Regional Information Report No. 1J12-04

2010 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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ABSTRACT

Spot shrimp, *Pandalus platyceros*, are targeted by a pot fishery in Southeastern Alaska. Historically the fishery harvested as much as one million pounds, though about six hundred thousand pounds were harvested in the 2009/10 season. An annual survey was implemented in 1997, and currently occurs in mid-September in two analysis areas each in Districts 3 (Section 3-A), 7, and 12. A single analysis area is surveyed in District 13 (Section 13-C). During the 2010 survey a total of 840 pots were set and 19,336 individual shrimp measured. As part of a survey redesign, we switched to setting nine 5-pot strings of small-mesh pots daily in Districts 3 and 7, but, due to cost recovery contracts, we continued to set six 10-pot strings of alternating small and large-mesh pots daily in Districts 12 and 13. This switch allowed 9 additional index pots to be sampled daily in Districts 3 and 7, improving spatial coverage and statistical power of survey data. Overall CPUE of size extra-large or greater shrimp increased for three analysis areas, remained the same for one, and decreased for three. Similarly, mean carapace length increased for four analysis areas, remained the same for one, and decreased for two. The magnitude of change varied greatly between both districts and analysis areas. Although the general trend was towards increases, CPUE and mean carapace length remain well below the baseline in almost all survey locations. Planned future survey changes include integrating the use of 5-pot strings in Districts 12 and 13 in the 2011 survey, expanding the survey to more districts, reducing the impact of the survey on the resource, and development of a model to estimate shrimp population size from survey indices.

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 fishing 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.

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. For more detailed information about these metrics see Bishop et al. (2009).

Overview of Fishery Management

The Southeastern Alaska pot shrimp fishery is managed inseason by emergency order to limit harvest in each district or section to levels as close as possible to guideline harvest levels (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. Guideline Harvest Ranges (GHRs) were first established in regulation in 1997 following initial implementation of separate, district-specific GHRs by emergency order for the 1995/96 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 1990/91 to 1994/95 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 2010 preseason pot shrimp survey in Southeastern Alaska.

METHODS

The preseason pot shrimp survey occurs annually in portions of four districts during September. In 2010 the District 3, Section 3-A and District 7 surveys were conducted aboard the R/V *Medeia* from September 8 to 19, while the District 12 and 13 surveys occurred aboard the *F/V Matilda Bay* September 15–24.

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 locations were spread out enough 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) was used to longline each pot in the set at 20 (Districts 3 and 7), or 10 (Districts 12 and 13) -fathom intervals. Pot composition of each set differed between survey areas. Strings in Districts 3 and 7 consisted of five “small” mesh 42-in diameter pots with 1 ⅛-in mesh and four tunnels spaced 20 fathoms apart along the groundline. As part of a project to increase the definition of the data collected in the survey, the number of strings set daily in Districts 3 and 7 was increased from 6 to 7 per day to 8 to 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.

Both small and large mesh pots were part of the original survey design, to allow for determination of the 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 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 (Appendix B for results of power analyses examining the effect of increased sample size on data definition).

Strings in Districts 12 and 13 consisted of ten 42-in diameter pots, five with 1 ¾-in mesh and three tunnels and five with 1 ⅛-in mesh and four tunnels set in an alternating order at 10 fathom intervals. On these survey legs, six established survey stations were set daily, as well as one “experimental” set to increase shrimp poundage for cost-recovery purposes, and to explore new shrimp grounds. Although large mesh pots were still employed in these districts, those pots were not sampled because the District 12 and 13 survey legs were chartered, cost recovery surveys wherein an industry vessel is used and retains the catch of the survey for sale. Thus a decrease in the number of pots per string (10 to 5), even with an increase in the number of strings set (6 to 9) would produce 15 fewer pots fished per day, thereby reducing cost recovery revenue. It is currently planned that Districts 12 and 13 will move to 9 5-pot strings for the 2011 survey.

SAMPLING SHRIMP

To avoid bias due to pot numbers 1 and 10 (1 and 5 in Districts 3 and 7) sometimes being off the bottom, only shrimp from pot numbers 2 to 9 (2–4 in Districts 3 and 7) 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 in Districts 3 and 7, 1 and 10 in Districts 12 and 13). 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 2–9 (2–4 in Districts 3 and 7), 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 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/or 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 under "general shrimp".

Size-at-sex

Daily, approximately 50 mid-sized shrimp were randomly selected from any 3 pots for a total of 150 per day and 600 per trip. 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 2010 pot shrimp survey, CTD casts were made at three 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 2) increased for 3 areas, stayed the same for 1 area, and decreased for 3 areas. Carapace lengths increased for 4 areas, stayed the same for 1 area, and decreased for 2 areas. The degree of increases and decreases varied and are explained in greater detail below. L_{50} values have not yet been determined for the 2010 survey and will be available in the 2010/11 Stock Status Report. Although CPUEs and CLs generally increased relative to the prior year, they remain well below the baseline in almost all areas.

DISTRICT 3, SECTION 3-A

Catch rate

CPUE of >L shrimp increased 119% from the 2009 value in Hetta Inlet, but is currently 48% of baseline (Figure 6). Likewise, catch rate of >L shrimp increased 259% from the 2009 value in mid-Cordova Bay, but is currently 8% of baseline. Both areas' CPUE of >L shrimp are significantly below baseline value and neither area shows any significant short term trend.

Carapace length

Mean CL increased 4% from the 2009 value in Hetta Inlet, but is currently 94% of baseline (Figure 6). Mean CL increased 2% from the 2009 value in mid-Cordova Bay, but is currently 91% of baseline. Both areas' mean CLs are significantly below baseline values and neither area shows any significant short term trend.

DISTRICT 7

Catch rate

Catch rate of >L shrimp increased 2% from the 2009 value in Lower Ernest Sound, but is 44% of baseline (Figure 7). Catch rate of >L shrimp decreased 25% from the 2009 value in Upper Ernest Sound, and is currently 28% of baseline. Both areas' CPUEs of >L shrimp are significantly below baseline values and neither area shows any significant short term trend.

Carapace length

Mean CL increased 1% from the 2009 value in Lower Ernest Sound, and is currently 99% of baseline (Figure 7). Mean CL was the same as the 2009 value in Upper Ernest Sound, and is currently 91% of baseline. Lower Ernest Sound mean CL shows no significant difference from baseline, but an increasing short term trend. Upper Ernest Sound mean CL is significantly below baseline and shows no short term trend.

DISTRICT 12

Catch rate

Catch rate of >L shrimp increased 114% from the 2009 value in West Tenakee Inlet and is 123% of baseline (Figure 8). Catch rate of >L shrimp decreased 39% from the 2009 value in East Tenakee Inlet, and is currently 16% of baseline. West Tenakee Inlet CPUE of >L shrimp shows no significant difference from baseline, nor any short term trend. East Tenakee Inlet CPUE of >L shrimp is significantly below baseline and shows no short term trend.

Carapace length

Mean CL increased 2% from the 2009 value in West Tenakee Inlet and is 104% of baseline (Figure 8). Mean CL decreased 5% from the 2009 value in East Tenakee Inlet, and is currently 88% of baseline. West Tenakee Inlet mean CL is significantly above baseline, but shows no short term trend. East Tenakee Inlet mean CL is significantly below baseline and shows no short term trend.

District 13, Section 13-C

Catch rate

Catch rate of >L shrimp decreased 48% from the 2009 value in Hoonah Sound, and is 54% of baseline (Figure 9). Hoonah Sound CPUE of >L shrimp is significantly below baseline and shows no short term trend.

Carapace length

Mean CL increased 1% from the 2009 value in Hoonah Sound and is 95% of baseline (Figure 9). Hoonah Sound mean CL is significantly below baseline and shows no 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 snails; noncommercial crab species; noncommercial shrimp species; and squat lobsters (*Munida quadrispina*)

DISCUSSION

During the first year of using an increased number of 5-pot small mesh pot strings, we found that we could set, haul and sample an average of 9 strings daily; this allowed an additional 36 pots to be pulled in District 3 and in District 7. 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.

One problem encountered during the 2010 preseason survey was the high tidal amplitude. The District 3, Section 3-A and District 7 surveys occurred during the highest tidal ranges of the year for those locations. This is thought to have contributed to the loss of a full string of gear in District 3, Section 3-A as the high water liberated a great deal of beach flotsam which may have snagged the buoys. Secondly, commercial fishermen report that catchability decreases during periods of high tidal amplitude. Comparisons between historic CPUE and tidal amplitude during the survey are planned to examine this issue.

Next Steps

For the 2011 survey we plan to implement the method changes used this year in Districts 3 and 7 in the District 12 and 13 survey legs. The main problem with this implementation is in the cost recovery portion of the charter contract, as even though we sample more index pots when running 5 small mesh pot strings, we fish 15 less pots per day than when using 10-pot strings. It is also likely that the time per pot to measure shrimp will increase.

The next 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.

The first priority for expansion of the stock assessment program will be to establish annual preseason surveys in all districts where the upper end of the GHR is ≥ 50,000 and data confidence is low. This includes Districts 1, 2, Section 3-B/C, District 6 and District 10. Prioritizing areas in order of mean harvest from 1998/99 to 2009/10 yields, respectively: District 1, District 2, District 10, and Sections 3-B/C. Commercial catches from currently surveyed districts make up 40.5% of recent historical harvest (1998/99–2009/10), and 38.6% of the 2009/10 harvest. We currently sample only two of the seven highest producing districts, numbers 1 (Section 3-C) and 4 (District 7). If the two highest priority districts were added to the survey (Districts 1 and 2) the surveyed districts would cover 66.0% of historic harvest, and 56% of the 2009/10 harvest. If all four areas are added the surveyed districts would cover 76.2% of historic harvest, and 71.6% of the 2009/10 harvest.

The final priority is to begin 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 2010 pot shrimp survey in Districts 3, 7, 12, and 13 of Southeastern Alaska.

