Marine Area 10
Mark-Selective Recreational Chinook Fishery,
December 1, 2008 – January 31, 2009

Post-season Report

REVISED DRAFT

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EXECUTIVE SUMMARY

The Washington Department of Fish and Wildlife (WDFW) implemented a winter mark-selective Chinook fishery (MSF) in Marine Area 10 for the second season, from December 1, 2008 through January 31, 2009. Consistent with the 2004 Puget Sound Chinook Harvest Management Plan (Puget Sound Indian Tribes and WDFW 2004) and the intent of previous Puget Sound/Strait of Juan de Fuca mark-selective Chinook fisheries, the primary goal for this pilot fishery was to provide meaningful opportunity to the recreational angling public while minimally impacting ESA-listed Puget Sound Chinook salmon. WDFW's Puget Sound Sampling Unit (PSSU) implemented an intensive monitoring program in Area 10 throughout the fishery in order to collect the data needed to estimate key parameters characterizing the fishery and its impacts on wild salmon. Sampling activities included dockside creel sampling, test fishing, and on-the-water effort surveys. Among other parameters, efforts emphasized data collection needs for the estimation of: *i*) the mark rate of the targeted Chinook population, *ii*) the total number of Chinook salmon harvested (by size [legal or sublegal] and mark-status [marked or unmarked] group), *iii*) the total number of Chinook salmon released (by size and mark-status group), *iv*) the coded-wire tag- (CWT) and/or DNA-based stock composition of marked and unmarked Chinook mortalities[1], and *v*) the total mortality of marked and unmarked double index tag (DIT) CWT stocks.

Creel samplers staffed a total of five different access sites on 39 of the 62 days that Area 10 was open under mark-selective harvest regulations. Samplers interviewed an estimated 26% of all participating anglers (n = 518 angler trips) and sampled 25% of all marked Chinook harvested (n = 64). To obtain estimates of Chinook encounters by mark/size class in the Area 10 winter fishery, test fishers spent 30 days (126.9 hours) on the water pursuing Chinook using test fishing methods.

Additionally, PSSU staff conducted six on-the-water effort surveys (total-Area counts of the number of boats and anglers), in which samplers interviewed 132 boats with 257 anglers; of these, 165 anglers (64%) exited the fishery via sites within the sample frame. During the six effort surveys, we encountered a total of 3 charter vessels with 8 anglers, comprising just 3% (8 out of 257 total anglers; Appendix E) of the total (i.e., charter and private) boat effort surveyed. Charter boat effort was included in the estimated proportion of effort outside of our sample site frame (i.e., in expansions for never-sampled sites); therefore, estimates of catch and effort from charter boats were part of our total-Area creel estimates for the entire fleet.

Based on our creel sampling activities, we estimated that 2,029 angler trips were completed by the private fleet during the fishery. With a CPUE of 0.12 Chinook landed per angler trip, these anglers harvested a grand total of 251 marked and no unmarked Chinook; they released an estimated 1,545 Chinook (1,047 marked and 498 unmarked). Harvested Chinook averaged 67 cm (range: 54 to 79 cm) in total length and were larger than the legal minimum size limit ($\geq$22 in or 56 cm TL) in most instances (dockside marked Chinook observations, 64 legal /65 total or 98%). Most of the Chinook harvested were of brood year 2006 origin (i.e., age 2 fish in

[1] Though the necessary tissue samples have been collected, DNA-based estimates of stock composition are presently unavailable for Puget Sound/Strait of Juan de Fuca mark-selective fisheries. In the present report, CWT-based (unexpanded) estimates of the stock composition of marked Chinook harvest are provided.

December or age 3 fish in January). In addition, 4 CWTs were recovered from harvested fish, all of which were from Puget Sound release sites.

During their two months of sampling in Area 10, test fishers encountered a total of 202 Chinook salmon; of these, 18% were legal-size and 72% were marked. The test fishers had an overall catch per unit of effort ("CPUE") of 0.53 legal-marked Chinook encounters per angler trip. Chinook encountered by test fishers averaged 42 cm (range: 25 to 81 cm) in total length and were predominantly 1 and 2 years in age (66% of marked and 91% of unmarked totals). We estimated the overall mark rate at 72% (89% for legal-size Chinook only) and size/mark-status composition at 15.8% legal-marked, 2.0% legal-unmarked, 56.4% sublegal-marked, and 25.7% sublegal-unmarked.

By combining dockside sampling results (i.e., legal-marked Chinook harvest estimates) and test fishery size/mark-status composition data, we generated size/mark-status group-specific estimates of encounters and mortalities. We estimated that a total of 1,796 Chinook were encountered (retained and released) during the Area 10 fishery, with 284 of these being legal-marked, 36 legal-unmarked, 1,013 sublegal-marked, and 462 sublegal-unmarked individuals. Among released encounters, an estimated 6 legal-marked, 5 legal-unmarked, 202 sublegal-marked, and 92 sublegal-unmarked Chinook (305 overall) were estimated to have died due to handling and release effects. Thus, in total, we estimated that 459 marked (54% due to direct harvest) and 98 unmarked Chinook mortalities occurred as a result of the Area 10 fishery.

All Chinook impacts were less than expectations set by pre-season Fishery Regulation Assessment Model (FRAM) runs (model run 2108). The impact of the Area 10 fishery on unmarked Chinook was approximately 20% of what was anticipated, with 98 unmarked total mortalities (landed + released) estimated via creel surveys compared to 480 unmarked total mortalities predicted by FRAM.

Finally, regarding impacts of MSF's on the coded-wire tag (CWT) program, we estimated that one unmarked Chinook belonging to double-index tag (DIT) groups may have died due to the handling-and-release impacts of the two-month Area 10 winter mark-selective Chinook fishery.

INTRODUCTION

In recent years, abundant runs of hatchery Chinook salmon (*Oncorhynchus tshawytscha*) have mixed with depressed runs of wild Chinook salmon in the marine environments of the Puget Sound and Strait of Juan de Fuca. Providing recreational anglers with opportunities to harvest abundant hatchery stocks while simultaneously protecting weaker, wild stocks has proven to be a significant conservation and management challenge. The combination of large-scale hatchery marking (i.e., fin clipping) programs and mark-selective harvest regulations makes it possible for anglers to pursue and harvest hatchery Chinook salmon while minimally impacting wild salmon populations. In such "mark-selective fisheries" (MSFs), anglers are generally allowed to retain adipose-fin clipped ("marked") hatchery fish and are required to release unharmed any unclipped ("unmarked", predominantly wild) salmon encountered[2].

Since the first marine selective Chinook fishery occurred in Marine Catch Areas 5 and 6 (Strait of Juan de Fuca) in 2003 (WDFW 2008a), mark-selective Chinook salmon fishing regulations have been implemented on a pilot basis in multiple Puget Sound Marine Catch Areas during both summer and winter seasons. As of the close of the 2007-08 fishing season, pilot *summer* selective Chinook seasons have occurred in Areas 5 and 6 for six years (2003-2008; WDFW 2008a; WDFW 2009a) and in Areas 9, 10, 11, and 13 for two years (2007 and 2008; WDFW 2007a and 2007b, WDFW 2009b and 2009c); pilot *winter* selective Chinook fisheries have occurred in Areas 8-1 and 8-2 for three complete seasons (2005-06, 2006-07, and 2007-08; WDFW 2008b, WDFW 2009d). From December 1, 2008 through January 31, 2009, the Washington Department of Fish and Wildlife (WDFW) implemented the second year of the mark-selective Chinook fishery in Area 10 during the winter season. Consistent with the 2004 Puget Sound Chinook Harvest Management Plan (Puget Sound Indian Tribes and WDFW 2004) and the intent of previous mark selective Chinook fisheries, the primary goal for this pilot fishery was to provide meaningful opportunity to the recreational angling public while minimally impacting ESA-listed Puget Sound Chinook salmon.

Given the pilot nature of the Area 10 winter selective Chinook fishery, WDFW's Puget Sound Sampling Unit was tasked with implementing an intensive monitoring program during the entirety of its December 1, 2008 to January 31, 2009 season. Our primary goal was to collect the data needed to estimate key parameters characterizing the impacts of this fishery on wild salmon. As per State–Tribal agreement (WDFW and NWIFC 2008), we tailored our sampling so that we could reliably estimate: *i*) the mark rate of the targeted Chinook population, *ii*) the total number of Chinook salmon harvested (by size [legal or sublegal] and mark-status [marked or unmarked] group), *iii*) the total number of Chinook salmon released (by size and mark-status group), *iv*) the coded-wire tag- (CWT) and/or DNA-based stock composition of marked and unmarked Chinook mortalities[3], and *v*) the total mortality of marked and unmarked double

[2]The regulations specific to the 2008-09 Area 10 mark-selective fishery allowed for the retention of up to two legal-sized (≥22 inches [56 cm]) marked Chinook salmon per day and required the immediate release of all unmarked or sublegal Chinook. Additionally, anglers were: *i*) required to use single-point, barbless hooks while fishing for salmon, *ii*) held to a combined (all salmon species) two-fish daily limit during the Area 10 mark-selective fishery, and *iii*) held to a handling rule that prevented them from bringing unmarked and/or sublegal Chinook aboard their vessels.

