Regional Operational Plan CF.2A.2014.03

Upper Cook Inlet Offshore Test Fishery Project

by

Pat Shields

and

Mark Willette

March 2014

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

Symbols and Abbreviations

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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)

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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Alaska Department of Fish and Game, Division, Soldotna

Alaska Department of Fish and Game
Commercial Fisheries Division

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Pat Shields and Mark Willette
Alaska Department of Fish and Game, Commercial Fisheries Division,
43961 Kalifornsky Beach Road, Suite B, Soldotna, Alaska

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SIGNATURE PAGE

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Approval

Title	Name	Signature	Date
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Biometrician	Xinxian Zhang	[illegible]	3/18/2014
Research Coordinator	Lowell Fair	Lowell Fair	3/18/14

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PURPOSE

The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries, annually operates an offshore test fishery (OTF) project near the southern boundary of the Upper Cook Inlet (UCI) salmon management area. The primary goal of the project is to estimate the total sockeye salmon *Oncorhynchus nerka* run returning to UCI during the commercial salmon fishing season. The project is an important tool for fishery managers in achieving sustainable escapement goals while harvesting surplus fish in a manner than complies with Alaska Board of Fisheries management directives. In 2012, a second test fishery vessel was added to examine the spatial and temporal distributions of various sockeye and coho salmon stocks in the Central District of the UCI management area.

Key Words: salmon, *Oncorhynchus* spp., Upper Cook Inlet, Alaska, test fishery, migratory behavior, GSI.

BACKGROUND

In 1979, the ADF&G began an offshore test fishery (OTF) project near the southern boundary of the Upper Cook Inlet (UCI) salmon management area (Figure 1). The project was designed to estimate the total sockeye salmon *Oncorhynchus nerka* run (including run timing) returning to UCI during the commercial salmon fishing season. These data have become extremely important to ADF&G staff, helping to adjust commercial fishing times and areas to most efficiently harvest surplus sockeye salmon or restrict fisheries that may overharvest specific stocks. In recent years, the Alaska Board of Fisheries (BOF) has assembled various management plans requiring inseason abundance estimates of the Kenai sockeye salmon run to implement specific plan provisions. The OTF project has increasingly become one of the most important tools fishery managers utilize to make inseason fishery management decisions that comply with BOF management directives. In 2006, ADF&G added a third objective to determine the spatial and temporal distribution of various sockeye salmon stocks entering UCI using genetic stock identification (GSI) techniques. The focus of this project component was to identify stock-specific migration routes, run timings, and inseason forecasting techniques. Test fishing results have been reported annually since 1979 (Waltemyer 1983, 1984, 1986a-b; Hilsinger and Waltemyer 1987; Hilsinger 1988; Tarbox and Waltemyer 1989; Tarbox 1990–1991, 1994–1998a-b, 1999; Tarbox and King 1992; Shields 2000, 2001, 2003; Shields and Willette 2004, 2005, 2007, 2008, 2009a-b, 2010).

In 2012, ADF&G initiated a second UCI test fishery project focused on identifying migration routes and run timings of Susitna and other UCI sockeye salmon stocks passing through the Central District. The goal of this project was to determine if conservation efforts through time and area restrictions could lessen harvest rates on sockeye salmon bound for the Susitna River and provide increased opportunity for sport and subsistence fishermen in northern Cook Inlet. This project added an additional test fish transect across Cook Inlet near the northern tip of Kalgin Island (Figure 2). This transect location was selected to determine if migrating Susitna sockeye salmon were beginning to split off from Kenai and Kasilof sockeye salmon at this latitude. If so, managers could use this knowledge to more efficiently harvest non-Susitna stocks, while allowing Susitna-bound fish to pass through the Central District. The northern test fishery followed the same general sampling protocols utilized for the southern test fishery, i.e. a drift gillnet vessel fished 6 stations every day during July recording catch per effort statistics and collecting sockeye salmon tissue samples for later GSI analyses. In 2013, ADF&G began collecting tissue samples for GSI analyses of coho salmon captured by the northern test fishery vessel. The goal of this project component was the same as for sockeye salmon, i.e. identification of migration routes and run timings of Susitna and other UCI coho salmon stocks passing through the Central District. This operational plan describes a modification to the plan described by Shields and Willette (2013).