Location	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
Ernest Sound	55.84199	-132.20849
Clarence Strait	55.47283	-132.02035
Cordova Bay	55.02875	-132.63788

Table 2–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

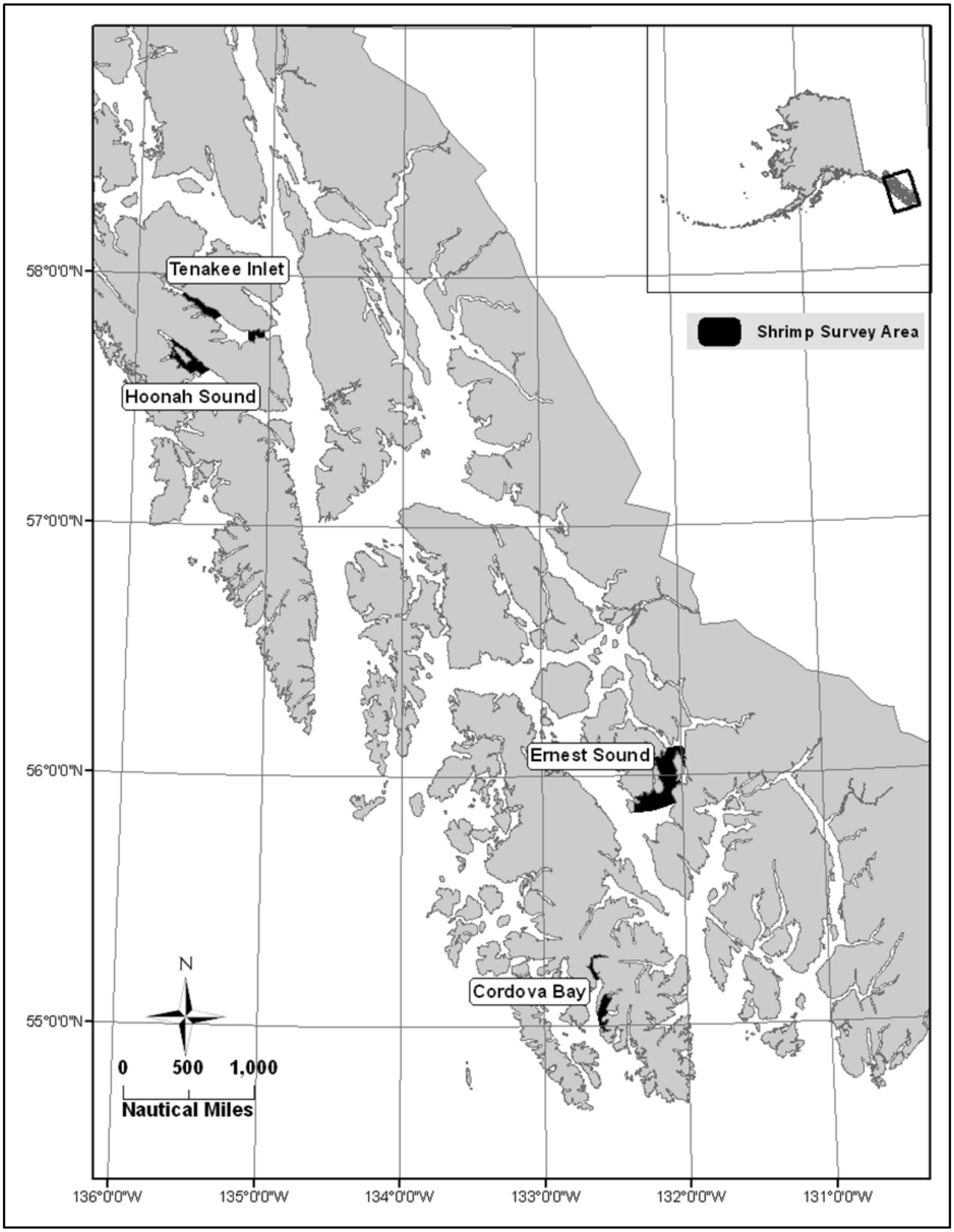

Figure 1.–Spot shrimp, Pandalus platyceros, survey areas in Southeastern Alaska, Registration Area A.

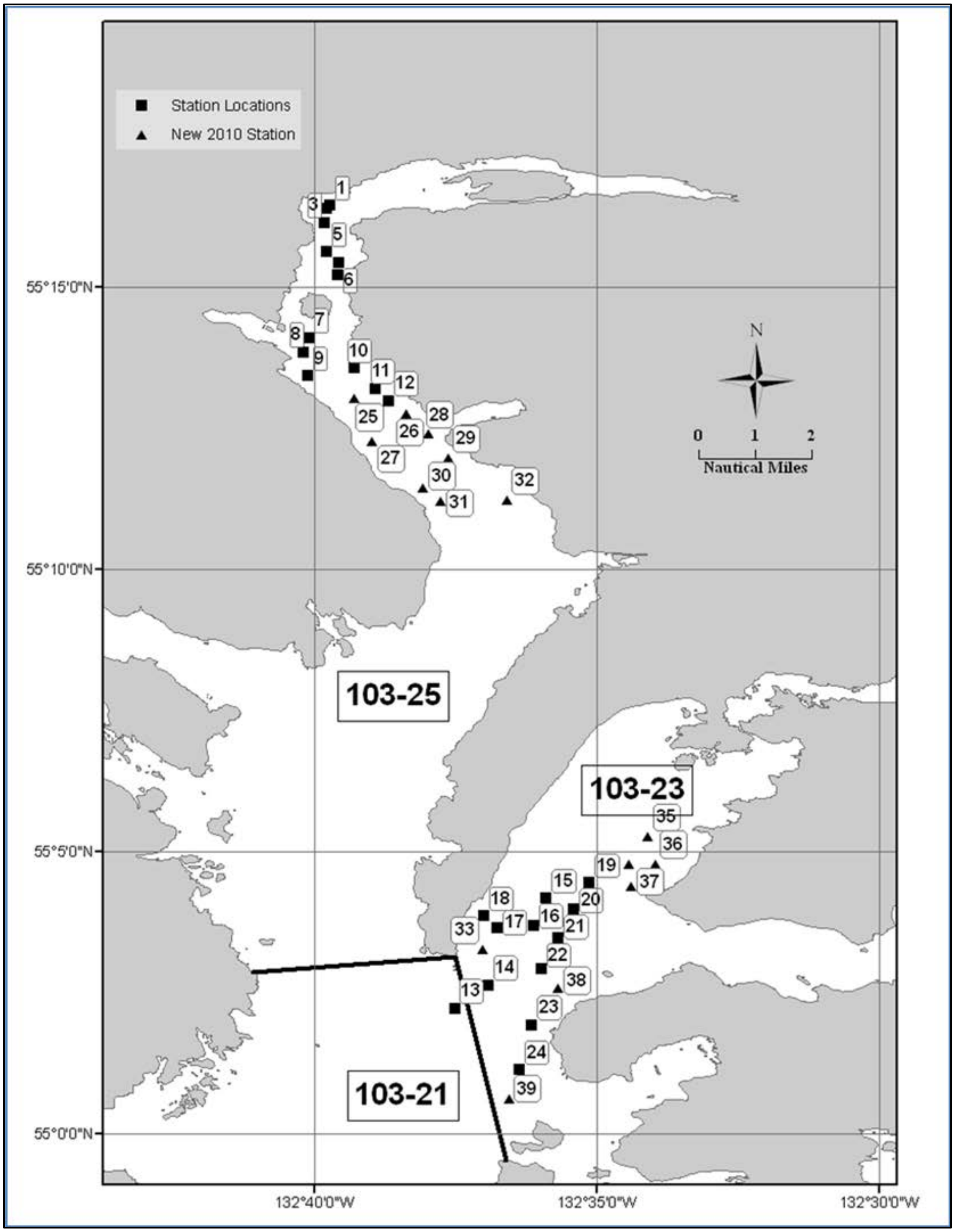

Figure 2.–Station locations of 5-pot longlined strings in mid-Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during the 2010 survey.

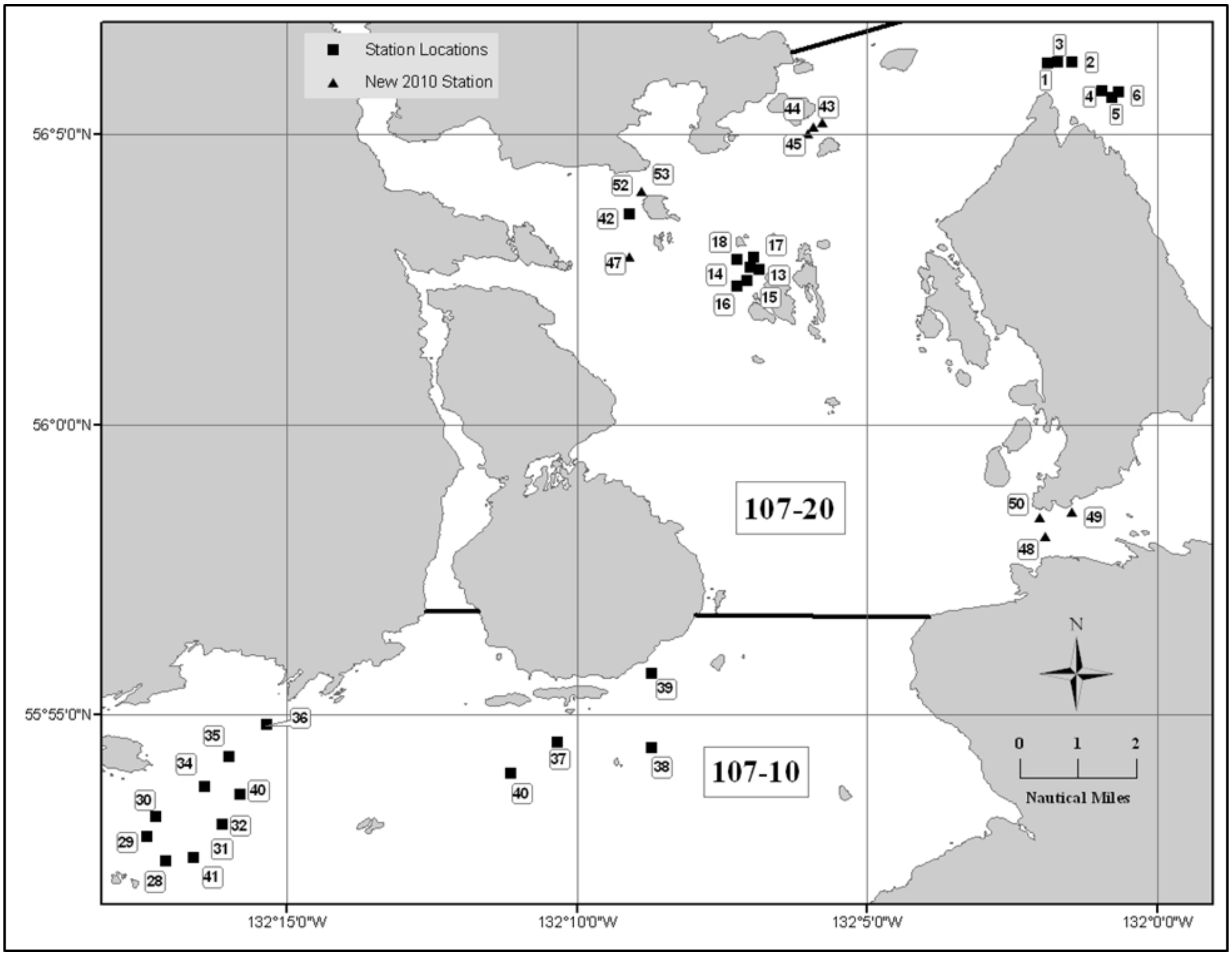

Figure 3.–Station locations for 5-pot longlined strings in Lower Ernest Sound (107-10) and Upper Ernest Sound (107-20) analysis areas of District 7, Southeastern Alaska during the 2010 survey.

