

Fishery Data Series No. 11-02

Coho *Oncorhynchus kisutch* and Chinook Salmon *O. tshawytscha* Smolt Releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2008

by

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and

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February 2011

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Mathematics, statistics	
centimeter	cm	Alaska Administrative Code	AAC	<i>all standard mathematical signs, symbols and abbreviations</i>	
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H_A
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	e
hectare	ha	at	@	catch per unit effort	CPUE
kilogram	kg	compass directions:		coefficient of variation	CV
kilometer	km	east	E	common test statistics	(F, t, χ^2 , etc.)
liter	L	north	N	confidence interval	CI
meter	m	south	S	correlation coefficient (multiple)	R
milliliter	mL	west	W	correlation coefficient (simple)	r
millimeter	mm	copyright	©	covariance	cov
		corporate suffixes:		degree (angular)	$^\circ$
Weights and measures (English)		Company	Co.	degrees of freedom	df
cubic feet per second	ft ³ /s	Corporation	Corp.	expected value	E
foot	ft	Incorporated	Inc.	greater than	>
gallon	gal	Limited	Ltd.	greater than or equal to	\geq
inch	in	District of Columbia	D.C.	harvest per unit effort	HPUE
mile	mi	et alii (and others)	et al.	less than	<
nautical mile	nmi	et cetera (and so forth)	etc.	less than or equal to	\leq
ounce	oz	exempli gratia (for example)	e.g.	logarithm (natural)	ln
pound	lb	Federal Information Code	FIC	logarithm (base 10)	log
quart	qt	id est (that is)	i.e.	logarithm (specify base)	\log_2 , etc.
yard	yd	latitude or longitude	lat. or long.	minute (angular)	'
		monetary symbols (U.S.)	\$, ¢	not significant	NS
Time and temperature		months (tables and figures): first three letters	Jan, ..., Dec	null hypothesis	H_0
day	d	registered trademark	®	percent	%
degrees Celsius	°C	trademark	™	probability	P
degrees Fahrenheit	°F	United States (adjective)	U.S.	probability of a type I error (rejection of the null hypothesis when true)	α
degrees kelvin	K	United States of America (noun)	USA	probability of a type II error (acceptance of the null hypothesis when false)	β
hour	h	U.S.C.	United States Code	second (angular)	"
minute	min	U.S. state	use two-letter abbreviations (e.g., AK, WA)	standard deviation	SD
second	s			standard error	SE
Physics and chemistry				variance	
all atomic symbols				population	Var
alternating current	AC			sample	var
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				

FISHERY DATA SERIES NO. 11-02

COHO *ONCORHYNCHUS KISUTCH* AND CHINOOK SALMON *O. TSHAWYTSCHA* SMOLT RELEASES INTO COOK INLET, PRINCE WILLIAM SOUND, AND RESURRECTION BAY, ALASKA, 2008

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ABSTRACT

In 2008, ADF&G released approximately 916,293 coho salmon *Oncorhynchus kisutch* and 1,305,990 Chinook salmon *O. tshawytscha* smolts in Cook Inlet, Prince William Sound, and Resurrection Bay to increase angling opportunity and relieve angling pressure on wild stock salmon populations. There were 10 Chinook salmon and 6 coho salmon release groups in all. Every smolt in each release group was thermally marked to identify the area of release from returning adults. Chinook salmon smolt from 3 groups released at brood collection sites (283,750 thermally marked fish) were also marked with an adipose clip and a coded wire tag to identify hatchery fish (adipose fin missing) and naturally-produced fish (adipose fin present) in the fishery, brood collection, and escapement at those sites. For individual release groups, the percentage of fish retaining coded wire tags ranged from 98.8% to 99.5% and the percentage of fish with acceptable adipose clips ranged from 99.9% to 100%. Fish size distribution at time of release was estimated for all 3 Chinook salmon release groups with coded-wire-tagged fish and one coho salmon release group without coded wire tags. All 3 of the coded-wire-tagged Chinook salmon release groups achieved a production goal of 80% of the smolt within a target size range of 5.1–15.0 g. The production goal for coho salmon was to have 80% of the smolt within a target size range of 15.1–25.0 g. The percentage of coho salmon smolts within the target size range for 1 release group was 63.2%.

The number of Chinook salmon in the three release groups with coded wire tags was obtained during tagging. Hatchery inventory methods were used to estimate the number of all 6 coho salmon release groups and the 7 Chinook salmon release groups that did not receive adipose clips and coded wire tags.

Key words hatchery, adipose clip, coded wire tags, thermal marking, otolith, Chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, tag retention, size composition.

INTRODUCTION

Southcentral Alaska receives most of the state's sport fishing effort. Chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* smolts reared at Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) hatcheries have been stocked in numerous locations throughout Southcentral Alaska to improve or create terminal sport fisheries and to relieve pressure on wild stocks (Appendices A1 and A2). One element of the coho and Chinook salmon hatchery smolt stocking projects in Cook Inlet, Prince William Sound, and Resurrection Bay is the use of thermal marks (TM) to identify fish. Some salmon smolts are also marked with an adipose clip and a coded wire tag (CWT). TMs and CWTs are used to estimate the contribution of hatchery stockings to commercial fisheries, marine and freshwater recreational fisheries, and personal use fisheries. They can also be used to estimate spawning escapement in stocked streams, and estimate straying of stocked coho and Chinook salmon.

The accuracy of hatchery contribution estimates from CWT recoveries is highly dependent upon the accuracy of unmarked fish estimates in the release groups. Estimating the number of unmarked fish is not needed when using TMs because all fish are marked. However, determining the number of fish in each release group is still necessary. The methods used at Fort Richardson Hatchery (FRH) for determining the total number of unmarked fish and/or total number of fish in release groups include a tagging inventory (TI) count, a hatchery inventory (HI) estimate, and a water volume displacement (WV) estimate.

Another important element of hatchery smolt stocking programs is fish size. Weight and length of smolts at release are indicators of quality (Peltz and Starkey 1993). If smolt are too small at release, then ocean survival will be poor; and if smolt are too large at release, then ocean residence time will be reduced, thus shifting age composition of returns to younger, smaller fish (Sweet and Peltz 1994). To maximize ocean survival of hatchery smolt and to achieve an age composition similar to the age composition of the existing population, Peltz and Starkey (1993)

recommended that upon release, 80% of hatchery coho smolt weigh between 15.1 and 25.0 g, and that 80% of hatchery Chinook salmon smolt weigh between 5.1 and 15.0 g.

This project documented the release of Chinook and coho salmon smolts with TMs and CWTs in Cook Inlet, Prince William Sound, and Resurrection Bay in 2008. Specific objectives for this project were:

1. To estimate the long-term (greater than 30 days) tag retention rate and adipose-clip quality of each smolt release group with CWTs;
2. Verify the TM applied to the otoliths of fish in each coho and Chinook salmon release group;
3. To estimate the weight distribution of each Chinook salmon smolt release group with CWTs and one smolt release group of coho salmon without CWTs.
4. Our tagging goal was to mark all Chinook salmon in 3 release groups with an adipose clip and a CWT. A second goal was to mark all fish in all release groups with a thermal mark. We also compared smolt abundance by applying hatchery inventory (HI) and water volume displacement (WV) estimates to the tagging inventory (TI) count for all Chinook salmon release groups marked with an adipose clip and CWT.

Included in this report are recommendations for future marking and collecting of smolt release data. All data for this report are held and archived by Research and Technical Services, Sport Fish Division, Alaska Department of Fish and Game.

METHODS

Coho salmon broodstock from Bear Lake, Ship Creek (Little Susitna River), and Eklutna Tailrace (Jim Creek) were raised at Fort Richardson Hatchery (FRH). Chinook salmon broodstock from Deception Creek, Ship Creek, Crooked Creek, and Ninilchik River were also raised at FRH (Table 1). Fish from 16 release groups were stocked at 10 locations in Cook Inlet, 2 locations in Prince William Sound, and 1 location in Resurrection Bay.

SMOLT MARKING

Coded Wire Tags (CWTs)

All Chinook salmon smolts in 3 release groups were adipose clipped and injected with a CWT (Table 2). Unique tag codes were used for all release groups marked with CWTs.

A head mold is used to hold fish in the correct position and orientation for tagging. To determine which head mold sizes would provide the best tag placement, approximately 100 fish from each of the three broodstocks were measured from tip of snout to tail fork (to the nearest millimeter) within 7 days of tagging. Two or three head mold sizes that fit at least 80% of the length distribution were selected for tagging (Peltz and Hansen 1994). All fish were graded and tagged accordingly with a full-length CWT (1.1 mm) using a Northwest Marine Technology¹ Mark IV tag injector.

¹ Product names used in this publication are included for completeness but do not constitute product endorsement.

Table 1.—Total number of fish stocked at 13 locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2008.