This operational plan describes all studies associated with the UCI offshore test fishery projects. These studies are funded through four legislative appropriations: (1) UCI offshore test fishery (FM-358), (2) UCI sockeye salmon genetic stock identification, (3) Susitna River sockeye salmon migration (CP-621), and (4) UCI mixed stock sampling (FM-367).

OBJECTIVES

The objectives of the southern OTF project are to

1. Estimate an inseason UCI sockeye salmon total run (including run timing).
2. Estimate an inseason Kenai River sockeye salmon total run.
3. Estimate the spatial and temporal distribution of various sockeye salmon stocks entering UCI.

The objectives of the northern OTF project are to

1. Estimate the spatial and temporal distribution of Susitna River sockeye and Northern Cook Inlet coho salmon stocks passing through the Central District.

METHODS

TEST FISHING

Along the southern transect, salmon returning to UCI will be sampled by fishing 6 geographically fixed stations between Anchor Point and the Red River Delta (Figure 1). These stations have been fished since 1992 (Tarbox 1994) and were established based on analyses that showed they provided the most reliable estimates of inseason run size and timing. Stations were numbered consecutively from east to west, with station locations (latitude and longitude) determined with global positioning system technology. A chartered test fishing vessel will sample all 6 stations (numbered 4, 5, 6, 6.5, 7 and 8) daily, traveling east to west on odd-numbered days and west to east on even-numbered days.

The northern test fishing vessel will sample salmon at 8 geographically fixed stations along two transects (Table 1). Four stations will be sampled along a transect running west of Kalifornsky Beach to the northern tip of Kalgin Island, and 4 additional stations will be sampled along a transect running from the southern tip of Kalgin Island to Clam Beach (Figure 2). A chartered test fishing vessel will sample all 8 stations (numbered 2-9) daily. This sampling design will omit stations 1, 6, and 7 along the northern Kalgin Island transect sampled in 2012-2013 (Shields and Willette 2013), but the same station numbers (2-5) will be used for those stations still being sampled. The northern test fishing vessel will fish the stations to ensure there is no systematic difference in the time of day or tide stage between the stations sampled on the 2 transects. Both vessels will begin sampling on 1 July and continue through 31 July. The vessels will fish 366 m (1,200 ft or 200 fathoms) of multi-filament drift gillnet with a mesh size of 13 cm (5 1/8 inches). The nets will be 45 meshes deep and constructed of double knot Super Crystal[1] shade number 1, with filament size 53/S6F.

The following physical and chemical measurements will be taken at the start of each set: air temperature, water temperature and salinity (at 1 m below the surface), wind velocity and direction, tide stage, water depth, and water clarity. Air and water temperatures (°C) and salinity (ppt) will be measured using a YSI salinity/temperature meter. Wind speed will be measured in knots and direction will be recorded as 0 (no wind), 1 (north), 2 (northeast), 3 (east), 4 (southeast), 5 (south), 6 (southwest), 7 (west), or 8 (northwest) using a Kestrel 4000 pocket weather tracker. Tide stage will be classified as 1 (high slack), 2 (low slack), 3 (flooding), or 4 (ebbing) by observing the movement of the vessel while drifting with the gill net. Water depth will be measured in fathoms (fm) using a Simrad echo sounder, and water clarity will be measured in meters (m) using a 17.5 cm secchi disk, following methods described by Koenings et al. (1987).

All salmon captured in the drift gillnet will be identified by species and enumerated. The number of fish captured at each station (*s*) on each day (*i*) will be expressed as a CPUE statistic, or index point, and standardized to the number of fish caught in 100 fathoms of gear in one hour of fishing time:

$$CPUE_{s,i} = \frac{100\,fm \;\; x \;\; 60\,\mathrm{min} \;\; x \;\; number\ of\ fish}{fm\ of\ gear \;\; x \;\; MFT} \ . \tag{1}$$

Mean fishing time (*MFT*) will be

$$MFT = (C - B) + \frac{(\mathrm{B} - \mathrm{A}) + (\mathrm{D} - \mathrm{C})}{2} \ , \tag{2}$$

where A = time net deployment started,

B = time net fully deployed,

C = time net retrieval started, and

D = time net fully retrieved.

Once deployed at a station, the drift gillnet will be fished 30 minutes before retrieval is started. However, since the net will be capable of capturing fish prior to being fully deployed or retrieved. *MFT* will be adjusted by summing the total time taken to set and retrieve the net, then dividing this time in half, and adding it to the time when the entire net is deployed.

