Regional Information Report No. 1J12-13

2011 Southeastern Alaska Pot Shrimp Survey Report

by

Quinn Smith

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Alaska Department of Fish and Game **Division of Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, Special Publications and the Division of Commercial Fisheries Regional Reports. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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	use 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

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By
Quinn Smith
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas

Alaska Department of Fish and Game
Division of Commercial Fisheries, Publications Section
802 3rd, Douglas, Alaska, 99824-0020

December 2012

Quinn Smith
Alaska Department of Fish and Game, Division of Commercial Fisheries
802 3rd St., Douglas, AK, USA

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ABSTRACT

Spot shrimp, *Pandalus platyceros*, are targeted by a commercial pot fishery in Southeastern Alaska. Historically the fishery harvested as much as one million pounds, though about five hundred fifty thousand pounds were harvested in the 2010/2011 season. An annual survey was implemented in 1997, and currently occurs in August and September in Districts 1, 2, 3 (Section 3-A), 7, 12, and 13 (Section 13-C). During the 2011 survey a total of 1,170 pots were set and 28,425 individual shrimp measured. The survey program was expanded in 2011 to include Districts 1 and 2. This was made possible due to legislative increment funding, and survey redesign. As part of a survey redesign, we began setting nine 5-pot strings of small-mesh pots daily in all areas. This change allowed 9 additional index pots to be sampled daily, improving spatial coverage and statistical power of the survey data. Overall CPUE of greater than large size-class shrimp increased for two areas, stayed the same for one area, and decreased for four areas. Carapace lengths increased for one area, stayed the same for one area, and decreased for five areas. The degree of increases and decreases varied and are explained in greater detail below. L_{50} values increased for three areas, stayed the same for two areas, and decreased for two areas. Values generally remain well below the baseline in almost all areas, with the exception of CPUE of small size-class shrimp.

Key words: Spot shrimp, *Pandalus platyceros*, stock assessment, Southeastern Alaska, pot fishery, pot survey

INTRODUCTION

SURVEY OBJECTIVES

The goals of the shrimp pot survey are to:

1) Develop a useful index of abundance for spot shrimp,
2) Estimate the size composition of spot shrimp captured,
3) Estimate L_{50} of spot shrimp population, and
4) Describe pot shrimp fishery bycatch species composition.

HISTORY OF THE SURVEY

The survey program for spot shrimp, *Pandalus platyceros*, in Southeastern Alaska was initiated in 1996 through a pilot survey, conducted in District 7, with the goal of investigating gear and methods. The pot shrimp preseason survey began in the District 3, Section 3-A analysis areas of Hetta Inlet and mid-Cordova Bay in 1997. Surveys in Districts 7 (Upper Ernest Sound), and 13 (Hoonah Sound) were added in 1999. A pilot survey in District 12, (Tenakee Inlet) took place in 2000, and the Tenakee inlet survey began in 2002. In 2003 the Lower Ernest Sound analysis area was added to District 7. Pilot surveys in Districts 1(Back & West Behm Canal, George & Carroll Inlets) and 2 (Kasaan Bay and Cholmondeley Sound) took place in 2011 (Figure 1).

In addition to the preseason survey, a postseason survey was conducted in District 3, Section 3-A from 1999 to 2002, and in District 7 from 2001 to 2002, with the goal of estimating shrimp abundance using change-in-ratio methods (Clark and Love 2003) to assess the appropriateness of guideline harvest ranges (GHRs). For a more detailed description of the development of the shrimp pot survey see Love and Bishop (2005).

HOW SURVEY DATA IS USED

Data collected during the preseason survey is used in conjunction with dockside sampling, on-the-grounds sampling, fish tickets, and commercial logbooks to assess the status of shrimp stocks and set Guideline Harvest Levels (GHL). For more detailed information about how these metrics are applied see Bishop et al. (2009).

OVERVIEW OF FISHERY MANAGEMENT

The Southeastern Alaska pot shrimp fishery is managed inseason, with season length determined by emergency order, to limit harvest in each district or section to levels as close as possible to GHLs established by the Alaska Department of Fish and Game (department) prior to each season. Fishery managers monitor catch per unit effort (CPUE) on the fishing grounds when possible. They also utilize call-in programs; daily fish tickets; and logbook data for inseason management. GHRs were first established in regulation in 1997 following initial implementation of separate, district-specific GHRs by emergency order for the 1995/1996 season. The lower limit of each GHR is 0 (indicating that an area may not open during a season), and the upper limits were originally set based on average harvest levels from the 1990/1991–1994/1995 seasons. GHRs have been adjusted several times for many, but not all, management units. A thorough review of the history of, and rationale for, GHL changes by management unit—including the timing for creation of new management units—is provided in the triennial Alaska Board of Fisheries report (Smith et al. 2012). GHL recommendations are made annually based on stock assessment results.

OBJECTIVE

The objective of this report is to describe the particular methods and results of the 2011 preseason pot shrimp survey in Southeastern Alaska.

METHODS

The preseason pot shrimp survey occurs annually in portions of six districts during August and September. In 2011 the District 1, Section 13-A and District 12 surveys were conducted aboard the *R/V Medeia* from August 9–20 (District 1), and September 12–23 (Districts 12 and 13) , while the Districts 2, 3, and 7 surveys occurred aboard the *R/V Kestrel* September 13–28.

SAMPLE DESIGN

Stations sampled in the survey are static, not changing from year to year, thus giving an index of shrimp abundance, size, and reproductive condition. Stations were originally chosen in areas that local fishermen had identified as productive grounds, and specific sampling locations were distributed so as to have coverage of all major fishing grounds in each analysis area.

SETTING AND PULLING

Pots were set between 13:00 and 18:00 each afternoon and pulled from 08:00 to 13:00, thus achieving a soak time of no less than 18 and no more than 22 hours. Each pot is baited with 2 pints of chopped Alaska winter-caught bait herring in a bait jar and one half of a pink salmon hanging bait. Baiting occurred daily, and bait was not thawed more than 12 hours prior to use.

Strings of longlined shrimp pots were used to capture spot, *P. platyceros*, and incidentally coonstripe, *P. hypsinotus*, shrimp. Floating groundline (½-in diameter) was used to longline each pot in the set at 20-fathom intervals. Strings consisted of five 42-in diameter pots with 1 ⅛-in mesh and four tunnels. As part of a project to increase the accuracy of the data collected in the survey, the number of strings set daily in Districts 12 and 13 was increased from 6–7 per day to 8–10 per day. Each day 6 or 7 strings were set, as well as 3 or 4 new exploratory strings. This was possible because we removed the "large" (1 ¾-in) mesh pots from the sampling design in these districts. This same process was used in Districts 3 and 7 on the 2010 surveys.

Both small and large mesh pots were part of the original survey design, to allow for determination of shrimp size at 100% retention, as well as to allow a combined index removal and change-in-ratio modeling of population size (Chen et al. 1998a, Chen et al. 1998b). Both pot sizes were retained after the postseason shrimp surveys were discontinued for two reasons, first there was some indication that small mesh pots might saturate with small shrimp, effectively reducing the catchability of, and under representing, large shrimp at high shrimp population densities, and secondly for the utility in having a survey gear with the same mesh size as most commercial fishing gear. Recent streamlining of shrimp data analysis has included the development of a matrix of data scored in a repeatable fashion to represent shrimp stock health for each district. Matrix inputs include survey, fish ticket, and sampling data. In order to avoid double scoring a single data source, only data from small mesh pots was used in the matrix. Small mesh pots were used because statistical examination of data from large and small mesh pots allayed concerns about reduced catchability of large shrimp in small mesh pots, and they better represented the abundance of small shrimp.

Changing from 10-pot to 5-pot strings was possible because further examination (using the Durbin-Watson statistic), found that there was no autocorrelation between pots in a string in any year of the survey. Thus each pot is an individual sampling unit, and removing pots from a string should have no effect. This allowed us to decrease the number of pots on a string from 10 to 5 (removing all the large mesh pots), and freed us to add strings in order to cover more of the fishing grounds, and increase the amount of data collected during the survey (see Appendix B-1 for results of power analyses examining the effect of increased sample size on data definition).

SAMPLING SHRIMP

To avoid bias due to pot numbers 1 and 5 in a set sometimes being off the bottom, only shrimp from pot numbers 2–4 from each set were sampled. As each set was hauled, pot condition was recorded; next each pot's content was dumped into separate baskets pre-labeled with the pot order. All small mesh pots from each string were sampled (besides pot numbers 1 and 5). Bycatch was removed from the baskets and abundance, and species (or species group) recorded.

Carapace Length Frequency and CPUE

For all small mesh pot numbers 2–4, carapace length (CL) for all or a subsample of spot shrimp were measured to the nearest 0.5 mm. The presence or absence of eggs, parasites, and soft-shell condition were also recorded. Before sampling, shrimp were sorted according to the presence or absence of eggs; then subsampled by number, taking care to randomly select shrimp for measuring. Non-egged and egg bearing shrimp may be subsampled at different rates, depending on their abundance, with the goal of obtaining a total subsample of 50 to 100 shrimp per sampled pot.

In District 7 only, coonstripe shrimp CLs were also measured at a low subsample rate. In all districts, one pink and one sidestripe shrimp CL was measured per pot, when present, to represent the entire group of that species in the pot and the number captured recorded as the subsample rate to determine the count per pot. Other shrimp species were not measured, but their aggregate numbers were recorded as bycatch.

Size-at-sex

Daily, approximately 50 shrimp were randomly selected from any 3 pots for a total of 150 per day. These shrimp were retained whole and frozen to be sent to the department laboratory in

Petersburg for individual sexing in order to determine area-specific L_{50} values (the length at which half the individuals are male and half female).

EXTRA PROJECTS

Conductivity/Temperature/Depth (CTD)

During the 2011 pot shrimp survey, CTD casts were made at six established oceanographic stations throughout Southeastern Alaska (Table 1). Casts were made using a Seabird 19 plus CTD with conductivity, temperature, and depth sensors; the instrument is calibrated annually. Oceanographic stations were occupied in transit and the CTD was dropped at a speed of 1 m/s to a maximum depth of 250 m and retrieved. Surface water samples were taken at every third oceanographic station for inseason calibration of conductivity. Data was uploaded and archived at the National Oceanic Data Center and can be retrieved online at (*http://www.nodc.noaa.gov/*).

ANALYSIS

Catch-per-unit-effort and mean CL were calculated for large and small shrimp as the mean of the means of each pot for each analysis area. These values are compared to the area-specific long-term baselines, using a t-test. Short term trends were examined using linear regression on the last four year of data. Specimens collected for determining size at 50% female or L_{50} were sexed following the methods presented by Hoffman (1972). Size and sex data was examined by logistic regression with an inverse prediction probability of 0.5 to determine L_{50} at 95% confidence. For more detailed explanation of statistical tests and the use of the results see Bishop et al. (2009).

RESULTS

OVERVIEW

Overall CPUE of greater than large size class (>L) shrimp (Table 4) increased for 2 areas, stayed the same for 1 area, and decreased for 4 areas. Overall CPUE of large size class and smaller (<XL) shrimp increased for 4 areas, stayed the same for 1 area, and decreased for 2 area. Carapace lengths increased for 1 area, stayed the same for 1 area, and decreased for 5 areas. The degree of increases and decreases varied and are explained in greater detail below. L_{50} values increased for 3 areas, stayed the same for 2 areas, and decreased for 2 areas. Carapace lengths, CPUEs, and L_{50} generally remain well below the baseline in almost all areas.

DISTRICTS 1 AND 2

Results from pilot surveys in Districts 1 and 2 are located in Tables 2–3. Since 2011 was the first year of these surveys, there is no historical data with which to compare the results.

DISTRICT 3, SECTION 3-A

Catch Rate

CPUE of >L shrimp decreased 18% from the 2010 value in Hetta Inlet, and is currently 40% of the baseline (Figure 9). Likewise, catch rate of >L shrimp decreased 84% from the 2010 value in mid-Cordova Bay, and is currently 1% of the baseline. Both areas' CPUE of >L shrimp are significantly below baseline values and neither area shows any significant short term trend.

Carapace Length

Mean CL decreased 2% from the 2010 value in Hetta Inlet, and is currently 92% of the baseline (Figure 9). Mean CL was also decreased 2% from the 2010 value in mid-Cordova Bay, and is currently 90% of the baseline. Both areas mean CLs are significantly below baseline values and neither area shows any significant short term trend.

Size-at-sex

L_{50} was the same as the 2010 value in Hetta Inlet, and is currently 97% of the baseline (Figure 10). L_{50} was also the same as the 2010 value in mid-Cordova Bay, and is currently 95% of the baseline. Both areas L_{50}s are significantly below baseline values and neither area shows any significant short term trend.

DISTRICT 7

Catch Rate

Catch rate of >L shrimp increased 163% from the 2010 value in Lower Ernest Sound, and is currently 115% of the baseline (Figure 13). Catch rate of >L shrimp increased 351% from the 2010 value in Upper Ernest Sound, and is currently 127% of the baseline. Both areas CPUEs of >L shrimp are not significantly different from baseline values and neither area shows any significant short term trends.

