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Overview of the Lower Cook Inlet Area Commercial Herring Fishery and Recent Stock Status

by

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and

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November 2004

Alaska Department of Fish and Game **Divisions of Commercial Fisheries and Sport Fish**

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Pacific herring (*Clupea pallasi*) are found throughout the Lower Cook Inlet (LCI) management area. Historically, herring have been commercially harvested in four of the five LCI area fishery districts, however, low biomass in the Kamishak Bay/Southern Districts, and a preponderance of juvenile herring in the Outer/Eastern Districts precludes commercial fishing opportunities at this time. The Kamishak Bay sac roe seine fishery was the most recent closure, in 1999, following consecutive years with poor stock abundance indices. Despite six years without fishing mortality (1999-present), the Kamishak Bay stock has not rebounded to levels conducive to a sustainable commercial fishery. The department continues to assess the Kamishak Bay herring stock through aerial and vessel based abundance estimation and age sampling, respectively. The department was also recently funded to pursue a herring stock identification project to evaluate the stock structure of North Gulf of Alaska herring spawning aggregations, including those in Kamishak Bay.

Key words: age composition, Alaska Board of Fisheries, biomass, BOF, commercial fishery, Eastern District, Kachemak Bay, Kamishak Bay, Kamishak District, Lower Cook Inlet, Outer District, Pacific herring, Southern District, stock assessment, stock status

INTRODUCTION

This report reviews the history of Pacific herring (*Clupea pallasi*) fisheries in Lower Cook Inlet (LCI) and presents current stock status and projections for 2005. The objective of this report is to provide an overview of the status and management of Lower Cook Inlet herring resources.

The Lower Cook Inlet (LCI) management area is comprised of all marine waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point, and is divided into five fishing districts (Figure 1). Commercial herring fishing has historically occurred in four of the five management districts, with the Barren Islands District being the sole area where commercial herring fishing has not occurred.

LCI herring fishing first occurred in the Southern District in 1914 with the development of a gillnet fishery within Kachemak Bay (Figure 2). Eight salteries, six near Halibut Cove, were operating during the peak of the fishery. A purse seine fishery in Kachemak Bay began in 1923, but after three successive years of average annual harvests approaching 8,000 short tons (st; 1 short ton = 2,000 pounds), herring populations, and the fishery, collapsed.

The next LCI herring fishery began in 1939 and was centered in the Resurrection Bay and Day Harbor areas of the Eastern District (Figure 2). Product from this purse seine fishery was used exclusively for oil and meal reduction. Although the fishery continued through 1959, peak harvests occurred from 1944 to 1946 and averaged 16,000 st each of those years. After this period, stocks sharply declined, apparently due to over-exploitation.

HISTORY AND DEVELOPMENT OF THE SAC ROE FISHERY

Japanese market demand for salted herring roe resulted in development of a sac roe fishery in the 1960s. The relatively high prices paid to fishermen caused rapid expansion of the fishing fleet and harvest. In an effort to decrease the risk of a stock collapse and to sustain the fishery, the department established, what at that time were considered, conservative management strategies and guideline harvest levels. However, following a period of suspected overexploitation, herring stocks throughout LCI generally declined after 1973. Prior to the start of the 1974 season, concern over the declining trend led the Alaska Board of Fish and Game to establish a quota of 4,000 st for all of LCI. The only allowable gear type in the LCI herring sac roe fishery is purse seine. The limited

entry permit system for sac roe herring seining in Cook Inlet was implemented in 1977, and at the present time, 74 permanent and two interim use permits are issued for the management area.

OUTER/EASTERN DISTRICTS

During the early years of sac roe herring fishing in LCI, seining occurred primarily in the Outer and Eastern Districts (Figure 2), with the majority of effort and harvest once again concentrated in Resurrection Bay of the Eastern District. The first major harvest occurred in 1969, when 760 st of herring were taken in the Eastern District (Table 1). The catch increased dramatically in 1970 to a record high of 2,100 st in this district, but the stocks, and resultant harvests, declined over the next three seasons. The Alaska Board of Fish and Game allocated 1,000 st from the total LCI quota of 4,000 st to each of the Outer and Eastern Districts beginning with the 1974 season. However, stock abundance continued to decline and these quotas were never achieved. As a result, the Outer and Eastern Districts were closed to herring fishing from 1975 to 1984.

In 1985, the sac roe fishery was allowed to resume in the Outer and Eastern Districts on a very conservative basis, even though no noticeable change in spawning biomass had been observed. Because of the stocks' reduced abundance and extreme vulnerability to fishing, guideline harvest levels were set at 150 to 200 st for each of the four fishing areas created within these two districts. Fishing effort in 1985 was minimal and the majority of the harvest (216 st) once again occurred in Resurrection Bay. Only limited and sporadic harvests occurred in these two districts after 1985, with the majority of both the herring catch and the observed biomass comprised of fish age 4 and younger.

Despite considerable opportunity for exploratory fishing on a daily basis in the Outer and Eastern Districts during 1991 and 1992, the predominance of juvenile herring (Schroeder 1989) and the history of marginally acceptable roe recoveries from fish caught in these areas contributed to a lack of interest by fishermen and processors. These conditions prevailed from 1993 - 2004 and, consequently, the Outer and Eastern Districts were not opened to purse seining in any of the past twelve seasons.

In the fall of 2001, the Alaska Board of Fisheries adopted a new regulatory herring fishery management plan affecting the Outer, Eastern and Southern Districts. The plan contains seven specific criteria that must be met prior to consideration of a commercial fishery for herring in these districts. Since the plan's implementation in 2002, no changes in abundance levels or stock composition have been documented in the Outer and Eastern Districts herring populations; as specified in the management plan, no commercial fishery openings have occurred or been considered.

KAMISHAK BAY DISTRICT

Since 1973, most LCI sac roe harvests occurred within the Kamishak Bay District. Historical commercial harvests have ranged from a low of 240 st in 1973 to a high of 6,100 st in 1987 (Table 1), with estimated exvessel values ranging from $70,000 to $9.30 million (Table 2). After the initial harvest in 1973, Kamishak herring catches increased dramatically over the next three years, peaking at 4,800 st in 1976. Harvests dropped sharply during the ensuing three seasons, and by 1980 the stocks had declined to a point that the Kamishak Bay fishery was closed entirely for the next five consecutive years.

Although the Kamishak Bay District herring season remained fairly constant during the 1970's, roughly from late April through June, a significant management change occurred during this time.