Catch and CPUE data for stations not fished will be interpolated by averaging catches from the previous and following days. However, when 3 or more consecutive days are missed, the

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

proportion of the catch or CPUE for each station from all previous days will be used to estimate missing values.

Daily $CPUE_i$ data will be summed for all m stations as follows:

$$CPUE_i = \sum_{s=1}^{m} CPUE_{s,i} \ . \tag{3}$$

Cumulative $CPUE_i$ ($CCPUE_d$) will be

$$CCPUE_d = \sum_{i=1}^{d} CPUE_i \ , \tag{4}$$

where: d = date of the estimate.

DESCRIBING THE SALMON MIGRATION AND PROJECTING TOTAL RUN

Sockeye salmon catches from only the southern test fishery will be used to project the total UCI sockeye salmon run. The sockeye salmon run will be described for each of the previous years based on historical test fishing data as described in Mundy (1979):

$$Y_{yr,d} = 1 \Big/ \left(1 + e^{-(\mathrm{a} + \mathrm{bd})}\right) \ , \tag{5}$$

where: $Y_{yr,d}$ = modeled cumulative proportion of $CCPUE_{yr,f}$ (f = final day of season) for year yr as of day d, and

a and b = model parameters.

Variables without the subscript yr indicating year refer to the current year's estimate. To determine which of the previous run timing curves most closely fit the current year's data and to estimate total run for the entire season (TR_f), a projection of the current year's $CCPUE_d$ at the end of the season ($CCPUE_f$) will be estimated (Waltemyer 1983):

$$CCPUE_f = \frac{\sum_{d=0}^{D} CCPUE_d^{\,2}}{\sum_{d=0}^{d} Y_{yr,d} \cdot CCPUE_d} \ . \tag{6}$$

This model is based on the assumption that the modeled cumulative proportions ($Y_{yr,d}$) for previous year yr are the same as the current year (Mundy 1979). To test this assumption, inseason Y_d will be estimated as

$$Y_d = \frac{CCPUE_d}{CCPUE_f} \ , \tag{7}$$

and the mean squared error (MSE) between Y_d and $Y_{yr,d}$ will be estimated as

$$MSE = \frac{\sum_{d=0}^{D}\left(Y_{yr,d} - Y_d\right)^2}{d+1} \ . \tag{8}$$

Previous years will be ranked from lowest MSE (best model) to highest (worst), and the 'best fit' years will be used to estimate $CCPUE_f$ for the current year. Catchability, or the fraction of the available population taken by a defined unit of fishing effort, will be estimated as

$$q_d = \frac{CCPUE_d}{r_d} \tag{9}$$

where: q_d = estimated cumulative catchability as of day d, and

r_d = cumulative total run as of day d.

The cumulative total run on day d will be the sum of all estimates for commercial, recreational, and personal use harvests to date, total escapement to date, and the number of residual (i.e., residing) sockeye salmon in the district. Commercial harvest data will be estimated inseason from catch reports called or faxed into the ADF&G office. All commercial salmon harvests in UCI, whether sold or kept for personal use, must be reported to the Soldotna ADF&G office by fishermen or processors within 12 hours of the close of a fishing period. Personal use and recreational harvests will be estimated inseason by examining catch statistics from previous years' fisheries on similar-sized runs. Total escapement to date will include estimated escapements into all monitored systems (Crescent, Susitna, Kenai, and Kasilof rivers, and Fish Creek) and unmonitored systems, which are assumed to be 15% of the escapement into monitored systems (Tobias and Willette 2003). The number of residual fish in the district will be estimated by assuming harvest rates of 70% in set net fisheries, 35–40% in district-wide drift net fisheries (based on the number of boats that fished), and 25% in reduced district drift net fisheries (Mundy et al. 1993). For example, if the drift gillnet fleet harvested 500,000 sockeye salmon on an district-wide fishing period, the number of sockeye salmon originally in the district would be 1,250,000 (500/0.40=1,250), and the number remaining, or residual, would be 750,000 (1,250–500=750).

Passage rate is an expansion factor used to convert CPUE into numbers of salmon passing the test fishing transect into UCI. Passage rate on day d will be estimated as

$$PR_d = 1/q_d \ . \tag{10}$$

Total run at the end of the season (TR_f) will be estimated as

$$TR_f = PR_d \cdot CCPUE_f. \tag{11}$$

The day that approximately 50% of the total run has passed the OTF transect (M) will be estimated as

$$M = a/b\,, \tag{12}$$

where a and b = model parameters (equation 5).