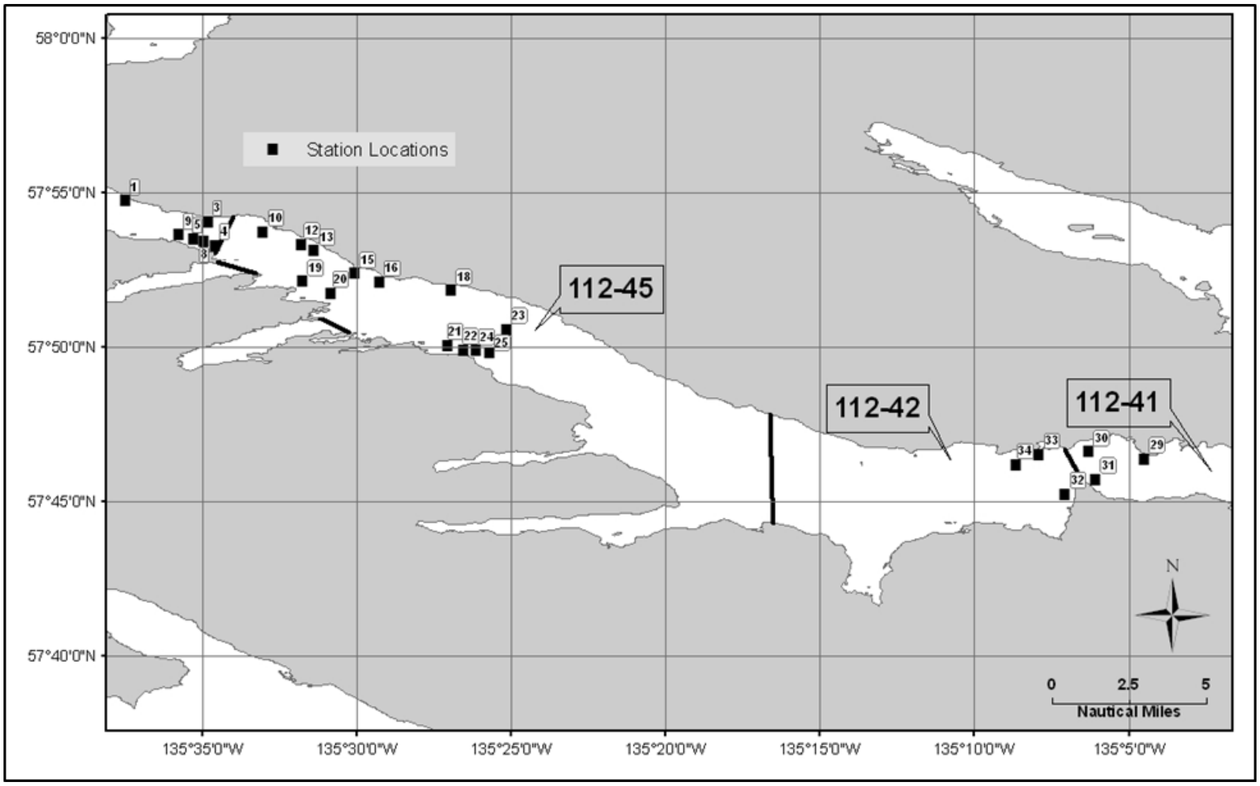

Figure 4.–Station locations for 10-pot longlined strings in East Tenakee (112-41, and 112-42), and West Tenakee Inlet (112-45) analysis areas of District 12, Tenakee, Southeastern Alaska during the 2010 survey.

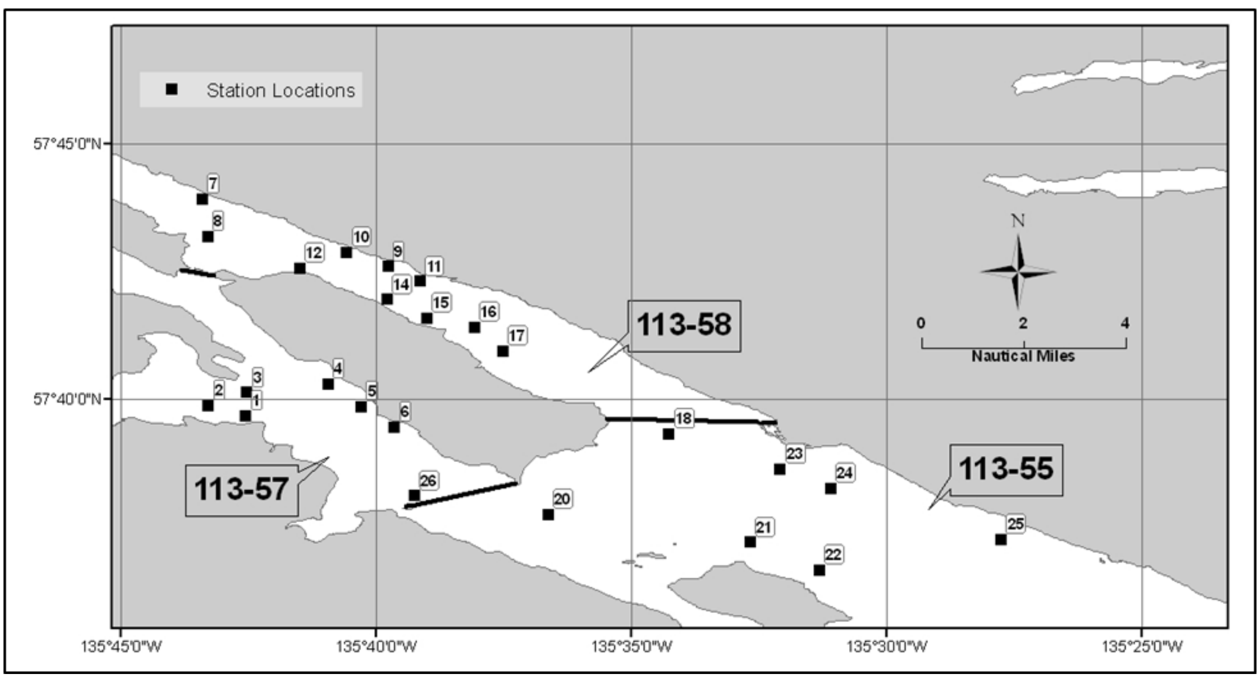

Figure 5.–Station locations for 10-pot longlined strings in the Hoonah Sound (113-55, 113-57, and 113-58) analysis area of District 13, Section 13-C, Southeastern Alaska during the 2010 survey.

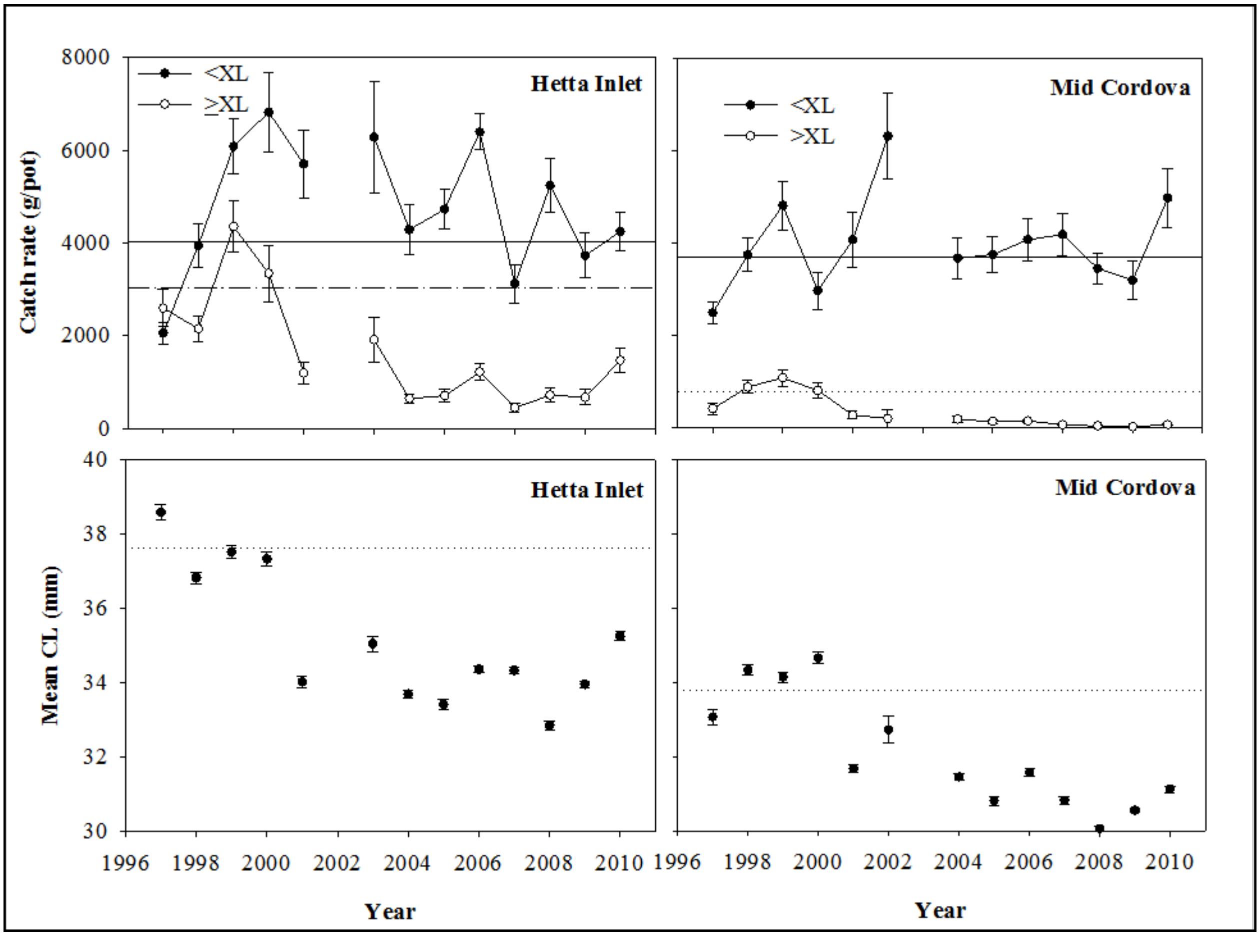

Figure 6.–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of mid-Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during 1997–2010 surveys. Reference lines represent the long-term baselines.