Release Area	Release Location	Broodstock	Inventory method used	Estimated number of fish in release group
Chinook Salmon				
Cook Inlet	Deception Creek	Deception Creek	tagging inventory	112,219
Cook Inlet	Ship Creek	Ship Creek	hatchery inventory	341,495 ^a
Cook Inlet	Eklutna Tailrace	Ship Creek	hatchery inventory	114,136
Cook Inlet	Crooked Creek	Crooked Creek	tagging inventory	114,588 ^a
Cook Inlet	Halibut Cove	Ninilchik River	hatchery inventory	58,674 ^a
Cook Inlet	Homer Spit	Ninilchik River	hatchery inventory	212,141 ^a
Cook Inlet	Seldovia	Ninilchik River	hatchery inventory	54,464
Cook Inlet	Ninilchik River	Ninilchik River	tagging inventory	56,943
Prince William Sound	Fleming Spit	Deception Creek	hatchery inventory	114,627
Prince William Sound	Valdez, Old Town Site	Deception Creek	hatchery inventory	126,703
Coho Salmon				
Cook Inlet	Bird Creek	Ship Cr (Little Susitna River)	hatchery inventory	113,035
Cook Inlet	Campbell Creek	Ship Cr (Little Susitna River)	hatchery inventory	83,421
Cook Inlet	Eklutna Tailrace	Eklutna Tailrace (Jim Creek)	hatchery inventory	118,139
Cook Inlet	Homer Spit	Ship Cr (Little Susitna River)	hatchery inventory	122,843 ^a
Cook Inlet	Ship Creek	Ship Cr (Little Susitna River)	hatchery inventory	245,490 ^a
Resurrection Bay	Seward Lagoon	Bear Lake	hatchery inventory	233,365
Total				2,222,283

^a Estimated release number adjusted for mortalities that occurred at release sites during imprinting.

Fish were anesthetized with Tricaine Methane Sulfonate (MS-222) before tagging. The adipose fin was excised at the base using surgical scissors. Tags were then injected into the noses of the fish, and the fish were sent through a Quality Control Device (QCD). The QCD detected the magnetized tag and separated the fish with tags from those without tags. All fish without tags were injected again. Quality control checks for tag placement were conducted following initial daily startup, and following a change in head mold size or a change in tagging personnel. During each quality control check, a minimum of 2 tagged fish were dissected to determine tag placement (Moberly et al. 1977; Figure 1). Head mold or wire placement adjustments were made when necessary. The fish that were dissected to determine tag placement were not included in the tagged fish counts.

After tagging, all fish were held in net pens overnight to determine short-term mortality and short-term tag retention rates. All overnight mortalities were counted and recorded. Short-term retention rates were estimated daily by passing a random sample of 200 fish through the QCD. Daily tag retention rate (D_i) of surviving smolts was estimated as a binomial proportion:

$$\hat{D}_i = \frac{n_i}{n_{ti}}, \quad (1)$$

Table 2.—Summary of coded-wire-tagging data and smolt release estimates for Chinook salmon stocked in Cook Inlet, 2008.

Release Parameter	Chinook Salmon Release Site			Totals
	Deception Creek	Nimilchik River	Crooked Creek	
Fish with adipose clip and CWT				
Initial number	113,315	57,162	115,297	285,774
Mortalities	1,096	219	709	2,024
Total fish released (tagging inventory)	112,219	56,943	114,588	283,750
Coded Wire Tags				
Tag codes	31-03-71 31-03-73	31-03-72	31-03-70 31-03-69	
Tagging dates	3/11/2008 3/26/2008	2/6/2008 2/15/2008	2/19/2008 3/10/2008	
Date of tag retention check	6/13/2008	5/14/2008	5/29/2008	
Days elapsed since tagging	79	89	80	
Tag retention sample size	797	762	752	
Estimated tag retention at release	99.2%	99.5%	98.8%	99.1%
Tag retention variance	9.38638E-06	6.86175E-06	1.5745E-05	
Estimated number of tagged fish released	111,321	56,658	113,213	281,192
Tagged fish variance	118,204	22,249	206,745	
Adipose finclips				
Percentage of fish with acceptable clips ^a	100.0%	99.9%	100.0%	
Estimated number of adipose-clipped fish released	112,219	56,868	114,588	283,675

^a An acceptable rating was given to fish with at least 80% of the adipose fin removed.

where:

n_i = number of live smolts in the sample tagged on day i that retained the tag, and

n_{ti} = total number of live smolts in the sample tagged on day i ,

and tag retention variance was estimated as:

$$Var(\hat{D}_i) = \frac{\hat{D}_i(1 - \hat{D}_i)}{n_{ti} - 1}. \quad (2)$$

Fish checked for overnight tag retention were also examined for adipose-clip quality. At least 80% fin removal was required for the clip to be acceptable.

Tagged smolts were transferred to the rearing unit following overnight mortality checks and held until release. Fish mortality was monitored daily and all adipose-clipped mortalities were recorded.

Long-term tag retention was estimated for all release groups at least 30 days after tagging (Blankenship 1990). At least 750 adipose-clipped fish were randomly sampled from the

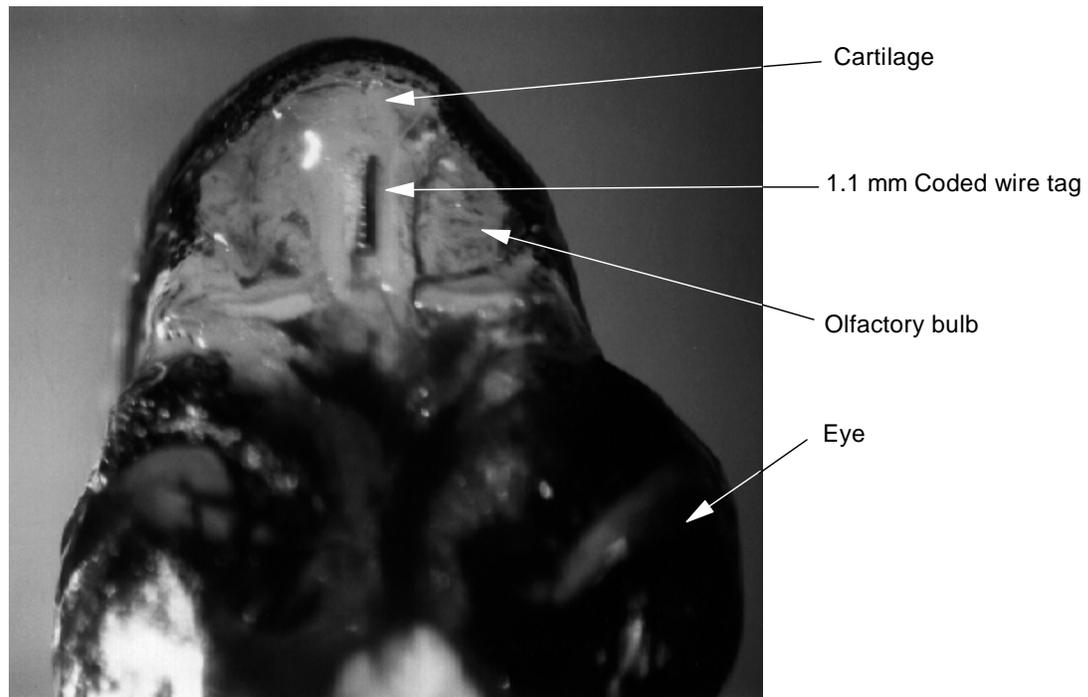
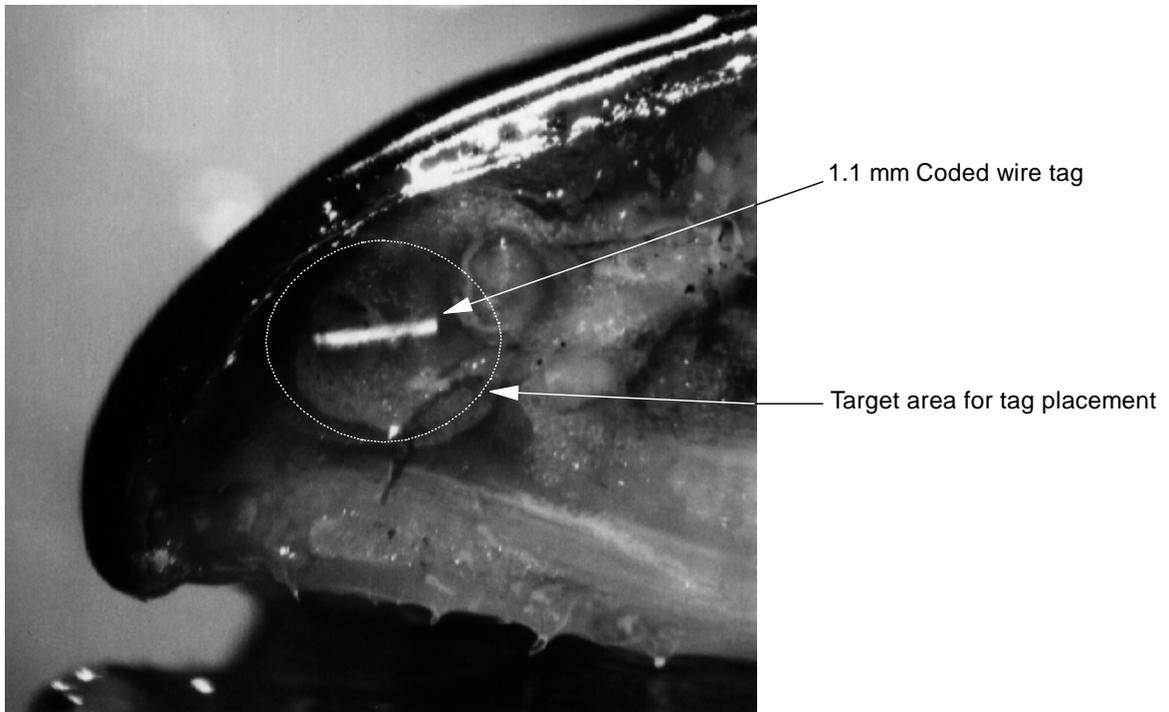