[3] Though the necessary tissue samples have been collected, DNA-based estimates of stock composition are presently unavailable for Puget Sound/Strait of Juan de Fuca mark-selective fisheries. In the present report, CWT-based (unexpanded) estimates of the stock composition of marked Chinook harvest are provided.

index tag (DIT) CWT stocks. In addition, we acquired and analyzed relevant data characterizing other aspects of the pilot fishery, including descriptors of fishing effort, fishing success (catch [landed Chinook] per unit effort), the length and age composition of encountered Chinook, and the overall intensity of our sampling efforts.

In the following pages, we report the results generated through our Area 10 monitoring activities from December 1, 2008 through January 31, 2009. We first provide a brief review of our in-season sampling and post-season assessment methods and then present detailed results for each component of our selective-fishery monitoring program. Results are presented according to the following sequence: *i*) the intensity (i.e., spatial and temporal coverage) of sampling efforts is described; *ii*) estimates of fishery characteristics obtained from creel survey data are reviewed; *iii*) the results from our recreational test fishery are presented; and *iv*) total fishery impacts—estimated based on the combination of creel and test fishery data—are reviewed and compared with pre-season expectations (i.e., based on Fishery Regulation Assessment Model [FRAM] predictions). Finally, we provide a detailed description of our impact estimation scheme as well as additional and relevant data in a series of appendices (i.e., sample-rate tables and sampling summaries; age composition tables [for landed catch and test fishery encounters]; and raw CWT recoveries).

METHODS

Marine Catch Area Description

Marine Catch Area 10 encompasses the waters around the largest population center in the Puget Sound Region. Encompassing 100-200 mi^2 (206-512 km^2) of marine water, Area 10 extends from the Apple Cove Point – Edwards Point line south to a projected east-west line through the north tip of Vashon Island (**Figure 1**).

Monitoring Program Overview

Our sampling program for the Area 10 fishery incorporated comprehensive and complementary data collection strategies, including dockside angler interviews (with catch sampling), on-the-water (instantaneous) effort surveys, test-fishery-based sampling, and voluntary reports of completed trips provided by charter boats and private anglers (**Figure 2**). Although we provide a brief review of the field and analytical methods associated with our sampling efforts here, we refer the reader to WDFW (2007b or 2008b) for additional detail.

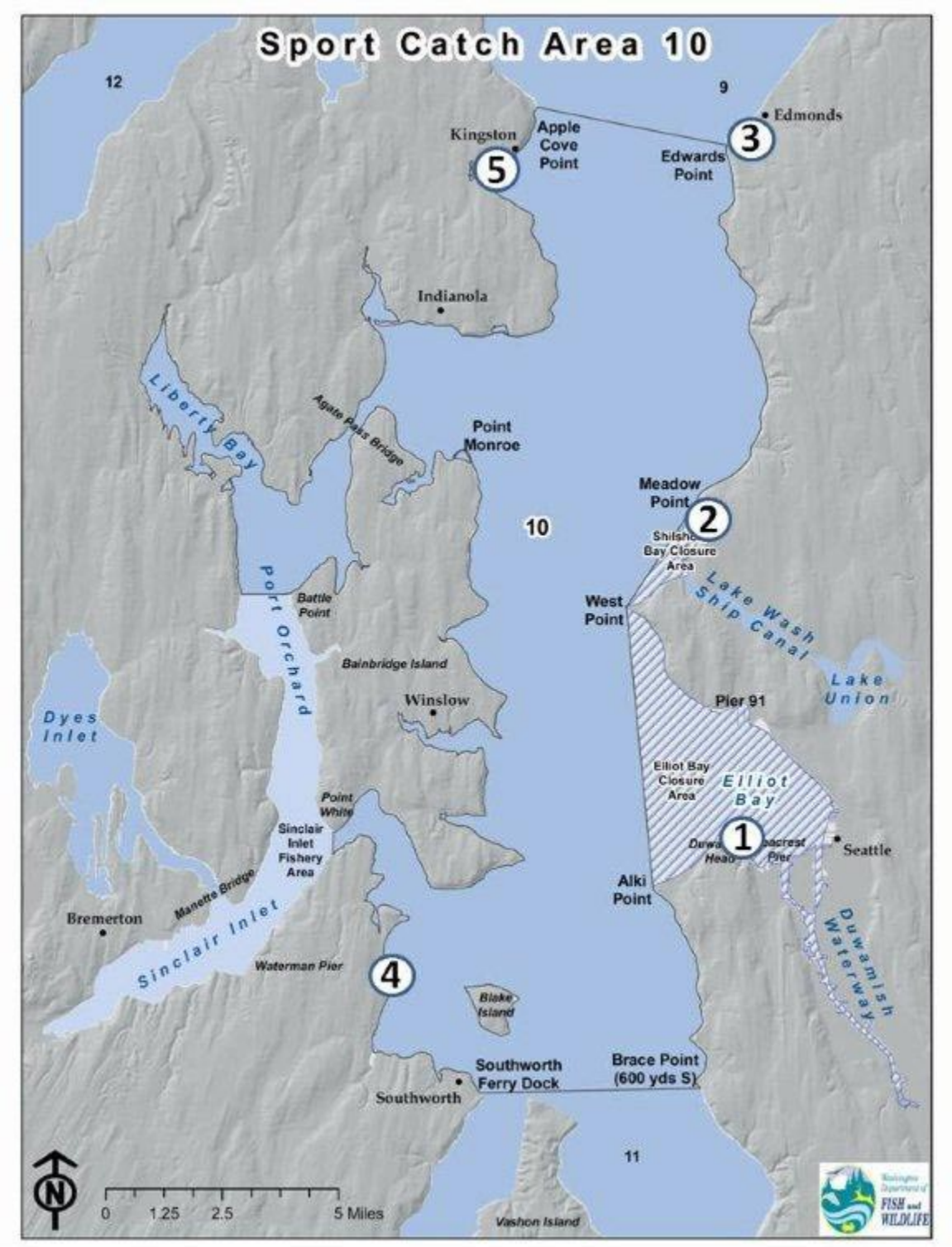

Figure 1. Map of Marine Catch Area 10 in Puget Sound, where the second season of the pilot winter selective Chinook fishery occurred from December 1, 2008 through January 31, 2009. Circled numbers represent boat ramps sampled by PSS staff during the winter fishery: 1) Don Armeni ramp; 2) Shilshole ramp; 3) Edmonds Marina dry storage; 4) Manchester ramp; and 5) Kingston ramp.

Catch and Effort: Sampling and Estimation

We collected data on total catch (observed harvest and reported releases[4]) and total angling effort using a two-stage stratified cluster sample design. At the first stage, we selected five sample days from two temporal strata (weekday [Monday-Thursday], with $n = 2$ days sampled; weekend [Friday-Sunday], with $n = 3$ days sampled) during each week of the fishery. On each selected sample day, we selected two access points (i.e., public ramps, boathouses, etc.) from our Area 10 sample frame for creel sampling. Access site (i.e., cluster) selection was achieved at the second stage using a probability-proportional-to-size (PPS) sampling algorithm (the Yates-Grundy or "natural" method, Cochran 1977). The measure of size used in PPS sampling was equivalent to the fraction of total sample-frame effort attributed to a given site; this quantity was estimated using data collected during instantaneous on-the-water surveys (i.e., "boat surveys") conducted routinely during the course of the fishery. Our sample frame included all moderate-to-high effort, public boat launch facilities that are used to access Area 10, including: Armeni Ramp, Shilshole Public Ramp, Kingston Public Ramp, Manchester Public Ramp, and Edmonds Marina Dry Storage. Given that some effort was excluded from our sample frame (i.e., private and/or low-effort access sites), we also estimated the out-of-frame effort proportion from boat survey data and accounted for this quantity in estimates of fishery-wide totals (e.g., catch and effort).

At access sites selected for sampling on scheduled sample days, samplers interviewed *all* anglers exiting the Area 10 fishery. During interviews, samplers acquired data on trip duration, trip intent (i.e., targeted species), fishing method(s) employed (downrigger or diver trolling, jigging, mooching, or other), and fish encountered (kept and/or released, by species). When an interviewed party possessed Chinook or coho salmon, samplers inspected them for CWTs using wand detectors, and collected snouts from CWT positive individuals for later lab processing. Additionally, samplers took length measurements (fork and total) and scale samples from landed Chinook.

By combining dockside interview data with estimates of size measures, we generated daily estimates (and variances) of total fishing effort and landed Chinook catch (by mark-status group) for our sample frame using Murthy's population-total estimator (Murthy 1957, Cochran 1977, WDFW 2008b). We then expanded these estimates to account for the out-of-frame effort proportion and then again to obtain stratum totals (**Table 1**). To minimize the influence of recall bias on our assessment, we estimated Chinook releases as the difference between retained catch (i.e., from the Murthy estimator, based on *observed* landings) and total Chinook encounters (i.e., releases = encounters – retained catch) generated using the bias-corrected Conrad and McHugh (2008) approach. Briefly, encounters were estimated by dividing the creel estimate of legal-marked Chinook harvest by a test fishery-based estimate of the proportion of the fishable Chinook population that is of legal size and marked (i.e., our former "Method 2" approach; e.g., WDFW 2007a). Given that this approach yields negatively biased estimates if anglers release any of the legal-marked Chinook they encounter, Conrad and

[4] In an evaluation of bias in mark-selective fishery parameter estimates, Conrad and McHugh (2008) concluded that recall errors likely cause bias in interview-based estimates of total salmon *releases*. Thus, although estimates of total salmon releases based solely on angler-reported data were generated for this report (**Appendix D**), we focus exclusively on bias-corrected "Method 2" estimates of Chinook encounters (and releases) in our review of the Area 10 fishery.