From 1973 through 1977, the fishery was basically "open season until closed", but in 1978 it was changed to "closed season until opened by emergency order" (Table 5). In order to determine appropriate opening times and harvest levels, this revision required more active assessment of the herring stocks by the department.

Herring stocks appeared to respond positively and rebuild rather quickly following the 5-year closure that began in 1980. The fishery was reopened in 1985, with a resulting harvest of 1,100 st (Table 1). Beginning in 1985, the commercial fishery in Kamishak Bay District was regulated to achieve a 10 - 20% exploitation rate mandated by the Alaska Board of Fisheries. By 1989, fishing efficiency had increased to a level where intensive regulatory management was required to maintain harvests within guideline levels, to direct the fishery at herring aggregations with high quality roe, and to protect younger age herring from harvest. From 1985 through 1989, harvests averaged about 3,900 st, with a peak catch of 6,100 st in 1987 (Table 1).

Management of the Kamishak Bay District between 1990 and 1997 stabilized the average harvest at roughly 40% of the 1987 record high catch. However, hindcast biomass estimates generated by an age-structured-assessment (ASA) model show that stocks were declining steadily throughout the decade (Table 3, Figure 4), and by 1998 the commercial herring catch in the Kamishak Bay District totaled only 300 st despite several extended district-wide openings. As a result, the fishery has been closed since 1999 due to low abundance levels.

The present Kamishak Bay District Herring Management Plan (KBDHMP) was formally adopted into regulation by the Board of Fisheries in October 2001. The two key components of the new plan include a reduction in the maximum exploitation rate allowed in the fishery, from a former level of 20% of the forecasted herring biomass to a more conservative level of 15% (scaled depending on the forecasted biomass), and a reduction in the biomass threshold (the minimum volume necessary in order to allow a fishery) from 8,000 st to 6,000 st. One feature retained from the former plan includes a management strategy intended to limit the harvest of herring age 5 and younger. The intent of the present plan is to stabilize commercial harvests at lower than historical levels in order to prevent dramatic stock declines and subsequent extended commercial fishery closures. In addition, because the spawning stock of Kamishak Bay herring is believed to reside in waters of north Shelikof Strait in the Kodiak Management Area for at least a part of the year, the KBDHMP dictates that 10% of the allowable harvest of Kamishak Bay herring be allocated to the Shelikof food/bait fishery.

SOUTHERN DISTRICT

Sac roe herring seining in the Southern District began in the early 1960's, but catches were sporadic and relatively insignificant until 1969. That year, over 550 st were taken, followed the next season by a district record high harvest of 2,700 st (Table 1). Although commercial harvests continued during the 1970's, albeit at much lower levels, observed low abundance of herring has virtually precluded commercial openings during the past 25 years in the Southern District. The only exception occurred in 1989, when 10 vessels in a single 2.5-hour opening harvested 170 st of herring averaging 8.9% roe recovery. As previously mentioned, potential herring fishery openings in the Southern District are now regulated by a herring fishery management plan identical to that governing the Outer and Eastern Districts, and seven specific criteria must be met prior to allowing commercial harvest.

2004 SEASON OVERVIEW

ASSESSMENT METHODS

The primary method of herring biomass assessment in LCI is the aerial survey. Aerial surveys are conducted annually throughout the herring-spawning season in the Kamishak Bay and Southern Districts, from late April through early June, to determine relative abundance and distribution of herring. Aerial surveys of the Outer and Eastern Districts are not normally conducted due to the size of the area and the characteristically poor weather in the Gulf of Alaska, which precludes surveys on a regular basis and makes aerial biomass estimation in these districts impractical. Data collection methods in the Kamishak Bay and Southern Districts are similar, with numbers and distribution of herring schools, location and extent of milt, and visibility factors affecting survey results recorded on index maps for each survey. Three standard conversion factors are used to estimate herring biomass based on each 538 ft^2 (50 m^2) of school surface area sighted and water depth: 1) 1.52 st for water depths of 16 ft or less); 2) 2.56 st for water depths between 16 and 26 ft; and 3) 2.83 st for water depths greater than 26 ft (Lebida and Whitmore 1985, Otis and Bechtol 1999).

Due to invariably poor weather and water clarity, aerial surveys rarely provide reliable estimates of total biomass returning to Kamishak District Bay waters (Otis et al. 1998). As a result, an age-structured-assessment (ASA) model has been used for the past eleven years to forecast herring abundance for Kamishak Bay, as well as to "hindcast" previous years' total abundance. This dynamic model incorporates a variety of heterogeneous data sources including: times series of commercial catch age composition; total run age composition; and aerial survey biomass estimates from years with adequate survey conditions and coverage. The model simultaneously minimizes the differences between expected and observed return data for each of its components, updates hindcasts of previous years' abundance, and generates a forecasted estimate of the following year's return.

Another tool the department utilizes to aid in herring assessment in the Kamishak Bay District, and opportunistically in the Southern District, is a chartered commercial seine vessel. In years when a commercial fishery does not occur, the department is unable to utilize the fleet to collect samples for age composition analysis. The chartered commercial purse seine vessel is able to collect such samples and related information to further aid in understanding Kamishak Bay herring population dynamics. As long as sufficient funding is available, separate sampling charters are conducted to sample the early and late components of the spawning migration. In years when a fishery occurs, age samples are readily obtained from the early part of the migration targeted by the fishery, and a single "late season" sampling charter is used to obtain a more complete picture of the overall return. Hydroacoustic observations and water temperature/depth parameters are concurrently recorded during the charters. The information gathered during these sampling efforts provides age class data that: 1) allow the staff to generate an age composition estimate of the overall biomass observed by aerial surveyors throughout the entire duration of the spawning migration; and 2) facilitates the evaluation of the relative strength of recruit year classes. This is critical in generating the annual herring forecast. The charters further serve to informally verify the relative magnitude of herring biomass observed by aerial surveyors.

KAMISHAK BAY DISTRICT 2004 SEASON SUMMARY

Aerial survey coverage to assess the Kamishak Bay herring stock in 2004 was considered poor, while overall observation conditions were considered fair. Several 6- to 9-day "gaps" in coverage, or periods during which no surveys were flown due to poor weather, occurred during the 2004 survey season. Aerial surveyors documented a cumulative total of less than 900 st of herring in the Kamishak Bay District this season, by far the lowest volume in the past 13 years. Four consecutive years of low aerial survey abundance indices indicate the lack of a significant recruitment event in Kamishak Bay during any recent season. This contrasts with other North Gulf of Alaska herring populations, including Kodiak and Prince William Sound, which have experienced population growth due to strong recruitment events in recent years. One hypothesis for the lack of recruitment in Kamishak Bay derives from the relatively poor condition of the fish observed recently, characterized by low average weights-at-age, which can lead to higher than normal mortality.