Figure 1.—Proper placement of a coded wire tag in a small fish.

population and checked for tag retention using a hand-held CWT detector. Long-term tag retention rate (D_j) of surviving smolts, and its variance, were also estimated as a binomial proportion (equations 1 and 2) for each group,

where:

- n_i = number of smolts in the sample that retained the tag; and
- n_{ii} = total number of tagged smolts in the sample.

The number of fish released with CWTs was estimated as:

$$\hat{T}_j = (N_j - M_j)\hat{D}_j, \quad (3)$$

and its variance as:

$$Var(\hat{T}_j) = (N_j - M_j)^2 Var(\hat{D}_j), \quad (4)$$

where:

- N_j = number of fish injected with a tag in group j ,
- \hat{D}_j = long-term tag retention of release group j , and
- M_j = total number of mortalities of tagged fish in group j .

A minimum of 750 smolts per rearing unit was examined for adipose-clip quality within 7 days of release. Finclips were rated as acceptable or not acceptable. An acceptable rating was given to those with at least 80% of the adipose fin removed.

Thermal Marks (TMs)

Thermal marks were applied to all Chinook salmon embryos before hatching. Thermal mark patterns were assigned by the Mark, Tag, and Age Laboratory operated by ADF&G Division of Commercial Fisheries (Table 3). At approximately 310 cumulative temperature units (CTUs)—number of days post fertilization multiplied by average daily temperature in centigrade—for coho salmon and 360 CTUs for Chinook salmon, otoliths were developed enough to accept a mark, as verified by the Mark, Tag, and Age Laboratory. Embryos were exposed to a series of 4–5°C water temperature changes (both increases and decreases), with each temperature decrease resulting in the deposit of a dark protein ring on the developing otolith (Monk *Unpublished*²). Water temperature changes were scheduled every 24 hours, with a 72-hour warm water exposure occurring between bands of rings. The assigned patterns of dark protein rings applied to the otoliths (Figure 2) are used to identify the area of release from returning adult salmon. Onset Stowaway XTI data loggers recorded incubation water temperature every 15 minutes throughout the marking period to generate thermal profiles for each mark type (Figure 3).

Voucher samples containing approximately 50 fish from each egg lot were collected before moving fish to the raceways (ponding) and were submitted to the Mark, Tag, and Age Laboratory for mark verification.

² Monk, K. M. *Unpublished*. Thermal marking manual: A guideline to the induction of thermal marks in otoliths for the purpose of mass-marking hatchery stocks. Located at Alaska Department of Fish and Game, Division of Commercial Fisheries, Mark, Tag, and Age Laboratory, 10107 Bentwood Place, Juneau, Alaska, 99802-5526.

Table 3.—Summary of Chinook and coho salmon thermal marks (hatch codes) for smolt stocked at locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2008.

Release Area	Mark Group(s)	Release Location	Hatch code ^a
<u>Chinook salmon</u>			
	Cook Inlet	Ship Creek	2,3H
	Cook Inlet	Eklutna Tailrace	2,3H
	Cook Inlet	Ninilchik River	2,3H
	Cook Inlet	Halibut Cove	2,3H
	Cook Inlet	Seldovia	2,3H
	Cook Inlet	Homer Spit	2,3H
	Cook Inlet	Deception Creek	2,3H
	Cook Inlet	Crooked Creek	2,3H
Prince William Sound		Fleming Spit	2,4H
Prince William Sound		Valdez	2,4H
<u>Coho salmon</u>			
	Cook Inlet	Ship Creek	1,5H
	Cook Inlet	Campbell Creek	1,5H
	Cook Inlet	Bird Creek	1,5H
	Cook Inlet	Homer Spit	1,5H
	Cook Inlet	Eklutna Tailrace	1,5H
Resurrection Bay		Seward Lagoon	2,4H

^a Hatch codes indicate the number of rings within each of 2 bands of thermal marks.

Coho Salmon

Coho salmon were thermally marked in 2006 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify fish as belonging to Cook Inlet or Resurrection Bay release groups. Cook Inlet release groups were indicated by 1 band of 1 ring followed by 1 band of 5 rings (1,5H) and Resurrection Bay release groups were indicated by 1 band of 2 rings followed by 1 band of 4 rings (2,4H).

Chinook Salmon

Chinook salmon were thermally marked in 2006 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify fish as belonging to Cook Inlet or Prince William Sound release groups. The first band consisted of 2 rings for all fish, and the second band consisted of 3 rings for Cook Inlet release groups (2,3H) or 4 rings for Prince William Sound release groups (2,4H).

Smolt Enumeration

The number of fish in all 16 release groups was obtained (before release) using the tagging inventory (TI) count, hatchery inventory (HI) abundance estimate, and/or water volume

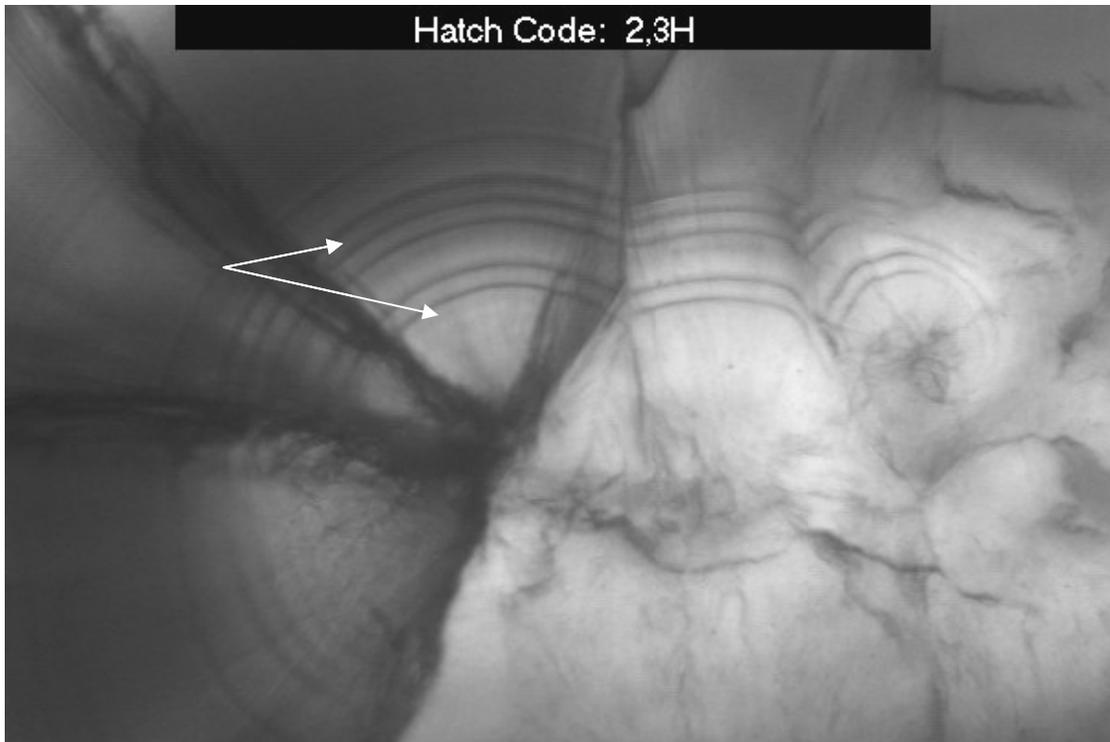


Figure 2.—Image of a thermal mark applied to Chinook salmon released into Cook Inlet.