McHugh estimated a "correction" factor to account for this phenomenon and incorporated it into their estimator (see **Appendix A** for complete computational details). Although we do not review estimates of Chinook releases based solely on angler accounts in our assessment, we supply these estimates, as well estimates of retained catch and/or releases for other salmon species, in appendices to this report (**Appendix D**).

Although they were not used in producing creel estimates, Voluntary Trip Reports (VTRs) were also completed and returned by a subset of private fleet anglers, to obtain additional information on Chinook encounter rates by mark status and size class in the Area 10 winter selective fishery. Anglers were asked to record the date, number of anglers, target species, catch Area, each Chinook or coho hooked, whether the fish was kept or released, species (if they positively identified the fish), total length to the nearest 1/8th inch, and whether the fish was adipose fin-clipped (marked) or not clipped (unmarked).

For on-the-water surveys conducted during the second season of the Area 10 winter selective fishery, we continued the modified approach employed last year, in which we stratified survey data based on Tengu Derby days (each Sunday in December only) versus non-Tengu days. The Tengu Derby is the longest running salmon derby in Washington State and is open to 'moochers' (defined in WDFW reports as 'weight and bait' gear type) only. In December 2008, the Tengu Derby occurred every Sunday (4 Sundays) throughout the month and was confined to Elliott Bay. We conducted 2 boat surveys on 2 Sundays during the month of December. Anglers were specifically asked whether or not they were derby participants, and samplers noted this information on the survey form. Most of the derby participants originated from the Don Armeni Ramp in West Seattle. We separated out Tengu anglers from the boat survey data to obtain site size measures for non-Sundays. We included Tengu anglers for calculating Sunday size measures throughout the month. Tengu anglers made up a significant portion of the angling effort at Armeni Ramp on the two Sunday angler surveys, with the unadjusted percentage of effort increasing to 35% (with Tengu anglers) from 0.7% (without Tengu anglers; see **Appendix E** for a summary of Tengu versus non-Tengu size measures).

As a final note, in the previous (2007-08) season of the Area 10 winter selective Chinook fishery, we separated charter vessels from private (non-charter) boats in generating the catch and effort estimates for Area 10 (WDFW 2009e). We used the Murthy estimator method to estimate total salmon encounters for private boats in Area 10, while a complete census (from VTRs and follow-up phone calls) approach was used for charter boats. Given the logistical and estimation difficulties that arise as a result of our separate charter/fleet sampling breakout, we explored datasets from past years and considered bias analytically in order to identify the areas/seasons where a special charter treatment is absolutely necessary (analysis done by WDFW Biologist Peter McHugh, February 2009, with input from NWIFC Biometrician Robert Conrad). Briefly, we evaluated how much CPUEs for the overall fleet versus charter boats would have to differ and/or how great the charter effort proportion (of the total effort) would have to be in order for a meaningful bias to impact our catch estimates. From this evaluation, we determined that pooling charter and fleet data in the Murthy estimates would not significantly compromise estimate integrity in the Area 10 winter selective fishery. The combination of charter effort proportions (very small) and CPUE ratios (relatively high) suggested that pooling causes negligible (<3%) bias; therefore, we elected to include charter vessels in our Murthy estimate for the Area 10 winter fishery in 2008-09.

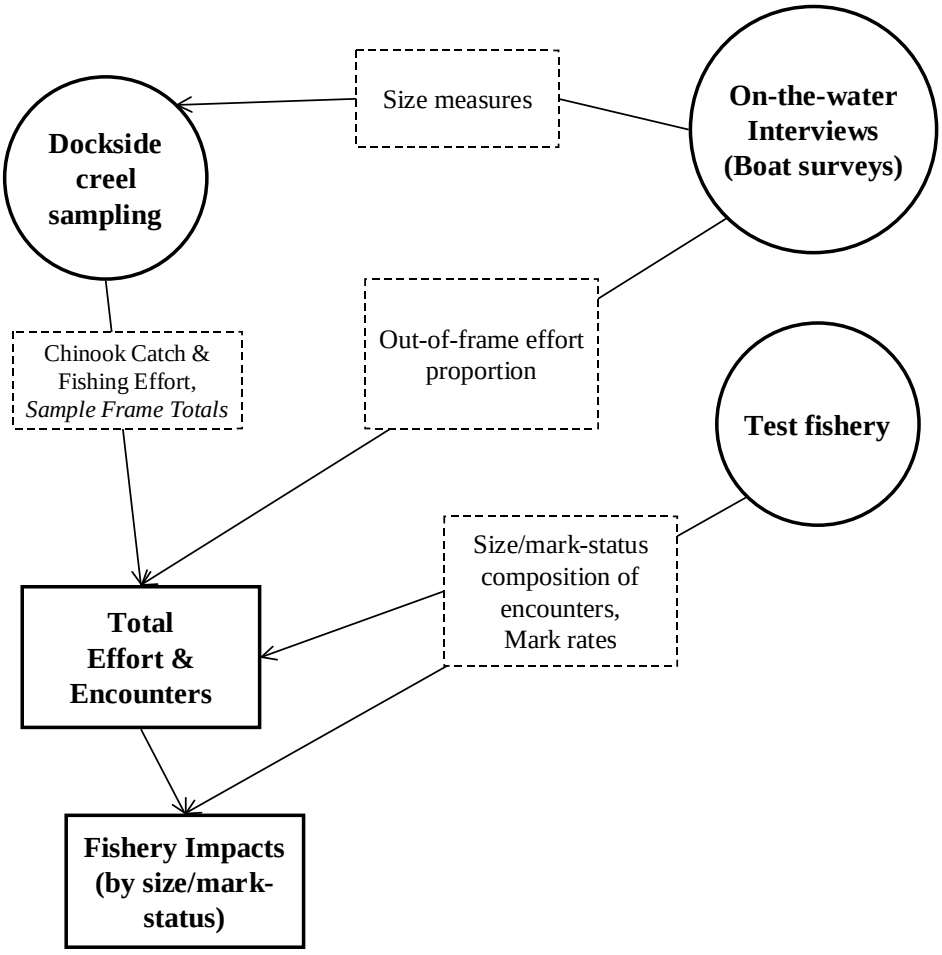

Figure 2. Conceptual diagram of the monitoring plan implemented in Area 10 during its December 1, 2008 to January 31, 2009 mark-selective Chinook season. Circles represent discrete sampling activities, dashed boxes represent parameters that are estimated using data from a given activity, and solid boxes depict key quantities estimated from the comprehensive plan. 'Encounters' includes both harvested and released Chinook salmon.

Test Fishery Methods

In order to obtain accurate estimates (i.e., free from survey-based recall error) of the size (legal or sublegal) and mark-status (marked or unmarked) composition of the pool of Chinook salmon encountered by anglers participating in the fishery, we conducted a recreational test fishery during the entirety of the mark-selective Chinook season (**Table 1**). Our test boat crew consisted of two WDFW technicians, each fishing with a single rod for five days a week (Monday-Friday). Test fishers focused their efforts at locations that optimized their overall encounter rate and mirrored choices made by the at-large private fleet. Also, test fishers fished for Chinook using the same methods as the recreational fleet, as prescribed by supervisory staff based on dockside interview results for the preceding week. For each fish brought to boat, test fishers logged details on its identity (species), size (fork length and total length), and, if

appropriate, mark status (marked or unmarked). For Chinook salmon encounters only, test fishers additionally collected scale and DNA samples (~1-cm^2 piece of dorsal fin tissue).

Estimating Fishery Impacts

Total Encounters and Mortalities

We characterized the overall impacts of the fishery in terms of grand-total estimates of encounters and mortalities and by using estimates specific to each of the four size/mark-status groups (i.e., legal-marked [LM], sublegal-marked [SM], legal-unmarked [LU], and sublegal-unmarked [SU]; **Table 1**). As indicated above and in contrast to previous (i.e., prior to summer 2008) post-season MSF reports, we used only one approach to estimate total Chinook encounters and, consequently, mortalities. This single method was selected as a result of a thorough state–tribal review of bias potential in estimators of encounters in MSFs (see Conrad and McHugh 2008 for details). In brief, total encounters were estimated by dividing creel estimates of legal-marked Chinook harvest by the test fishery-based proportion of the targeted Chinook population that was of legal size and marked, inclusive of a bias correction accounting for the modest level of "high grading" that may occur in this fishery. We then decomposed total encounters into size/mark-status group-specific estimates using test-fishery encounters composition data.

We estimated total Chinook mortality resulting from the fishery by applying assumed mortality rates to the total harvest and release estimates for the four size/mark-status groups (LM, LU, SM, and SU). For retained Chinook, the mortality estimate was equivalent to the total harvest estimate for the applicable size/mark-status group. We applied selective fishing mortality (*sfm*) rates of 15% and 20% to legal (marked and unmarked) and sublegal (marked and unmarked) release totals, respectively, to estimate release mortality. See **Appendix A** for a complete description of our impact estimation procedure, including formulae for total and variance estimators.

The final step of our overall impacts assessment involved comparing fishery outcomes to pre-season expectations. To do this, we compared season-total estimates of Chinook encounters and mortalities to pre-season modeled values (FRAM model run number 2108) for each size and mark status category.