The department conducted vessel charters to collect age composition samples during the early (27 April - 5 May) and late (15 - 22 May) season periods of 2004. The early sampling period coincided with the arrival of the first fish on the grounds, which in turn corresponds to the traditional timing of the commercial fishery, while the second charter collected age composition samples during the latter portion of the return in 2004. Unfortunately, data from the two charters corroborated the overall low abundance of the population observed by department aerial surveyors. During the 17 days spent in the district, the contracted vessel collected over 1,600 fish for age/weight/length (AWL) analysis. These AWL samples indicate that the Kamishak Bay herring population is currently comprised mainly of young, recruit aged herring (Table 4).

Using the ASA model, the department estimated the total 2004 return at 2,546 st (Otis *in prep.*; Tables 3 and 4, Figure 4); an 8% decrease from the 2003 hindcast estimate of 2,765 st. Recruitment into the spawning population has been roughly equivalent to the loss of spawners due to natural mortality over the past several years, resulting in no major gains to the population since the stock decline leveled out around 1998 (Figure 4). The overall return this season was dominated by age-3 and age-5 herring, at 30% and 25% of the population by number, respectively (Table 4, Figure 5).

SOUTHERN DISTRICT 2004 SEASON SUMMARY

A total of four aerial surveys were flown in the Southern District between April 30 and May 21 in 2004, all conducted under relatively good conditions. The 2004 run biomass, estimated as the sum of all daily biomass estimates, totaled only 397 st, a slight decrease from the previous year's estimate of 558 st, and the second lowest estimate in the past decade. The peak 2004 individual biomass survey (264 st) occurred on May 4, with the majority of herring observed off Glacier Spit. Peak surveys in areas where herring historically have been observed were as follows: Mallard Bay, 21 st on May 21; east of the Homer Spit/Mud Bay, 53 st on May 4; and Glacier Spit, 210 st on May 4. Consistent with the past twenty years, low abundance levels in the Southern District precluded any commercial fishing during the 2004 season.

OUTER/EASTERN DISTRICT 2004 SEASON SUMMARY

As in recent seasons, no herring assessment occurred in the Outer and Eastern Districts during 2004. Unlike the Southern and Kamishak Bay Districts, historical samples from the Outer and Eastern Districts have contained a relatively high percentage of age-2 (sexually immature) herring. No

discernible shift to older age herring has ever been observed in this area, suggesting the possibility that the Outer and Eastern Districts may be feeding and rearing grounds for juvenile fish from another area.

RECENT AND UPCOMING RESEARCH

In addition to the department's ongoing herring stock assessment program, two additional research projects were completed in 2003. The first project evaluated the effectiveness of two herring stock identification techniques (Otis and Heintz 2003), and the second synthesized all of the historical stock assessment and commercial fishery data available for Kamishak Bay into a geographical information systems (GIS) database (Otis and Spahn 2003).

The stock identification project was undertaken, in part, to better understand the relationship between Kamishak Bay and West Side Kodiak Island herring stocks. The KBDHMP dictates that 10% of the allowable harvest for Kamishak Bay be allocated to the Shelikof food/bait fishery because it appears these two stocks mix during part of the year around the north end of Shelikof Strait (Johnson et. al. 1988; unpublished data). The extent to which these stocks intermix is poorly understood and the ramifications of their mixing greatly complicate the assessment and management of each stock. The department successfully applied for a grant (Project 02538) from the *Exxon Valdez* Oil Spill Trustee Council (EVOS-TC) to investigate the feasibility of using two relatively new stock identification techniques, fatty acid composition of heart tissue and elemental composition of otoliths, to distinguish between several Alaska herring stocks.

Detailed results of that study are available in Otis and Heintz (2003), but a brief summary is provided here. We evaluated the capabilities of otolith microchemistry and heart tissue fatty acid profile to identify the stock of origin for herring sampled from four spawning aggregations in the North Gulf of Alaska (NGA), and two outside the NGA (Sitka and Togiak). Otolith microchemistries were measured in parts per thousand (ppt) using an electron microprobe. Fatty acid profiles were determined by performing trans-esterification and fatty acid chromatography on purified lipids from whole hearts. A MANOVA revealed significant regional differences among the mean fatty acid profiles of heart lipids from Sitka, NGA and Togiak herring, and among the four NGA stocks. Cross-validation of discriminant functions demonstrated that fatty acid profiles could be used to correctly identify unknown samples more than 90% of the time. Otolith microchemistries were also significantly different between Sitka and Togiak and among some NGA stocks, however, otolith microchemistries could not effectively discriminate between NGA and other regions, or between two of the four NGA stocks. We concluded that heart tissue fatty acid profiles can be used to discriminate among NGA Pacific herring, but further work is necessary to verify the temporal stability of the biomarkers our study identified before they can be used to determine stock contributions from mixed-stock herring fisheries in this region.

The second project recently completed was intended to compile historical survey data that had never been digitized. The department successfully applied for National Marine Fisheries Service funds to synthesize all of the historical Kamishak Bay herring stock assessment and commercial fishery data into a comprehensive GIS database. Much of this historical information, dating back to 1973, previously existed only in hard copy form on aerial survey maps. Observations made during these aerial surveys were digitized for the purpose of improving access to, and facilitating analysis of, this relatively long-term dataset. The dataset included over 6,300 individual biological observations including: herring schools, herring spawn events, and incidental

observations of marine mammals and seabirds. Other data provided on the finished CD ROM included fishery management areas, age-weight-length sample data, hyper-linked photographs of the area's geography, fauna, and fishery, and commercial harvest effort and catch records (Otis and Spahn 2003).

Finally, the department recently received further EVOS funding to follow up on the positive results of the herring stock identification pilot study. In 2005 and 2006, we plan to collect additional samples from spawning aggregations around the state to verify the temporal stability of the fatty acid biomarkers identified during the pilot study, which will enable us to eventually apply this promising technique towards determining stock contributions from mixed-stock herring food/bait fisheries in Alaska.

2005 SEASON OUTLOOK

KAMISHAK BAY DISTRICT

The forecasted herring biomass generated by the ASA model for 2005 in the Kamishak Bay District is 3,058 st (Table 4, Figure 4). This total is below the current regulatory threshold of 6,000 st for which a commercial harvest can be considered. In addition, over 48% of the predicted return in 2005 (by weight) will be comprised of herring age-5 and younger (Table 4, Figure 5). Since the forecast is below threshold and the KBDHMP directs the department to limit the harvest of fish age-5 and younger, the sac roe fishery in the Kamishak Bay district will remain closed for the 2005 season. The resource, and hence the commercial fishery, is best served by protecting the remaining spawning population in order to rebuild it to a harvestable level.