Carapace Length

Mean CL increased 3% from the 2010 value in Lower Ernest Sound, and is currently 103% of the baseline (Figure 13). Mean CL decreased 1% from the 2010 value in Upper Ernest Sound, and is currently 91% of the baseline. Lower Ernest Sound mean CL is significantly greater than the baseline, with an increasing short term trend. Upper Ernest Sound mean CL is significantly below the baseline and shows no short term trend.

Size-at-sex

L_{50} was the same as the 2010 value in Lower Ernest Sound, and is currently 103% of the baseline (Figure 14). L_{50} decreased 6% from the 2010 value in Upper Ernest Sound, and is currently 93% of the baseline. Lower Ernest Sound L_{50} is not significantly different from the baseline, and shows no short term trend. Upper Ernest Sound L_{50} is significantly below the baseline and shows no short term trend.

DISTRICT 12

Catch Rate

Catch rate of >L shrimp decreased 88% from the 2010 value in West Tenakee Inlet, and is currently 28% of the baseline (Figure 17). Catch rate of >L shrimp decreased 6% from the 2010 value in East Tenakee Inlet, and is currently 15% of the baseline. Both areas CPUEs of >L shrimp are not significantly different from baseline values and neither area shows any significant short term trend.

Carapace Length

Mean CL was the same as the 2010 value in West Tenakee Inlet, and is currently 104% of the baseline (Figure 17). Mean CL decreased 2% from the 2010 value in East Tenakee Inlet, and is currently 87% of the baseline. West Tenakee Inlet mean CL is significantly above the baseline, but shows no short term trend. East Tenakee Inlet mean CL is significantly below the baseline and shows no short term trend.

Size-at-sex

L_{50} was the same as the 2010 value in West Tenakee Inlet, and is currently 98% of the baseline (Figure 18). L_{50} increased 1% from the 2010 value in East Tenakee Inlet, and is currently 96% of the baseline. Both areas mean L_{50}s are significantly below baseline values and neither area shows any significant short term trend.

DISTRICT 13, SECTION 13-C

Catch Rate

Catch rate of >L shrimp increased 45% from the 2010 value in Hoonah Sound, and is currently 79% of the baseline (Figure 21). Hoonah Sound CPUE of >L shrimp shows no significant difference from the baseline and shows no short term trend.

Carapace Length

Mean CL decreased 1% from the 2010 value in Hoonah Sound, but is currently standing at 94% of the baseline (Figure 21). Hoonah Sound mean CL is significantly below the baseline and shows no short term trend.

Size-at-sex

L_{50} was the same as the 2010 value in Hoonah Sound, and is currently standing at 91% of the baseline (Figure 22). Hoonah Sound L_{50} is significantly below the baseline value and shows no significant short term trend.

BYCATCH

All bycatch caught in the surveys were enumerated and classified either by species or species group. The top four bycatch groups were squat lobsters (*Munida quadrispina*); noncommercial shrimp species; noncommercial crab species; and snails.

DISCUSSION

During the first year of using an increased number of 5-pot small mesh pot strings in all survey areas, we found that we could set, haul and sample an average of 9 strings daily, the same number as in the pilot method change in Districts 3 & 7 in 2010. This allowed an additional 36 pots to be pulled in Districts 12 & 13. We believe this is the maximum number of strings we can pull while maintaining the standardized soak times with the current sampling regime. The time taken to count and measure shrimp prevents us from pulling more strings.

Due to increased funding by the legislature we were able to add three survey areas in District 1 to the 2011 survey. Also, due to cost savings from conducting the District 12 & 13 surveys on a state vessel, rather than a chartered vessel, we were able to add two survey areas in District 2. This means that we now survey districts that account for 64% of the historical harvest, and 52% of the 2010/2011 harvest. This is a notable improvement from the 33% of the recent historical harvest (1998/1999–2010/2011), and 39% of the 2010/2011 harvest the survey covered prior to the 2011 season.

NEXT STEPS

The next shrimp research priority is to decide how to integrate the data obtained from the new strings into the long-term index of abundance for each district. In order to reduce interannual variation, each district has established stations. A linear regression is used to compare short term trends over the past four years, thus the introduction of new stations, though allowing for a higher sample size, creates unequal sample sizes and the potential for the introduction of bias over the short term. One possibility is to collect data from the new stations for four years before integrating the data into management; although this would likely be the smoothest way to integrate the data, it has obvious disadvantages as the collected data would not become useful for management for four years.

An additional priority is expansion of the stock assessment program to establish annual preseason surveys in all districts where the upper end of the GHR is ≥ 50,000 lb and data confidence is low. This includes Section 3-B/C, District 6 and District 10. Prioritizing areas in order of mean harvest from 1998/1999–2010/2011 yields, respectively: District 6, District 10, and Sections 3-B/C. If these three areas are added the surveyed districts would cover 82% of historic harvest, and 82% of the 2009/2010 harvest.

The final priority is to begin shrimp life history parameter studies, particularly to obtain a better understanding of growth in Southeastern Alaska. Further study of growth may allow implementation of catch-survey modeling-based estimation of population size, and a shift from the current index-based to abundance-based management.

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TABLES AND FIGURES

Table 1–Latitude and longitude of CTD cast stations occupied during the 2011 pot shrimp survey in Southeastern Alaska.

Location	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
West Behm	55.58435	-131.81601
George & Carroll	55.30817	-131.49914
Hoonah Sound	57.57518	-135.50236
Tenakee Inlet	57.75844	-135.14554
Chatham Strait	57.58943	-134.76149
Stephens Passage	58.21163	-134.59097

Table 2–Spot shrimp CPUE and carapace length from pilot surveys in Districts 1 and 2.

			Carapace Length (mm)			CPUE (g/pot)				
Year	District	Analysis Area	N	Mean	SE	N	<XL	SE	≥XL	SE
2011	1	Back Behm Canal	2,782	37.96	0.115	59	2,528	225	2,191	314
2011	1	West Behm Canal	1,510	37.12	0.163	55	1,294	230	723	136
2011	1	Inner Ketchikan Inlets	655	37.11	0.316	54	255	62	213	50
2011	2	Cholmondeley Sound	2,788	35.37	0.093	57	4,586	301	1,548	192
2011	2	Kassaan Bay	2,299	35.48	0.093	54	2,479	291	713	96

Table 3– Spot shrimp L50 and standard error from pilot surveys in Districts 1 and 2 during the 2011 surveys.

				L_{50}		
Year	District	Analysis Area	N	Lower 95% CI	Estimate	Upper 95% CI
2011	1	Back Behm Canal	333	41.10	41.89	42.81
2011	1	West Behm Canal	209	42.09	44.08	47.64
2011	1	Inner Ketchikan Inlets			Inadequate sample size	
2011	2	Cholmondeley Sound	408	38.39	39.33	40.66
2011	2	Kassaan Bay	159	37.44	38.80	41.33

Table 4–Individual shrimp size class weight delineations used by the survey.

Analysis size group	Size class	Shrimp Weight (g)
Large and smaller	XS	W≤19.5
	Small	19.5< W <23.5
	Medium	23.5≤W <30.5
	Large	30.5≤W <40.5
Greater than large	XL	40.5≤W <50.5
	XXL	50.5≤W <67.5
	XXXL	67.5≤ W <101.5
	Jumbo	101.5≤ W

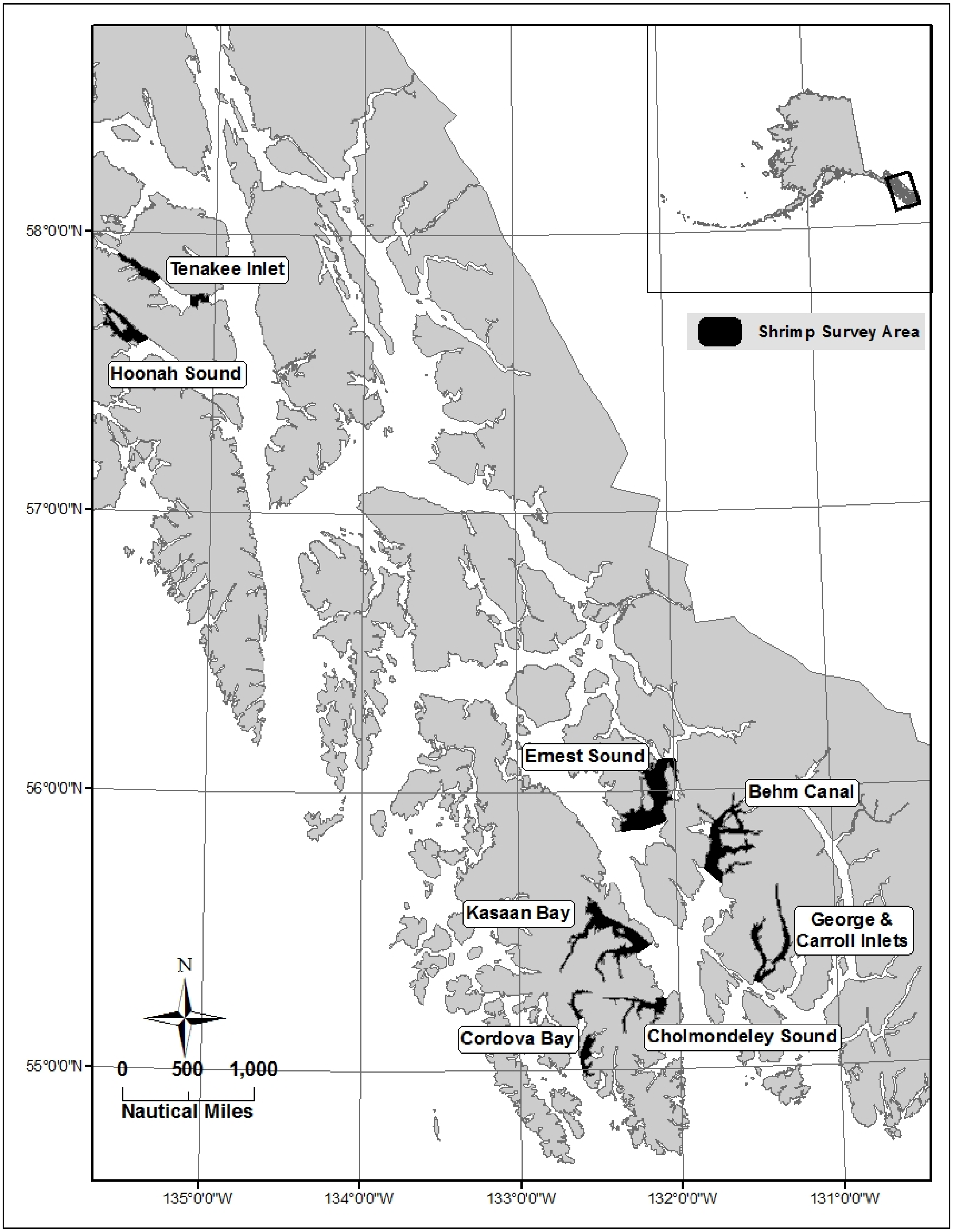

Figure 1–Spot shrimp, *Pandalus platyceros*, survey areas in Southeastern Alaska, Registration Area A.

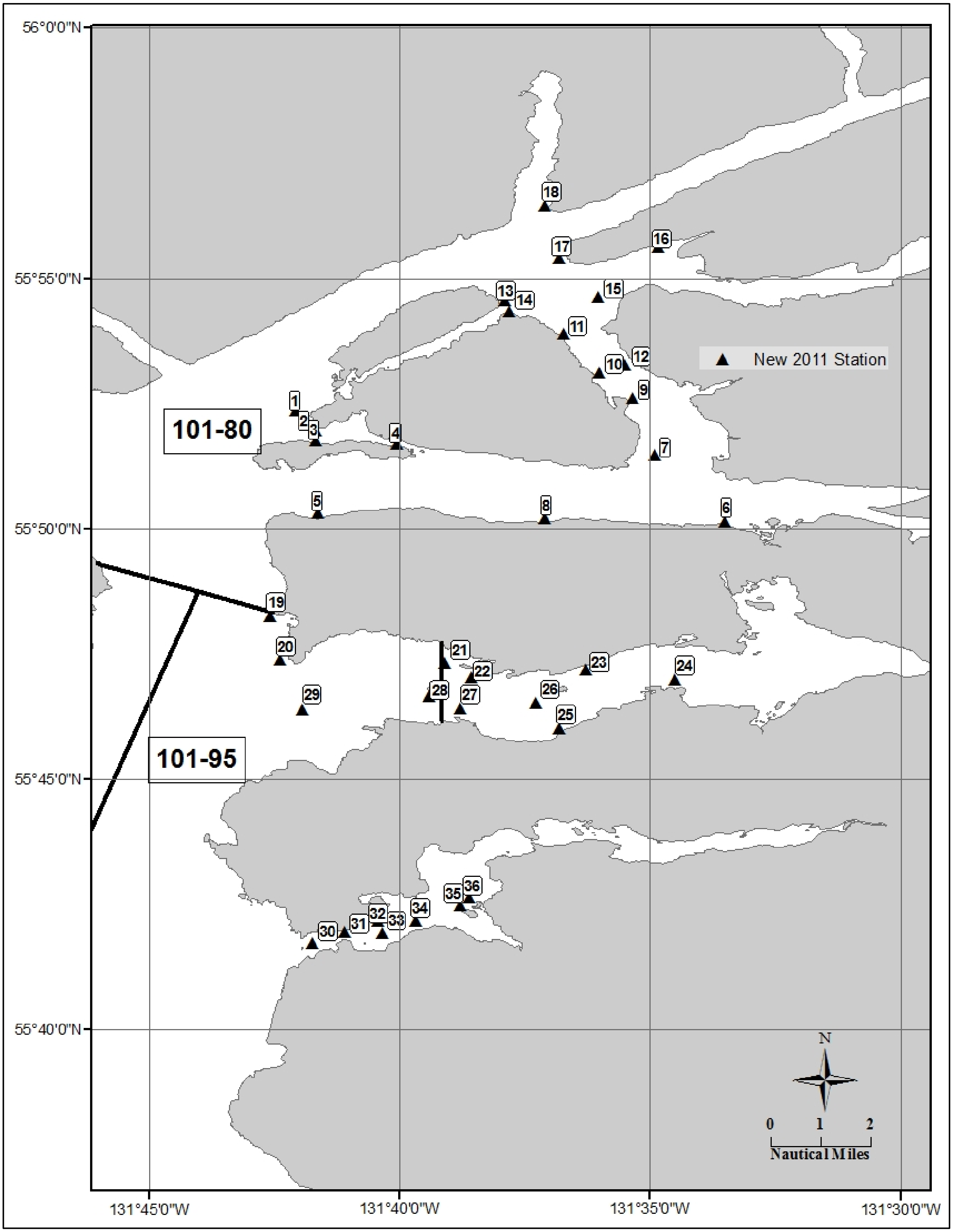

Figure 2–Station locations of 5-pot longlined strings in West and Back Behm Canals, District 1, Southeastern Alaska, during the 2011 survey.