Table 1. Sampling/estimation details on target parameters associated with the overall Area 10 mark-selective fishery monitoring program (**Figure 1**).

Activity	Focal Parameter(s)	Secondary Parameter(s)	Sample Unit(s)	Finest Estimation Time Step	Comments
Dockside Creel Sampling	Fishing effort (boat & angler trips); kept and released fish[1]	Catch rates (CPUE); length, age, and CWT composition of harvest[2]	Angler trip; kept fish; reported fish release	Week[1]	Within weeks, estimates are also produced by strata (weekday/weekend).
Test Fishing	Size (legal/sublegal) and mark-status composition (marked, unmarked) of encountered Chinook	Chinook length, age, and DNA-based[3] stock composition; species composition of non-Chinook encounters	Fish encounter	Season (2 months)	Too few encounters occurred to assess mark rates on a finer time scale.
Overall Fishery Impacts Estimation	Total Chinook encounters and mortalities, by size/mark-status group	Ratios of encounters and mortalities per kept Chinook	N/A	Season (2 months)	
Coded-wire tag (CWT) Impacts Estimation	Marked/unmarked double-index tag (DIT) encounters and mortalities	N/A	N/A	Season (2 months)	The temporal resolution of DIT impacts is constrained by the total number of tags recovered.

[1] Under the "bias-corrected Method-2" approach, Chinook releases can be estimated only as finely as test fishery data allow.
[2] The length and CWT composition of landed catch was assessed on a season-wide basis for impact estimation.
[3] Though samples were collected, DNA-based estimates of stock composition are not yet available for this fishery.

CWT Impacts

To understand the potential effects of the Area 10 fishery on CWT-based cohort-reconstruction efforts, we estimated the total number of unmarked-tagged Chinook mortalities that may have occurred during the course of its season. We acquired information for all marked CWT double index tag (DIT) groups present in landed catch and then applied the methods described by the Selective Fisheries Evaluation Committee – Analysis Work Group (SFEC-AWG 2002) to estimate the number of unmarked DIT fish encountered[5]. We subsequently estimated the number of these fish that may have died due to hook-and-release impacts using an *sfm* analogous that was used in FRAM modeling. Given our interest in characterizing the impacts of mark-selective regulations on the CWT program and not recreational fishing in general, we used an *sfm* of 10% in all unmarked-DIT mortality calculations. Thus, we used 10% instead of 15% (applied above to legal-sized releases) since unseen drop-off mortality (the 5% differential) should theoretically be the same for selective and non-selective fisheries.

[5] For all unmarked-DIT encounters and mortalities calculations, we relied on the DIT unmarked-to-marked ratio (λ) estimated at the time of juvenile release.

RESULTS & DISCUSSION

Summary of Sampling Efforts

Sampled Access Sites

Sites within the Area 10 sample frame included Armeni Public Ramp, Edmonds Marina (Dry Storage), Kingston Public Ramp, Manchester Public Ramp, and Shilshole Public Ramp. All sites within the sample frame were sampled at least once during the duration of the fishery and appear in **Table 2** and **Appendix F**. Sample sites for the first week of the fishery were selected based on historical catch and effort data and supervisor input.

Table 2. List of sites sampled during the Area 10 selective Chinook fishery, December 1, 2008 – January 31, 2009.

Area 10 Sampled Sites	Total Days Sampled	% of Total
Armeni Public Ramp	15	**19.2%**
Edmonds Dry Storage	12	**15.4%**
Kingston Public Ramp	9	**11.5%**
Manchester Public Ramp	7	**9.0%**
Shilshole Public Ramp	35	**44.9%**
TOTAL	**78**	**100.0%**

Boat Survey Summary

We conducted a total of 6 boat surveys during the Area 10 winter selective fishery (**Table 3**). Boat surveys were used to estimate the percentage of effort from sites within the sample frame (versus sites out of the sample frame), and the proportion of angler effort originating at each access site. In the 6 boat surveys, samplers interviewed 132 boats with 257 anglers; of these, 165 anglers (64%) exited the fishery via sites within the sample frame. During the six effort surveys, samplers encountered a total of 3 charter vessels with 8 anglers, comprising just 3% (8 out of 257 total anglers; Appendix E) of the total (i.e., charter and private) boat effort surveyed. An additional 110 Tengu Derby participants were encountered during on-the-water surveys (**Appendix E**).

Winter fishery characteristics were such that on foul weather days and weekdays, angling effort was minimal or non-existent. We attempted to complete boat surveys on days when it was logistically feasible and when we expected to capture the most angling effort. Four boat surveys were cancelled and rescheduled due to inclement weather (all during December).

Table 3. Monthly summary of boat surveys conducted during the Area 10 selective fishery, December 1, 2008 through January 31, 2009.

Boat Survey Schedule: Area 10 Winter 2008-09	
Month	**Date Conducted**
December	12/5, 12/7,12/28
January	1/4, 1/11, 1/16
Total Surveys	**6**

Fishery Characteristics

Estimates of Fishing Effort and Catch

During the two-month Area 10 winter selective fishery, we estimated that a total of 251 Chinook (all marked) were retained over the course of 2,029 angler trips (**Table 4**). We estimated that anglers released a total of 1,545 Chinook (1,047 marked and 498 unmarked). Thus, the total estimated number of Chinook encountered in the Area 10 winter selective fishery was 1,796. In addition, we estimated that anglers retained 10 coho (5 marked and 5 unmarked), 7 chum salmon, and released 272 coho salmon (61 marked, 29 unmarked, and 182 unknown mark type) (**Appendix D**).

Table 4. Estimates of total fishing effort and the total number of Chinook salmon kept and released during the December 1, 2008 to January 31, 2009 Area 10 selective fishery. Values may not add exactly due to rounding error.

Month	**Stat Week**	**Start Date**	**End Date**	**Est. Effort** [1/]		**Est. Retained Chinook** [1/]		**Est. Released Chinook** [2/]		**Est. Total Chinook Encounters**
				Boats	**Anglers**	**AD**	**UM**	**AD**	**UM**	
DEC	49	1-Dec	7-Dec	458	771	93	0	387	184	665
	50	8-Dec	14-Dec	64	138	6	0	27	13	46
	51	15-Dec	21-Dec	17	17	0	0	0	0	0
	52	22-Dec	28-Dec	41	69	2	0	8	4	14
	53/1	29-Dec	4-Jan	84	141	20	0	85	40	145
JAN	2	5-Jan	11-Jan	34	63	2	0	10	5	17
	3	12-Jan	18-Jan	190	363	58	0	241	115	414
	4	19-Jan	25-Jan	149	305	53	0	219	104	376
	5	26-Jan	31-Jan	83	164	17	0	69	33	119
Season Total:				**1,120**	**2,029**	**251**	**0**	**1,047**	**498**	**1,796**
Variance:				9,122	28,377	2,635	0	83,989	17,841	220,428
Standard Error:				96	168	51	0	290	134	469
CV (%):				9%	8%	20%	-	28%	27%	26%
95% CI:				932-1,307	1,699-2,359	151-352	-	478-1,615	236-760	876-2,716

[1/] Estimated boats, anglers, and retained salmon catch were estimated via the Murthy estimator method.
[2/] Released Chinook were estimated as the difference between total Chinook encounters generated using a bias-corrected "Method 2" estimator (see **Appendix A** and Conrad and McHugh (2008) for additional details) and creel estimates of retained Chinook.

Trends in Angling Effort, CPUE, and Total Chinook Encounters

Angling effort was low to moderate during the two-month Area 10 winter selective Chinook fishery. Effort was highest at the start of the fishery (week 49), with 771 estimated angler trips in the first week. Thereafter, effort dropped and then increased again to a second peak in statistical week 3, with 363 estimated angler trips. Effort was at its lowest in week 51, with 17 angler trips estimated (**Figure 3**). Angler effort was lowest on weekdays, with an average of 24 estimated angler trips per day, while it was moderate on Fridays with an average of 38 angler trips per day, and highest on weekends, averaging 54 angler trips per day. In total, anglers made 2,029 estimated angler trips throughout the two-month fishery.

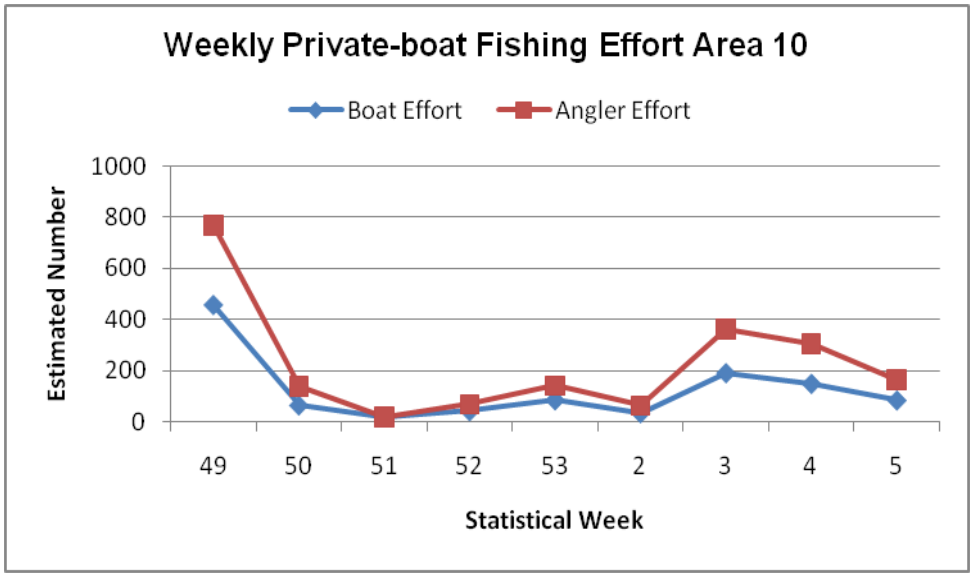

Figure 3. Weekly patterns in fishing effort during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. See the WDFW statistical week calendar in **Appendices B1** and **B2** for day and month equivalents to plotted statistical weeks.