Since the test fishery will not encompass the entire sockeye salmon run, the total $CCPUE_f$ for the test fishery will be estimated postseason using 2 methods (Equations 13 and 14):

$$CCPUE_f^h = CCPUE_f \cdot \frac{H_t}{H_L}\ , \tag{13}$$

where $CCPUE_f^h$ = total estimated $CCPUE_f$ for the season based on harvest,

H_t = total commercial harvest for the season,

H_L = total commercial harvest through final day of test fishery (f+2), and

L = number of days (lag time) it took salmon to travel from test fishery to commercial harvest areas (2 days).

Additionally, $$CCPUE_t^r = CCPUE_f \cdot \frac{E_t + H_t}{E_L + H_L}\,, \tag{14}$$

where $CCPUE_t^r$ = total estimated $CCPUE_f$ for the season based upon total run,

E_t = total escapement for the season,

H_t = total commercial harvest for the season,

E_L = total UCI escapement through the final day of the test fishery, summed from 6 different streams,

H_L = total UCI commercial harvest through the final day of the test fishery, and

L = number of days (lag time) it took salmon to travel from the test fishery to spawning streams or commercial harvest areas.

The total run adjustment to $CCPUE_f$ (Equation 14) has replaced adjustments based on harvest alone (Equation 13), primarily due to changes to commercial fishing management plans made by the BOF. Management plans now provide much less fishing time in August than in the past; therefore, adjustments based on harvest alone would not accurately reflect the additional fish that entered the district after the test fishery ended.

The total run to date on the last day of the test fishery will be estimated from the sum of all commercial harvests and escapements. Total escapement will be estimated by summing (1) passage from 3 sockeye salmon sonar sites on the Kenai, Kasilof and Crescent rivers, (2) an estimate of the total Susitna River sockeye salmon escapement, (3) the Fish Creek sockeye salmon weir count, and (4) an estimate of sockeye salmon escapement into unmonitored systems.

The total Susitna River sockeye salmon escapement will be estimated by expanding weir counts at Chelatna, Judd, and Larson lakes to reflect the total Susitna River sockeye salmon escapement (Yanusz et al. 2007, 2011a, 2011b). Total escapement into all unmonitored systems in UCI will be estimated as 15% of the total escapement into monitored systems (Tobias and Willette 2003). Lags will be applied to approximate the migration times for fish travelling from the test fish transect to particular destinations. A migration time of 2 days will be assumed for fish harvested in the commercial fishery. We will use migration times between the test fishery and escapement projects estimated by Mundy et al. (1993), i.e., Crescent River (1 day), Kasilof and Kenai rivers (4 days), and Fish Creek (7 days). The migration time from the test fishery to the Susitna River weirs (14 days) will be estimated from Mundy (1993) and radio telemetry studies in the Susitna River (Yanusz et al. 2007, 2011a, 2011b). The number of sockeye salmon harvested in sport and personal use fisheries after test fishing has ceased will be assumed to be negligible. Adjusted estimates of $CCPUE_f$ ($CCPUE_t^h$ and $CCPUE_t^r$) will be used for postseason estimates of TR_f.

GENETIC STOCK COMPOSITION ESTIMATES

Both test fishery vessels will generally collect tissue samples from every sockeye salmon captured at each station following standard ADF&G Gene Conservation Laboratory (GCL) methods (Appendix I). However, if the station sockeye salmon catch on the southern test fishery vessel exceeds 50 fish in one day, only 50 tissue samples will be collected. If the station sockeye salmon catch on the northern test fishery vessel exceeds 75 fish in one day, only 75 tissue samples will be collected. The maximum sample size on the northern vessel was set at a higher level to provide for more spatial and temporal resolution in stock composition estimates. On the southern test fishery vessel, lengths (mid-eye to fork) will be measured for the first 30 sockeye salmon sampled for genetics, but on the northern test fishery vessel, sockeye salmon lengths will not be measured. Both test fishery vessels will collect tissue samples from every coho salmon captured at each station but lengths will not be measured. All tissue samples will be transported to the GCL for post season laboratory analyses (Habicht et al. 2007). Aggregate samples comprised of 400 specimens will be constructed to estimate stock compositions using a Bayesian mixture model (Habicht et al. 2007). Samples (n=400) will be constructed for various temporal and spatial strata identified post season depending upon the number of specimens collected at each station on each date.