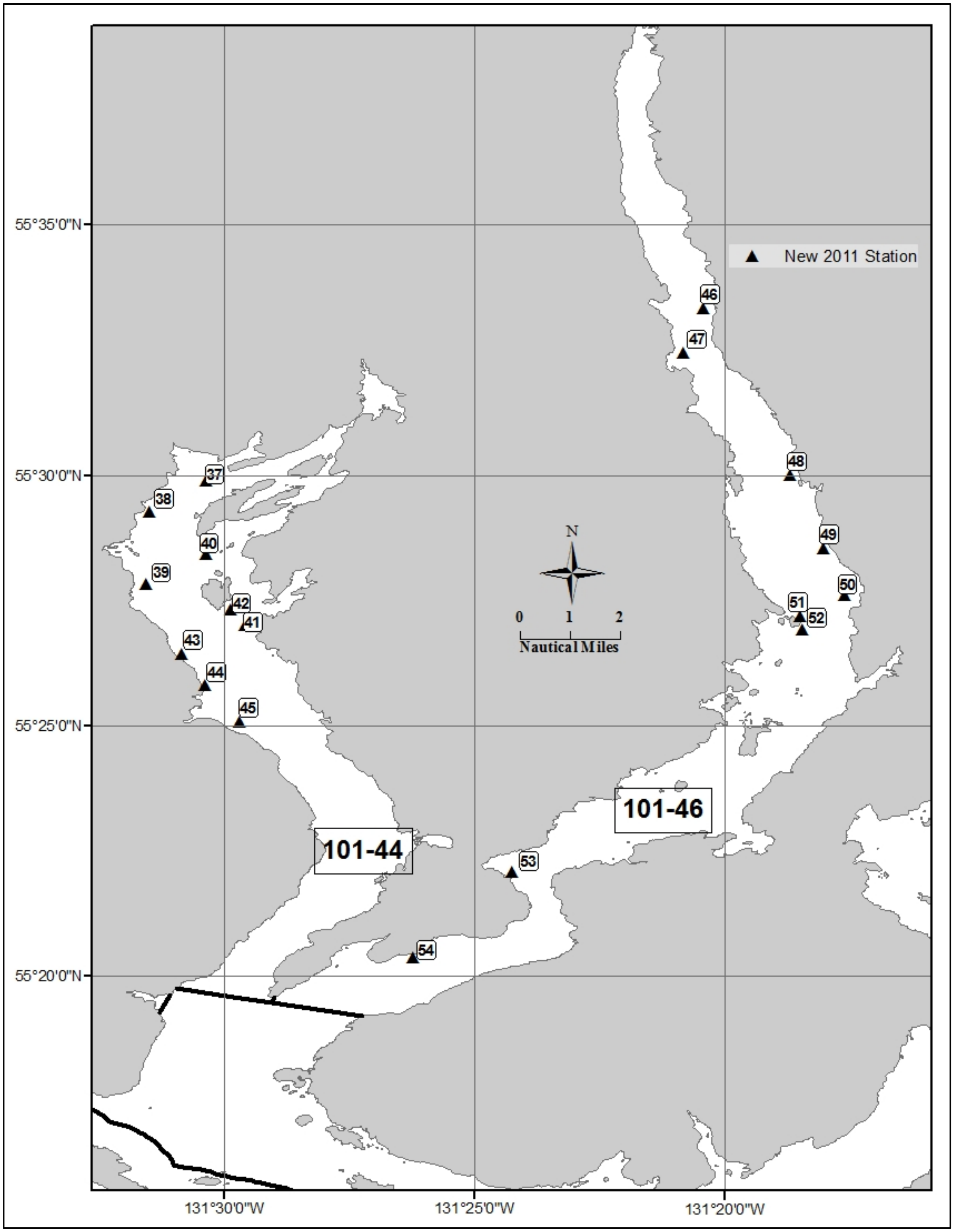

Figure 3–Station locations of 5-pot longlined strings in George and Carroll Inlets, District 1, Southeastern Alaska, during the 2011 survey.

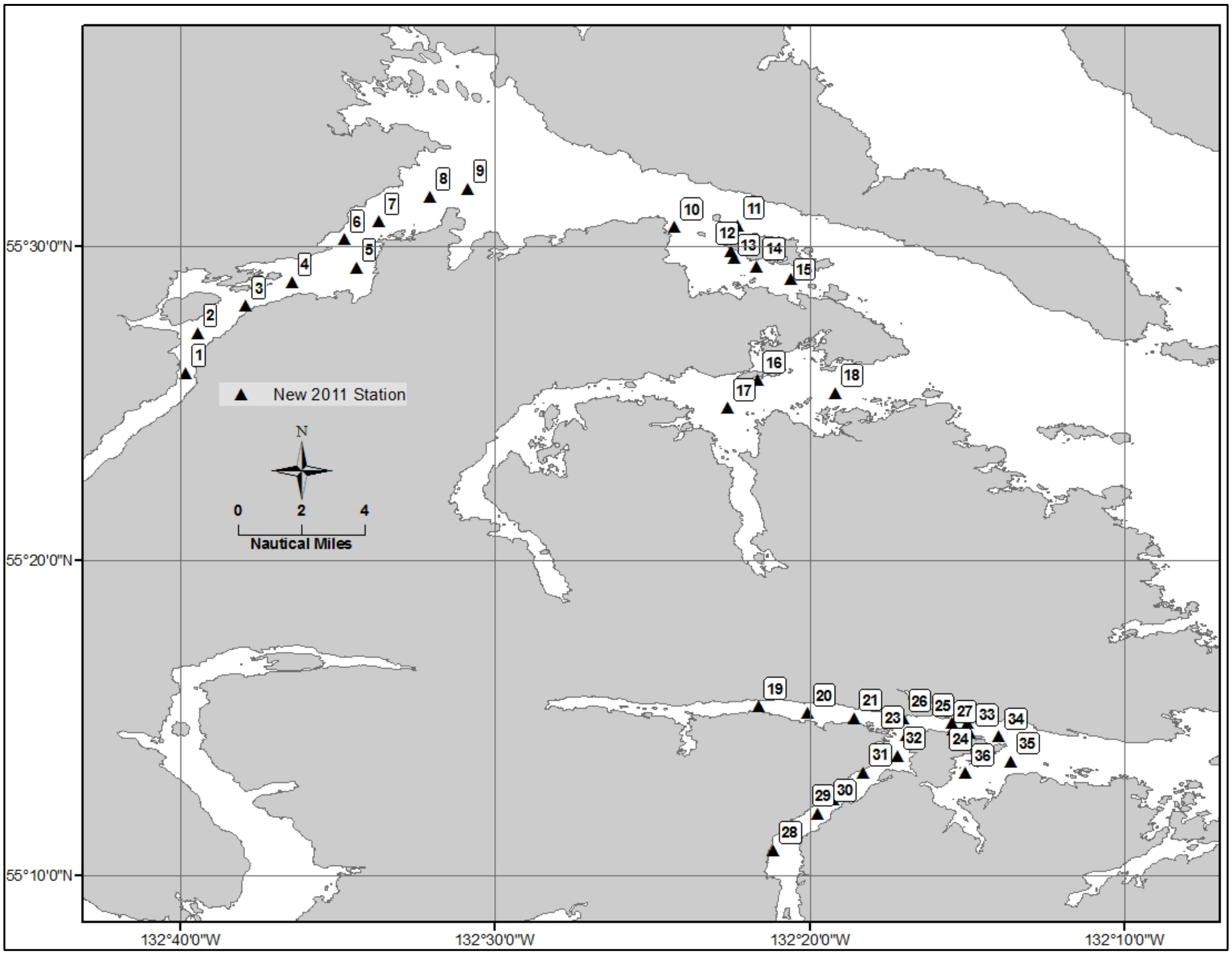

Figure 4–Station locations of 5-pot longlined strings in Kasaan Bay and Cholmondeley Sound, District 2, Southeastern Alaska, during the 2011 survey.

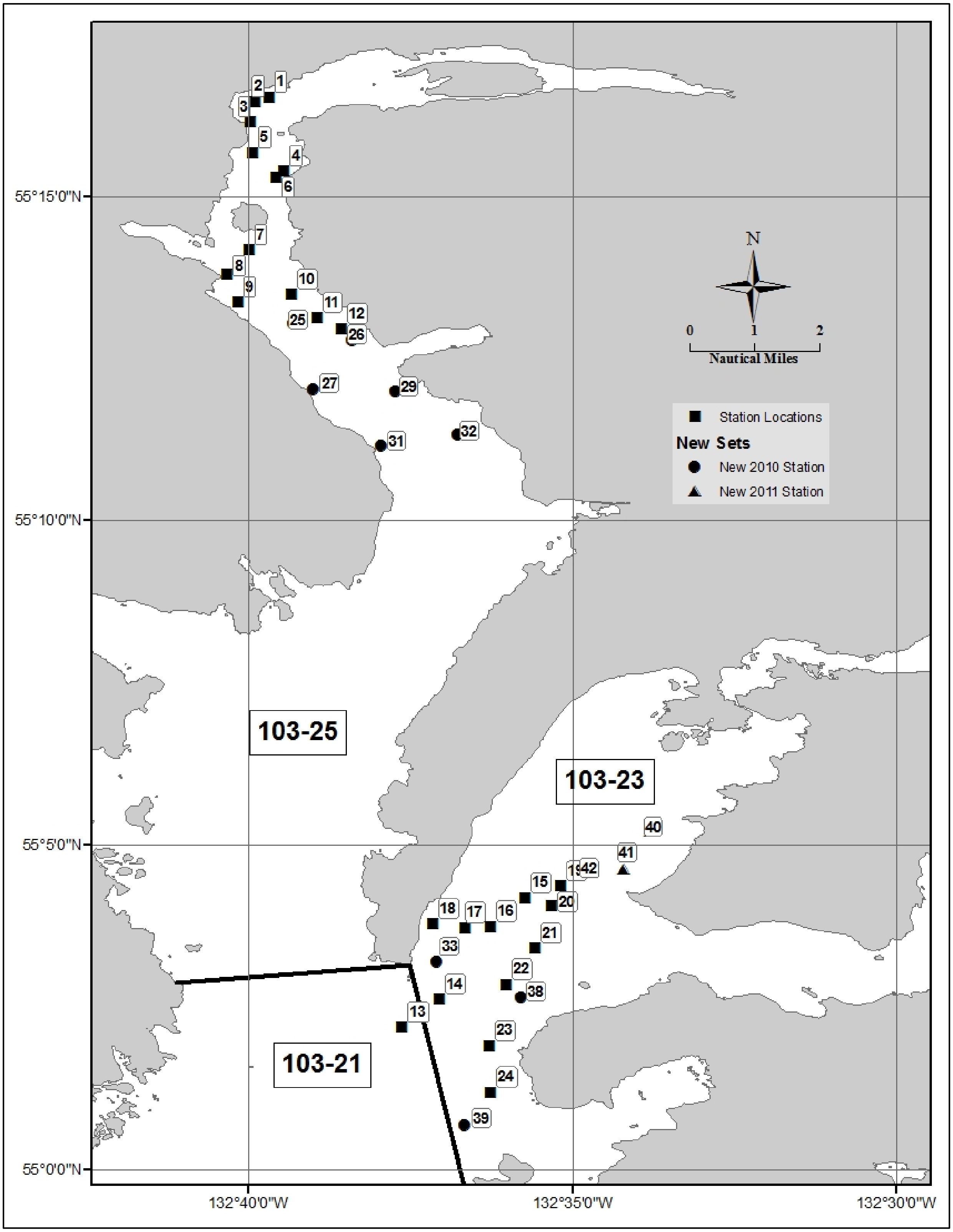

Figure 5–Station locations of 5-pot longlined strings in mid-Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during the 2011 survey.