Catch per unit of effort (CPUE) for the Area 10 winter selective fishery was low overall, with a season wide CPUE of 0.12 Chinook retained per angler trip. CPUE was highest in week 4, with 0.17 Chinook retained per trip, and lowest in week 51 with 0.0 Chinook retained per angler trip (**Figure 4**).

We estimated that anglers retained 251 Chinook (all marked) and released 1,545 Chinook (1,047 marked and 498 unmarked) in the Area 10 winter selective Chinook fishery (**Table 4**). Anglers retained an average of 28 Chinook per week and released an average of 172 Chinook per week over the course of the fishery. The highest number of weekly estimated Chinook encounters occurred during week 49 with 665 Chinook encountered (93 retained and 572 released). The lowest number of weekly Chinook encounters occurred during week 51, with no Chinook encountered (**Figure 5**).

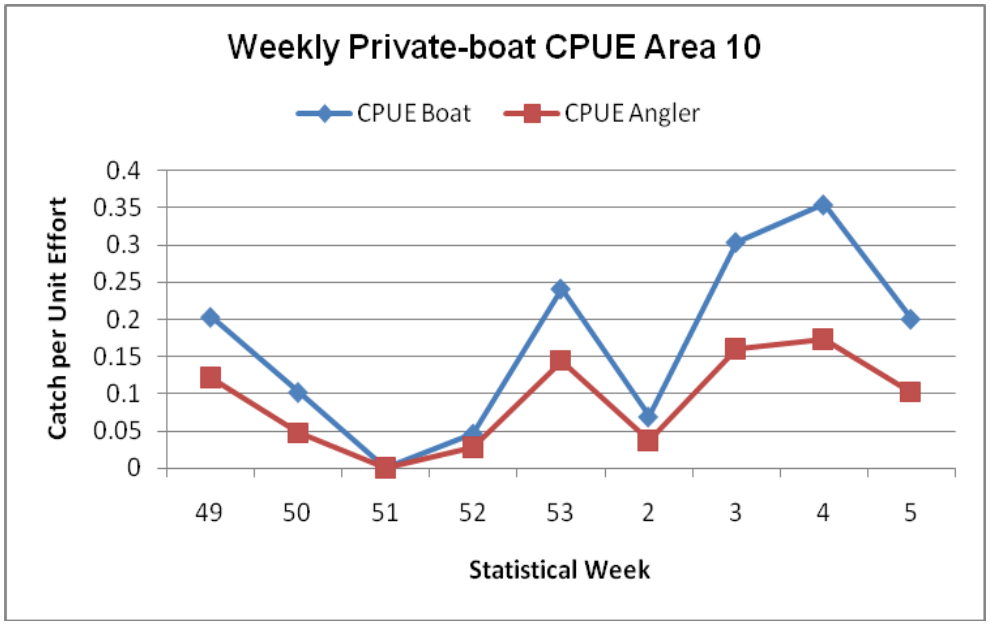

Figure 4. Weekly patterns in CPUE (landed Chinook per angler or boat trip) during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. See the WDFW statistical week calendar in **Appendices B1** and **B2** for day and month equivalents to plotted statistical weeks.

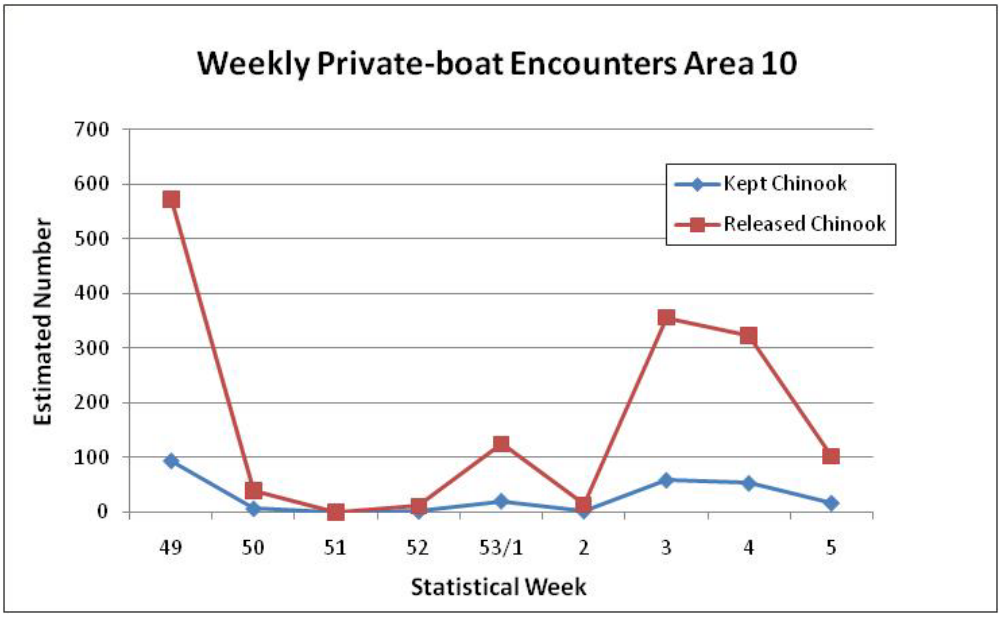

Figure 5. Weekly patterns in total Chinook harvest and releases during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. Released Chinook were estimated as the difference between total Chinook encounters generated using a bias-corrected "Method 2" estimator (see **Appendix A** and Conrad and McHugh (2008) for additional details) and creel estimates of retained Chinook. See the WDFW statistical week calendar in **Appendices B1** and **B2** for day and month equivalents to plotted statistical weeks.

Characteristics of Harvested Chinook

Length samples were collected from 65 Chinook salmon (64 marked and 1 undetermined) during dockside angler interviews (**Table 5**). All of the fish sampled were measured (fork length and total length) and examined for the presence of a coded wire tag (CWT). Retained Chinook ranged from 54 to 79 cm total length and averaged 66.5 cm (SD = 6.0cm; **Figure 6**). One of the 65 (2%) Chinook sampled was sub-legal size. At 66.5 cm, the average length of these fish was 10.7 cm greater than the legal limit (55.8 cm).

Table 5. Summary of length samples collected during dockside angler interviews from retained Chinook salmon in the Area 10 selective Chinook fishery, December 1, 2008 – January 31, 2009.

	Number Sampled		
Mark Type	**Legal-size**	**Sublegal-size**	**Total**
Marked	63	1	64
Unmarked	0	0	0
Undetermined	1	0	1
Total	**64**	**1**	**65**

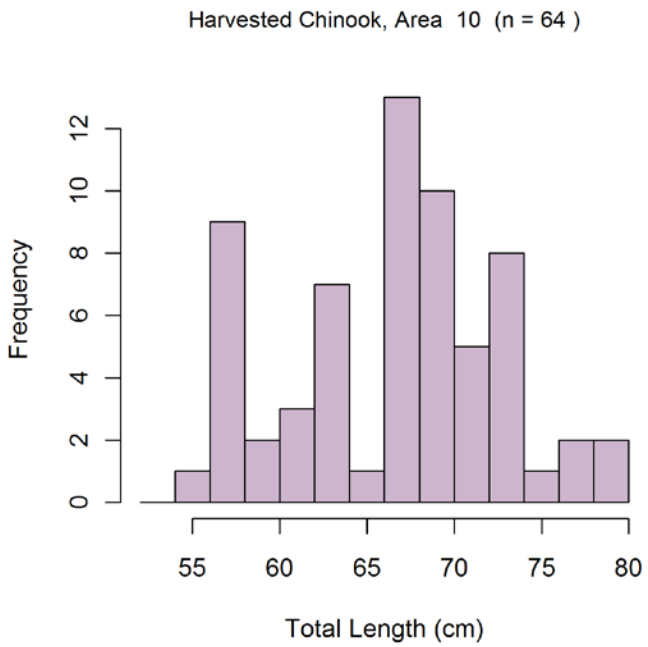

Figure 6. Length-frequency distribution of retained marked Chinook sampled at dockside during the Area 10 mark-selective Chinook fishery, December 1, 2008 – January 31, 2009.

Scale samples were collected from all Chinook sampled (65), and 60 (92%) of these could be read. Of the marked Chinook that were aged (60), 4 (7%) were from brood year 2007, 30 (50%) were from brood year 2006 and 26 (43%) were from brood year 2005 (**Appendix G**). The majority of harvested Chinook were sub-yearling outmigrants.

CWT Samples

Samplers recovered a total of 4 marked Chinook containing coded-wire tags (CWTs), out of 64 retained marked Chinook that were sampled during dockside angler interviews. The total sample size of 64 retained Chinook included fish sampled from the two sites selected per sample day for creel (Murthy) estimates, in addition to Chinook landed at other (baseline) sampling sites in Area 10 during the December-January winter season. Of the 4 CWT recoveries, 100% were from Puget Sound hatcheries (50% from South and 50% from Central Puget Sound) (**Table 6**; **Appendix H**). Of the 4 recoveries, half were associated with a double-index tag (DIT) group (See *Overall Fishery Impacts: Estimated CWT-DIT Impacts* for estimated unmarked DIT mortality results).