Without a commercial fishery in 2005, the department expects to once again obtain samples with a chartered commercial seine vessel during the early and late spawning components of the 2005 run. The department will also attempt to conduct comprehensive aerial surveys throughout the spawning season, from mid-April to early June, as conditions permit.

OTHER DISTRICTS

Based on the persistent trend of low herring abundance in the Southern District and a historical preponderance of juvenile herring in the Outer and Eastern Districts, no commercial herring harvests are anticipated during 2005 in any of these areas. Monitoring of the Southern District herring stocks will occur as in the past through the use of aerial surveys in conjunction with test fishing samples collected on an opportunistic basis.

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TABLES AND FIGURES

Table 1.–Commercial catch of Pacific herring (*Clupea pallasi*) in short tons and effort in number of permits by district in the commercial sac roe seine fishery, Lower Cook Inlet 1961-2004[a].

	Southern		Kamishak		Eastern		Outer		Total	
Year	Tons	Permits	Tons	Permits	Tons	Permits	Tons	Permits	Tons	Permits
1961	0		0		1		0		1	
1962	0		0		0		0		0	
1963	1		0		0		0		1	
1964	0		0		0		0		0	
1965	2		0		0		0		2	
1966	0		0		7		0			7
1967	0		0		0		0			0
1968	20		0		0		0			20
1969	551		0		758		38			1,347
1970	2,709		0		2,100		0			4,809
1971	13	2			831	22			844	24
1972	1	1			30	1			31	2
1973	204	16	243	14	831	25	301	12	1,579	37
1974	110	7	2,114	26	47	5	384	26	2,655	45
1975	24	5	4,119	40					4,143	41
1976	0		4,842	66					4,842	66
1977	291	13	2,908	57					3,199	58
1978	17	7	402	44					419	44
1979	13	3	415	35					428	36
1980										
1981	---		---		---		---		---	
1982	---		---		---		---		---	
1983	---		---		---		---		---	
1984	---		---		---		---		---	
1985	---		1,132	23	204	7	12	2	1,348	29
1986	---		1,959	54	167	4	28	3	2,154	57
1987	---		6,132	63	584	4	202	9	6,918	69
1988	---		5,548	75	0	0	0	0	5,548	75
1989	170	6	4,801	75	0	0	0	0	4,971	75
1990	---		2,264	75	---		---		2,264	75
1991	---		1,992	58	0	0	0	0	1,992	58
1992	---		2,282	56	0	0	0	0	2,282	56
1993	---		3,570	60	---		---		3,570	60
1994	---		2,167	61	---		---		2,167	61
1995	---		3,378	60	---		---		3,378	60
1996	---		2,984	62	---		---		2,984	62
1997	---		1.746[b]	45[b]	---		---		1,746	45
1998	---		331[b]	20[b]	---		---		331	20
1999	---		100[c]	1[c]	---		---		100	1
2000	---		---		---		---		---	---
2001-2004	---		---		---		---		---	---
Averages:										
1971-80	75	7	1,671	40	435	13	171	10	2,016	39
1981-90	170	6	3,639	61	191	3	48	3	3,867	63
1991-2000			2,061	53					2,061	53
1981-2000			2,692	56	136	2	35	2	2,784	57

[a] Data source: ADF&G fish ticket database.

[b] Includes both commercial harvest and ADF&G test fish harvest.

[c] Commercial fishery closed, ADF&G test fish harvest only.

Table 2.–Preseason estimates of biomass and projected sac roe seine harvests, and actual harvests, for Pacific herring (*Clupea pallasi*) in short tons, average roe recovery, number of permits making landings and exvessel value in millions of dollars, Kamishak Bay District, Lower Cook Inlet, 1981-2004.

	PRESEASON		Actual	Average	No. of	Exvessel
	Forecasted	Projected[a]	Commercial	Roe	Permits	Value[b]
1981	[c]	---	CLOSED	---	---	---
1982	[c]	---	CLOSED	---	---	---
1983	[c]	---	CLOSED	---	---	---
1984	[c]	---	CLOSED	---	---	---
1985	[c]	[d]	1,132	11.3	23	1.00
1986	[c]	[d]	1,959	10.4	54	2.20
1987	[c]	3,833	6,132	11.3	63	8.40
1988	[c]	5,190	5,548	11.1	74	9.30
1989	37,785	5,000	4,801	9.5	74	3.50[e]
1990	28,658	2,292	2,264	10.8	75	1.80
1991	17,256	1,554	1,992	11.3	58	1.30
1992	16,431	1,479	2,282	9.7	56	1.40
1993	28,805	2,592	3,570	10.2	60	2.20
1994	25,300	3,421	2,167	10.6	61	1.50
1995	21,998	2,970	3,378	9.8	60	4.00
1996	20,925	2,250	2,984	10.1	62	6.00[e]
1997	25,300	3,420	1,746	9.3	45	0.40
1998	19,800	1,780	331	8.5	20	0.07
1999	[f]	---	CLOSED	---	---	---
2000	6,330	---	CLOSED	---	---	---
2001	11,352	---	CLOSED	---	---	---
2002	9,020	---	CLOSED	---	---	---
2003	4,771	---	CLOSED	---	---	---
2004	3,552	---	CLOSED	---	---	---
1981-2004 Average	18,486	2,982	2,878	10.3	56	3.08

[a] Kamishak Bay allocation only, does not include Shelikof Strait food/bait allocation.
[b] Exvessel values exclude any postseason retroactive adjustments (except where noted).
[c] Prior to 1989, preseason forecasts of biomass were not generated.
[d] Prior to 1987, preseason harvest projections were not generated.
[e] Includes retroactive adjustment.
[f] 1999 preseason biomass calculated as a range of 6,000 to 13,000 st.

Table 3.–Estimate of Pacific herring (*Clupea pallasi*) total biomass in short tons using two different methods, actual commercial sac roe seine harvest in short tons, and hindcast estimate of percent exploitation, Kamishak Bay District, Lower Cook Inlet, 1981-2004.