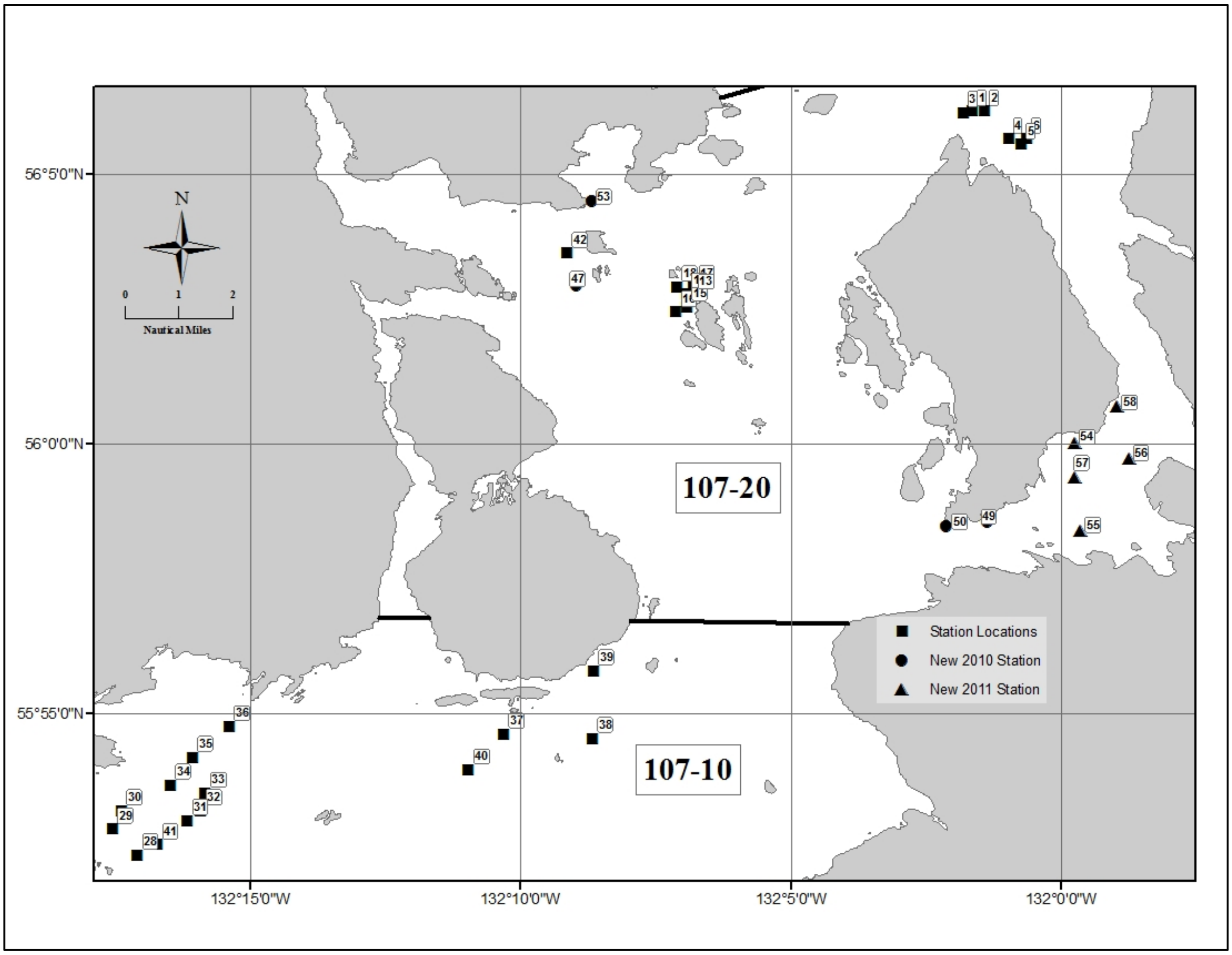

Figure 6–Station locations for 5-pot longlined strings in Lower Ernest Sound (107-10) and Upper Ernest Sound (107-20) analysis areas of District 7, Southeastern Alaska during the 2011 survey.

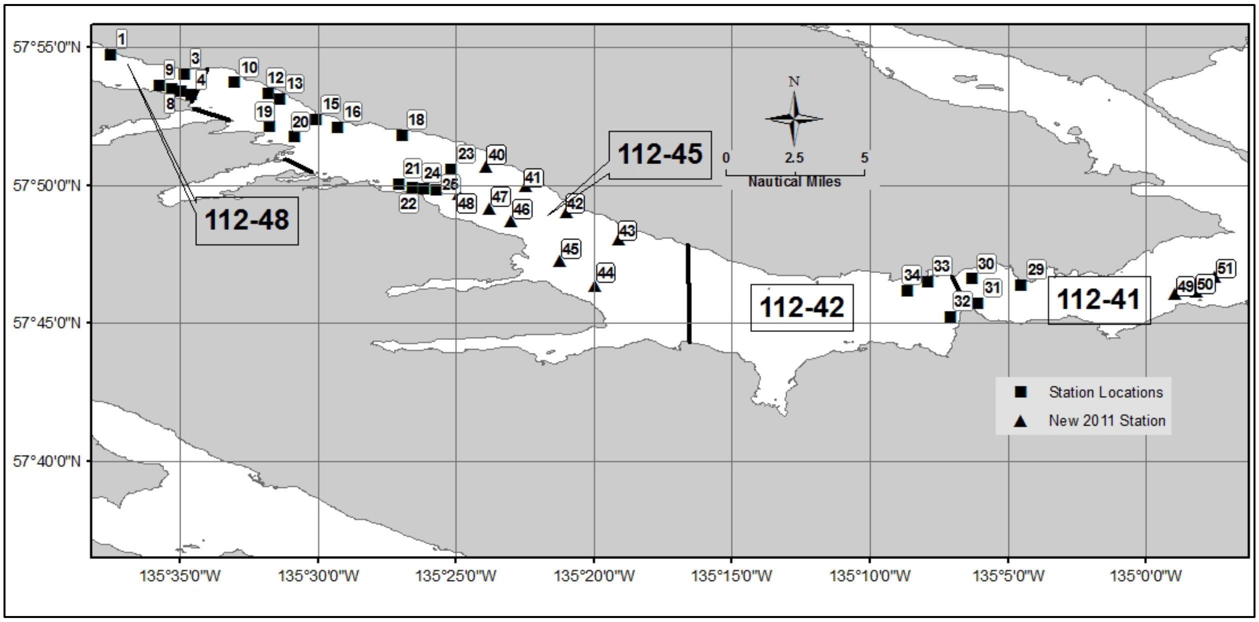

Figure 7–Station locations for 10-pot longlined strings in East Tenakee (112-41, and 112-42), and West Tenakee Inlet (112-45) analysis areas of District 12, Tenakee, Southeastern Alaska during the 2011 survey.

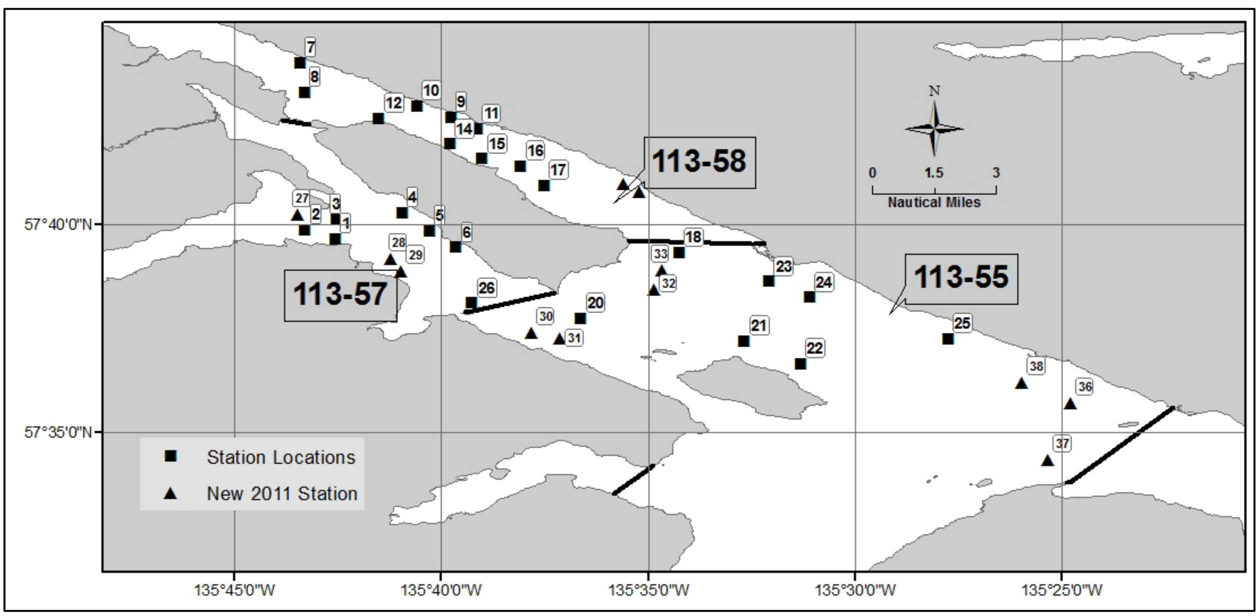

Figure 8–Station locations for 10-pot longlined strings in the Hoonah Sound (113-55, 113-57, and 113-58) analysis area of District 13, Section 13-C, Southeastern Alaska during the 2010 survey.

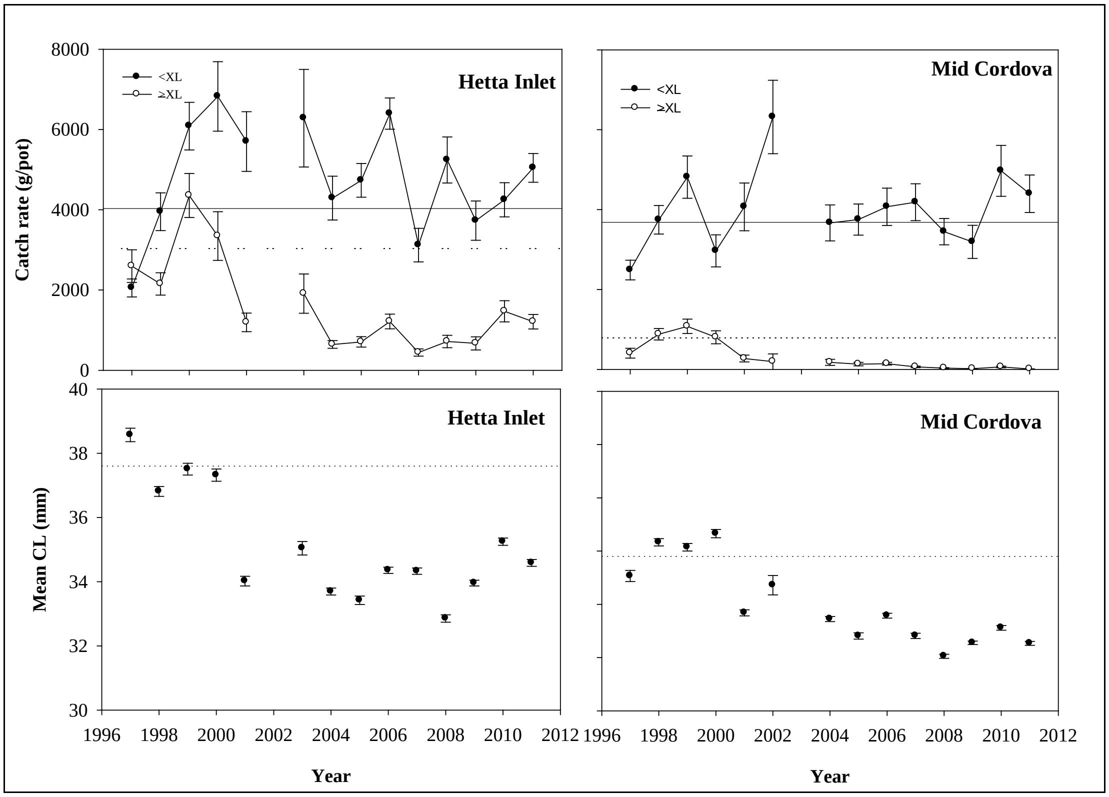

Figure 9– Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of mid-Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during 1997–2011 surveys. Reference lines represent the long-term baselines.

