data into separate files in a database format, with each line a complete record. The attached pages will serve as examples. Note: although beach numbers 31 and 32 are closed to harvest, if diggers are observed, their number should be included.

Digger count file format directions:

Enter beach number using the following designations:

- 11 Whiskey Gulch: Anchor River to Happy Cr.
- 21 Happy Valley: Happy Creek to Deep Creek
- 31 Ninilchik Bar
- 321 Ninilchik South: Deep Creek to Ninilchik River
- 322 Ninilchik North: Ninilchik River to Lehman's
- 33 Lehman's to Set Net Access
- 411 Set Net Access
- 412 Oil Pad Access
- 51 Tower to Bluff
- 521 Clam Gulch South: Bluff to A frame
- 522 Clam Gulch North: North of Clam Gulch Access Road
- 53 A frame to South extension Cohoe Loop
- 61 South extension of Cohoe loop to Kasilof River

Enter date as yymmdd, without any spaces. Because the tides are negative, the Worksheet Global Default Other International Negative should be set so that a negative sign instead of parenthesis is printed around negative values. Tidal strata is either 1 for tides between -1.0 through -2.9 feet or 2 for tides of -3.0 feet or lower. Count is actual diggers counted on the beach.

Length-at-age file format directions:

Line is a unique line number for each line.

Beach areas are designated as follows. The first number is the beach, the second number is the sublocation and the third number is the section:

- 11 Whiskey Gulch: Anchor River to Happy Cr.
- 21 Happy Valley: Happy Creek to Deep Creek
- 31 Ninilchik Bar
- 321 Ninilchik South: Deep Creek to Ninilchik River
- 322 Ninilchik North: Ninilchik River to Lehman's
- 33 Lehman's to Set Net Access
- 411 Set Net Access
- 412 Oil Pad Access
- 51 Tower to Bluff
- 521 Clam Gulch South: Bluff to A frame
- 522 Clam Gulch North: North of Clam Gulch Access Road
- 53 A frame to South extension Cohoe Loop
- 61 South extension of Cohoe loop to Kasilof River

Enter date as yymmdd, without any spaces. Because the tides are negative, the Worksheet Global Default Other International Negative should be set so that a negative sign instead of parenthesis is printed around negative values. Age, total length and length at annulus are input directly into an ASCII file using the automatic calipers. This data is then imported into an Excel workbook.

Abundance file format directions:

Line is a unique line number for each line. Beach area and subarea will be entered using designations as listed above for the length-at-age format. For 2011 all sampling will be conducted on beach 3, subarea 2 and subarea 3. Site location is broken into two columns, one for N or S of the Ninilchik River and one for the mile number from the Ninilchik River if south of the Ninilchik River or the mile number south from Leman's if north of the Ninilchik River. Time is the time digging the quadrat was started. Distance is the distance in feet from the gravel's edge where the quadrat is being dug sampling takes place. Enter date as mmddyy, without any spaces. Because tides are negative, be sure the format of cells in which tide is entered is set so that a negative sign (rather than parentheses) is printed around negative values. Sample number is for each quadrat dug at a specific distance from the gravel's edge along the transect and may have a value of up to 7 for each sample location. The number of clams <80 mm and ≥80 mm in length (this will always be one) as well as total length of each clam is entered.

Appendix D.–Abundance sampling schedule, locations, and data entry form.

Appendix D1.–Abundance start time and sample date for each Location.

Date	Tide height (ft)	Slack low tide time	Leave office time	Approximate start time	Survey Beach	ADF&G location	APU location
4/16	-2.8	10:54 AM	6:45 AM	7:45 AM	Ninilchik	NINS-1	
4/17	-2.9	11:32 AM	7:30 AM	8:30 AM	Clam Gulch	CGN-5	
4/18	-2.5	12:12 PM	8:15 AM	9:15 AM	Clam Gulch	CGS-4	
4/28	-2.9	9:34 AM	5:30 AM	6:30 AM	Clam Gulch	CGS-2	CGN-3
4/29	-3.6	10:14 AM	6:15 AM	7:15 AM	Ninilchik	NINS-3	NINS-5
4/30	-3.6	10:53 AM	7:00 AM	8:00 AM	Clam Gulch	CGN-4	CGS-1
5/1	-3.0	11:31 AM	7:30 AM	8:30 AM	Clam Gulch	CGS-5	CGN-1
5/16	-4.1	11:16 AM	7:15 AM	8:15 AM	Ninilchik	NINS-4	NINS-2
6/13	-4.4	10:18 AM	6:15 AM	7:15 AM	Clam Gulch	CGN-2	
6/14	-4.9	11:01 AM	7:00 AM	8:00 AM	Clam Gulch	CGS-3	
6/15	-4.8	11:46 AM	7:45 AM	8:45 AM			