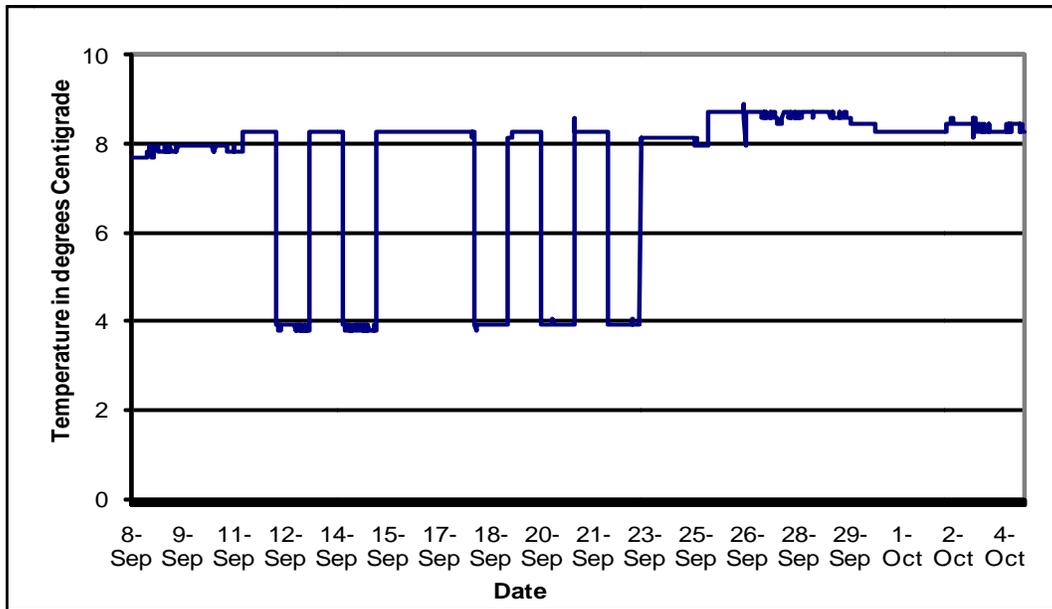


Figure 3.—Thermal marking temperature profile for Chinook salmon released into Cook Inlet in 2008 with a thermal mark (hatch code) of 2,3H.

displacement (WV) abundance estimate (see below for details on each of these methods). The TI counts were compared to the HI and WV estimates to determine the precision of the HI and WV estimates. In raceways where a TI was not conducted, and the HI and WV point estimates differ by less than 10%, the HI estimates were used. If the point estimates differ by more than 10%, the estimate from the technique determined to be more accurate when compared to the TI was used.

Tagging Inventory (TI)

A TI count was obtained from the tag counter on the Mark IV CWT injector for the three Chinook salmon release groups in which every fish was injected with a CWT. Thus, the number of injected tags counted for each release group equaled the number of fish in each release group. For these release groups, fish mortality was monitored daily and subtracted from the original TI count to yield a final fish count for each release group.

Hatchery Inventory (HI) Estimates

The HI abundance technique used at Fort Richardson Hatchery (FRH) was based on the weight of fish in a raceway. These estimates were obtained when fry were moved from small indoor raceways to large outdoor raceways. Approximately 10 randomly selected net loads of fish were used to estimate mean fish weight. Because a net full of fish was too large to enumerate (approximately 600-800 fish), the net was manually halved numerous times until 50-100 fish remained in the net. These fish were weighed and hand counted from a bucket to determine mean fish weight. The total weight of fish, obtained using the accumulative weight feature on the electronic scale, was then divided by the mean fish weight to establish the HI abundance estimate in that raceway. The number of fish released from an outdoor raceway equaled the original outdoor raceway estimate minus the fish stocked or transferred, and minus the mortalities from date of loading into the outdoor raceway to the date of release.

Volumetric Estimates

Fish abundance (number or weight) was also estimated volumetrically using a transport tank when transporting fish to the release site. This estimate is a function of the tank volume (gallons), the ratio of the volume of water displaced in the tank sight gauge to the volume of water placed in the tank (mm/gallon), and the ratio of the number (or weight) of fish which displace a volume of water in the tank sight gauge (fish/mm or kg/mm).

For fish transport, each tank was filled with water and the water level on the tank sight gauge recorded to the nearest millimeter. Fish were then pumped from the raceway into each of the transport tanks. The water level on the tank gauge was recorded again after fish were loaded into each of the tanks. The millimeters of water displaced for each tank was determined, and using a known displacement value of kilograms of fish per millimeter (Appendix B1), the total weight of fish in the tank was estimated. Total number of fish was estimated by dividing the total fish weight by the mean fish weight.

FRH estimated mean weight by obtaining fish samples from five nets of fish before loading the tanks. Each net of fish was split in half several times until the desired sample size (50-100 fish) was achieved. The fish were poured into a pre-weighed bucket of water, weighed to the nearest gram, and counted out of the bucket. Mean weight was calculated for each of the five samples, and an overall mean weight was calculated by summing the five sample mean weights and dividing by the sum of the five fish counts.

SIZE ESTIMATION

A sample of fish from each raceway containing CWT-tagged Chinook salmon and one raceway of coho salmon were individually weighed and measured. Fish were crowded to one end of the raceway and a minimum of 510 fish were dipnetted and put into a small holding pen. Each fish sampled was measured to the nearest millimeter and weighed to the nearest 0.1 g.

RESULTS

SMOLT MARKING

Coded Wire Tags (CWTs)

In 2008, 283,750 Chinook salmon smolts with an adipose clip and a coded wire tag (CWT) were released in Cook Inlet (Table 2). The goal of 100% of the Chinook salmon CWT-tagged in 3 release groups was achieved.

Long-term tag retention was estimated 79-89 days after tagging (Table 2). Tag retention rates ranged from 98.8% to 99.5% (Table 2). Adipose finclip quality ranged from 99.9% to 100%.

Thermal Marks (TMs)

TM digital images of voucher samples and thermal profiles recorded by the Onset Stowaway XTI data loggers indicate that Chinook and coho salmon release groups were marked with their assigned TM (Table 3, Appendices A1 and A2).

SMOLT RELEASES

In 2008, Fort Richardson Hatchery (FRH) released an estimated 916,293 coho salmon smolts at 6 locations in Cook Inlet and Resurrection Bay and an estimated 1,305,990 Chinook salmon smolts at 10 locations in Cook Inlet and Prince William (Table 1).

SMOLT ENUMERATION

Tagging inventory (TI) counts were reported and compared to the results of hatchery inventory (HI) and water volume displacement (WV) estimation techniques for the three TI Chinook salmon release groups; the HI estimates were within 4.1% of the TI count, and the WV estimates were within 5.3% of the TI count (Table 4). The difference between the HI and WV estimates was greater than 10% for 6 of the 21 rearing units. Because the HI estimates were more accurate than the WV estimates when compared to the TI counts, HI estimates were reported as the release number for all 6 coho salmon release groups (916,293 smolts) and 7 of 10 Chinook salmon release groups (1,305,990 smolts) (Tables 1 and 2).

SIZE ESTIMATION

The production goal for coho salmon was to have 80% of the fish weigh between 15.1 and 25.0 g. The one coho salmon release group (Homer Spit) sampled for weight did not achieve the production goal (63.2%, Table 5). The production goal for Chinook salmon was to have 80% of the fish weigh between 5.1 and 15.0 g. All 3 Chinook salmon release groups achieved the production goal (Crooked Creek = 92.9%, Deception Creek = 93.8%, Ninilchik River = 97.3%) (Table 5).

Table 4.—A comparison of hatchery inventory (HI) estimates, water volume (WV) population estimates, and tagging inventory (TI) counts (where available) for Chinook and coho salmon reared at Fort Richardson Hatchery and released in 2008.

Rearing Unit	Hatchery Inventory	Displacement Estimate	Tagging Inventory	TI/HI difference	TI/WV difference	HI/WV difference
Chinook salmon						
Crooked Creek	119,706	121,250	114,783	4.1%	5.3%	1.3%
Deception Creek	114,085	108,033	112,219	1.6%	-3.9%	-5.6%
Ninilchik River ^a	54,714	59,534	56,943	-4.1%	4.4%	8.1%
Ship Creek ^a	114,435	110,654				-3.4%
Ship Creek ^a	114,914	118,376				2.9%
Ship Creek ^a	113,346	110,833				-2.3%
Eklutna Tailrace	114,136	122,538				6.9%
Halibut Cove ^a	59,784	56,483				-5.8%
Homer Spit ^a	113,020	108,336				-4.3%
Homer Spit ^a	113,570	96,645				-17.5%
Seldovia	54,464	51,800				-5.1%
Fleming Spit	114,627	117,385				2.3%
Valdez	126,703	112,941				-12.2%
Coho salmon						
Bird Creek	113,035	112,306				-0.6%
Campbell Cr	83,421	73,364				-13.7%
Eklutna Tailrace	118,139	122,209				3.3%
Homer Spit ^a	125,108	126,160				0.8%
Ship Creek ^a	123,942	122,053				-1.5%
Ship Creek ^a	123,548	96,483				-28.1%
Seward Lagoon	118,997	108,003				-10.2%
Seward Lagoon	114,368	103,656				-10.3%

Note: For rearing units that did not contain tagged fish, neither a tagging inventory nor comparisons to a tagging inventory could be obtained.

^a Estimates include mortalities that occurred at the release site while holding fish for imprinting. These estimates differ from the final release number presented in Table 1.