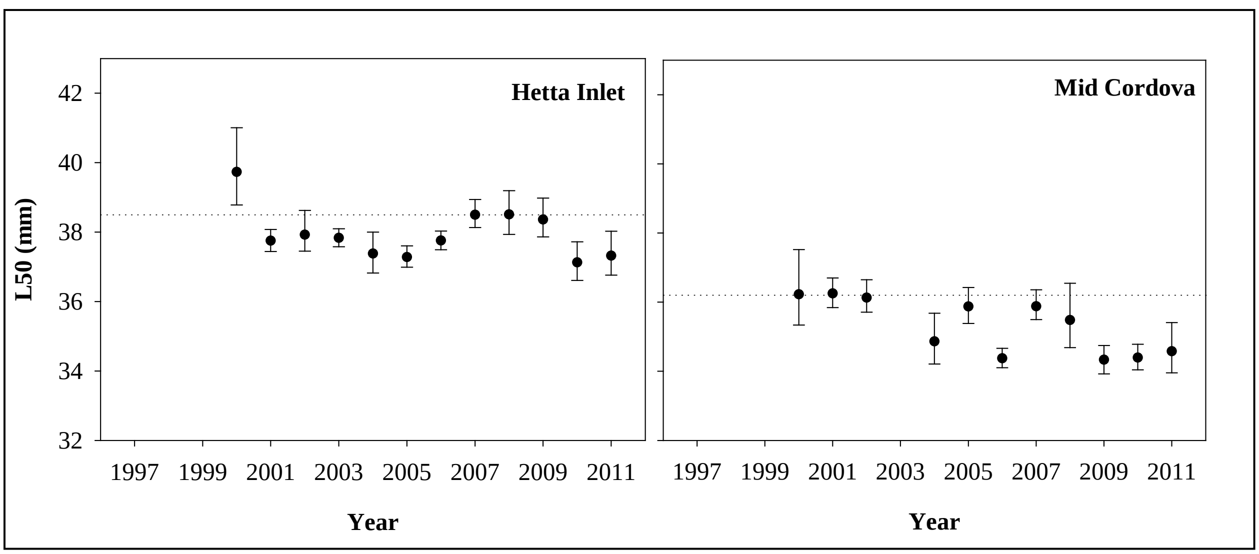

Figure 10–Spot shrimp L50 and standard error from preseason surveys of mid-Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during 2000–2011 surveys. Dotted line represents the long-term baseline.

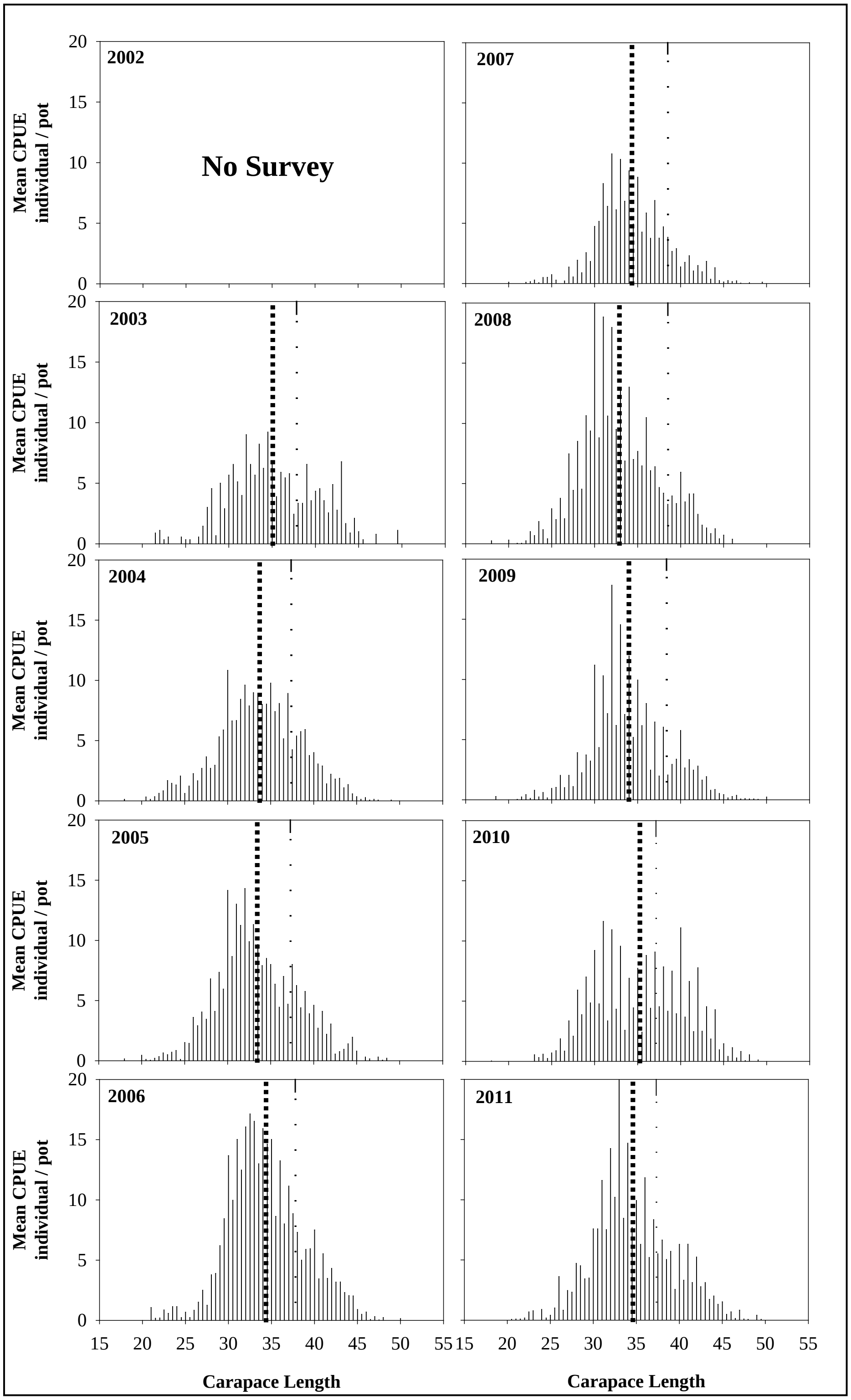

Figure 11–Shrimp length frequencies in the Hetta Inlet Survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

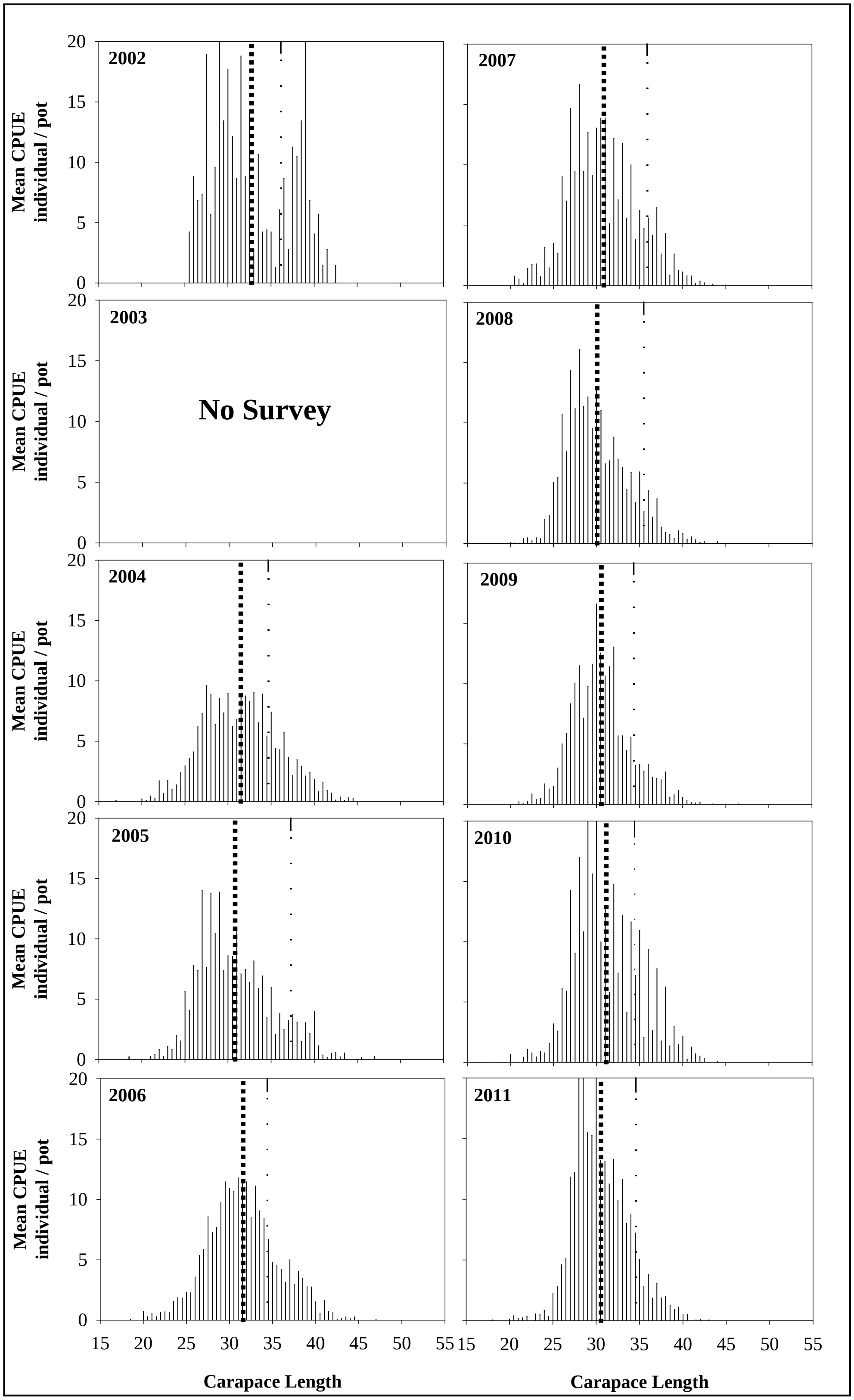

Figure 12–Shrimp length frequencies in the mid-Cordova survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

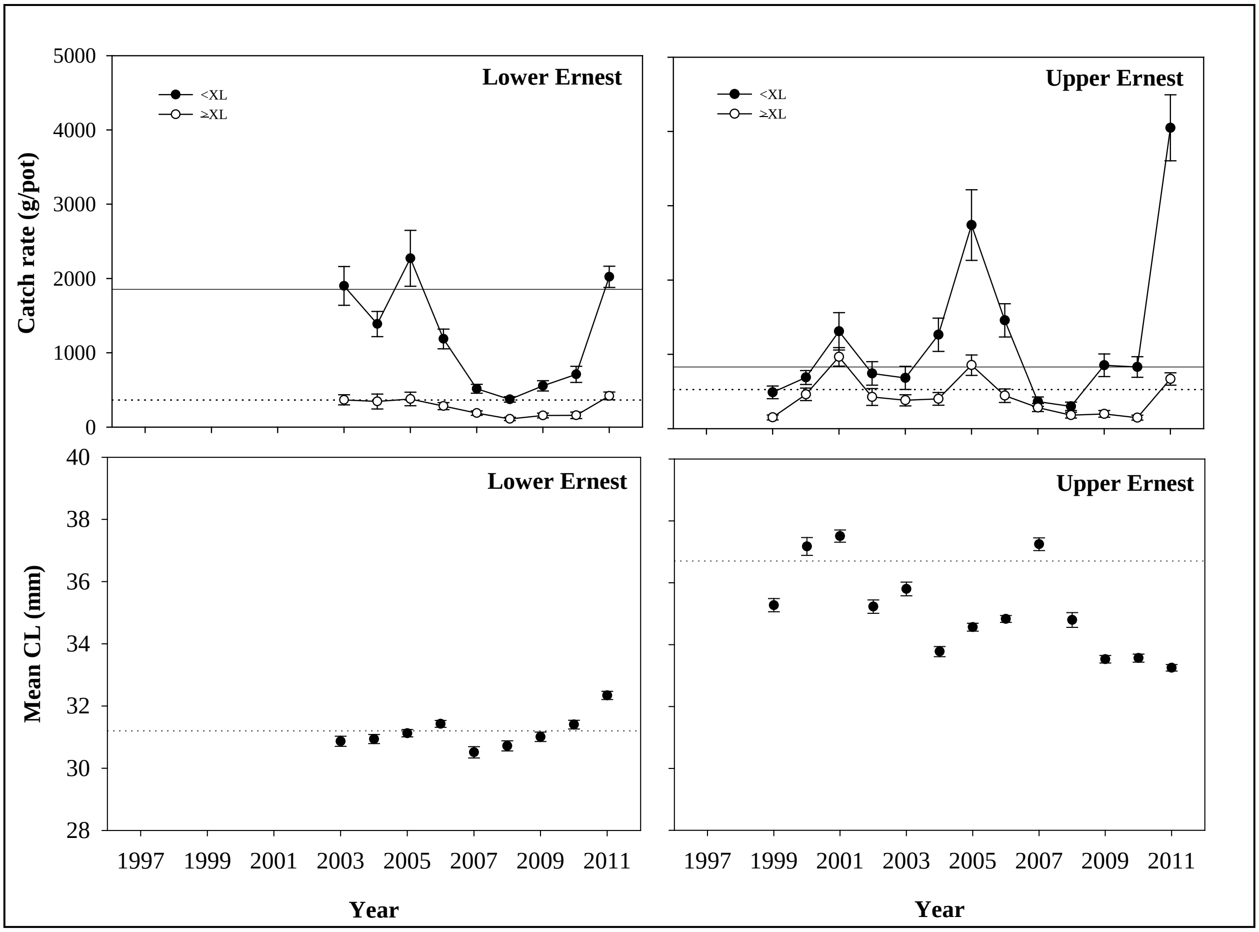

Figure 13–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of Lower Ernest Sound and Upper Ernest Sound analysis areas of District 7, Southeastern Alaska during 1999–2011 surveys. Dotted line represents the long-term baseline.