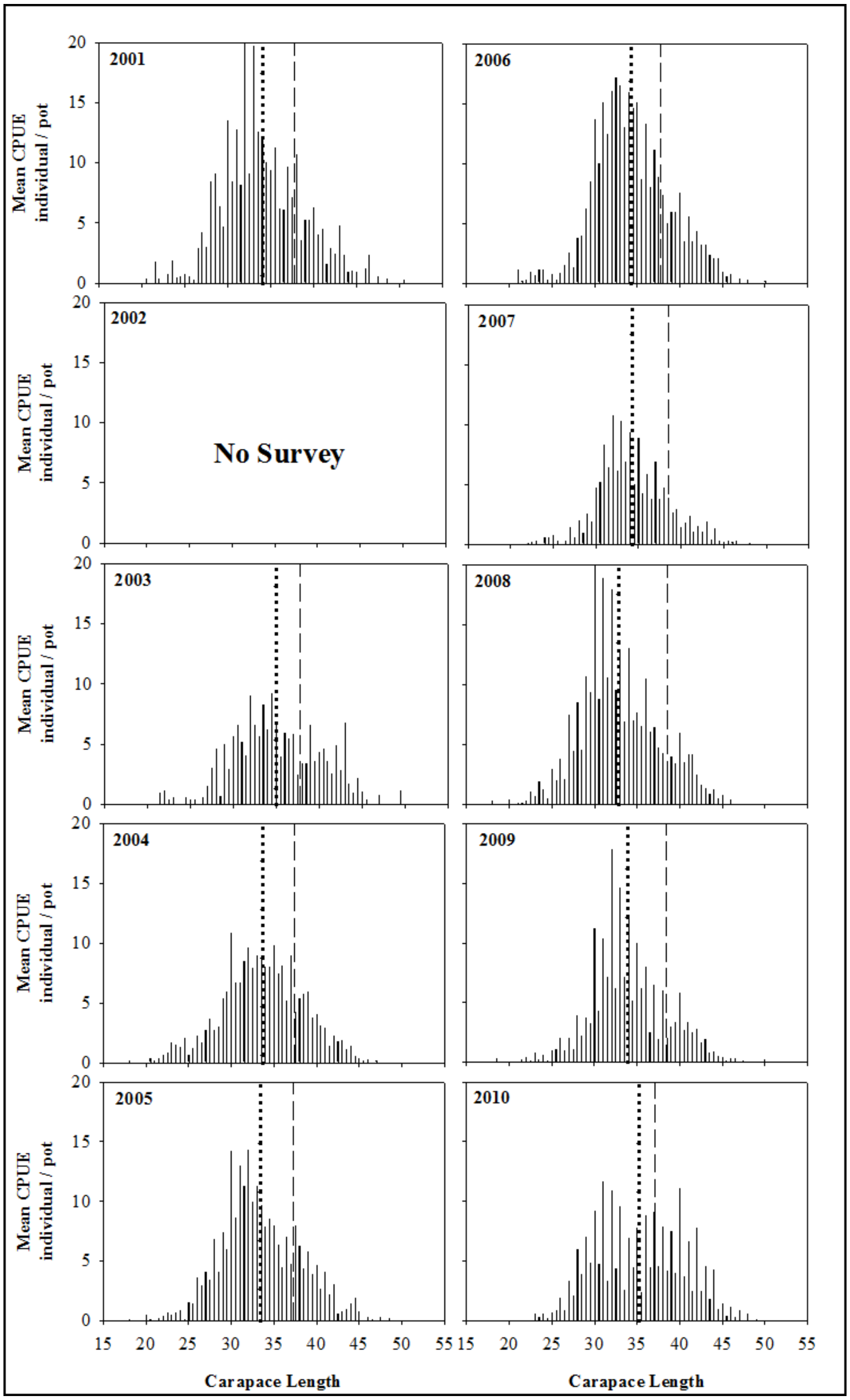

Figure 7.–Shrimp length frequencies in the Hetta Inlet Survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

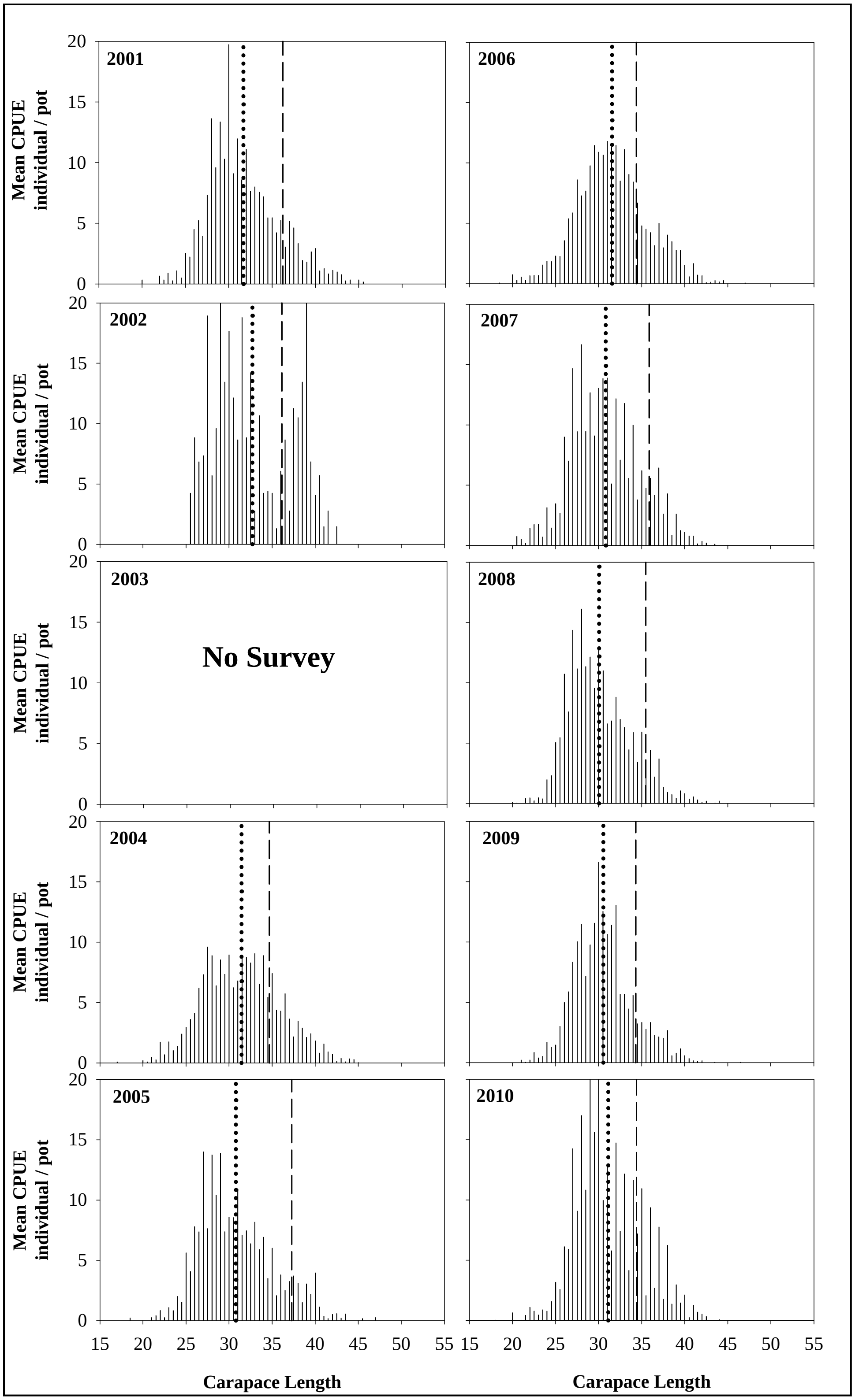

Figure 8.–Shrimp length frequencies in the mid-Cordova survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