SCHEDULE AND DELIVERABLES

Information on daily salmon catch per unit effort and environmental conditions will be communicated to the UCI fishery management staff on a daily basis. Sockeye salmon run size will be projected approximately twice each week beginning after July 20. Genetic samples will be transported to the ADF&G Gene Conservation Laboratory at the end of the field sampling season. Genetic analyses of tissue samples will be conducted during the fall following the field season. Data collected will be analyzed and reported in an annual ADF&G peer reviewed Fisheries Data Series Report.

RESPONSIBILITIES

Pat Shields, UCI area management biologist, ADF&G. Duties: Project design, statistical analysis, run projection, report writing.

Mark Willette, UCI area research biologist, ADF&G. Duties: Project design, statistical analysis, run projection, report writing.

Aaron Dupuis, UCI assistant area management biologist, ADF&G. Duties: field crew training, logistical support and data management, report writing.

Fishery technicians, ADF&G. Duties: Assist with fishing operations, data collection and genetic sample collection

Xinxian Zhang, Biometrician, ADF&G. Duties: Provide statistical supervision and assist in project design. Provide statistical review of data analysis. Provide biometric review of reports.

Chris Habicht, geneticist, ADF&G. Duties: Project design, supervision of genetic sample analyses, report writing.

Andy Barclay, fishery biologist, ADF&G. Duties: Statistical analyses of genetic data, report writing.

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TABLES AND FIGURES

Table 1.–Coordinates of stations fished by the northern offshore test fishery vessel.

	Latitude			Longitude	
Station	Degrees	Minutes		Degrees	Minutes
2	60	27.511		151	28.630
3	60	28.271		151	34.367
4	60	28.792		151	38.323
5	60	29.421		151	42.983
6	60	20.125		151	54.508
7	60	18.610		151	43.743
8	60	18.095		151	40.000
9	60	16.780		151	31.020