Table 6. Summary of coded-wire tags recovered from Chinook salmon harvested during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. The "No. DITs" field corresponds to the number of tags that belonged to double-index tag groups.

Release Region[1]	Release Site	Rearing Location	CWT's Recovered	No. DIT's
Puget Sound-Central	Big Soos Creek	Soos Creek Hatchery	2 (50.0%)	2
Puget Sound-South	Kalama Creek	Kalama Creek Hatchery	1 (25.0%)	0
	Chambers Creek	Garrison Hatchery	1 (25.0%)	0
		Grand Total	**4**	**2**

[1]Unofficial release regions. Puget Sound regions were designated based on the WDFW marine catch area containing the river/stream network where juvenile releases originated (i.e., Areas 11 and 13 = South; Areas 9 and 10 = Central; and Areas 7, 8-1, and 8-2 = North).

Test Fishing Results

Gear Types and Fishing Time

The test boat in the Area 10 winter selective fishery attempted to emulate the fishing methods that private boat anglers used to encounter Chinook by using fishing methods in the same proportions as those reported by anglers during creel interviews. Fishing with downriggers was the predominate method used by anglers to encounter Chinook in the Area 10 winter fishery.

During dockside angler interviews, samplers recorded the predominant fishing method of anglers who successfully encountered Chinook, and results of these responses were used to inform the test fishing vessel on proportions of time to spend fishing with each gear type. A total of 135 boats were interviewed that encountered Chinook; of these, 97 (72%) used downriggers as the predominant method to encounter Chinook; 37 (27%) used the weight and bait method (also referred to as 'mooching'); and 1 boat (1%) used the jigging method (**Table 7**). The proportion of boats using the weight and bait method was higher in the Area 10 winter fishery, versus other winter mark-selective fisheries, due to the Tengu Derby occurring in the month of December (see *Catch and Effort: Sampling and Estimation,* in the methods section for information on Tengu Derby). Test fishers used downriggers as a fishing method 77% of the total fishing time and used weight and bait 23% of the total fishing time.

Test fishers in the Area 10 winter selective fishery were scheduled to fish 5 days per week (averaging just over 15 hours per week) during the two-month fishery, but poor weather conditions limited their time on the water (**Table 8**). Test fishers fished 30 days out of a possible 45 and logged 126.9 hours of fishing time.

Table 7. Fishing methods employed by private recreational anglers (from dockside interviews, based on number of boat trips sampled, n =135) and test fishers (based on hours fished, n = 126.9) during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery.

Statistical Week	DR		WB		Diver		Jig	
	Tst Boat	Fleet	Tst Boat	Fleet	Tst Boat	Fleet	Tst Boat	Fleet
49	100.0%	59.4%	0.0%	37.5%	0.0%	0.0%	0.0%	3.1%
50	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
52	100.0%	57.1%	0.0%	42.9%	0.0%	0.0%	0.0%	0.0%
53/1	100.0%	56.5%	0.0%	43.5%	0.0%	0.0%	0.0%	0.0%
2	100.0%	88.9%	0.0%	11.1%	0.0%	0.0%	0.0%	0.0%
3	81.4%	78.6%	13.9%	21.7%	0.0%	0.0%	4.7%	0.0%
4	0.0%	87.0%	100.0%	13.0%	0.0%	0.0%	0.0%	0.0%
5	0.0%	75.0%	100.0%	25.0%	0.0%	0.0%	0.0%	0.0%
Total	**76.6%**	**71.9%**	**22.6%**	**27.4%**	**0.0%**	**0.0%**	**0.9%**	**0.7%**

Chinook Encounters and Mark Rates

Test fishers for the Area 10 winter selective fishery encountered 202 Chinook (36 legal and 166 sublegal) in their 30 days and 126.9 hours of fishing time. The proportion of legal-size Chinook encounters in the test fishery was 18%. A large portion of the Chinook encounters were adipose fin clipped, with a legal size mark rate of 89% and an overall mark rate of 72%. For the duration of the Area 10 winter fishery, the season-total composition of Chinook encounters in the test fishery was 15.8% legal and marked; 2.0% legal and unmarked; 56.4% sublegal and marked; and 25.7% sublegal and unmarked (**Table 8**). We used these pooled season-wide estimates in our overall fishery impact estimation scheme (**Table 1**).

Table 8. Composition of test fishery Chinook encounters and associated mark-rate and size/mark-status proportion estimates the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. Variances associated with season-total size/mark status proportions and mark rates are provided in parentheses. AD=adipose fin-clipped (marked); UM=adipose fin intact (unmarked).

Stat Week	Fishing Effort		Legal		Sublegal [1/]		Total
	Days	Hours Fished	AD	UM	AD	UM	
49	6	27.8	10	2	13	17	42
50	3	12.2	5	1	19	9	34
51	1	4.2	0	0	2	0	2
52	3	9.4	3	1	14	5	23
53/1	2	8.9	0	0	9	1	10
2	4	16.1	3	0	24	8	35
3	5	22.8	10	0	33	12	55
4	2	8.7	0	0	0	0	0
5	4	16.8	1	0	0	0	1
Total	**30**	**126.9**	**32**	**4**	**114**	**52**	**202**
Size/mark-status composition:			0.158 (0.001)	0.020 (0.000)	0.564 (0.001)	0.257 (0.001)	
Legal size mark rate:			0.89 (0.003)				
Overall mark rate:			0.72 (0.001)				

[1/] In addition to the 202 (36 legal and 166 sublegal) Chinook encounters shown in the table, test fishers encountered 1 sublegal size Chinook of undetermined mark status (i.e., total encounters, n=203).

During the Area 10 winter season, the recreational fleet returned a total of 6 VTRs with 30 Chinook encounters (**Table 9**). Mark rates reported on VTRs were similar to mark rates in the test fishery. The legal-size mark rate for private (non-charter) boat anglers who returned VTRs was 100% (n=2 encounters), while the legal-size mark rate in the test fishery was 90% (**Table 8**). The overall Chinook mark rate on VTRs was 80.0% (n=30 encounters), while it was 72% in the test fishery (**Table 9**).

Table 9. Total Chinook encountered (retained and released) by private (non-charter) boat anglers reporting their catch on voluntary trip reports (VTRs) during the Area 10 mark-selective Chinook fishery (December 1, 2008 through January 31, 2009), with estimates of legal-size, sublegal-size, and overall mark rates.

Size	Mark Status	Month		Total	% Marked
		December (0 VTRs)	January (6 VTRs)		
Legal	**Marked**	0	2	2	
	Unmarked	0	0	0	
	Subtotal	**0**	**2**	**2**	**100.0%**
Sublegal	**Marked**	0	22	22	
	Unmarked	0	6	6	
	Subtotal	**0**	**28**	**28**	**78.6%**
Total		**0**	**30**	**30**	**80.0%**

Chinook Size and Age

An analysis of test fishery length data indicated that the majority of Chinook encountered were of sublegal size (82%; **Table 8, Figure 7**). The average size of Chinook encountered was 42 cm, with a minimum of 24.8 cm and a maximum of 81.1 cm (n =203). The overall mean size was significantly higher for marked fish encountered compared to unmarked (44.5 cm AD versus 35.5 cm UM, two sample t-test: t = 4.9, df = 145, P = 0.0000014). Given the abundance of sublegal-size Chinook in the test fishery, the average size of Chinook encountered in the test fishery (42 cm) was nearly 25 cm lower than that of harvested Chinook (66.5 cm) sampled during dockside angler interviews. Analysis of the 142 (99 ad-marked and 43 unmarked) readable scale samples obtained from the test fishery showed that a majority (49%) of these fish were of brood year 2007 origin (i.e., Age 1 in December or Age 2 in January; **Figure 8**, **Appendix G**). Additionally, most of the Chinook in the age analysis (82% for marked, 93% for unmarked) were subyearling outmigrants.

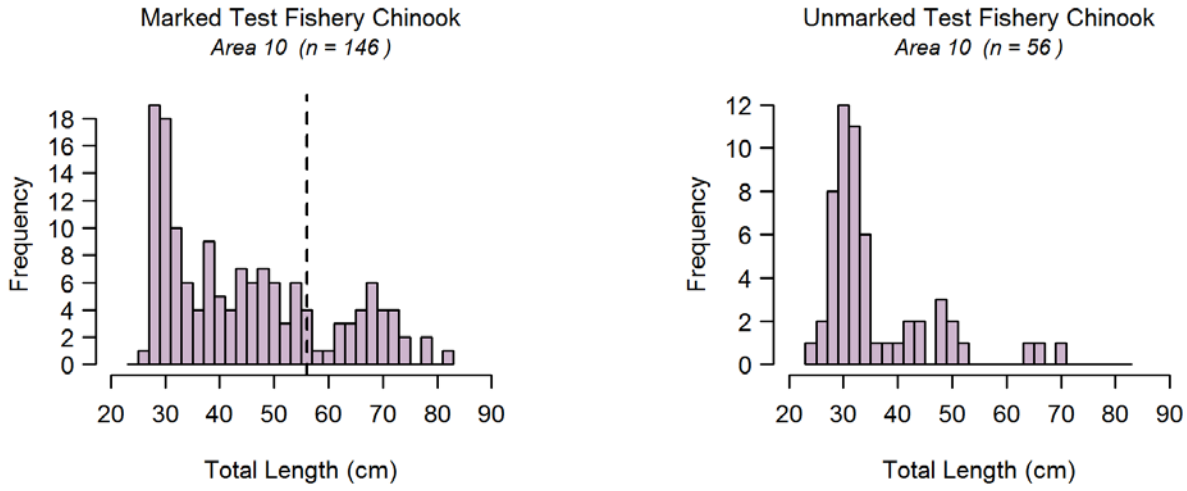

Figure 7. Length-frequency distributions of marked (left panel) and unmarked (right panel) Chinook encountered by test fishers during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. The dashed vertical line in the marked Chinook plot corresponds to the legal size limit (22 in or 56 cm).