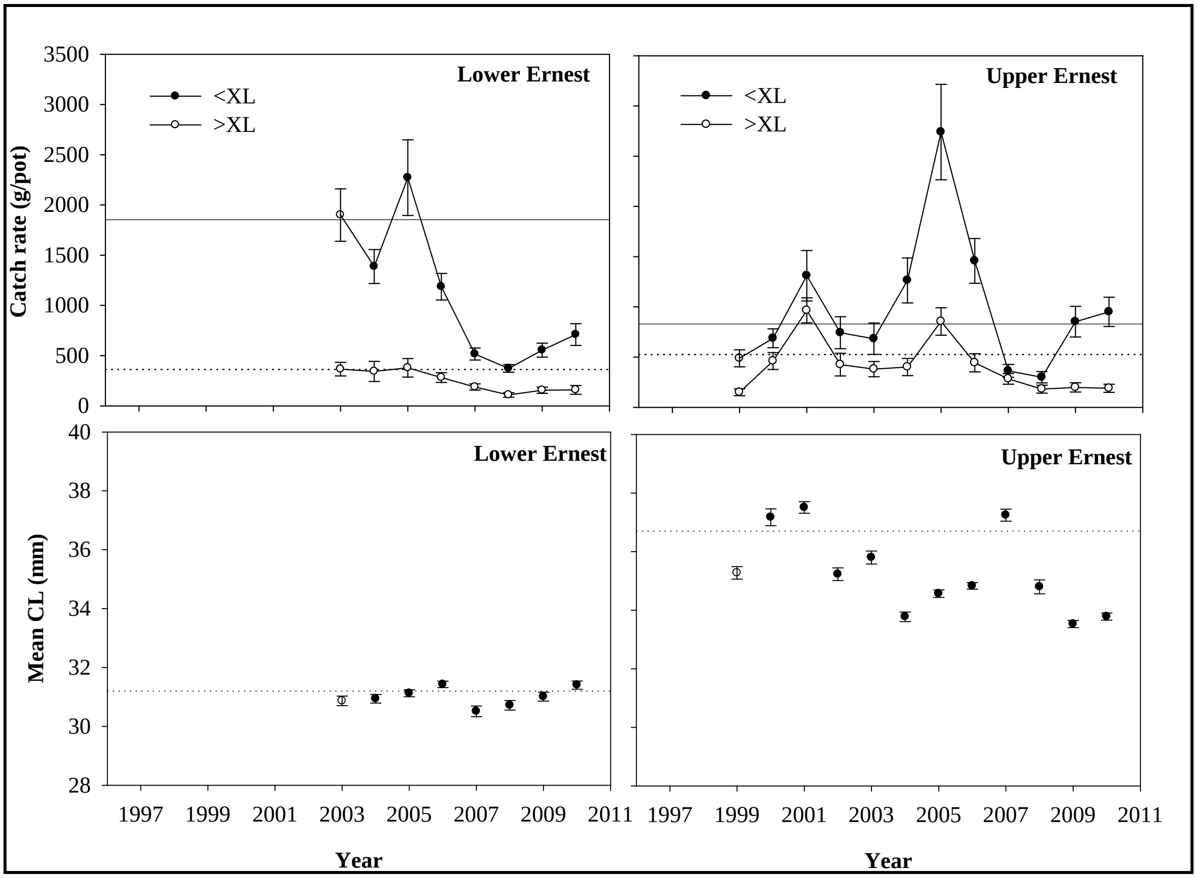

Figure 9.–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of Lower Ernest Sound and Upper Ernest Sound analysis areas of District 7, Southeastern Alaska during 1999–2010 surveys. Dotted line represents the long-term baseline.

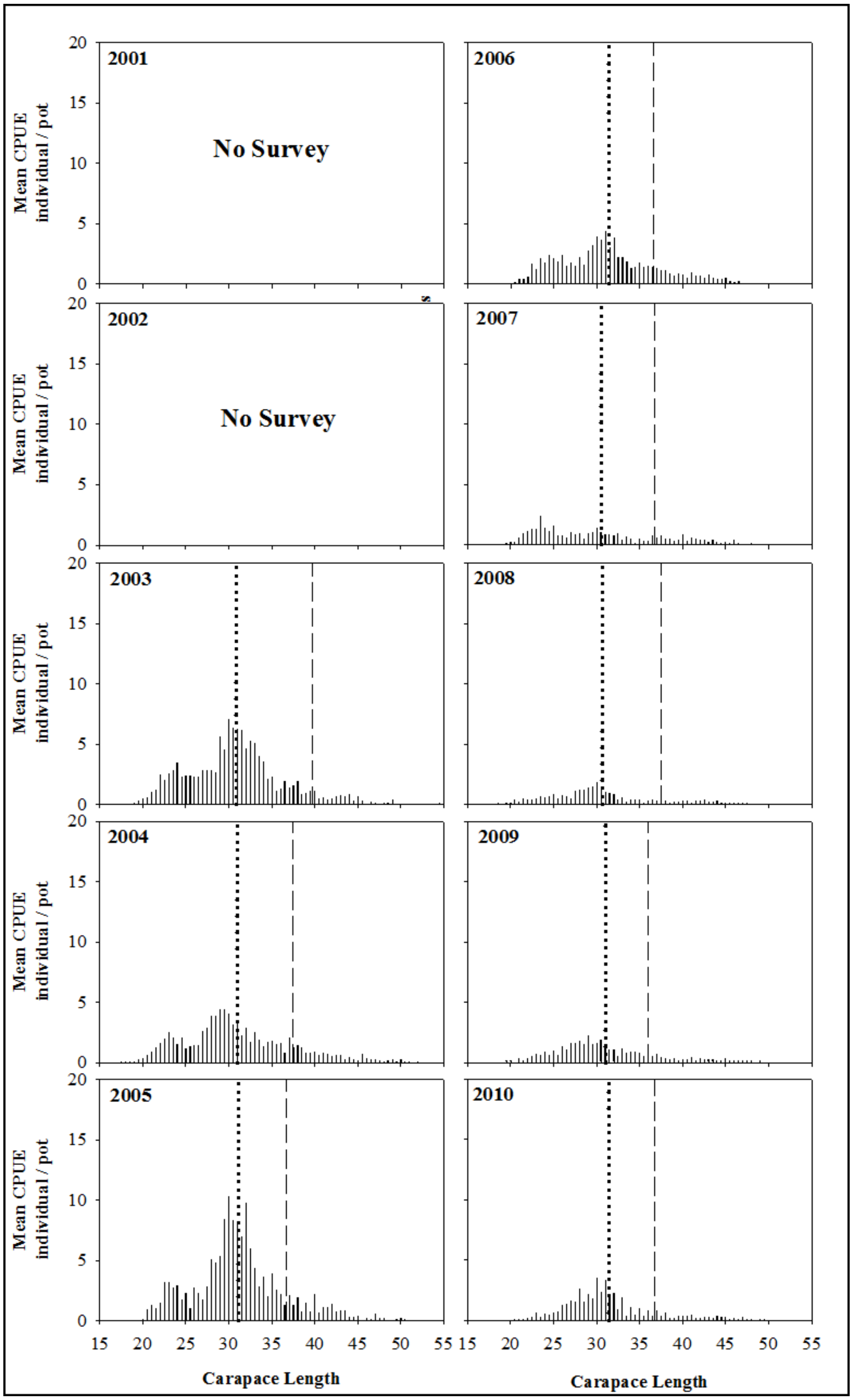

Figure 10.–Shrimp length frequencies in the Lower Ernest Sound survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

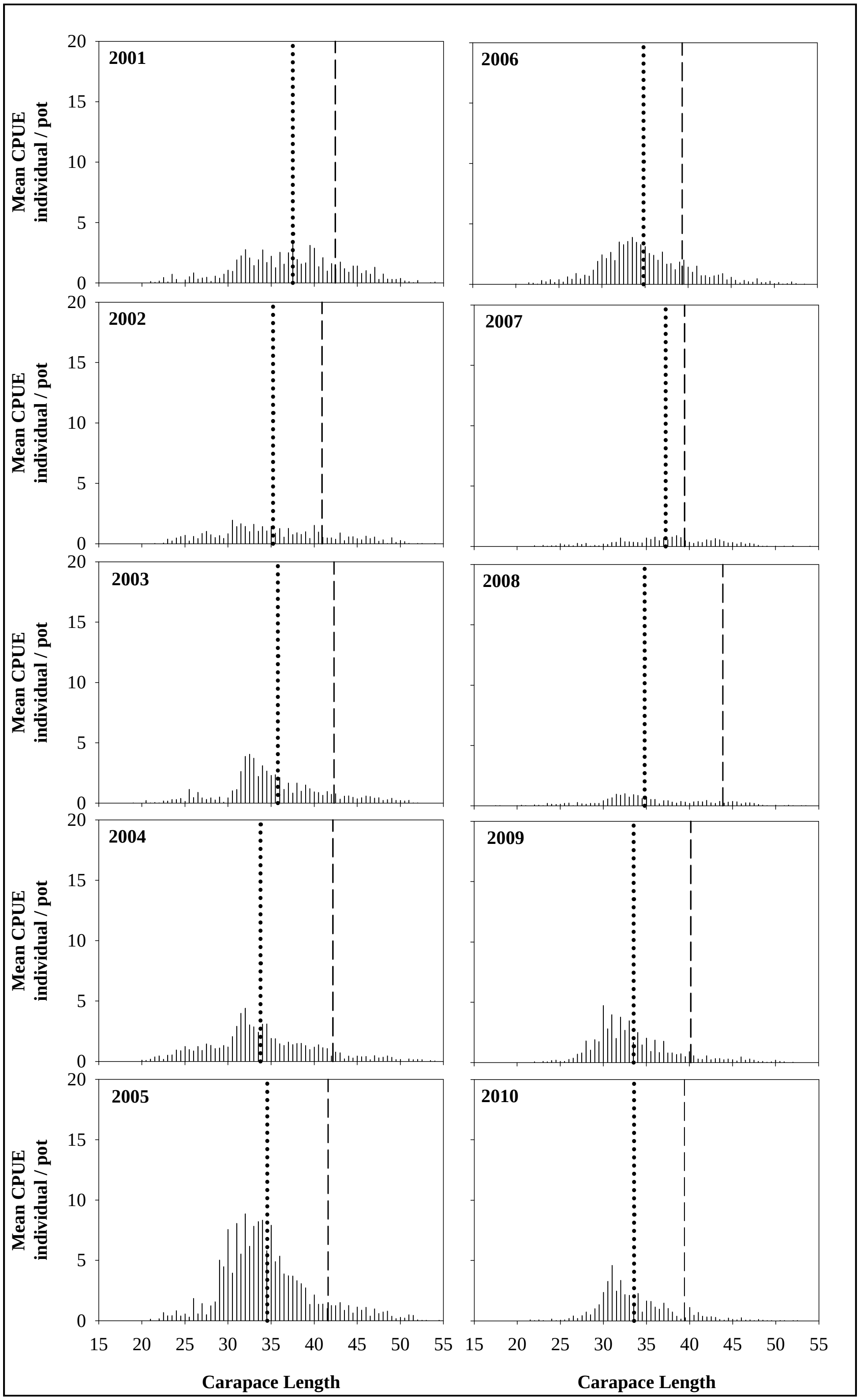

Figure 11.–Shrimp length frequencies in the Upper Ernest Sound survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