DISCUSSION

SMOLT MARKING

A point of emphasis for the coded wire tag (CWT) marking program has been to achieve good long-term tag retention rates. Average long-term tag retention in 2008 was 99.1%. Grading fish and using different sizes of head molds for tagging is responsible for maintaining acceptable (greater than 97%) long-term tag retention rates.

Table 5.—The percentage of fish within, below or above production goal target size for CWT-tagged Chinook salmon release groups and 1 coho salmon release group from Fort Richardson Hatchery in 2008.

Release Group	Percent		
	Below target	Within target	Above target
Coho Salmon^a			
Homer Spit	31.7%	63.2%	5.1%
Chinook Salmon^b			
Deception Creek	0.0%	93.8%	6.2%
Ninilchik River	0.0%	97.3%	2.7%
Crooked Creek	0.0%	92.9%	7.1%

^a Production goal target for coho salmon: 80% of smolt 15.1–25.0 g

^b Production goal target for Chinook salmon: 80% of smolt 5.1–15.0 g

Managers use adipose clips on hatchery-released fish to manage sport fisheries that target adult Chinook salmon returning to the Ninilchik and Kasilof rivers. Properly clipped fins are essential so that anglers and enforcement officials can distinguish between hatchery and non-hatchery fish.

Thompson and Blankenship (1997) found no fin regeneration in returning adult coho salmon when adipose fins were entirely removed at 12 months of age. When only the posterior two-thirds or the top two-thirds of the fin was removed, complete fin regeneration occurred in 23% of the fish. Partial fin regeneration occurred in 35% of the fish when the posterior two-thirds were removed, and in 63% of the fish when the top two-thirds were removed. Returning adults with partially regenerated adipose fins might not be identified as hatchery fish.

In our marked groups, 80% of the adipose fin was removed from $\geq 99.9\%$ of the smolts making fin regeneration unlikely. Identifying hatchery-released fish by the adipose finclip in the adult return should be reliable.

THERMAL MARKING

Each release group received the assigned thermal mark; therefore, a TM can identify area of release if it is recovered from commercial fisheries, marine or freshwater recreational fisheries, or personal use fisheries.

SMOLT ENUMERATION

Peltz and Hansen (1994) reported that numerous sources of error associated with water displacement values make the water volume (WV) displacement method of estimating

populations unreliable. They recommended this method be used only when other estimation methods cannot be used or when accuracy is not important.

For each of the three Chinook salmon rearing units, the hatchery inventory (HI) estimates were within 4.1% of the tagging inventory (TI) counts, and the TI counts and WV estimates were within 5.3% of each other. Improved techniques based on the weight of fish in each release group since 1997 have made the HI method as reliable as the mark-recapture method at Fort Richardson Hatchery (FRH) and Elmendorf Hatchery (EH) (Starkey et al. 1999). Improved transport tank loading techniques, such as eliminating immeasurable water when loading the tanks and taking accurate site gauge readings, likely account for the increased reliability of WV estimates at FRH.

SIZE ESTIMATION

To maximize ocean survival and maintain the age composition of the population, Peltz and Starkey (1993) recommended that 80% of hatchery coho salmon smolts weigh between 15.1 and 25.0 g, and hatchery Chinook salmon weigh between 5.1 and 15.0 g at release. The smaller than recommended release size for the Homer Spit coho salmon release group may reduce ocean survival resulting in fewer adult coho salmon returning to the lagoon in 2009.

RECOMMENDATIONS

1. All fish should be graded and tagged using the appropriate head mold sizes.
2. Continue proper tag placement to maintain acceptable (>97%) long-term retention rates for all groups.
3. Continue to monitor adipose-clip quality during tagging and at release.
4. Temperature changes of 4–5°C should occur every 24 hours between rings, and every 72 hours between bands of rings during thermal marking.
5. Follow the production goal size at release recommendations that 80% of coho salmon weigh between 15.1 and 25.0 g, and 80% of Chinook salmon weigh between 5.1 and 15.0 g.
6. Continue to record individual bucket weights when performing hatchery inventory procedures in case of electronic scale failure.

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APPENDIX A

Appendix A1.—Historical releases of coho salmon that were adipose-clipped and coded-wire-tagged and/or thermally marked.

Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagged			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Anchorage Urban Streams^b											
1994	Little Susitna	Ft Richardson	1996	31-25-06	302,857	M-R	93,975	92,565	30.56%		
Bird Creek											
1990	Little Susitna	Ft Richardson	1992	31-20-02, 03	95,377	M-R	44,903	37,629	39.50%		
1991	Little Susitna	Ft Richardson	1993	31-21-39	140,382	M-R	43,441	42,350	30.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-02	84,643	M-R	45,220	44,686	52.80%		
1993	Little Susitna	Ft Richardson	1995	31-23-37	154,753	M-R	45,666	45,490	29.40%		
1994	Little Susitna	Ft Richardson	1996	31-25-04	147,618	M-R	46,528	45,411	30.80%		
1995	Little Susitna	Ft Richardson	1997	31-26-01	146,612	HI	45,901	45,488	31.03%		
1995	Little Susitna	Ft Richardson	1997	31-26-27	147,953	HI	45,836	45,469	30.73%		
1996	Little Susitna	Ft Richardson	1998	31-26-25	164,211	HI	46,140	46,094	28.07%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-15	111,430	EC	37,344	36,746	32.98%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-43	97,409	EC	40,114	39,392	40.44%		
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		109,949	HI				Cook Inlet	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^c		100,605	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		104,974	HI				Cook Inlet	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		104,979	HI				Cook Inlet	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		113,035	HI				Cook Inlet	1,5H
Campbell Creek^b											
1990	Little Susitna	Ft Richardson	1992	31-20-04 31-20-05	97,076	M-R	43,681	39,444	40.60%		
1991	Little Susitna	Ft Richardson	1993	31-21-38	140,797	M-R	43,440	42,916	30.50%		
1992	Little Susitna	Ft Richardson	1994	31-23-03	87,686	M-R	44,144	42,963	49.00%		
1993	Little Susitna	Ft Richardson	1995	31-23-36	157,241	M-R	45,655	44,995	28.60%		
1995	Little Susitna	Ft Richardson	1997	31-25-62	71,519	TI	45,840	45,290	63.33%		
1996	Little Susitna	Ft Richardson	1998	31-26-52	83,317	HI	22,453	22,296	26.76%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-01-30	42,046	EC	20,879	20,378	48.47%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-02-30	63,730	EC	19,948	19,549	30.67%		

-continued-

Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagged			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Campbell Creek^b (continued)											
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-32	69,836	HI	21,568	20,813	29.80%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-97	61,323	HI	22,789	21,672	35.34%	Cook Inlet	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		78,576	HI				Cook Inlet	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		85,790	HI				Cook Inlet	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^c		60,387	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		78,405	HI				Cook Inlet	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		82,794	HI				Cook Inlet	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		83,421	HI				Cook Inlet	1.5H
Cottonwood Creek											
1990	Fish Creek	Big Lake	1992	31-20-08 31-21-09	53,900	M-R	35,341	32,938	61.10%		
1991	Fish Creek	Big Lake	1993	31-21-41	74,198	M-R	43,117	40,875	55.10%		
Eklutna Tailrace											
1996	Jim Creek	Ft Richardson	1998	31-26-27 31-26-54, 55,56	112,219	TI	112,219	111,882	99.70%		
1997	Jim Creek	Ft Richardson	1999	31-26-16	126,602	EC	44,073	42,663	33.70%		
1998	Jim Creek	Ft Richardson	2000	31-01-46	76,851	EC	40,514	40,149	52.24%		
1999	Eklutna Tailrace	Ft Richardson	2001	31-02-47	124,838	HI	43,713	43,494	34.84%		
2000	Eklutna Tailrace	Ft Richardson	2002	31-02-46	120,629	HI	44,518	44,295	36.72%	Cook Inlet	5H
2001	Eklutna Tailrace	Ft Richardson	2003		120,736	HI				Cook Inlet	5H
2002	Eklutna Tailrace	Ft Richardson	2004		131,979	HI				Cook Inlet	5H
2003	Eklutna Tailrace	Ft Richardson	2005 ^c		132,149	HI					
2004	Eklutna Tailrace	Ft Richardson	2006		132,212	HI				Cook Inlet	5H
2005	Eklutna Tailrace	Ft Richardson	2007		118,054	HI				Cook Inlet	1,5H
2006	Eklutna Tailrace	Ft Richardson	2008		118,139	HI				Cook Inlet	1,5H