Year	Aerial Survey Total Biomass Index (st)[a]	ASA Model Total Biomass Estimate (st)[b,c]	Actual Commercial Harvest (st)	Estimated Exploitation Rate (%)[b]
1981	5,130	24,963	CLOSED	
1982	4,835	33,480	CLOSED	
1983	4,750	35,513	CLOSED	
1984	6,500	34,469	CLOSED	
1985	13,320	34,001	1,132	3.3%
1986	26,001	30,952	1,959	6.3%
1987	35,332	29,696	6,132	20.6%
1988	29,548	23,549	5,548	23.6%
1989	35,701	19,610	4,801	24.5%
1990	30,258	15,779	2,264	14.3%
1991	3,666	16,107	1,992	12.4%
1992	21,874	14,476	2,282	15.8%
1993	4,918	12,701	3,570	28.1%
1994	4,413	10,375	2,167	20.9%
1995	6,878	8,274	3,378	40.8%
1996	5,331	6,086	2,984	49.0%
1997	3,115	4,140	1,746	42.2%
1998	3,288	3,266	331	10.1%
1999	12,456	3,052	CLOSED	
2000	10,502	3,006	CLOSED	
2001	3,430	2,811	CLOSED	
2002	3,748	2,733	CLOSED	
2003	1,938	2,765	CLOSED	
2004	857	2,546	CLOSED	
1981-2004 Average	11,574	15,847	2,878	22.3%

[a] This aerial survey biomass index represents the accumulative total herring biomass observed by aerial surveyors. It does not attempt to expand counts to make up for periods of inclement weather when surveys could not be flown; nor does it subtract fish to account for fish that may have been counted on successive survey days.

[b] These data are based on the best available data at the time of publishing and are subject to change; therefore all figures herein supersede those previously reported. These values are generated by the most recent run of the ASA model, which also generates a hindcast of each previous year's biomass.

[c] ASA model integrates heterogeneous data sources and simultaneously minimizes differences between observed and expected return data to forecast the following year's biomass as well as hindcast previous years' biomass.

Table 4.–Total biomass estimates and commercial catch of Pacific herring (*Clupea pallasi*) in short tons by age class, Kamishak Bay District, Lower Cook Inlet, 2004, and 2005 forecast.

Age	2004 Est. Spawning Biomass	Percent by Weight	2004 Commercial Harvest[a]	Percent by Weight	2004 Total Biomass	Percent by Weight	2005 Forecast Biomass	Percent by Weight
1								
2								
3	407	16.0%	0	NA	407	16.0%	679	22.2%
4	214	8.4%	0	NA	214	8.4%	561	18.3%
5	594	23.3%	0	NA	594	23.3%	243	8.0%
6	112	4.4%	0	NA	112	4.4%	654	21.4%
7	312	12.3%	0	NA	312	12.3%	100	3.3%
8	376	14.8%	0	NA	376	14.8%	269	8.8%
9	112	4.4%	0	NA	112	4.4%	266	8.7%
10	180	7.1%	0	NA	180	7.1%	75	2.5%
11	174	6.8%	0	NA	174	6.8%	86	2.8%
12	51	2.0%	0	NA	51	2.0%	92	3.0%
13+	13	0.5%	0	NA	13	0.5%	32	1.0%
TOTALS	2,546	100%	0		2,546	100%	3,058	100%

[a] Due to the low forecasted biomass, the commercial herring fishery in Kamishak Bay was not opened in 2004.

Table 5.–Summary of herring sac roe seine fishery openings and commercial harvests in the Kamishak Bay District of Lower Cook Inlet, 1964-2004.

Year	Dates of Openings	Total Hrs. Open	Harvest (short tons)	Catch Rate (short tons/ hour open)	Number of Permits w/Landings
1969-73	No closed periods				
1974	1/1 - 5/20		2,114		26
1975	1/1 - 6/6	(Closed Iniskin Bay 5/17)	4,119		40
1976	1/1 - 5/21	(Closed Iniskin Bay 5/17; reopened Kamishak 6/2)	4,824		66
1977	1/1 - 5/31	(Closed Kamishak Dist. 5/12; reopened 5/14 - 5/17; reopened 5/29 - 5/31)	2,908		57
1978[a]	4/16 - 5/31	96	402	4.2	44
1979	5/12 - 5/15	72	415	5.8	36
1980-84	CLOSED	0	0		
1985	4/20 - 6/15	1,350 (56.2 days)	1,132	0.8	23
1986	4/20 - 6/13	1,303 (54.3 days)	1,959	1.5	54
1987	4/21 - 4/23	65	6,132	94.3	63
1988	4/22 - 4/29	42	5,548	132.1	74
1989	4/17 - 4/30	24.5	4,801	196.0	74
1990	4/22 - 4/23	8	2,264	283.0	75
1991	4/26	1	1,922	1,922.0	58
1992	4/24	0.5	2,282	4,564.0	56
1993	4/21	0.75	3,570	4,760.0	60
1994	4/25	0.5	778	1,556.0	35
	4/29	1.0	1,338	1,338.0	53
1995	4/27	0.5	1,685	3,370.0	45
	4/28	1.0	1,693	1,693.0	44
1996	4/24	0.5	2,984	5,968.0	62
1997	4/25[b]	0.5	0	0	0
	4/29	1.5	1,580	1,053.3	42
	4/30	8.0	61	7.6	[c]
	5/1	12.0	51	4.3	4
	5/22[d]	[d]	54	[d]	-
1998	4/21	0.5	160	320.0	12
	4/22	2.0	136	68.0	11
	5/14[d]	[d]	10	[d]	-
	5/22[d]	[d]	23	[d]	-
1999	CLOSED	CLOSED	100[d]	[d]	-

- continued -

Table 5. (page 2 of 2)

Year	Dates of Openings	Total Hrs. Open	Harvest (short tons)	Catch Rate (short tons/ hour open)	Number of Permits w/Landings
2000	CLOSED	CLOSED	0	-	-
2001	CLOSED	CLOSED	0	-	-
2002	CLOSED	CLOSED	0	-	-
2003	CLOSED	CLOSED	0	-	-
2004	CLOSED	CLOSED	0	-	-

[a] Management by emergency order began.

[b] Despite the open fishing period, the entire fleet collectively agreed not to fish due to ongoing price negotiations with processors.

[c] To comply with AS 16.05.815 *Confidential nature of certain reports and records*, effort data has been masked where fewer than four vessels fished in a given area.

[d] ADF&G test fishing harvest.