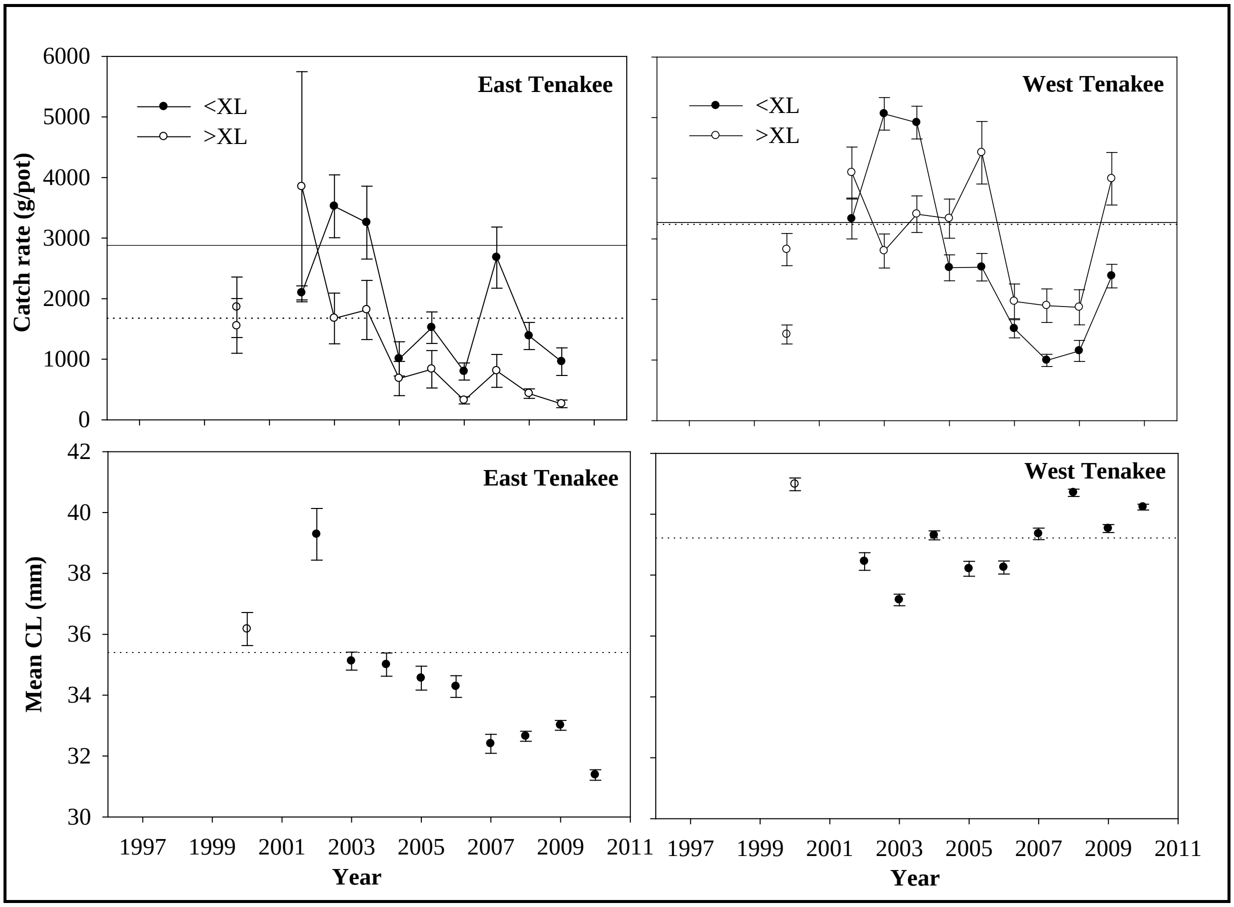

Figure 12.–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of East Tenakee, and West Tenakee Inlet analysis areas of District 12, Tenakee, Southeastern Alaska during 2000–2010 surveys. Dotted line represents the long-term baseline.

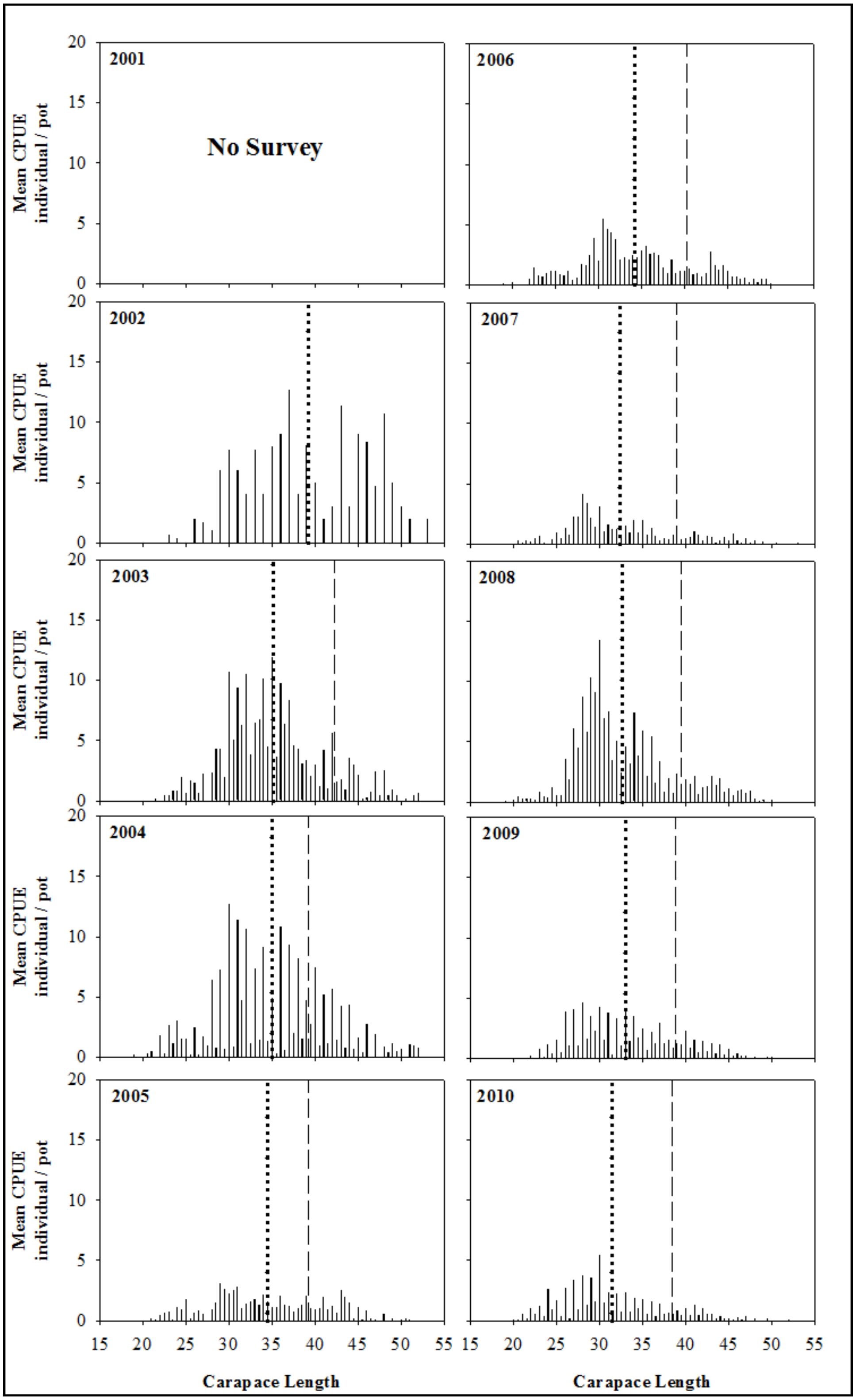

Figure 13.–Shrimp length frequencies in the East Tenakee survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

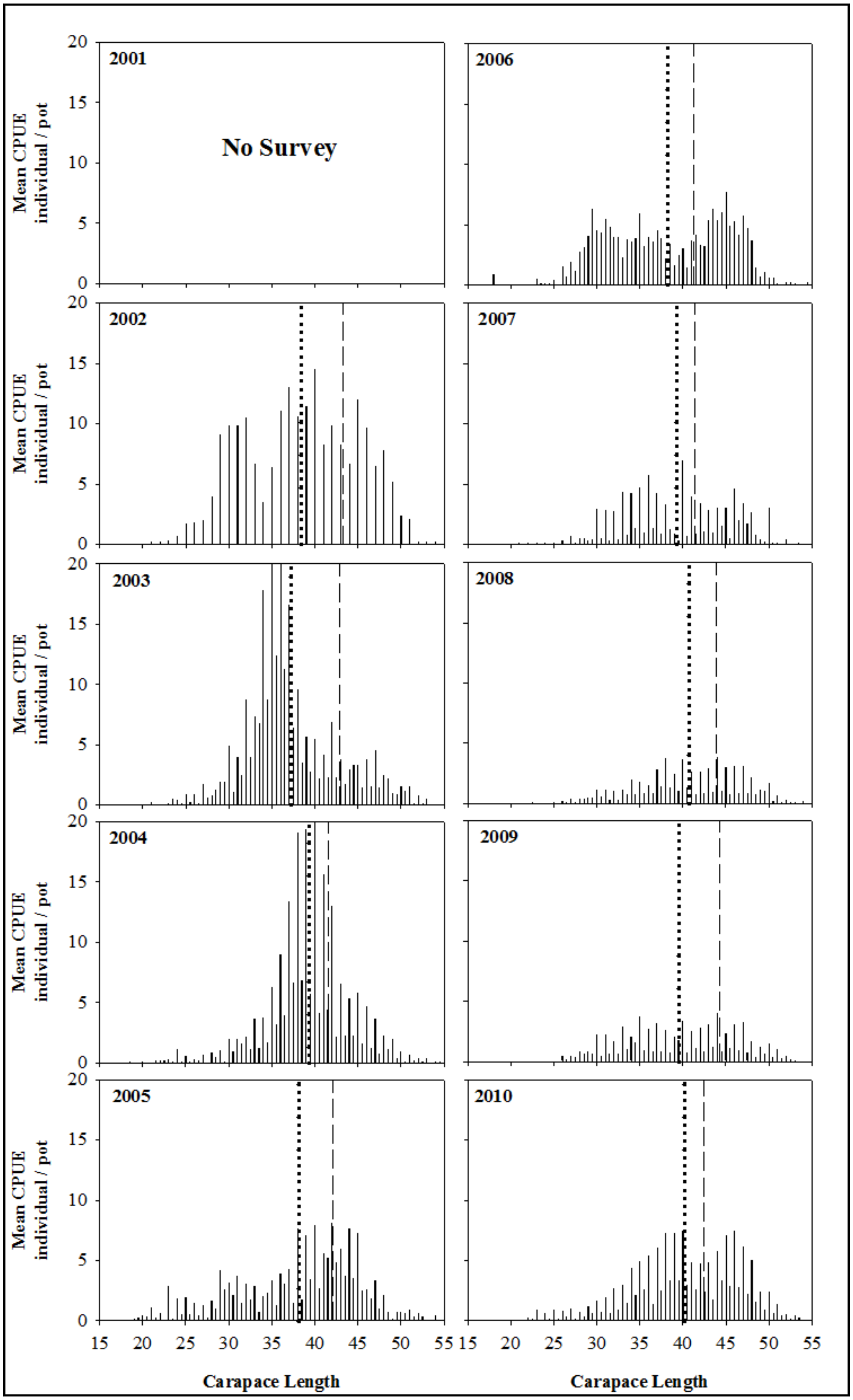

Figure 14.–Shrimp length frequencies in the West Tenakee survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