Appendix D2.–Abundance sampling start location and compass heading.

Beach	Location	Start		Site 1 Distance (m)	Sites >1 Distance (m)	Start GPS		Stop GPS	
		Distance (m)	Heading			Latitude	Longitude	Latitude	Longitude
Ninilchik South	1	278	310	4.0	15.2	60.050574	-151.671556	60.052430	-151.677664
	2	505	310	4.0	15.2	60.048722	-151.673242	60.050579	-151.679394
	3	732	310	4.0	15.2	60.046866	-151.674944	60.048700	-151.681084
	4	959	310	4.0	15.2	60.045016	-151.676530	60.046856	-151.682682
	5	1469	285	4.0	15.2	60.041797	-151.682932	60.044406	-151.687672
Clam Gulch North	1	229	265	14.0	15.2	60.242975	-151.402066	60.247929	-151.405025
	2	729	265	14.0	15.2	60.247231	-151.399398	60.243668	-151.407685
	3	1229	265	14.0	15.2	60.251720	-151.397899	60.252415	-151.403504
	4	1729	265	14.0	15.2	60.256152	-151.396458	60.256842	-151.402075
	5	2229	265	14.0	15.2	60.260577	-151.394822	60.261260	-151.400444
Clam Gulch South	1	179	265	7.6	15.2	60.238388	-151.405326	60.239062	-151.410933
	2	764	265	7.6	15.2	60.233247	-151.407529	60.233921	-151.413135
	3	1349	265	7.6	15.2	60.228277	-151.410609	60.228950	-151.416228
	4	1934	265	7.6	15.2	60.223307	-151.414176	60.223985	-151.419799
	5	2519	265	7.6	15.2	60.218548	-151.418686	60.219221	-151.424289

Appendix D 3.–Page 1 of data entry form for abundance sampling.

Date:		Beach:			Transect:			Crew:					Page x of x		
Site	Time	Plot	Sediment ¹			Wand Depth		Total Clams	Clam Size (mm) & Age					More Clams ⁴	
			Coal	Clay	Gravel	Start ²	End ³		1	2	3	4	5		
1		1													
1		2													
1		3													
1		4													
1		5													
1		6													
1		7													
Position: N 60. _____ ° W -151. _____ ° Comments:															
2		1													
2		2													
2		3													
2		4													
2		5													
2		6													
2		7													
Position: N 60. _____ ° W -151. _____ ° Comments:															
3		1													
3		2													
3		3													
3		4													
3		5													
3		6													
3		7													
Position: N 60. _____ ° W -151. _____ ° Comments:															
4		1													
4		2													
4		3													
4		4													
4		5													
4		6													
4		7													
Position:								Comments:							
¹ Yes for present, No for absent.								³ Wand depth to the nearest 10 cm after plot is emulsified.							
² Wand depth to the nearest 10 cm after 5 seconds.								⁴ Yes for when there are additional clams on other datasheet. No when there are ≤5 clams.							

Appendix E.–Razor clam file formats

Razor clam digger count file format

Beach	Year	Month	Day	Date	Tide	Strata	Count
11							
21							
31							
32							
33							
41							
51							
52							
53							
61							

Razor clam length-at-age file format (column headings)

Month, Day, Year, Beach, Sub_Loc, Subloc2, Age, Tot_Len, AN1, AN2, AN3, AN6,...,AN15,
Clam_Number

Razor clam abundance file format (column headings)

Line, Beach, SubArea, Loc. N/S, Loc. M., Time, Dist, Date, Tide, Sample, No_clams <80_mm, No_clams
≥80_mm, Length