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Brood		Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagged			Thermal Marking	
Year	Broodstock				Estimate	Type of Estimate ^a	Clipped Fish Released	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Fish Creek											
1990	Fish Creek	Big Lake	1992	31-20-12,13	74,953	M-R	45,538	43,625	58.20%		
1991	Fish Creek	Big Lake	1993	31-21-40	67,934	M-R	44,050	43,257	63.70%		
Homer Spit											
1996	Bear Lake	Elmendorf	1998	31-26-28	130,219	M-R	42,057	41,926	32.20%		
1997	Bear Lake	Elmendorf	1999	31-01-40	129,602	M-R	44,405	43,020	33.19%		
	Bear Lake	Elm/Ft. Rich	2000-01 ^c								
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-01-36	100,280	HI	44,992	44,812	44.69%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-98	95,648	HI	45,498	44,179	46.19%	Cook Inlet	5H
2000	Bear Lake	Ft Richardson	2002		120,707	HI				Cook Inlet	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		222,935	HI				Cook Inlet	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		130,243	HI				Cook Inlet	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^c		125,707	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		125,216	HI				Cook Inlet	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		127,711	HI				Cook Inlet	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		122,843	HI				Cook Inlet	1,5H
Little Susitna at Houston											
1990	Little Susitna	Ft Richardson	1992	31-20-07	154,466	M-R	21,884	19,564	12.70%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	148,282	M-R	21,404	20,312	13.70%		
Lowell Creek											
2000	Bear Lake	Ft Richardson	2002		119,512	HI				Resurrection Bay	4H
2001	Bear Lake	Ft Richardson	2003		124,389	HI				Resurrection Bay	4H
2002	Bear Lake	Ft Richardson	2004		131,989	HI				Resurrection Bay	4H
2003	Bear Lake	Ft Richardson	2005 ^c		132,276	HI					
2004	Bear Lake	Ft Richardson	2006		131,261	HI				Resurrection Bay	4H
2005	Bear Lake	Ft Richardson	2007		130,682	HI				Resurrection Bay	2,4H

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Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagged			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Nancy Lake											
1990	Little Susitna	Ft Richardson	1992	31-20-06	158,459	M-R	21,598	19,222	12.10%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	131,591	M-R	21,001	19,930	15.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-01	126,694	M-R	44,489	43,818	34.60%		
1993	Little Susitna	Ft Richardson	1995	31-23-39	151,985	M-R	46,261	45,245	29.80%		
Seward Lagoon											
2000	Bear Lake	Ft Richardson	2002		121,743	HI					Resurrection Bay 4H
2001	Bear Lake	Ft Richardson	2003		123,718	HI					Resurrection Bay 4H
2002	Bear Lake	Ft Richardson	2004		131,798	HI					Resurrection Bay 4H
2003	Bear Lake	Ft Richardson	2005 ^c		132,229	HI					
2004	Bear Lake	Ft Richardson	2006		131,326	HI					Resurrection Bay 4H
2005	Bear Lake	Ft Richardson	2007		132,811	HI					Resurrection Bay 2,4H
2006	Bear Lake	Ft Richardson	2008		233,365	HI					Resurrection Bay 2,4H
Ship Creek^b											
1990	Ship Creek	Elmendorf	1992	31-19-63 31-20-01	67,178	TI	44,086	38,443	57.20%		
1991	Ship Creek	Elmendorf	1993	31-21-36	54,764	PC	42,112	41,322	75.50%		
1992	Ship Creek	Elmendorf	1994	31-23-04	75,779	PC	44,031	41,722	55.10%		
1993	Little Susitna	Ft Richardson	1995	31-23-38	158,981	M-R	45,491	44,654	28.10%		
1995	Little Susitna	Ft Richardson	1997	31-25-63	232,066	TI,HI	45,925	45,741	19.71%		
1996	Little Susitna	Ft Richardson	1998	31-26-53 31-26-26	232,765	HI	67,812	66,997	28.78%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-14 31-01-29	165,388	EC	48,299	45,380	27.44%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-32 31-01-33	260,070	EC	61,640	58,989	22.68%		
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-61	233,563	HI	64,165	61,663	26.40%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-02-83	212,639	HI	67,959	63,678	29.95%		Cook Inlet 5H

-continued-

Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagged			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Ship Creek^b (continued)											
2001	Ship Cr (Little Susitna)	Ft Richardson	2003	31-02-74, 31-02-69	234,716	HI	64,234	64,125	27.32%	Cook Inlet	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004	31-02-81, 31-03-15	241,066	HI	63,222	62,906	26.09%	Cook Inlet	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^c		251,446	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		252,775	HI				Cook Inlet	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		255,400	HI				Cook Inlet	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		245,490	HI				Cook Inlet	1,5H
Wasilla Creek											
1990	Fish Cr	Big Lake	1992	31-20-10 31-20-11	76,315	M-R	44,148	41,985	55.00%		
1991	Fish Cr	Big Lake	1992	31-21-42	77,174	M-R	43,001	41,711	54.10%		
1994	Little Susitna	Ft Richardson	1996	31-25-05	145,923	M-R	46,980	46,839	32.10%		

^a M–R is mark-recapture; TI is tagging inventory; HI is hatchery inventory; EC is electronic count.

^b Campbell and Ship creeks were combined and termed "Anchorage Urban Streams" in 1996.

^c Stocking continued, but releases did not contain tagged or thermally marked fish.

Appendix A2.—Historical releases of Chinook salmon that were adipose-clipped and coded-wire-tagged and/or thermally marked.

Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagging			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Buskin River											
1994	Deception Cr	Elmendorf	1995	31-24-31	84,349	M-R	41,572	41,078	48.70%		
1995	Deception Cr	Elmendorf	1996	31-25-09	113,220	M-R	41,259	40,681	35.90%		
Crooked Creek											
1993	Crooked Cr	Elmendorf	1994	31-23-14	224,784	M-R	43,609	43,034	19.10%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-27	184,049	M-R	40,903	38,420	20.90%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-12	193,180	M-R	40,827	40,196	20.80%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-55	223,200	M-R	41,049	39,038	17.49%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-29	137,338	M-R	42,874	42,610	31.03%		
1998	Homer (Crooked Cr) ^c	Elmendorf	1999	31-01-41	192,304	M-R	43,431	42,649	22.17%		
1999	Crooked Cr	Elmendorf	2000	31-02-31, 31-01-34, 35	108,507	TI	108,507	105,578	97.30%		
2000	Crooked Cr	Elmendorf	2001	31-01-95, 31-02-36, 37	109,201	TI	109,201	107,454	98.40%		
2001	Crooked Cr	Elmendorf	2002	31-02-51, 31-01-96, 99	99,547	TI	99,547	98,452	98.90%	Crooked Cr	2,4H4 ^d
2002	Crooked Cr	Ft Richardson	2003	31-02-72, 73, 68	98,800	TI	98,800	94,058	95.20%	Cook Inlet	2,3H
2002	Crooked Cr	Ft.Richardson	2004	31-02-79, 80	80,601	TI	80,601	75,120	93.20%	Cook Inlet	2,3H
2003	Crooked Cr	Ft.Richardson	2005	31-03-39, 40, 17	113,613	TI	113,071	113,499	99.90%	Cook Inlet	2,3H ^e
2004	Crooked Cr ^f	Ft.Richardson	2006	31-03-56, 57, 51	111,705	TI	111,705	111,705	100.0%	Cook Inlet	2,3H
2005	Crooked Cr ^g	Ft.Richardson	2007	31-03-68, 31-03-52	111,382	TI	111,382	111,271	99.9%	Cook Inlet	2,3H
2006	Crooked Cr	Ft Richardson	2008	31-03-69, 31-03-70	114,588	TI	114,588	113,213	98.8%	Cook Inlet	2,3H
Deception Creek											
1991	Deception Cr	Ft Richardson	1992	31-21-03	179,724	M-R	44,089	33,464	18.60%		
1992	Deception Cr	Ft Richardson	1993	31-21-60	160,194	M-R	42,782	39,420	24.60%		
1993	Deception Cr	Ft Richardson	1994	31-23-17	177,913	M-R	46,289	45,921	25.80%		
1994	Deception Cr	Ft Richardson	1995	31-24-34	184,740	M-R	46,807	46,256	25.00%		
1995	Deception Cr	Ft Richardson	1996	31-25-14	186,918	M-R	47,700	47,145	25.20%		
1996	Deception Cr	Ft Richardson	1997	31-26-03, 04, 05, 06,	209,644	TI	209,644	207,973	99.20%		
1997	Deception Cr	Ft Richardson	1998	31-25-32	197,392	TI	197,392	195,615	99.10%		
1998	Deception Cr	Ft Richardson	1999	31-26-17, 18, 19, 20 31-01-31	201,586	TI	201,586	199,722	99.08%		