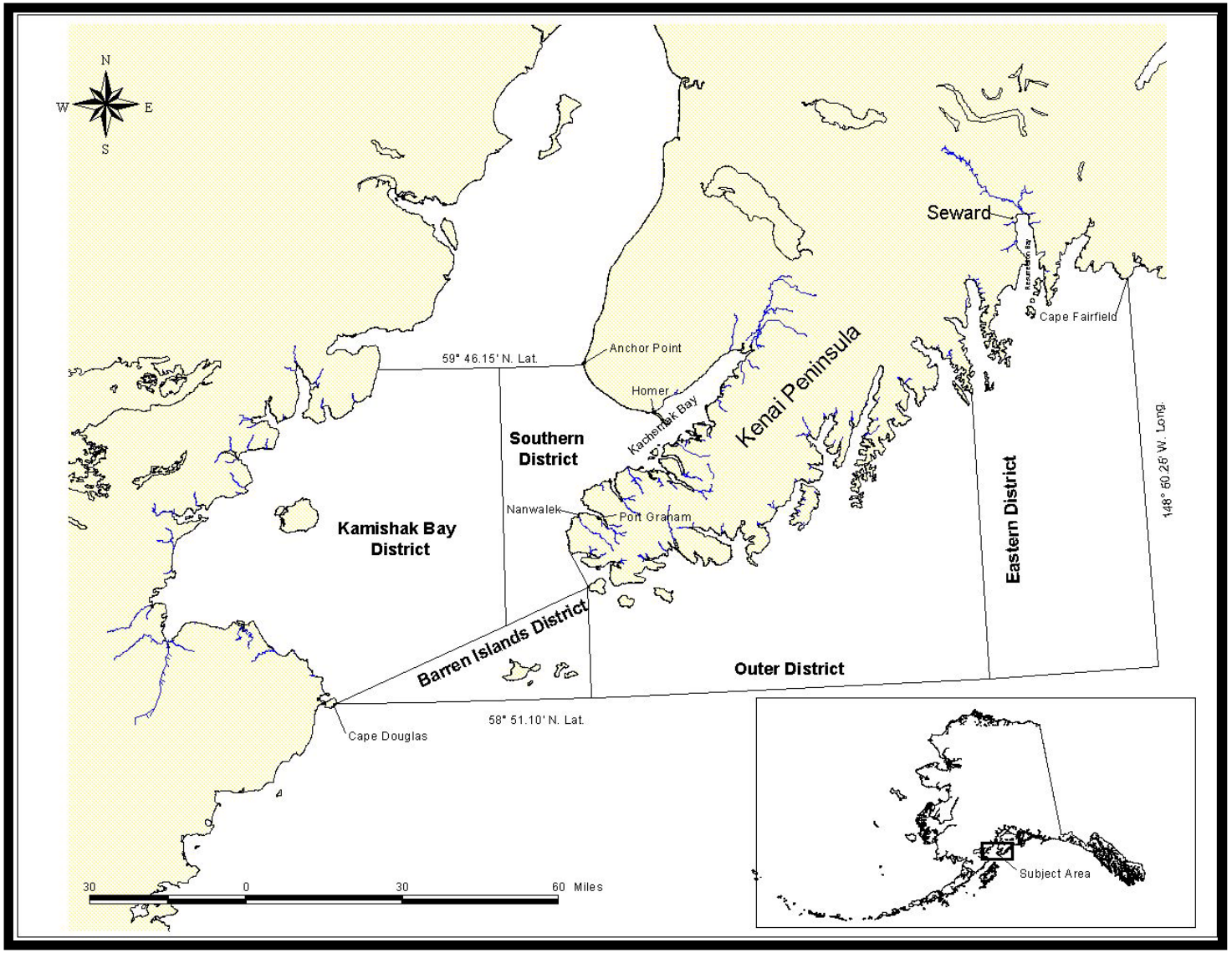

Figure 1.–Lower Cook Inlet salmon and herring management area with its five commercial fishery district boundaries.