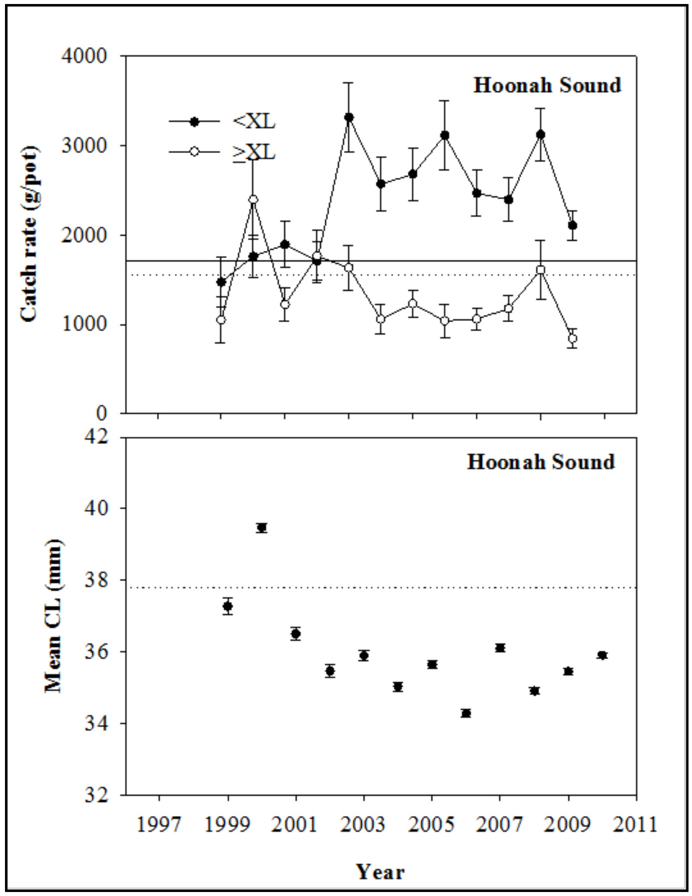

Figure 15.–Mean and standard error of spot shrimp CPUE and mean CL from preseason surveys of Hoonah Sound analysis areas of District 13, Section 13-C, Southeastern Alaska during 1999–2010 surveys. Dotted line represents the long-term baseline.

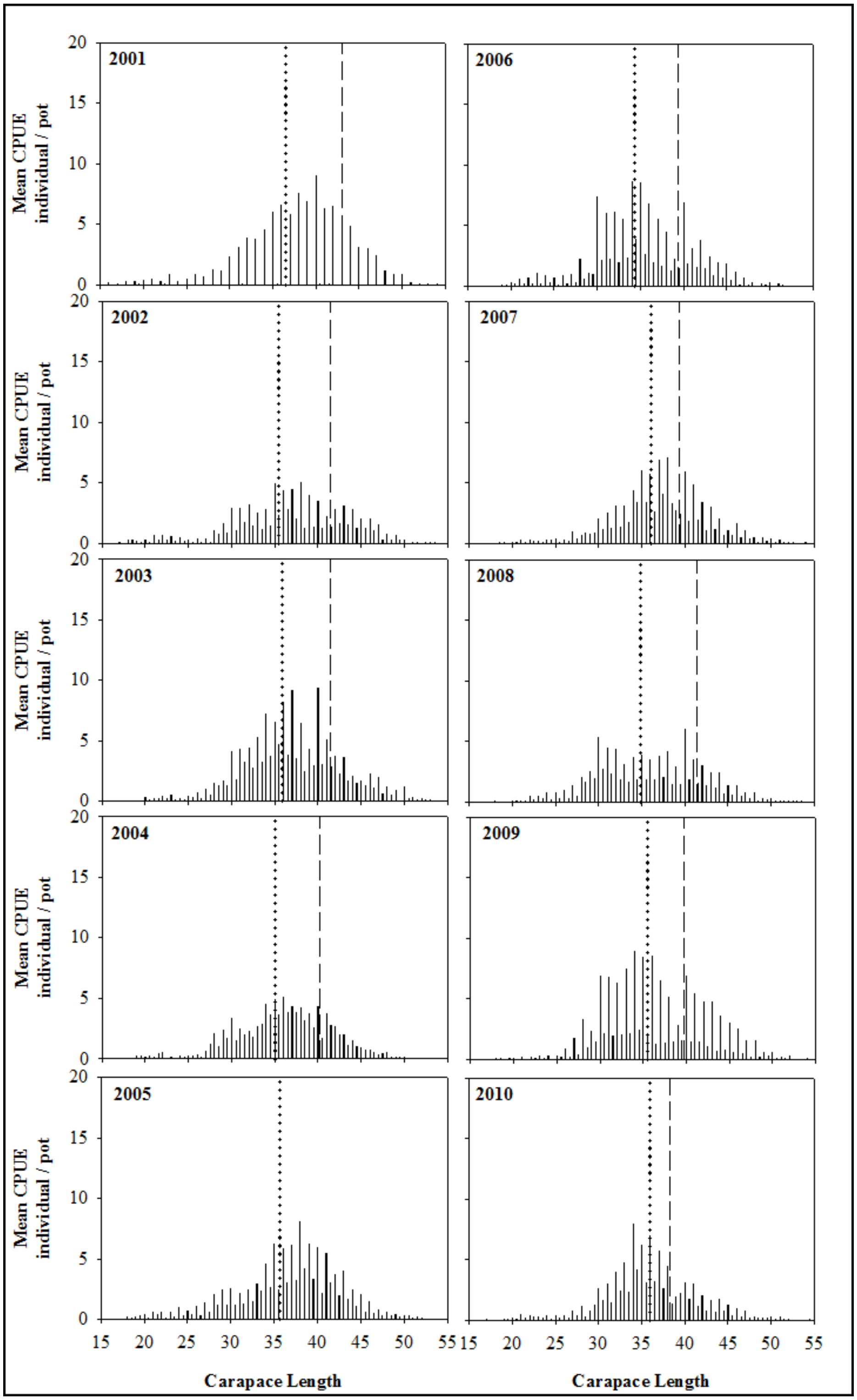

Figure 16.–Shrimp length frequencies in the Hoonah Sound survey from 2001–2010. Dotted line shows mean CL, and dashed line shows L_{50}.

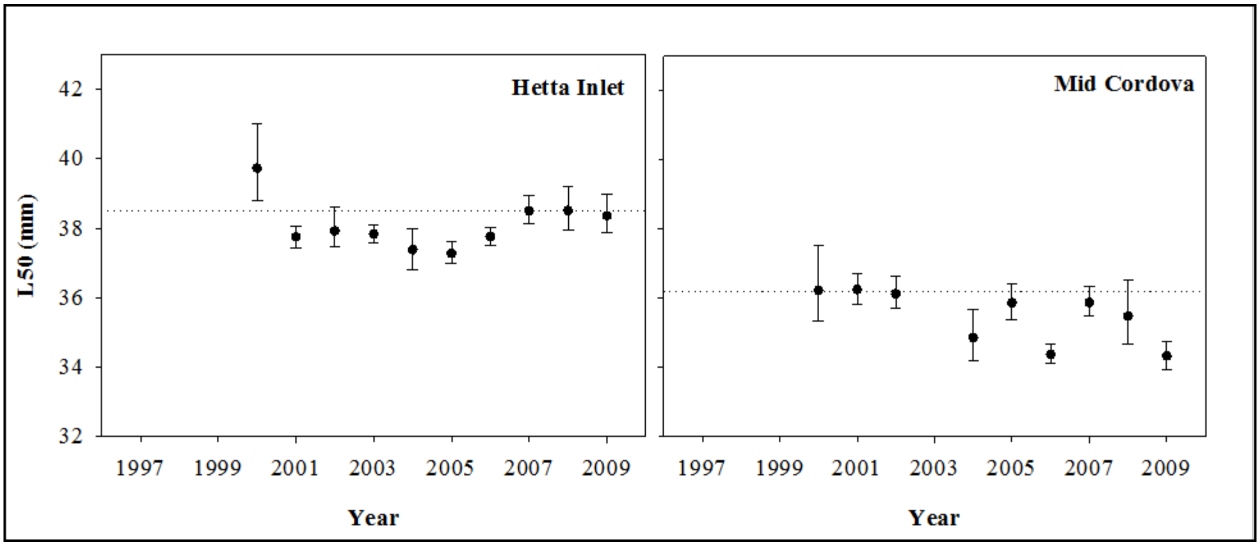

Figure 17.–Spot shrimp L_{50} and standard error from preseason surveys of mid Cordova Bay and Hetta Inlet analysis areas of District 3, Section 3-A, Southeastern Alaska during 2000–2010 surveys. Dotted line represents the long-term baseline.