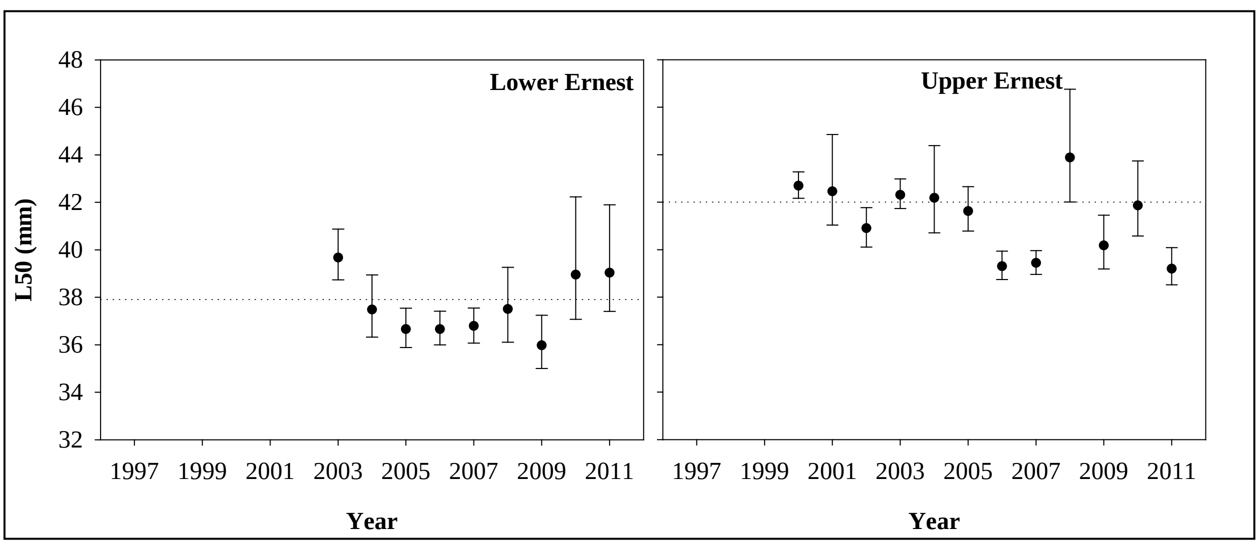

Figure 14–Spot shrimp L_{50} and standard error from Lower Ernest Sound and Upper Ernest Sound analysis areas of District 7, Southeastern Alaska during 2000–2011 surveys. Dotted line represents the long-term baseline.

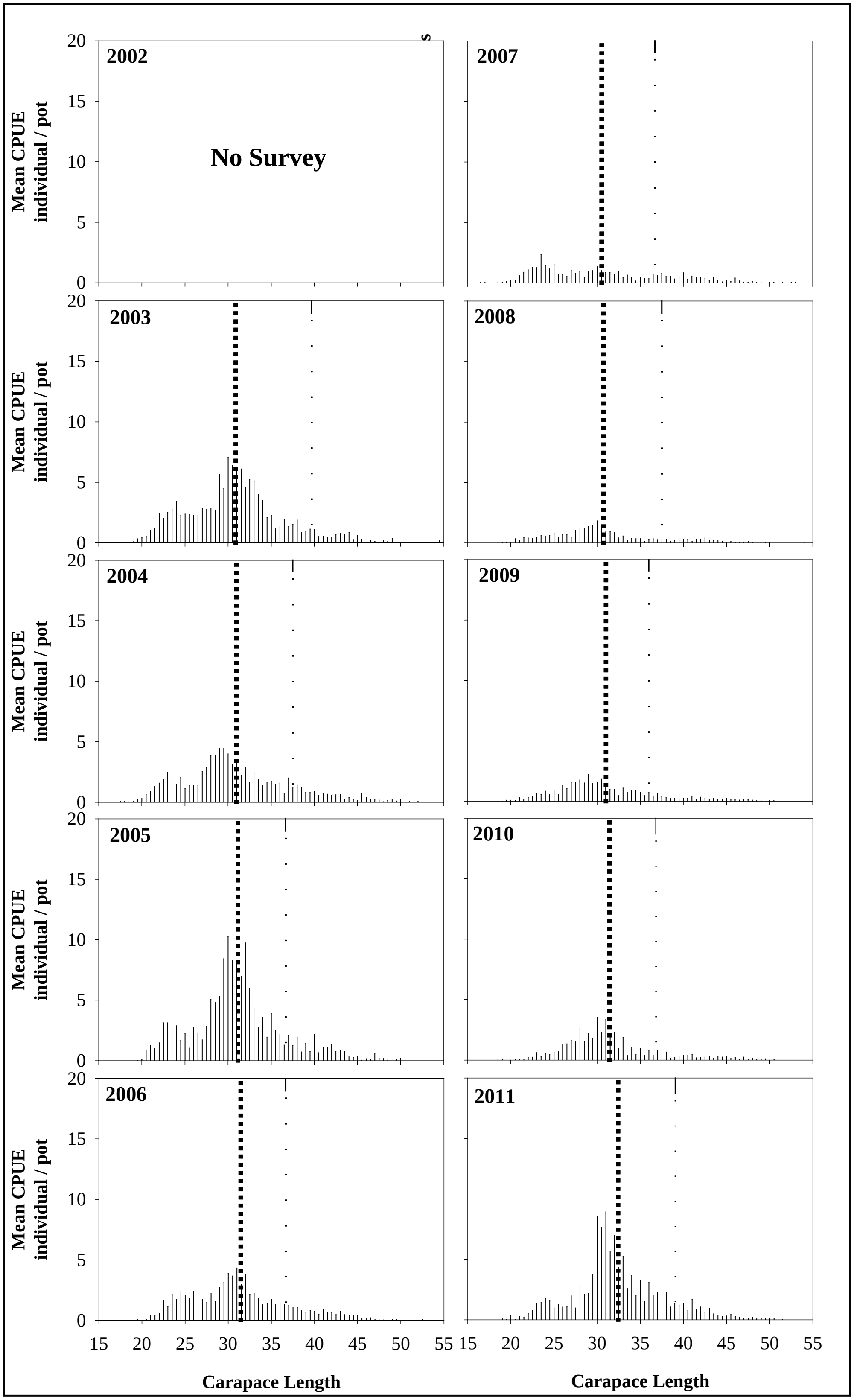

Figure 15–Shrimp length frequencies in the Lower Ernest Sound survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

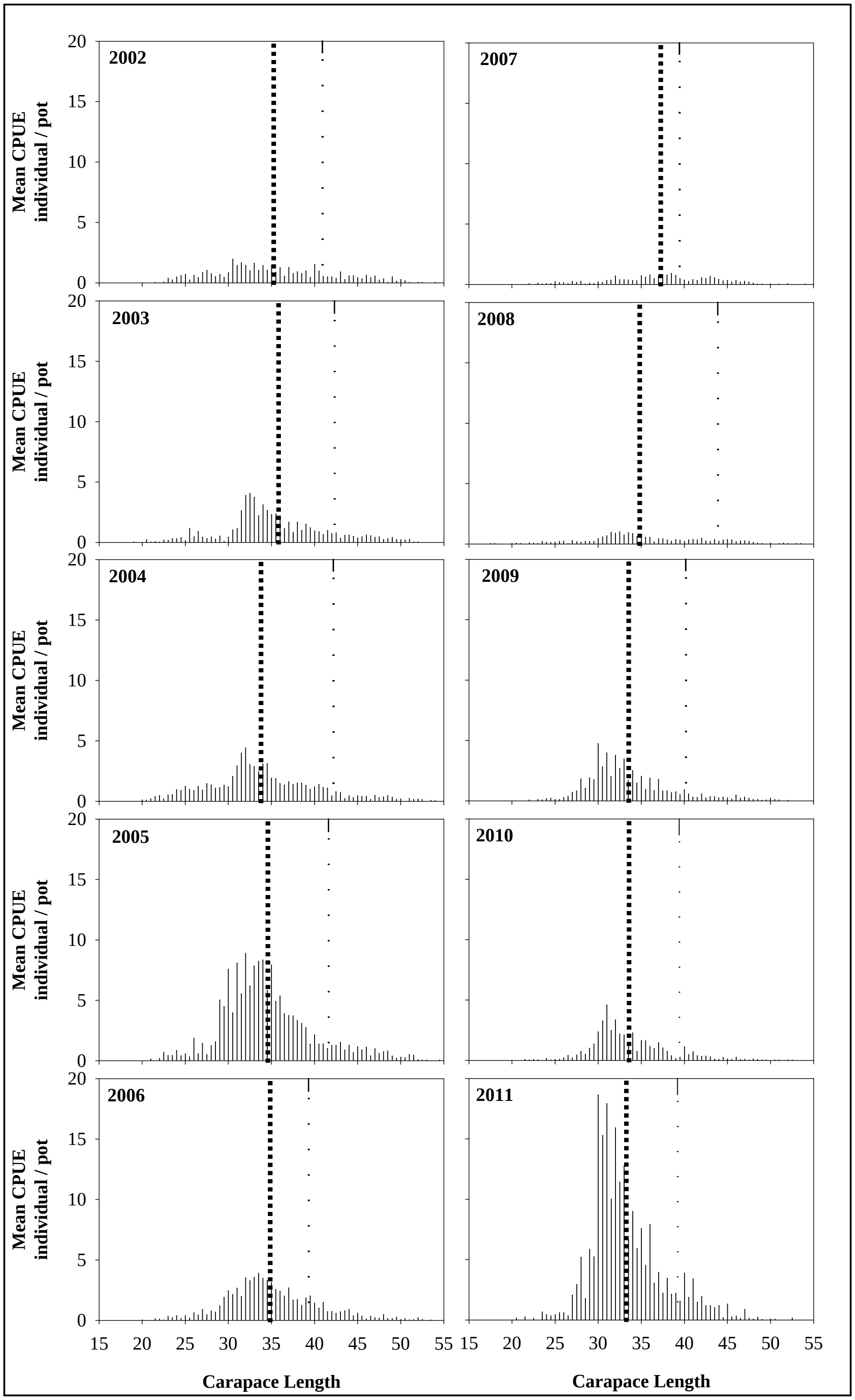

Figure 16–Shrimp length frequencies in the Upper Ernest Sound survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

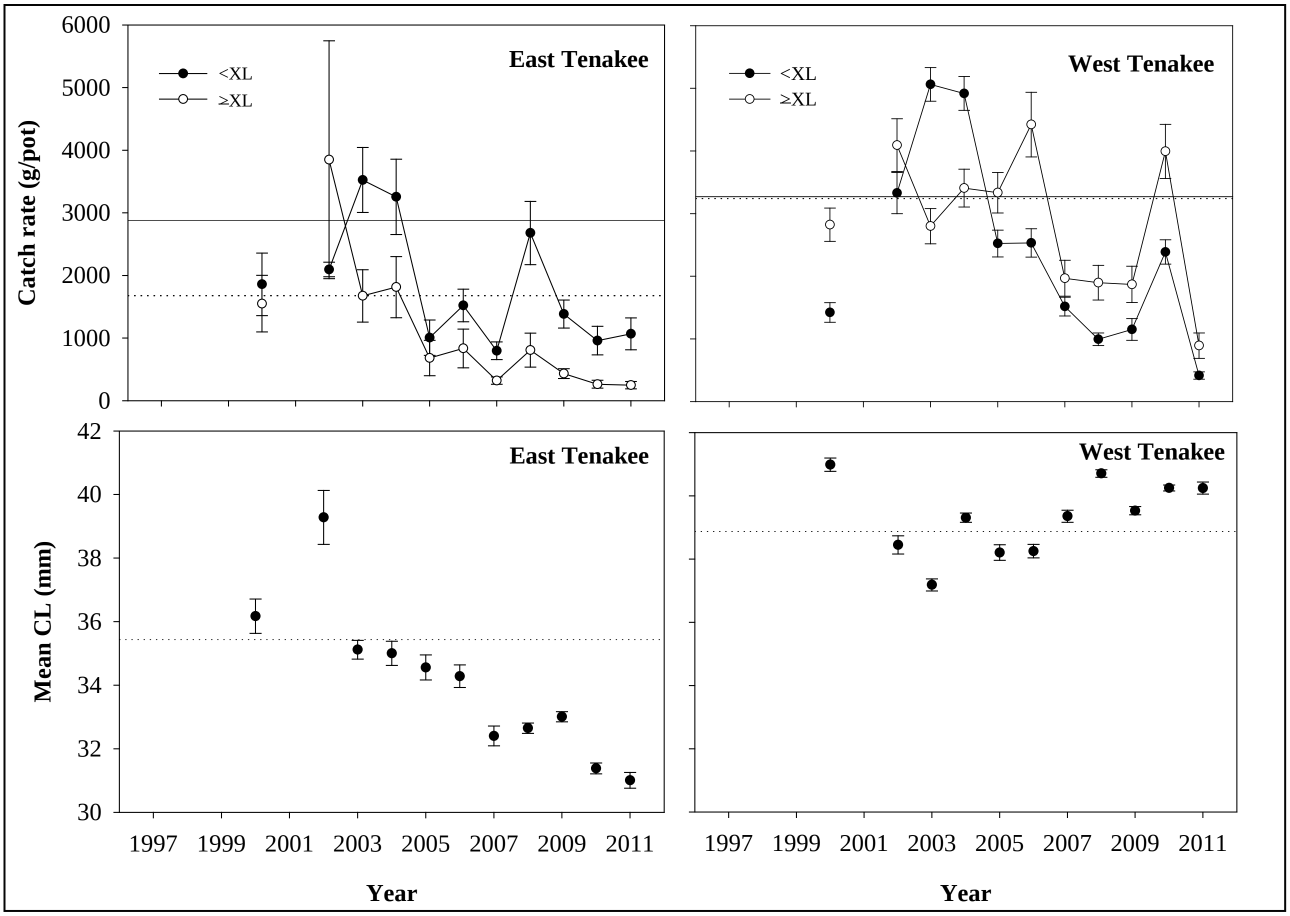

Figure 17–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of East Tenakee, and West Tenakee Inlet analysis areas of District 12, Tenakee, Southeastern Alaska during 2000–2011 surveys. Dotted line represents the long-term baseline.