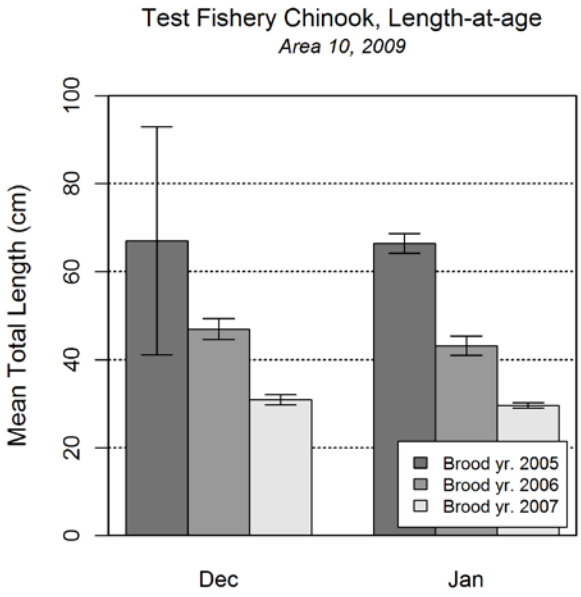

Figure 8. Monthly mean total length (+/- 95% CIs) of Chinook sampled by test fishers during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery, by brood year.

Other Fish Species Encountered

Other than Chinook salmon, Area 10 test fishers encountered coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), and 10 different species of marine fish (**Table 10**). In total, test fishers caught and released 82 fish other than Chinook salmon (19 coho, 1 chum, and 62 marine fish). Almost three-quarters of the marine fish encounters consisted of Pacific sanddab (*Citharichthys sordidus*).

Table 10. Summary of test fishery catches of species other than Chinook salmon during the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery.

Species	Total Catch
Buffalo sculpin (*Enophrys bison*)	1
Cabezon (*Scorpaenichthys mormoratus*)	1
Chum (*Onchorhyncus keta*)	1
Coho (*Oncorhynchus kisutch*)	19
Copper rockfish (*Sebastes caurinus*)	1
Dogfish shark (*Squalus acanthias*)	4
Lingcod (*Ophiodon elongatus*)	1
Pacific cod (*Gadus macrocephalus*)	3
Pacific sanddab (*Citharichthys sordidus*)	44
Quillback rockfish (*Sebastes maliger*)	2
Ratfish (*Hydroalgus colliei*)	2
Rock sole (*Lepidopsetta bilineata*)	3
Grand Total	**82**

Overall Fishery Impacts

Total Encounters and Mortalities

Based on the combination of dockside sampling results (**Table 4**) and test fishery size/mark-status composition data (**Table 8**), we estimated that 284 legal-marked, 36 legal-unmarked, 1,013 sublegal-marked, and 462 sublegal-unmarked Chinook salmon were encountered by anglers fishing in the Area 10 selective fishery from December 1, 2008 to January 31, 2009 (**Table 11**). The encounters were comprised mainly of released salmon (86%), with anglers releasing 6.2 Chinook (marked and unmarked combined; ~2 when including unmarked releases only) for every 1 retained.

Given the assumed mortality rates of 0.20 for sublegal and 0.15 for legal size Chinook salmon, we also estimated that 6 legal-marked, 5 legal-unmarked, 202 sublegal-marked and 92 sublegal-unmarked (305 overall) Chinook died due to the effects of handing and release (**Table 11**). Adding the release mortality (305) to the mortality from retained Chinook (251) gives a total mortality composition of 253 legal-marked, 5 legal-unmarked, 206 sublegal-marked, and 92 sublegal-unmarked Chinook, yielding a grand total (retained and released) mortality estimate of 557 Chinook in the two-month Area 10 winter selective fishery.

Table 11. Summary of season-wide fishery impact estimates for the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. Values may not add up perfectly due to rounding error.

Total Encounters (E): 1,796 **V(E): 220,428**										
Size/mark group	**Encounters**	**No. Retained**	**No. Rel'd**	**Rel. Mort. Rate**	**Rel. Mort.**	**Total Mortality**	**Var**	**SE**	**95% CI**	**CV (%)**
Legal marked	284	247	37	0.15	6	253	2,702	52	151 - 355	21
Legal unmarked	36	0	36	0.15	5	5	8	3	0 - 11	55
Sublegal marked	1,013	4	1,010	0.20	202	206	2,971	55	99 - 313	26
Sublegal unmarked	462	0	462	0.20	92	92	699	26	41 - 144	29
All groups combined	**1,796**	**251**	**1,544**		**305**	**557**	**6,380**	**80**	**400 - 713**	**14**

FRAM versus Creel Comparison

The estimated numbers of Chinook encounters and mortalities resulting from the Area 10 winter selective fishery were considerably less than predicted based on pre-season FRAM modeling results. The FRAM model predicted a total of 7,172 Chinook would be encountered during the fishery; field estimates indicate that actual encounters (1,796) were approximately 75% less than predicted (**Table 12, Figure 9**). Predicted marked Chinook encounters from FRAM were 74% higher than those estimated from field data, and unmarked Chinook encounters were 78% less than those predicted by FRAM. Predicted mark rates for sublegal size classes were similar to those estimated via creel surveys, while estimated mark rates for legal size classes were higher than predicted; FRAM predicted a 69% overall mark rate, while creel data estimated a mark rate of 72% (**Table 12**).

Table 12. Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook encounters for the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery.

Data Source	Group	Total Encounters	Legal	Sublegal	Landed Only
FRAM Encounters	Unmark.	2,244	484	1,760	29
	Mark.	4,928	953	3,975	895
	Total	7,172	1,437	5,735	924
	% Mark.	69	66	69	97
Estimated (Creel) Encounters	Unmark.	498	36	462	0
	Mark.	1,298	284	1,013	251
	Total	1,796	320	1,476	251
	% Mark.	72	89	69	100

The FRAM model predicted that a total of 3,119 Chinook would die (harvest and release mortality) as a result of the Area 10 winter selective fishery (480 unmarked and 2,639 marked) (**Table 13**). Total mortality estimated from creel results was 557 Chinook (98 unmarked and 459 marked), 18% of the predicted mortality (**Table 13**, **Figure 9**). The FRAM model most accurately predicted total landed mortalities and released sublegal mortalities for the Area 10 winter selective fishery, predicting that 924 Chinook would be landed, compared to 251 (27% of predicted) estimated via creel surveys. Released sublegal Chinook values were predicted to be 1,147, as compared to 294 (26% of predicted) estimated from the creel surveys.

Table 13. Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook mortalities for the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery.

	FRAM Chinook Mortalities			Estimated Chinook Mortalities		
Mortality Category	Unmark.	Mark.	Total	Unmark.	Mark.	Total
Total (Landed + Released)	480	2,639	3,119	98	459	557
Released Legal	99	949	1,048	5	6	11
Released Sublegal	352	795	1,147	92	202	294
Landed Only	29	895	924	0	251	251