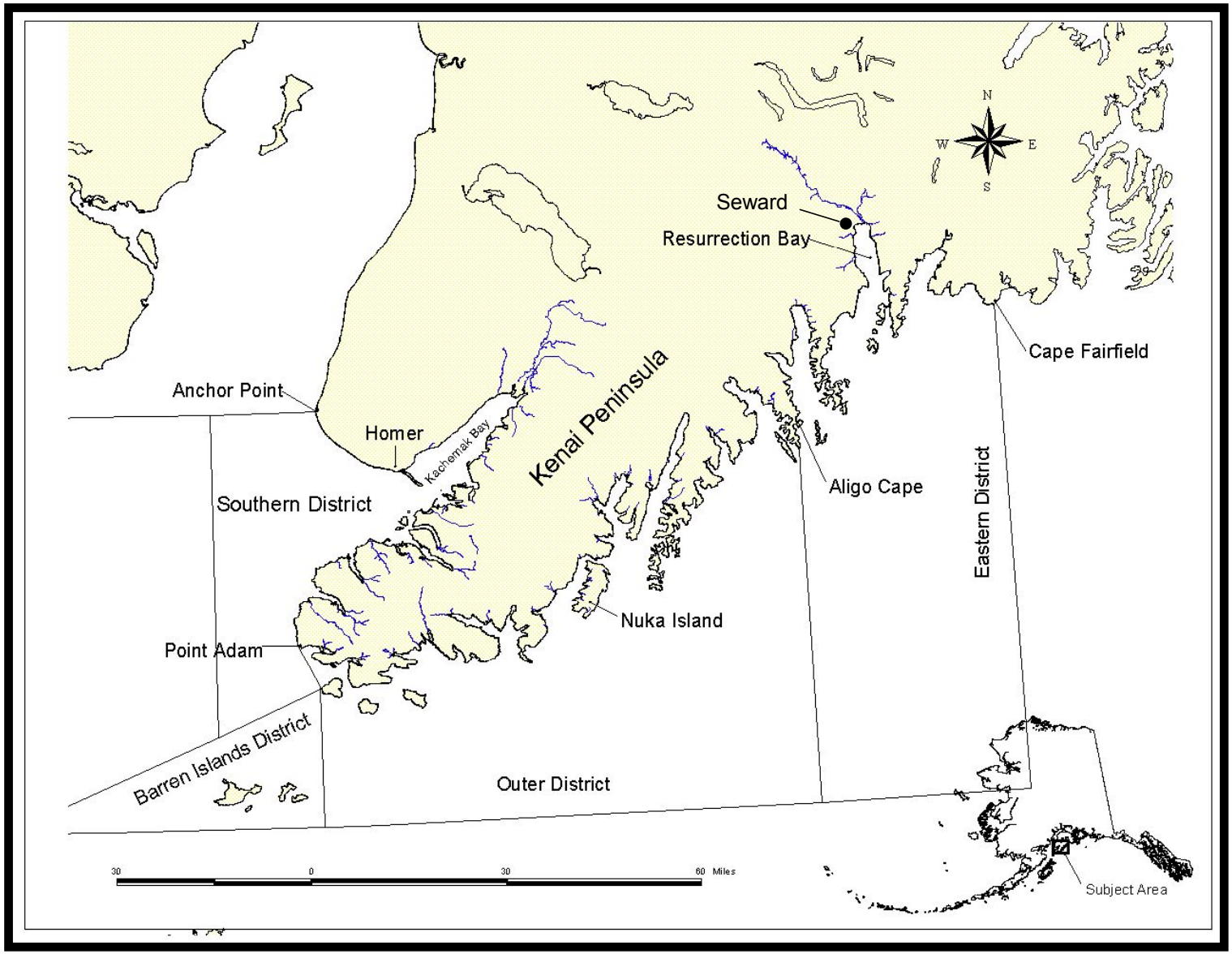

Figure 2.–Southern, Outer, and Eastern Districts in Lower Cook Inlet.

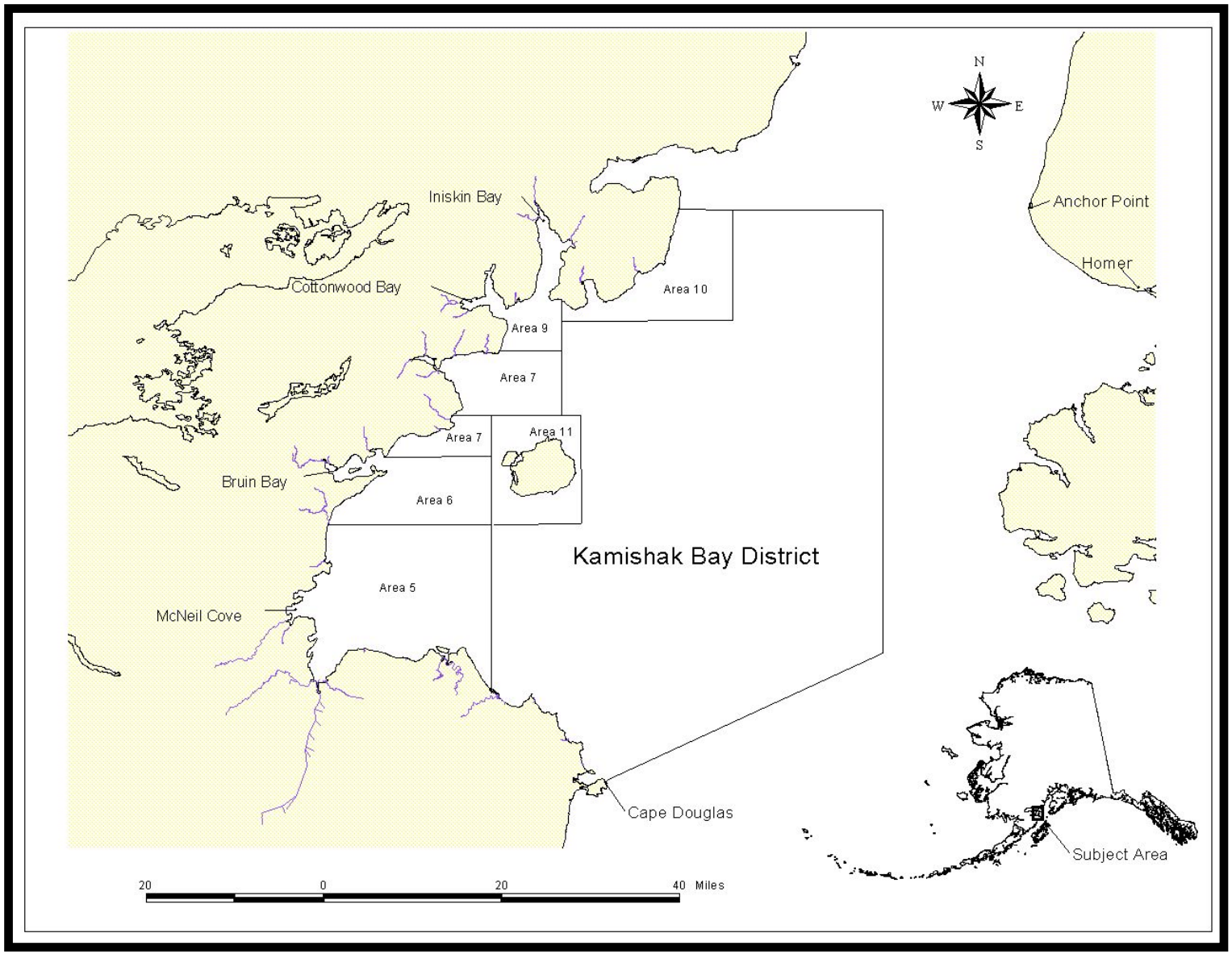

Figure 3.–Kamishak Bay District herring management areas in Lower Cook Inlet.