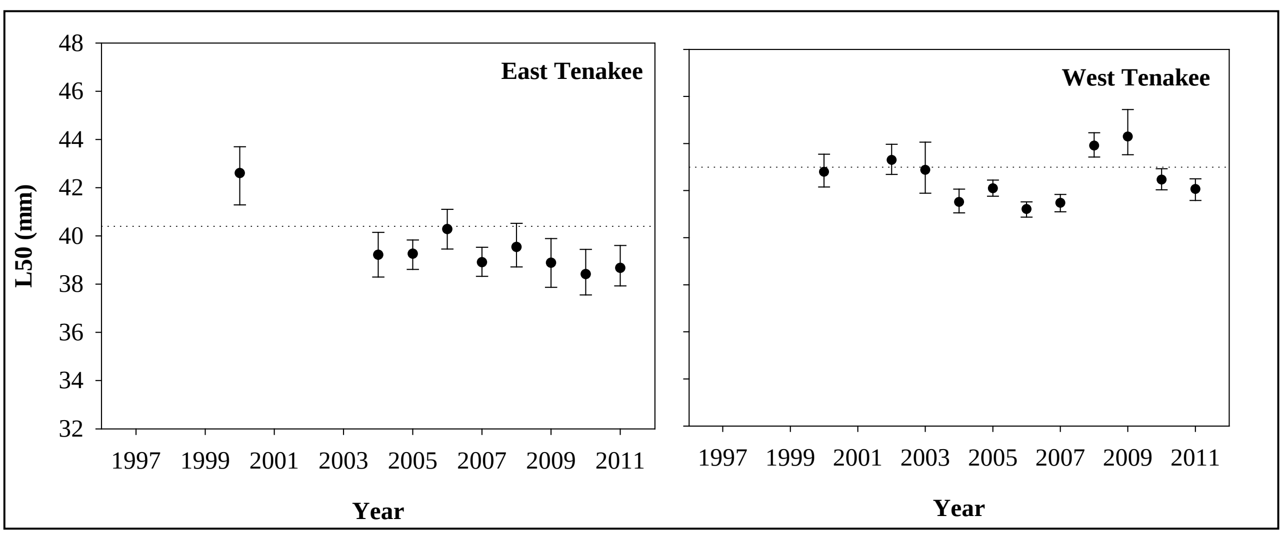

Figure 18–Spot shrimp L_{50} and standard error from East Tenakee, and West Tenakee Inlet analysis areas of District 12, Tenakee, Southeastern Alaska during 2000–2011 surveys. Dotted line represents the long-term baseline.

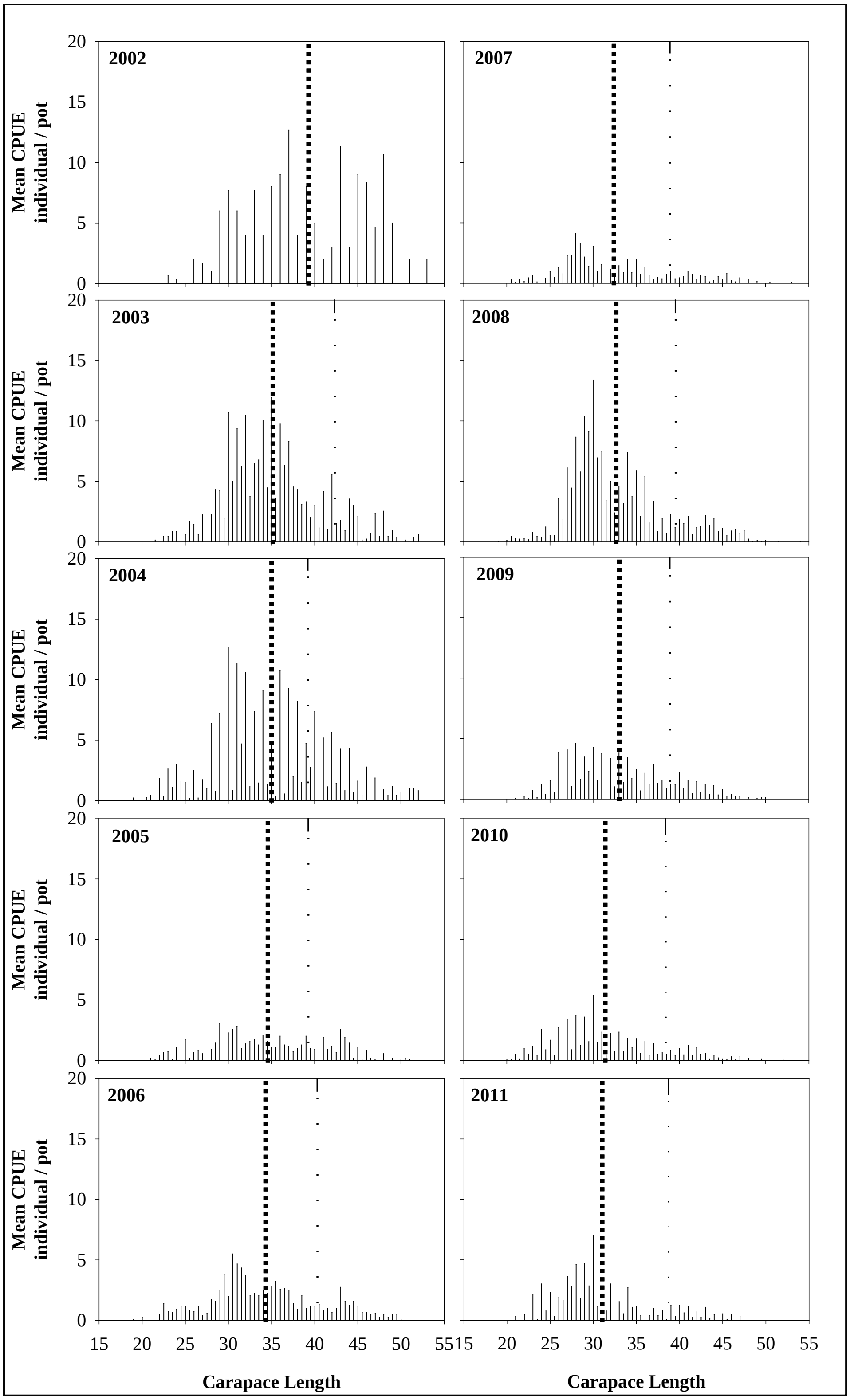

Figure 19–Shrimp length frequencies in the East Tenakee survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

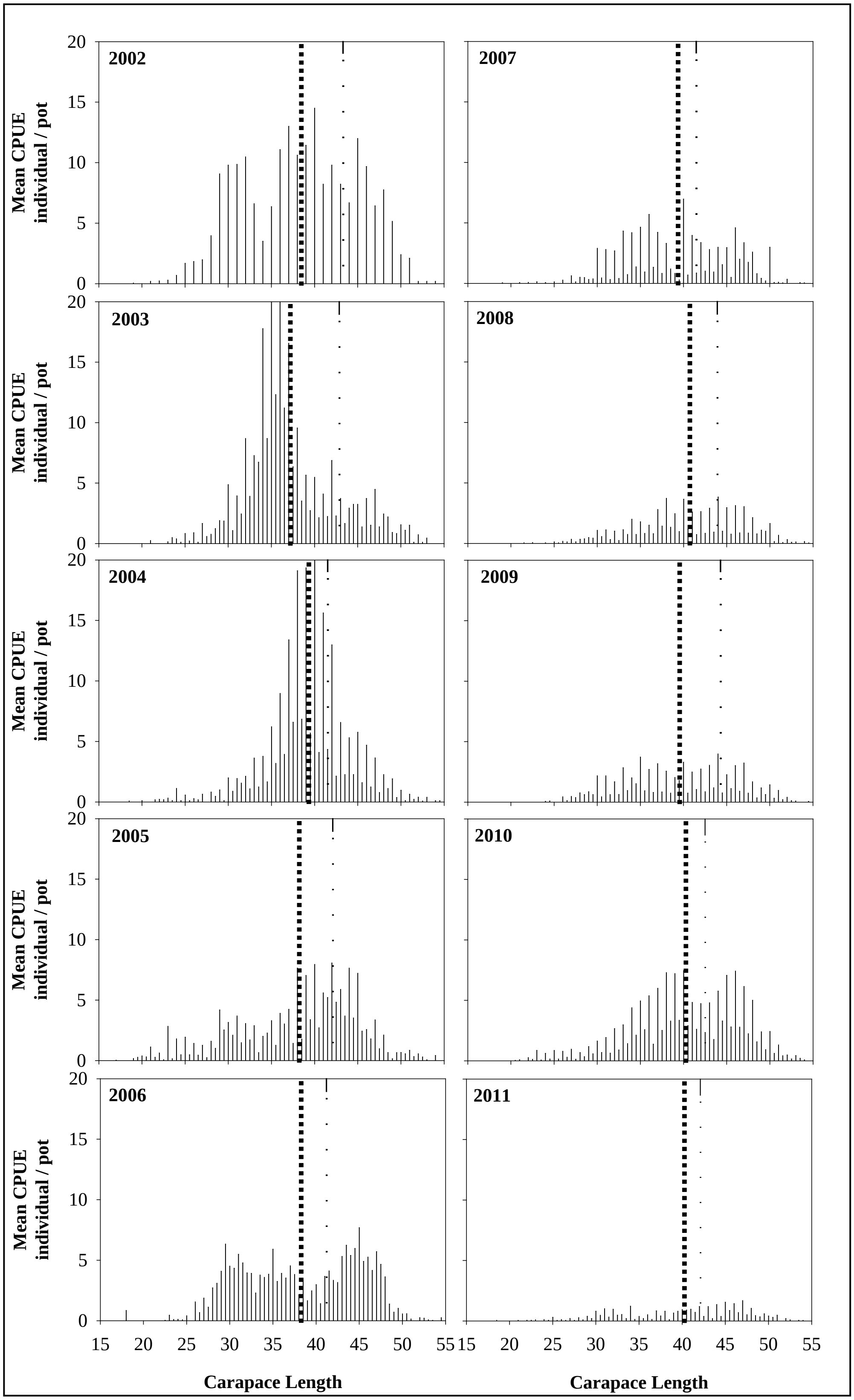

Figure 20–Shrimp length frequencies in the West Tenakee survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

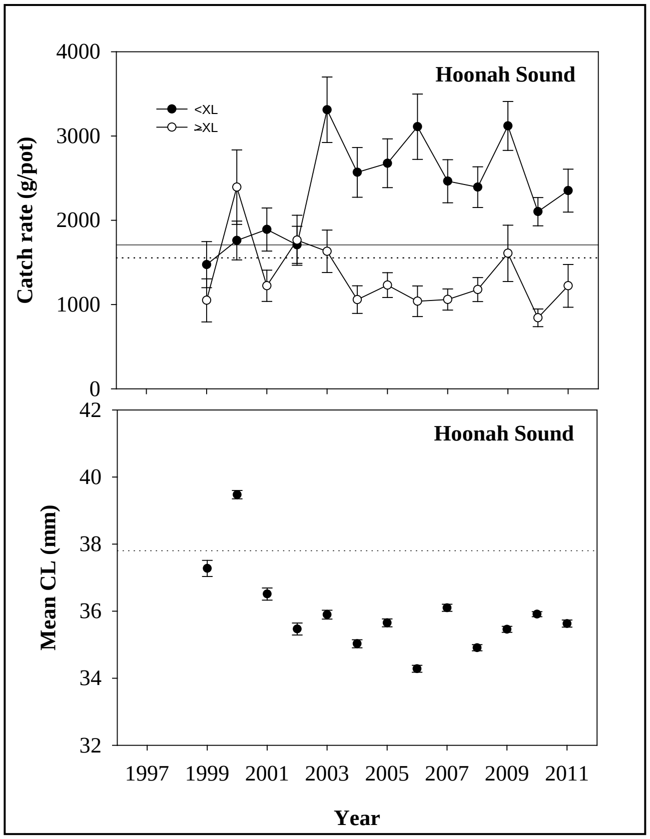

Figure 21–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of Hoonah Sound analysis areas of District 13, Section 13-C, Southeastern Alaska during 1999–2011 surveys. Dotted line represents the long-term baseline.