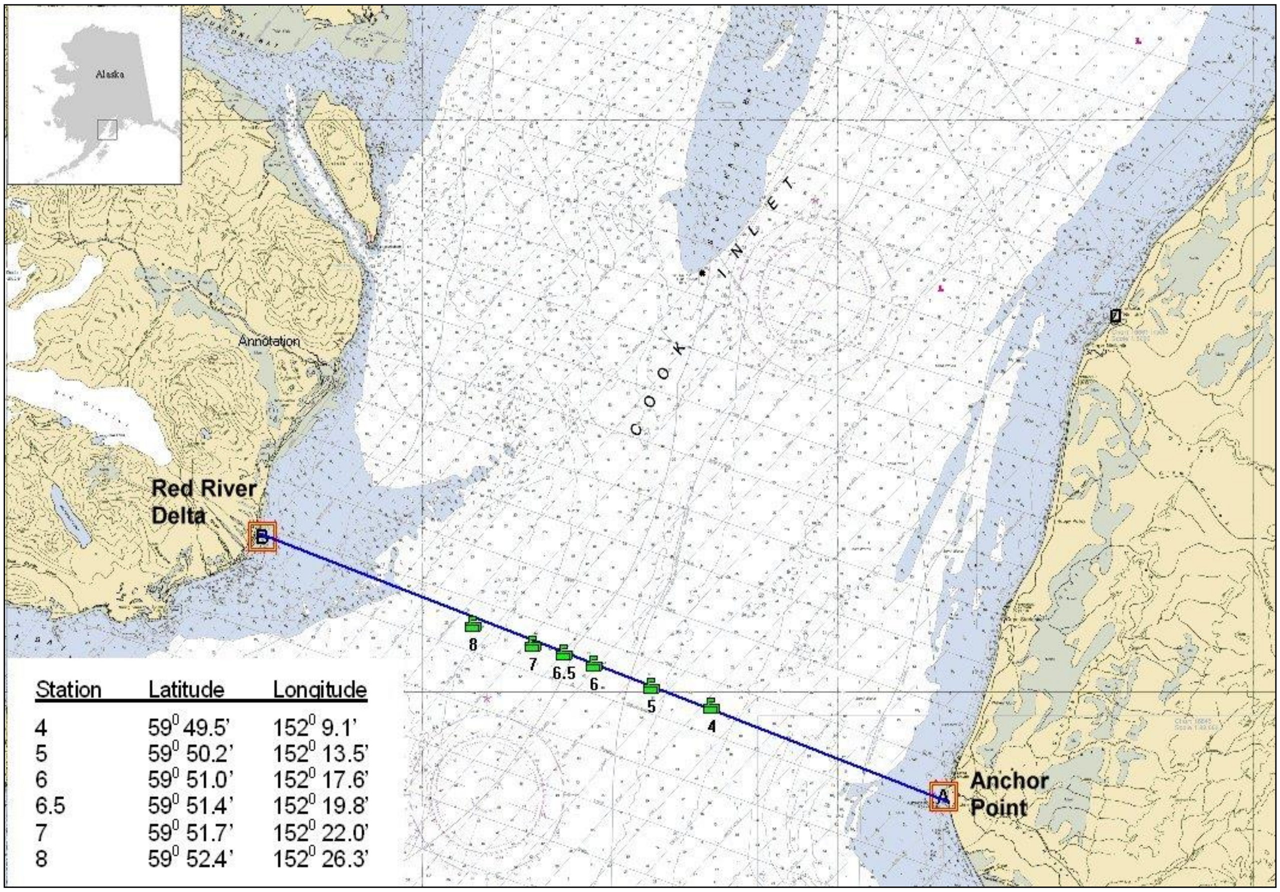

Figure 1.–Location of southern offshore test fish transect and fishing stations in Cook Inlet, Alaska.