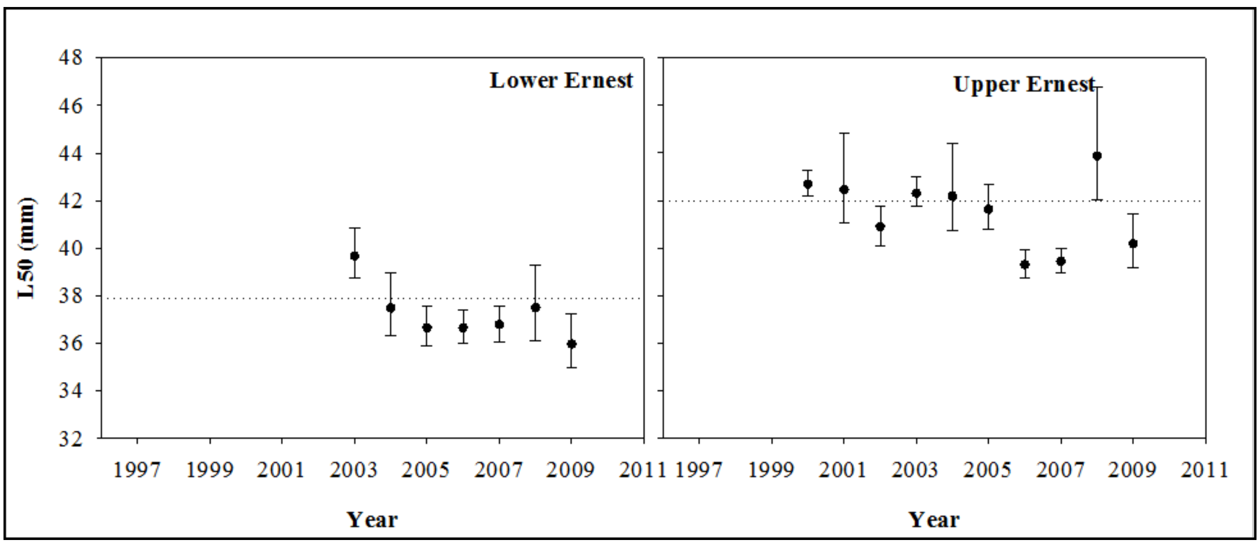

Figure 18.–Spot shrimp L_{50} and standard error from Lower Ernest Sound and Upper Ernest Sound analysis areas of District 7, Southeastern Alaska during 2000–2010 surveys. Dotted line represents the long-term baseline.

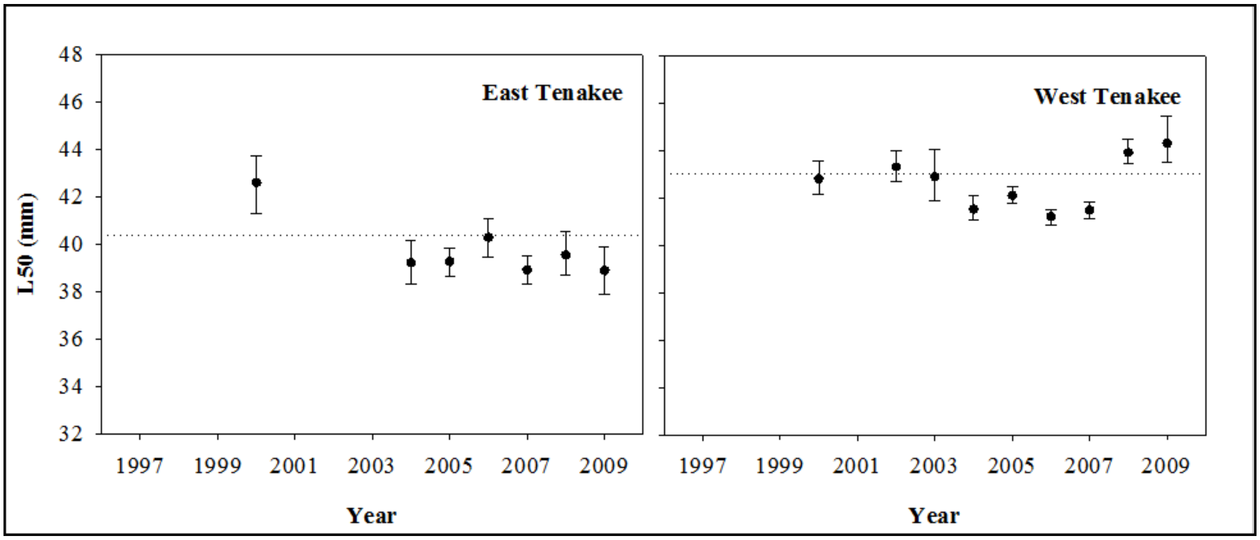

Figure 19.–Spot shrimp L_{50} and standard error from East Tenakee, and West Tenakee Inlet analysis areas of District 12, Tenakee, Southeastern Alaska during 2000–2010 surveys. Dotted line represents the long-term baseline.

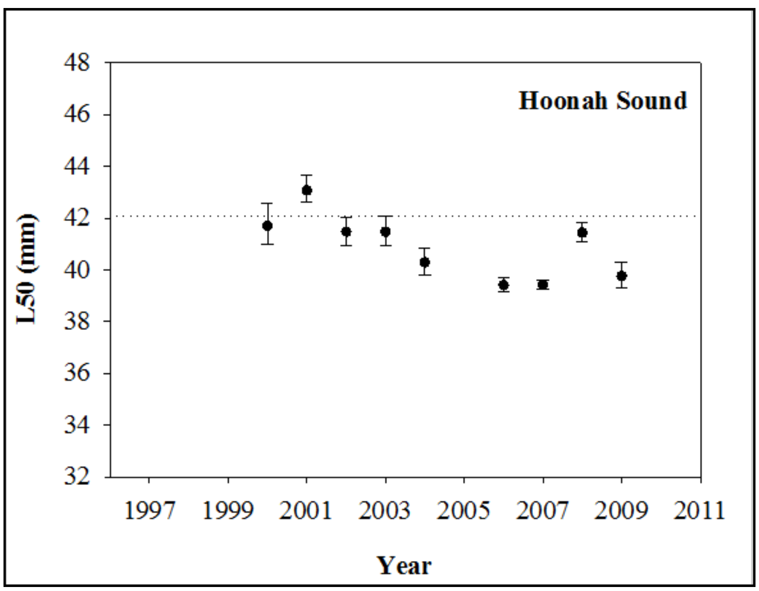

Figure 20.–Spot shrimp L_{50} and standard error from Hoonah Sound analysis areas of District 13, Section 13-C, Southeastern Alaska during 2000–2010 surveys. Dotted line represents the long-term baseline.

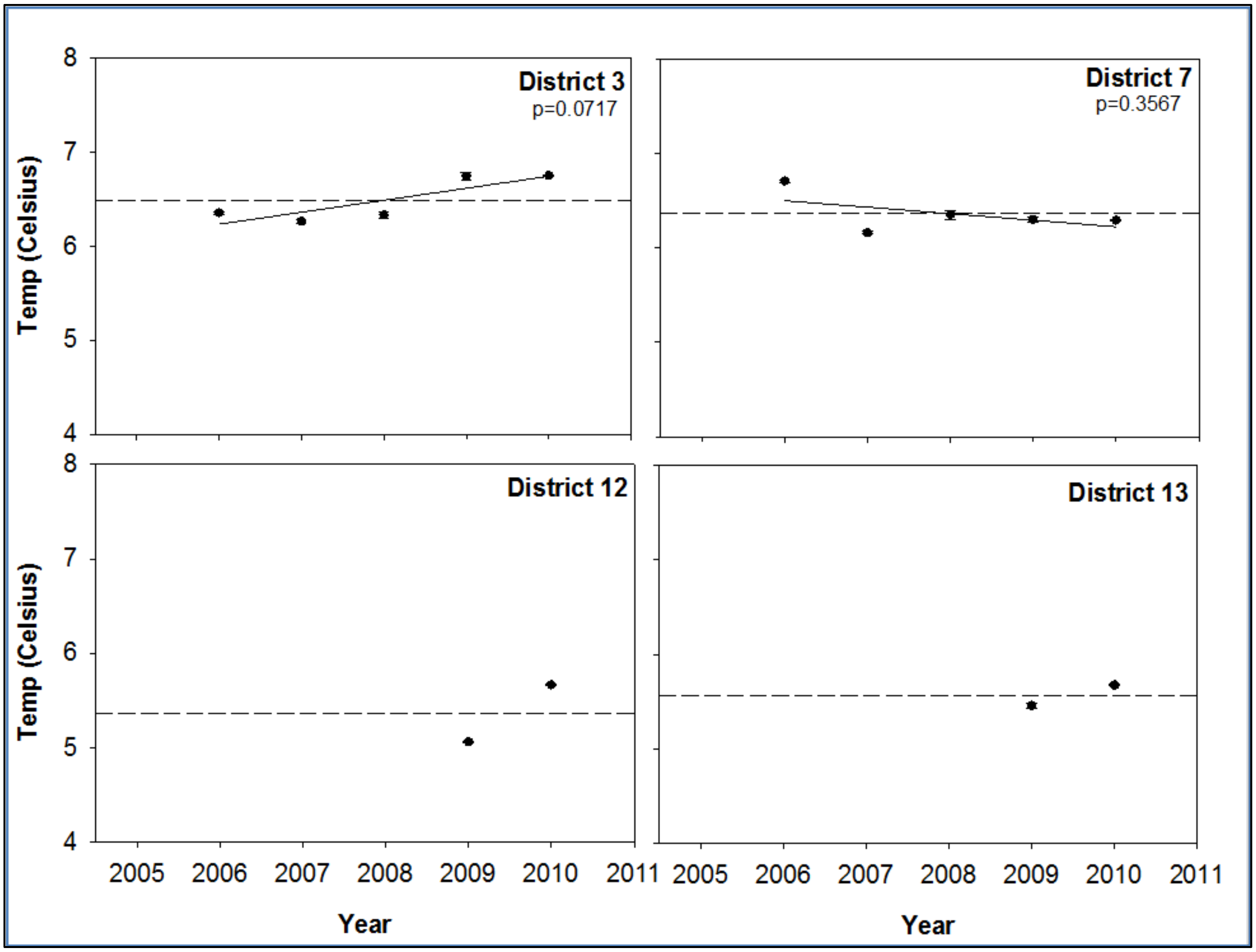

Figure 21.–Trends in mean bottom temperature, measured by attaching tidbits to pots during shrimp pot surveys in Districts 3, 7, 12, and 13 of Southeastern Alaska. Dotted lines represent mean temperature from all measured years.

APPENDICES

Appendix A–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 B–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 for years 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%)