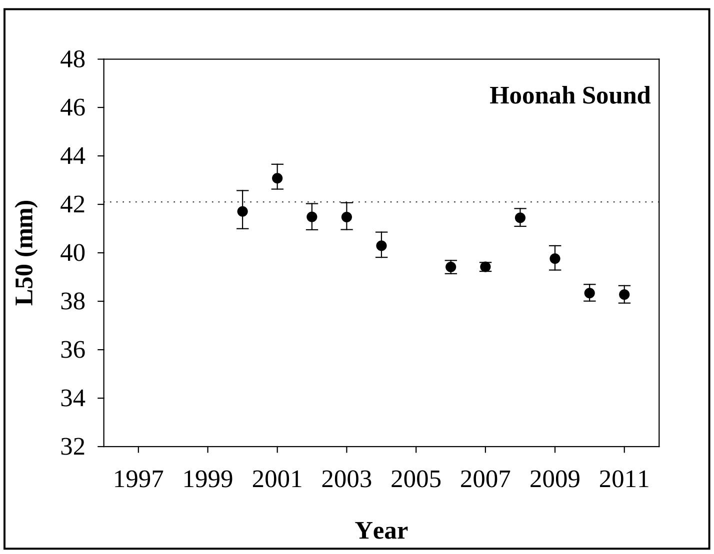

Figure 22–Spot shrimp L_{50} and standard error from Hoonah Sound analysis areas of District 13, Section 13-C, Southeastern Alaska during 2000–2011 surveys. Dotted line represents the long-term baseline.

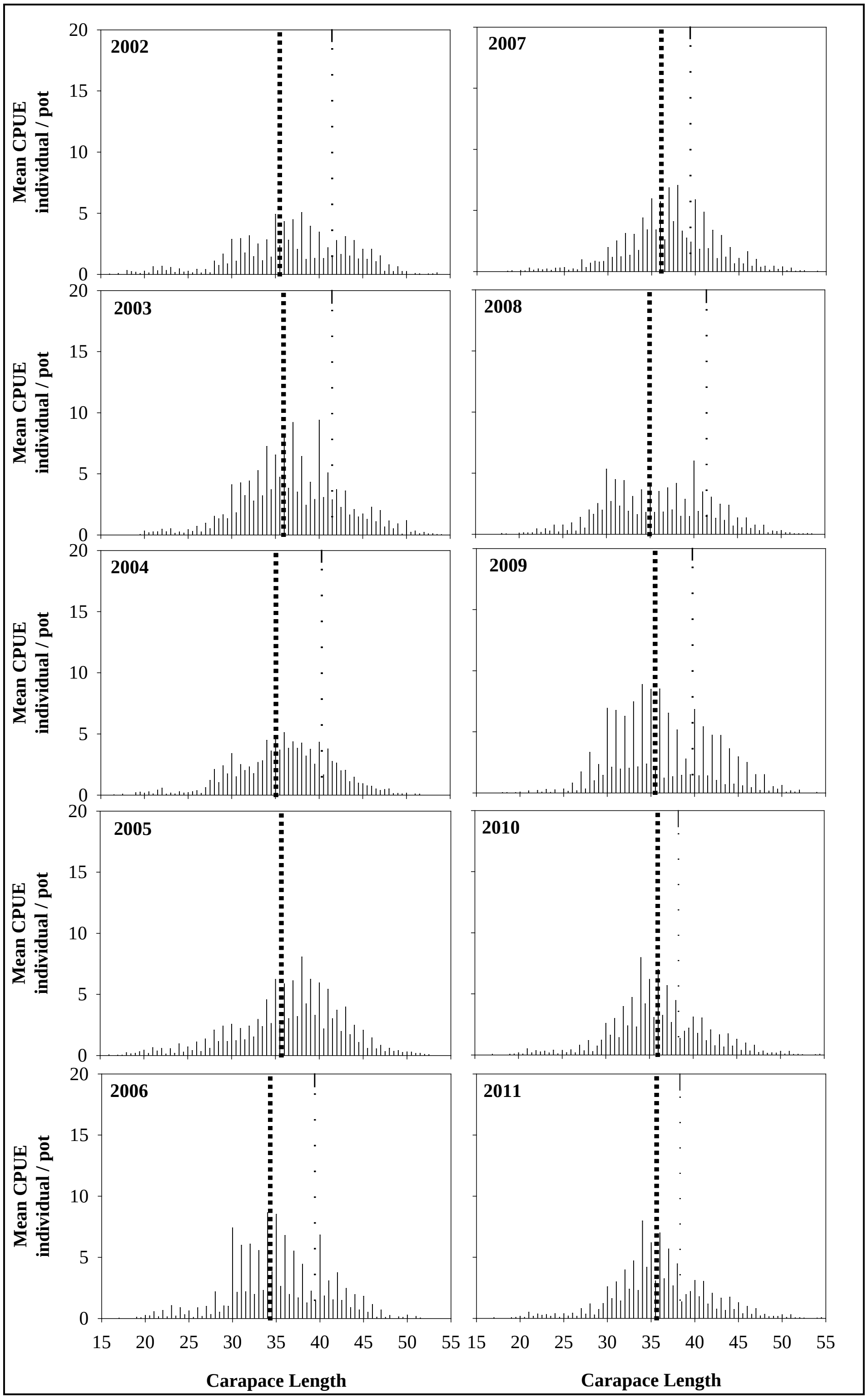

Figure 23–Shrimp length frequencies in the Hoonah Sound survey from 2002–2011. Dotted line shows mean CL, and dashed line shows L_{50}.

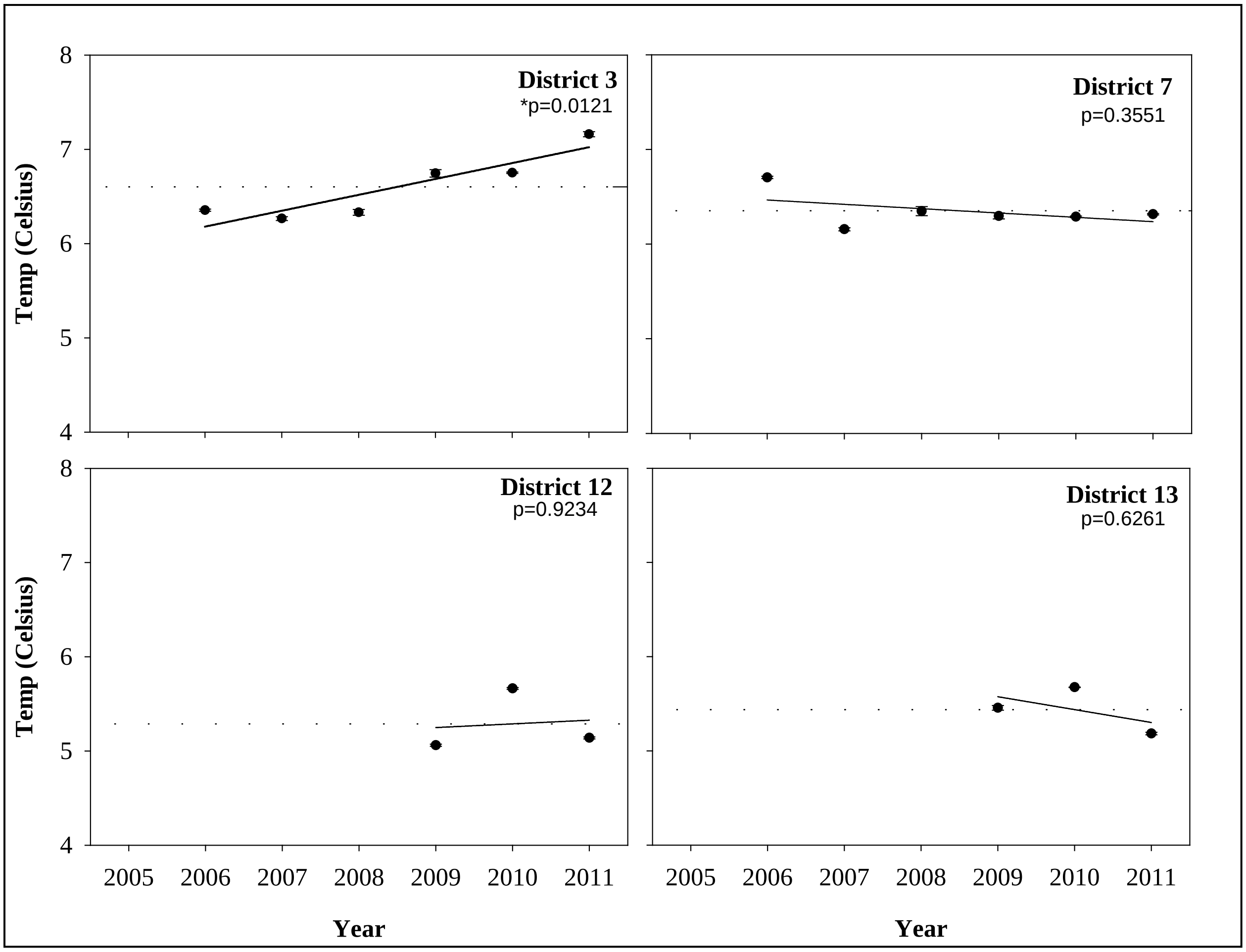

Figure 24–Trends in mean bottom temperature, measured by attaching tidbits to pots during shrimp pot surveys in Districts 3, 7, 12, and 13 of Southeastern Alaska. Dotted lines represent mean temperature from all measured years. Solid lines, and p-values show results of linear regression.

APPENDICES

Appendix A1–Spot shrimp baselines and their respective reference years for analysis of data from the pot shrimp survey in Districts 3, 7, 12, and 13 of Southeastern Alaska.

District	Analysis Area	Test	Baseline year range
3	Hetta Inlet	>L CPUE	1998–2000
		CL	1998–2000
		L_{50}	2001, 2003, 2004
	Mid-Cordova	>L CPUE	1998–2000
		CL	1998–2000
		L_{50}	2001, 2004, 2005
7	Lower Ernest	>L CPUE	2003–2005
		CL	2003–2005
		L_{50}	2003–2005
	Upper Ernest	>L CPUE	2000–2002
		CL	2000–2002
		L_{50}	2000, 2003, 2004
12	East Tenakee	>L CPUE	2000, 2002, 2003
		CL	2000, 2002, 2003
		L_{50}	2002–2004
	West Tenakee	>L CPUE	2000, 2002, 2003
		CL	2000, 2002, 2003
		L_{50}	2002–2004
13	Hoonah Sound	>L CPUE	2000–2002
		CL	2000–2002
		L_{50}	2000–2002
		L_{50}	2000–2002

Appendix B1–Results of power analyses conducted to determine the statistical power of sample sizes for CPUE and CL tests in the Southeastern Alaska pot shrimp survey, 2004–2009.

Metric	District	Mean kg per pot	SE	Mean number of pots set	Current detectable change (kg)	Theoretical detectable change setting 10 strings a day (kg)
CPUE of all shrimp	Section 3-A	4.58	2.89	66.17	1.01 (22%)	0.745 (16%)
	7	1.50	1.33	72.83	0.44 (29%)	0.343 (23%)
	12	4.47	3.05	62.80	1.10 (25%)	0.786 (18%)
	Section 13-C	3.87	3.50	65.50	1.22 (32%)	0.902 (23%)
CPUE of XL and larger shrimp	Section 3-A	0.397	0.637	66.17	0.22 (55%)	0.164 (41%)
	7	0.313	0.413	72.83	0.14 (44%)	0.106 (34%)
	12	2.299	2.21	62.80	0.79 (35%)	0.57 (25%)
	Section 13-C	1.158	1.47	65.50	0.52 (45%)	0.379 (33%)

Metric	District	Mean CL (mm)	SE	Mean number of pots set	Current detectable change (mm)	Theoretical detectable change setting 10 strings a day (mm)
Carapace length	Section 3-A	32.42	2.39	66.17	0.83 (3%)	0.62 (2%)
	7	32.98	3.66	72.83	1.22 (4%)	0.94 (3%)
	12	38.01	3.57	62.80	1.28 (3%)	0.92 (2%)
	Section 13-C	35.25	2.99	65.50	1.05 (3%)	0.77 (2%)