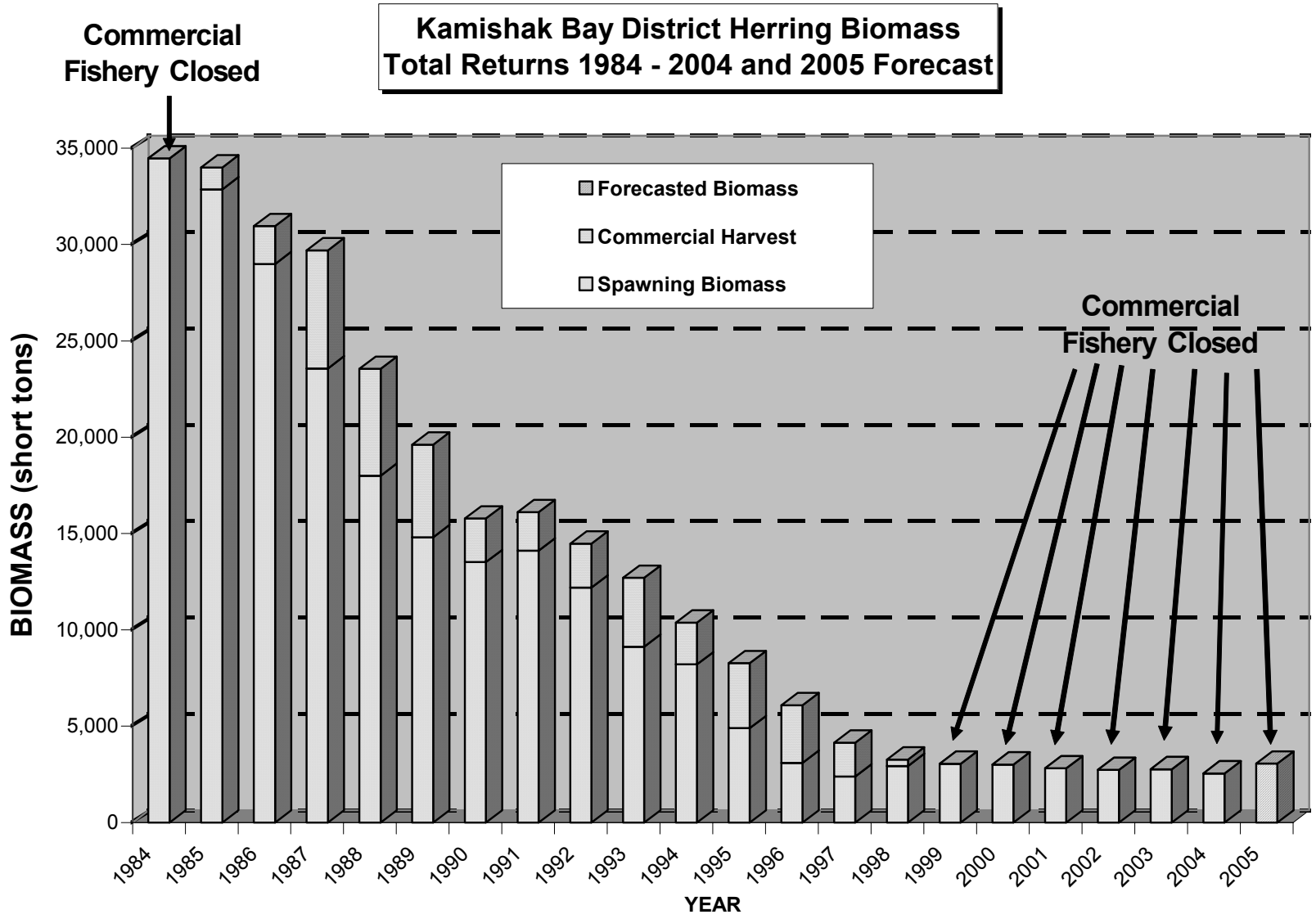

Figure 4.–Biomass estimates and commercial harvests of Pacific herring (*Clupea pallasi*) in the sac roe seine fishery, Kamishak Bay District, Lower Cook Inlet, 1984-2004, and 2005 projection.

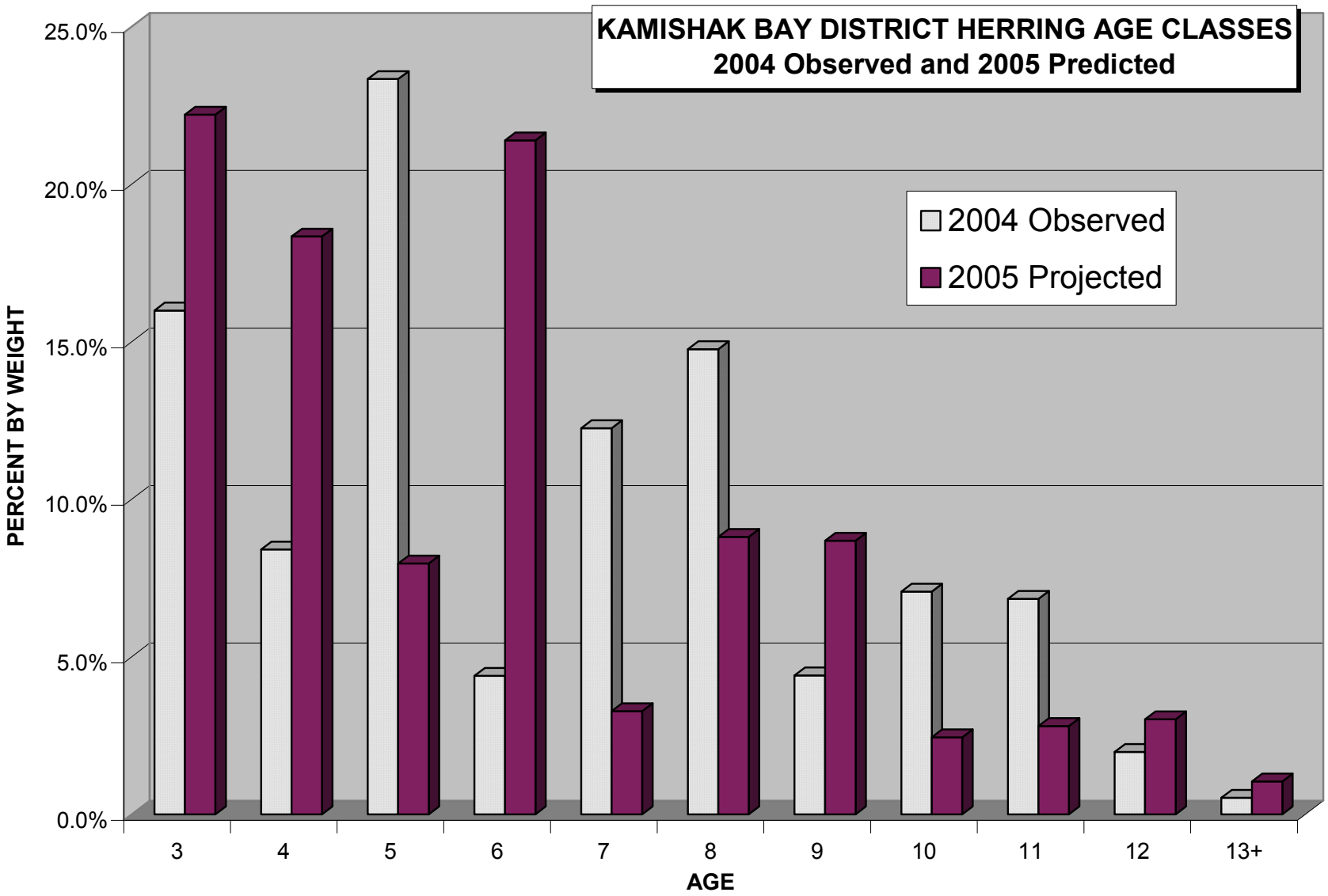

Figure 5.–Pacific herring (*Clupea pallasi*) age composition derived by purse seine sampling in Kamishak Bay District, Lower Cook Inlet, 2004, and 2005 projection.