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Brood		Release			Total Released		Coded Wire Tagging			Thermal Marking	
Year	Broodstock	Hatchery	Year	CWT Code	Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Deception Creek (continued)											
1999	Deception Cr	Ft Richardson	2000	31-26-21, 31-01-44, 31-02-33, 34, 35	206,496	TI	206,496	205,051	99.30%		
2000	Deception Cr	Ft Richardson	2001	31-02-41, 42, 43, 44,	207,465	TI	207,465	204,560	98.60%		
2001	Deception Cr	Ft Richardson	2002	31-01-92, 31-02-52, 53, 54, 55	197,277	TI	197,277	196,608	99.66%	Deception Cr	2,5H
2002	Deception Cr	Ft Richardson	2003	31-02-70, 71, 31-01-94	101,181	TI	101,181	99,562	98.40%	Cook Inlet	2,3H
2002	Deception Cr	Ft Richardson	2004	31-02-77, 78, 31-03-16	113,523	TI	113,523	104,101	91.70%	Cook Inlet	2,3H ^h
2003	Deception Cr	Elmendorf	2004	31-02-75, 76, 31-01-27	99,047	TI	99,047	97,660	98.60%	Cook Inlet	2,3H
2003	Deception Cr	Ft Richardson	2005	31-03-28, 29, 30, 31	163,016	TI	161,991	162,415	99.63%	Cook Inlet	2,3H ^e
2004	Deception Cr ^f	Ft Richardson	2006	31-03-53, 54, 55, 27	50,426	TI	50,426	50,376	99.90%	Cook Inlet	2,3H
2005	Deception Cr	Ft Richardson	2007	31-03-67, 31-03-26	103,016	TI	103,016	103,016	100.00%	Cook Inlet	2,3H
2006	Deception Cr	Ft Richardson	2008	31-03-71, 31-03-73	112,219	TI	112,219	111,321	99.20%	Cook Inlet	2,3H
Eagle River											
1993	Ship Creek	Elmendorf	1994	31-23-13	98,872	M-R	43,612	41,669	42.10%		
Eklutna Tailrace											
2001	Ship Creek	Elmendorf	2002		106,991	VOL				Eklutna Tailrace	2,3H3
2002	Ship Creek	Ft Richardson	2003		218,492	HI				Cook Inlet	2,3H
2002	Ship Creek	Ft Richardson	2004		215,165	HI				Cook Inlet	2,3H ^h
2003	Ship Creek	Ft Richardson	2005		164,586	HI				Cook Inlet	2,3H ^e
2004	Ship Creek	Ft Richardson	2006		213,250	HI				Cook Inlet	2,3H
2005	Ship Creek	Ft Richardson	2007		110,978	HI				Cook Inlet	2,3H
2006	Ship Creek	Ft Richardson	2008		114,136	HI				Cook Inlet	2,3H
Fleming Spit											
1998	Deception Cr	Ft. Richardson	1999	31-26-23	49,773	TI	45,705	45,385	91.18%		
1999	Deception Cr	Elmendorf	2000	31-01-38	45,000	VIS	17,358	17,236	38.30%		
2000	Deception Cr	Elmendorf	2001	31-02-38	94,812	HI	40,659	40,415	42.63%		
2001	Deception Cr	Ft. Richardson	2002	31-02-57	109,656	HI	40,054	39,573	36.09%	Prince William Sound	2,4H
2002	Deception Cr	Ft. Richardson	2003		109,757	HI				Prince William Sound	2,4H
2003	Deception Cr	Ft. Richardson	2004		58,000	HI				Prince William Sound	2,4H
2003	Deception Cr	Ft. Richardson	2005		87,591	HI				Prince William Sound	2,4H ^e

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Brood		Release		Total Released		Coded Wire Tagging			Thermal Marking	
Year	Broodstock	Hatchery	Year	CWT Code	Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Percent	Mark Group	Hatch Code
Fleming Spit (continued)										
2004	Ship Creek ⁱ	Ft. Richardson	2006		113,576	HI			Cook Inlet	2,3H ⁱ
2005	Deception Cr	Ft. Richardson	2007		119,860	HI			Prince William Sound	2,4H
2006	Deception Cr	Ft. Richardson	2008		114,627	HI			Prince William Sound	2,4H
Halibut Cove										
1993	Crooked Creek	Elmendorf	1994	31-23-15	98,872	M-R	21,205	21,038 21.30%		
1994	Ninilchik River	Elmendorf	1995	31-24-30	37,577	M-R	36,944	36,700 97.70%		
1995	Ninilchik River	Elmendorf	1996	31-25-11	97,729	M-R	40,688	39,345 40.30%		
1996	Ninilchik River	Elmendorf	1997	31-25-58	78,133	M-R	40,919	39,487 50.54%		
1997	Ninilchik River	Elmendorf	1998	31-26-32	65,893	M-R	38,476	38,041 57.73%		
	Ninilchik River	Elmendorf	1999-01 ^j							
2001	Ninilchik River	Elmendorf	2002		106,279	VOL			Kachemak Bay	2,4H3
2002	Ninilchik River	Ft Richardson	2003		106,844	HI			Cook Inlet	2,3H
2002	Ninilchik River	Ft Richardson	2004		103,771	HI			Cook Inlet	2,3H
2003	Ninilchik River	Ft Richardson	2005		112,521	HI			Cook Inlet	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		117,549	HI			Cook Inlet	2,3H
2005	Ninilchik River ^g	Ft Richardson	2007		54,560	HI			Cook Inlet	2,3H
2006	Ninilchik River	Ft Richardson	2008		58,674	HI			Cook Inlet	2,3H
Homer Spit (early run)										
1993	Crooked Creek	Elmendorf	1994	31-23-16	163,963	M-R	26,003	25,615 15.60%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-32	216,026	M-R	41,650	40,291 18.70%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-07	204,085	M-R	40,868	39,017 19.10%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-60	217,773	M-R	41,112	38,810 17.82%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-33	177,730	M-R	40,012	39,652 22.31%		
1998	Homer (Crooked Cr)	Elmendorf	1999	31-01-45	163,170	M-R	42,561	40,423 24.77%		
	Ninilchik River	Elmendorf	2000-01 ^j							
2001	Ninilchik River	Elmendorf	2002		190,026	VOL			Kachemak Bay	2,5H3
2002	Ninilchik River	Ft Richardson	2003		206,292	HI			Cook Inlet	2,3H
2002	Ninilchik River	Ft Richardson	2004		143,037	HI			Cook Inlet	2,3H
2003	Ninilchik River	Elmendorf	2004		25,706	VOL			Cook Inlet	2,3H
2003	Ninilchik River	Ft Richardson	2005		220,822	HI			Cook Inlet	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		224,053	HI			Cook Inlet	2,3H
2005	Ninilchik River	Ft Richardson	2007		226,972	HI			Cook Inlet	2,3H
2006	Ninilchik River	Ft Richardson	2008		212,141	HI			Cook Inlet	2,3H

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Brood Year	Broodstock	Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagging			Thermal Marking	
					Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Homer Spit (late run)											
1992	Kasilof River	Crooked Creek	1994	31-23-19	56,920	M-R	22,612	22,383	39.30%		
1994	Homer (Kasilof R)	Elmendorf	1995	31-24-33	123,048	M-R	41,054	40,466	32.90%		
1995	Homer (Kasilof R)	Elmendorf	1996	31-25-13	108,204	M-R	40,615	38,787	35.80%		
1996	Homer (Kasilof R)	Elmendorf	1997	31-25-61	100,933	M-R	41,028	39,264	38.90%		
1997	Homer (Kasilof R)	Elmendorf	1998	31-26-34	112,100	HI	40,158	39,997	35.68%		
	Homer (Kasilof R)	Elmendorf	1999 ^j								
Lowell Creek											
1996	Deception Cr	Elmendorf	1997	31-25-59	102,147	M-R	40,906	40,497	39.65%		
	Deception Cr	Elmendorf	1998-99 ^j								
	Crooked Creek	Elmendorf	2000-01 ^l								
2001	Crooked Creek	Elmendorf	2002		93,296	VOL				Resurrection Bay	2,5H3
2002	Crooked Creek	Ft Richardson	2003		110,331	HI				Resurrection Bay	2,5H
2002	Crooked Creek	Ft Richardson	2004		89,388	HI				Resurrection Bay	2,5H
2003	Crooked Creek	Ft Richardson	2005		100,088	HI				Resurrection Bay	2,5H ^c
Ninilchik River											
1991	Ninilchik River	Ft Richardson	1992	31-21-04	132,387	M-R	43,648	41,335	31.20%		
1992	Ninilchik River	Ft Richardson	1993	31-21-59	184,585	M-R	44,487	42,960	23.30%		
1993	Ninilchik River	Ft Richardson	1994	31-23-18	201,513	M-R	46,193	45,535	22.60%		
1994	Ninilchik River	Ft Richardson	1995	31-24-35	54,902	TI	54,902	54,353	99.00%		
1995	Ninilchik River	Ft Richardson	1996	31-25-15	51,688	TI	51,588	50,866	98.60%		
1996	Ninilchik River	Ft Richardson	1997	31-26-08	50,698	TI	50,698	50,292	99.20%		
1997	Ninilchik River	Ft Richardson	1998	31-26-35	48,798	TI	48,798	47,480	97.30%		
1998	Ninilchik River	Ft Richardson	1999	31-01-47	49,853	TI	49,853	48,906	98.10%		
1999	Ninilchik River	Ft Richardson	2000	31-02-48	51,298	TI	51,298	50,016	97.50%		
2000	Ninilchik River	Ft Richardson	2001	31-02-60	54,770	TI	54,770	54,441	99.40%		
2001	Ninilchik River	Ft Richardson	2002	31-02-82	54,631	TI	54,631	54,139	99.10%	Ninilchik River	2,3H
2002	Ninilchik River	Ft Richardson	2003	31-02-56, 31-01-83	47,997	TI	47,997	44,349	92.40%	Cook Inlet	2,3H
2002	Ninilchik River	Ft Richardson	2004	31-03-18	51,303	TI	51,303	51,252	99.90%	Cook Inlet	2,3H
2003	Ninilchik River	Ft Richardson	2005	31-03-41	55,229	TI	54,806	54,898	99.40%	Cook Inlet	2,3H ^e
2004	Ninilchik River ^f	Ft Richardson	2006	31-03-58	57,537	TI	57,537	57,537	100.00%	Cook Inlet	2,3H
2005	Ninilchik River	Ft Richardson	2007	31-03-66	56,325	TI	56,037	55,869	99.19%	Cook Inlet	2,3H
2006	Ninilchik River	Ft Richardson	2008	31-03-72	56,943	TI	56,868	56,658	99.50%	Cook Inlet	2,3H