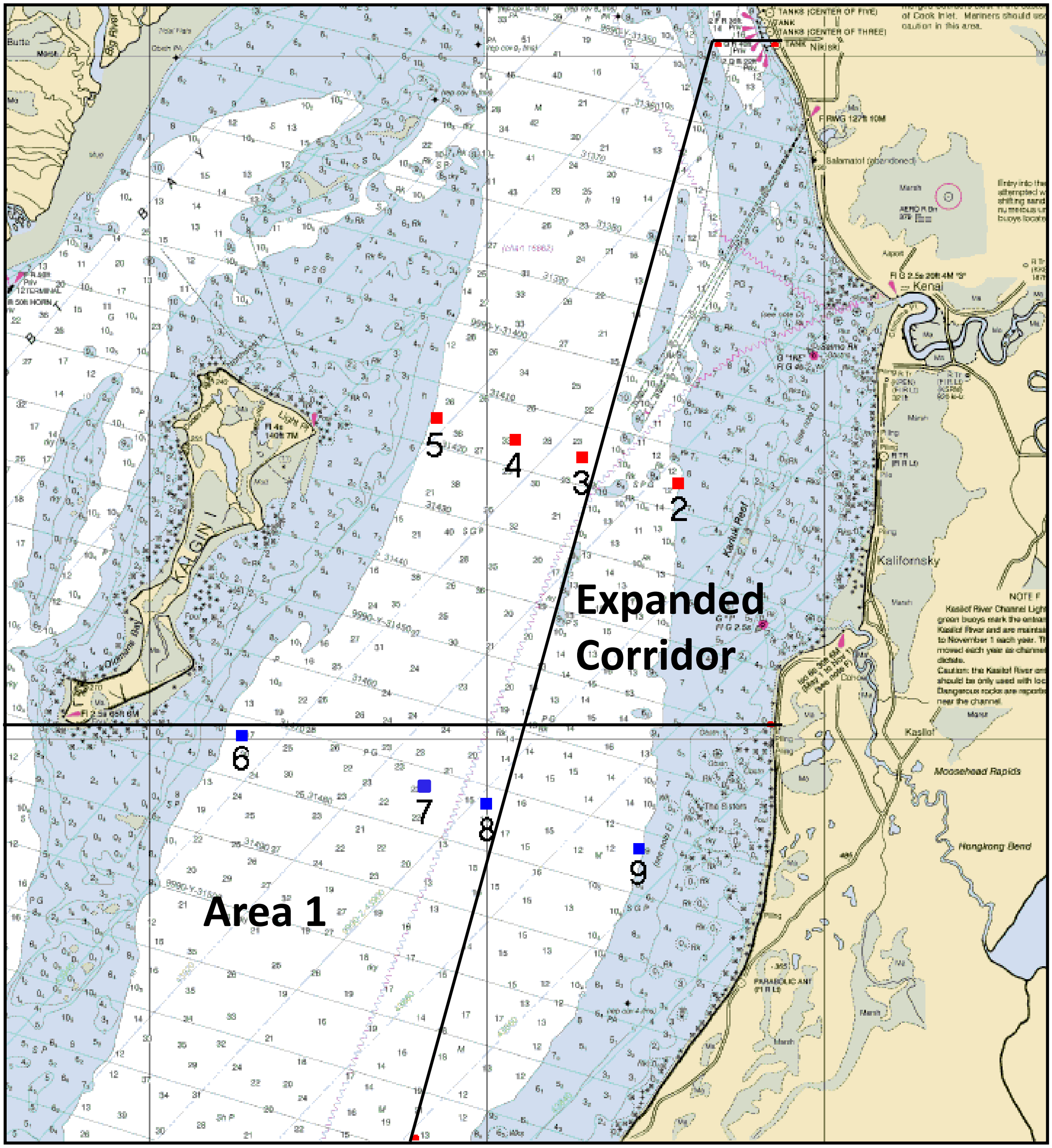

Figure 2.–Locations of northern offshore test fish transects and fishing stations in Cook Inlet, Alaska. Drift gillnet fishing area boundaries described in the Central District Drift Gillnet Fishery Management Plan (5AAC 21.353) are also indicated.

APPENDIX

Appendix A1.–Genetic tissue sample collection procedures.

UCI Test Fishery Project

Sampling Non-lethal Finfish Tissue for DNA Analysis

ADF&G Gene Conservation Lab, Anchorage

I. General Information

We use axillary process samples from individual fish to determine the genetic characteristics and profile of a particular run or stock of fish. This is a non-lethal method of collecting tissue samples from adult fish for genetic analysis. The most important thing to remember in collecting samples is that **only quality tissue samples give quality results**. If sampling from carcasses: tissues need to be as "fresh" and as cold as possible and recently moribund, do not sample from fungal fins.

Sample preservative: Ethanol (ETOH) preserves tissues for later DNA extraction without having to store frozen tissues. Avoid extended contact with skin.

II. Sample procedure:

1. Tissue type: Axillary process, clip axillary process from each fish (see attached print out).
2. Data to record: Record each vial number to paired data information.
3. Prior to sampling, fill the tubes half way with ETOH from the squirt bottle. Fill only the tubes that you will use for a particular sampling period.
4. To avoid any excess water or fish slime in the vial, wipe the axillary process dry prior to sampling. Using the dog toe nail clipper or scissors, clip off axillary process (**1/2 -1" max**) to fit into the cryovial.
5. Place axillary process into ETOH. The tissue/ethanol ratio should be **slightly less than 1:3** to thoroughly soak the tissue in the buffer.
6. Top up tubes with ETOH and screw cap on securely. Invert tube twice to mix ETOH and tissue. Periodically, wipe the dog toe nail clippers or scissor blade so not to cross contaminate samples.
7. Discard remaining ethanol from the 500ml bottle before returning samples. **Tissue samples must remain in 2ml ethanol** after sampling. HAZ-MAT paperwork will be required for return shipment. Store vials containing tissues at cool or room temperature, away from heat in the white sample boxes provided. In the field: keep samples out of direct sun, rain and store capped vials in a dry, cool location. Freezing not required.

III. Supplies included with sampling kit:

1. (1) – Dog toe nail clipper - used for cutting the axillary process
2. (1) – Scissors can be used to cut a portion axillary process – if clippers don't work for your crew
3. Cryovial- a small (2ml) plastic vial, pre-labeled.
4. Caps – with or without gasket to prevent evaporation of ETOH.
5. Cryovial rack- white plastic rack with holes for holding cryovials while sampling
6. Ethanol (ETOH) – in (2) 500 ml plus (1) – 125 ml Nalgen bottle
7. Squirt bottle – to fill or "top off" each cryovial with ETOH
8. Paper towels – use to blot any excess water or fish slime off axillary process
9. Printout of sampling instructions
10. (3) – three pair of lab gloves (size large)
11. Laminated "return address" label

IV. Shipping: HAZMAT paperwork is required for return shipment of these samples and is included in the kit.

Ship samples to: ADF&G – Genetics
333 Raspberry Road

Lab staff: 1-907-267-2247
Judy Berger: 1-907-267-2175

Axillary process tissue for Genetic Stock Identification (GSI)

Axillary process or "spine" located above the pelvic fin.