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Brood		Release		Total Released		Coded Wire Tagging			Thermal Marking		
Year	Broodstock	Hatchery	Year	CWT Code	Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Seldovia											
1993	Crooked Creek	Elmendorf	1994	31-23-11	107,246	M-R	46,754	45,439	42.40%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-29	116,165	M-R	41,609	40,678	35.00%		
1995	Ninilchik River	Elmendorf	1996	31-25-10	118,274	M-R	40,667	39,610	33.50%		
1996	Ninilchik River	Elmendorf	1997	31-25-57	103,757	M-R	41,279	39,834	38.39%		
1997	Ninilchik River	Elmendorf	1998	31-26-31	69,461	M-R	40,654	40,125	57.77%		
	Ninilchik River	Elmendorf	1999-01 ^j								
2001	Ninilchik River	Elmendorf	2002		83,045	VOL				Kachemak Bay	2,4H3
2002	Ninilchik River	Ft Richardson	2003		107,521	HI				Cook Inlet	2,3H
2003	Ninilchik River	Elmendorf	2004		88,682	VOL				Cook Inlet	2,3H
2003	Ninilchik River	Ft Richardson	2005		114,984	HI				Cook Inlet	2,3H ^c
2004	Ninilchik River	Ft Richardson	2006		113,974	HI				Cook Inlet	2,3H
2005	Ninilchik River	Ft Richardson	2006		54,276	HI				Cook Inlet	2,3H
2006	Ninilchik Rver	Ft Richardson	2008		54,464	HI				Cook Inlet	2,3H
Seward Lagoon											
2001	Crooked Creek	Elmendorf	2002		100,314	VOL				Resurrection Bay	2,5H3
2002	Crooked Creek	Ft. Richardson	2003		109,976	HI				Resurrection Bay	2,5H
2003	Crooked Creek	Elmendorf	2004		109,600	VOL				Resurrection Bay	2,5H
2003	Crooked Creek	Ft. Richardson	2005		114,847	HI				Resurrection Bay	2,5H ^c
2004	Deception/Crooked C	Ft. Richardson	2006		116,826	HI				Resurrection Bay	2,5H
2004	Ship Creek ⁱ	Ft. Richardson	2006		109,795	HI				Cook Inlet	2,3H ⁱ
Ship Creek											
1993	Ship Creek	Elmendorf	1994	31-23-12	199,830	M-R	44,138	42,864	21.50%		
1994	Ship Creek	Elmendorf	1995	31-24-28	218,487	M-R	40,764	38,570	17.70%		
1995	Ship Creek	Elmendorf	1996	31-25-08	231,444	M-R	41,221	40,109	17.30%		
1996	Ship Creek	Elmendorf	1997	31-25-56	326,371	M-R	40,522	40,319	12.36%		
1997	Ship Creek	Elmendorf	1998	31-26-30	204,741	M-R	42,073	41,565	20.30%		
1998	Ship Creek	Elmendorf	1999	31-01-42	197,168	M-R	44,265	42,262	21.44%		
	Ship Creek	Elmendorf	2000-01 ^j								

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Brood		Hatchery	Release Year	CWT Code	Total Released		Coded Wire Tagging			Thermal Marking	
Year	Broodstock				Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Ship Creek (continued)											
2001	Ship Creek	Elmendorf	2002		290,501	VOL				Ship Creek	2,4H4
2002	Ship Creek	Ft Richardson	2003		329,416	HI				Cook Inlet	2,3H
2002	Ship Creek	Ft Richardson	2004		209,060	HI				Cook Inlet	2,3H ^h
2003	Ship Creek	Elmendorf	2004		111,166	HI				Cook Inlet	2,3H
2003	Ship Creek	Ft Richardson	2005		344,191	HI				Cook Inlet	2,3H ^c
2004	Ship Creek	Elmendorf	2005		13,838	VOL					
2004	Ship Creek	Ft Richardson	2006		60,412	HI				Cook Inlet	2,3H
2004	Ship Creek ^l	Ft Richardson	2006		115,643	HI				Prince William Sound	2,4H ^l
2005	Ship Creek	Ft Richardson	2007		333,940	HI				Cook Inlet	2,3H
2006	Ship Creek	Ft Richardson	2008		341,495	HI				Cook Inlet	2,3H
Valdez Area											
1998	Deception Cr	Ft Richardson	1999	31-26-22	49,353	TI	46,528	45,923	93.05%		
1999	Deception Cr	Elmendorf	2000	31-01-37	115,582	M-R	41,728	41,060	35.52%		
2000	Deception Cr	Elmendorf	2001	31-02-39	94,701	HI	44,418	43,974	46.43%		
2001	Deception Cr	Ft Richardson	2002	31-02-58	107,861	HI	43,833	42,650	39.54%	Prince William Sound	2,4H
2002	Deception Cr	Ft Richardson	2003		109,661	HI				Prince William Sound	2,4H
2002	Deception Cr	Ft Richardson	2004		99,464	HI				Prince William Sound	2,4H ^h
2003	Deception Cr	Ft Richardson	2005		143,209	HI				Prince William Sound	2,4H ^c
2004	Ship Creek	Ft Richardson	2006		112,221	HI				Prince William Sound	2,4H
2005	Deception Cr	Ft Richardson	2007		126,241	HI				Prince William Sound	2,4H
2006	Deception Cr	Ft Richardson	2008		126,703	HI				Prince William Sound	2,4H

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Brood		Release			Total Released		Coded Wire Tagging			Thermal Marking	
Year	Broodstock	Hatchery	Year	CWT Code	Estimate	Type of Estimate ^a	Clipped Fish Released ^b	Tagged Fish Released	Percent Tagged	Mark Group	Hatch Code
Whittier Area											
1998	Deception Cr	Ft Richardson	1999	31-26-24	49,797	TI	45,023	43,897	88.21%		
1999	Deception Cr	Elmendorf	2000	31-01-39	119,389	M-R	43,551	42,898	35.93%		
2000	Deception Cr	Elmendorf	2001	31-02-40	95,823	HI	42,800	42,458	44.31%		
2001	Deception Cr	Ft Richardson	2002	31-02-59	109,763	HI	45,854	44,799	40.81%	Prince William Sound	2,4H
2002	Deception Cr	Ft Richardson	2003		109,700	HI				Prince William Sound	2,4H
2002	Deception Cr	Ft Richardson	2004		107,705	HI				Prince William Sound	2,4H ^h
2003	Deception Cr	Elmendorf	2004		20,906	VOL				Prince William Sound	2,4H
2003	Deception Cr	Ft Richardson	2005		118,059	HI				Prince William Sound	2,4H ^c

^a M–R is mark-recapture; TI is tagging inventory; HI is hatchery inventory; VIS is a visual estimate; VOL is volumetric estimate.

^b Beginning in 2005, number of clipped fish released is adjusted to reflect percent of acceptable finclips observed at release.

^c Corrections for release numbers reported in the 1999 report.

^d See 2001–2003 marking report for altered mark details.

^e See 2005 marking report for altered mark details.

^f Not sampled for long-term CWT retention or finclip quality at release. CWT data based on overnight tag retention and acceptable finclip rates.

^g Corrections for release numbers reported in the 2007 report.

^h See 2004 marking report for altered mark details.

ⁱ Due to a bacterial kidney disease (BKD) infection, release groups were switched at release in order to stock healthier fish at brood source release sites.

^j Stocking continued, but releases did not contain tagged or thermally marked fish.

APPENDIX B

Appendix B1.-Displacement values (kg/mm) for fish transport tanks.

Vehicle	Displacement kg/mm
SV33804	2.70
SV36544	2.60
SV36905	1.42
SV33697	2.20
SV33259	3.21

Source: John Unterberg, Alaska Department of Fish and Game, Fort Richardson Fish Hatchery, December 2010.