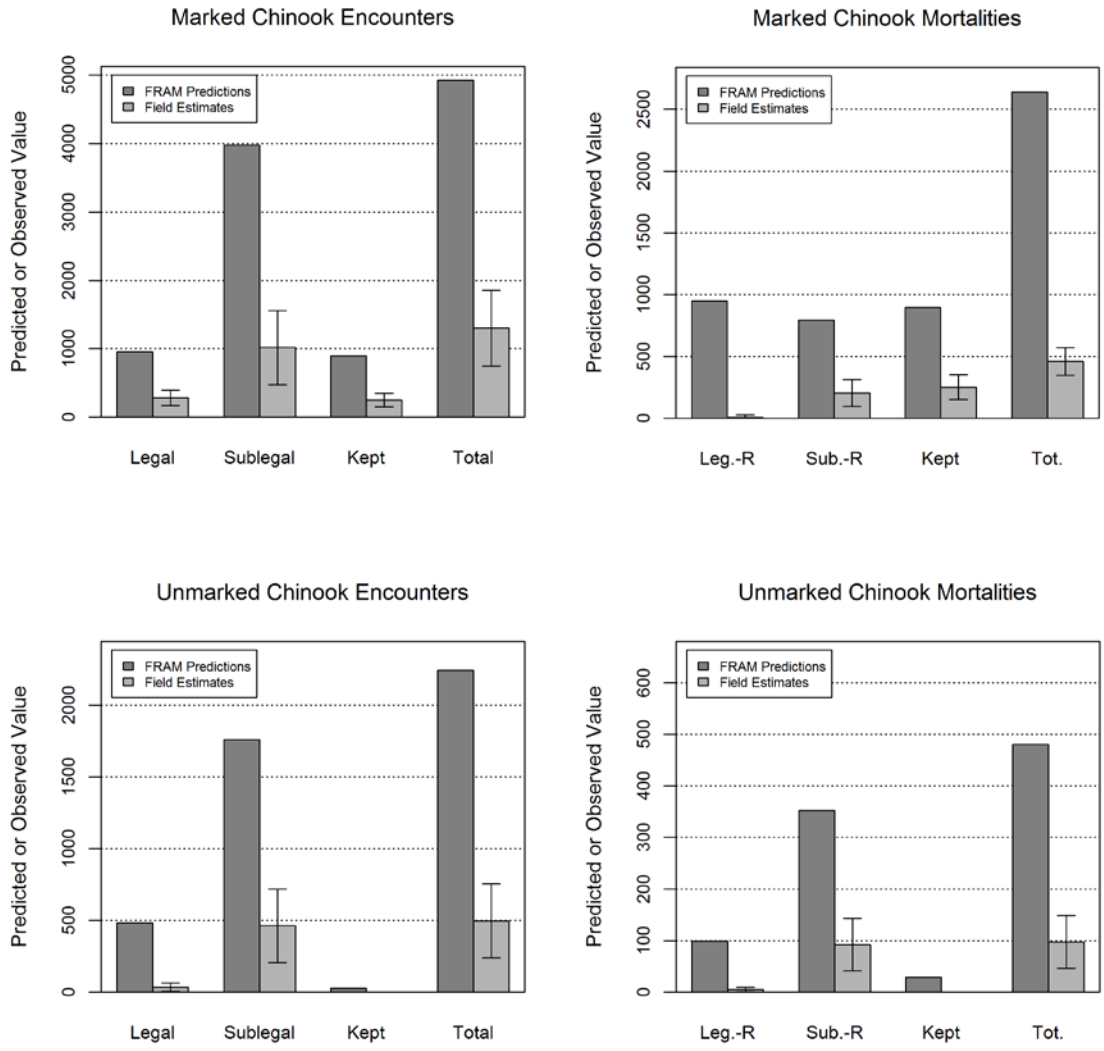

Figure 9. Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook encounters and mortalities for the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery. Error bars represent approximate 95% confidence intervals for field estimates.

Estimated CWT-DIT Impacts

Of the 4 coded-wire tags recovered during the Area 10 mark-selective Chinook fishery, 2 belonged to double-index tag (DIT) release groups (**Table 14**). Based on the release details associated with these tags and their unmarked sister groups, we obtained an estimate of the unmarked-to-marked ratio (λ) at juvenile release for each applicable hatchery of origin and brood year, and we used this value to estimate total unmarked DIT encounters for the entirety of the Area 10 fishery. In total, we estimated that 7 unmarked-DIT Chinook were caught and released during the fishery. Given an *sfm* rate of 0.10, we estimate that one of these unmarked-DIT Chinook may have died as a result of the two-month Area 10 winter mark-selective fishery.

Table 14. Summary of double-index tagged (DIT) Chinook kept by anglers, and estimated total mortality of unmarked DIT Chinook due to hook-and-release impacts resulting from the Area 10 December 1, 2008 - January 31, 2009 mark-selective Chinook fishery.

Hatchery	Brood Year	DITs Obs'd	AD DIT Harvest		UM DIT Enc.	UM DIT Mortality		
			Est.	var(Est.)		Est.	var(Est.)	SE(Est.)
Soos Creek Hatchery	2005	1	3.3	7.37	3.34	0.33	0.08	0.28
	2006	1	3.3	7.37	3.25	0.33	0.07	0.27
TOTAL		**2**	**6.5**	**14.73**	**6.59**	**0.66**	**0.15**	**0.55**

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REFERENCES

Cochran, W.G. 1977. Sampling Techniques (third edition). John Wiley and Sons. New York.

Conrad, R., and P. McHugh. 2008. Assessment of Two Methods for Estimating Total Chinook Salmon Encounters in Puget Sound/Strait of Juan de Fuca Mark-Selective Chinook Fisheries. Northwest Fishery Resource Bulletin Manuscript Series No. 2. http://www.nwifc.org/publications/northwest-fishery-resource-bulletin/; http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

SFEC-AWG. 2002. Pacific Salmon Commission, Joint Selective Fisheries Evaluation Committee Report, Investigation of methods to estimate mortalities of unmarked salmon in mark-selective fisheries through the use of double index tag groups. TCSFEC (02)-1, February 2002.

Murthy, M.N. 1957. Ordered and unordered estimators in sampling without replacement. Sankhya 18:379-390.

Puget Sound Indian Tribes and WDFW. 2004. Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component. Olympia, WA. 253 pp.

Washington Department of Fish and Wildlife (WDFW). 2007a. Marine Areas 9 and 10 Selective Chinook Fishery, July 16-31, 2007: Post-season Report. Draft Report: October 3, 2007. Washington Department of Fish and Wildlife. Olympia, Washington. 82 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2007b. Marine Areas 11 and 13 Selective Chinook Fishery, 2007: Post-season Report. Draft Report: October 30, 2007. Washington Department of Fish and Wildlife. Olympia, Washington. 80 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2008a. A Multi-year Assessment of the Marine Areas 5 and 6 Selective Chinook Fishery: 2005-2007. Final Report Draft: March 14, 2008. Washington Department of Fish and Wildlife. Olympia, Washington. 177 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2008b. A Multi-year Assessment of the Marine Areas 8-1 and 8-2 Selective Chinook Fishery: 2005-2007. Final Report Draft: February 25, 2008. Washington Department of Fish and Wildlife. Olympia, Washington. 149 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2009a. Marine Areas 5 and 6 Mark-Selective Recreational Chinook Fishery, Summer 2008: Post-season Report. Revised Draft Report: February 17, 2009. Washington Department of Fish and Wildlife. Olympia, Washington. 64 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2009b. Marine Areas 9 and 10 Mark-Selective Recreational Chinook Fishery, July 16-August 15, 2008. Revised Draft Report: February 23, 2009. Washington Department of Fish and Wildlife. Olympia, Washington. 60 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2009c. Marine Areas 11 and 13 Mark-Selective Recreational Chinook Fishery, Summer 2008. Revised Draft Report: February 24, 2009. Washington Department of Fish and Wildlife. Olympia, Washington. 64 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2009d. Marine Areas 8-1 and 8-2 Mark-Selective Recreational Chinook Fishery, November 1, 2007-April 30 2008. Revised Draft Report: February 20, 2009. Washington Department of Fish and Wildlife. Olympia, Washington. 62 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW). 2009e. Marine Area 10 Mark-Selective Recreational Chinook Fishery, December 1, 2007-January 31, 2008. Revised Draft Report: February 23, 2009. Washington Department of Fish and Wildlife. Olympia, Washington. 47 pp. http://wdfw.wa.gov/fish/salmon/suggested_reading.htm.

Washington Department of Fish and Wildlife (WDFW) and Northwest Indian Fisheries Commission (NWIFC). 2008. 2008-09 Co-managers' List of Agreed Fisheries. Olympia, Washington.

APPENDICES

Appendix A. Mark-selective fishery impact estimation details.

Below are definitions and equations for all quantities used in estimating mark-selective fishery impacts from the combination of creel survey information, test fishery results, and (where applicable) charter and/or derby accounts. The estimation sequence builds from monthly[6] estimators of encounters-by-class (i.e., the four size [legal, sublegal] × mark-status [marked, unmarked] groups) to season-wide impact estimates. Where appropriate, the encounters (kept and released) for charter, derby, and/or other fishery components accessed via a complete census (i.e., totals without variance) are simply added to relevant total private-fleet estimates.

A. Total and Class-specific Encounters Estimation

The first step towards quantifying mark-selective fishery impacts by size/mark-status class is to estimate total Chinook encounters ($\widehat{E}_i$, includes retained + released Chinook; See *Monthly Encounters* below) for each month of the fishery. Secondarily, encounters are apportioned to the appropriate size/mark-status group using encounters-composition data collected in the test fishery (See *Test-fishery Encounter Composition* on following page).

Monthly Encounters

$\widehat{E}_i$ = Total Chinook encounters for month *i*, which is estimated by combining creel estimates of legal-marked Chinook harvest ($\hat{K}_{LM\,i}$, defined on subsequent page) with a test fishery-based estimate of the proportion of the fishable Chinook population that is of legal size and marked ($\hat{p}_{LM\,i}$,defined on subsequent page). Given the potential for negative bias in $\widehat{E}_i$ if anglers release any of the legal-marked Chinook that they encounter, the $\widehat{E}_i$ estimator also includes a "correction" to account for this phenomenon (i.e., 1-$p_{\text{LM-R}}$, where $p_{\text{LM-R}}$ is the estimated legal-marked Chinook release rate)[7]. $\widehat{E}_i$ and its variance are estimated as:

$$(1) \qquad \hat{E}_i = \frac{\hat{K}_{LM}}{\left[\hat{p}_{LM}\,(1 - p_{LM-R})\right]}$$

$$(2) \qquad \mathrm{var}(\hat{E}_i) = \frac{1}{[(1 - p_{LM-R})^2]} * \left[\frac{\hat{K}_{LM\,i}{}^2}{\hat{p}_{LM\,i}{}^2} * \left(\frac{\mathrm{var}(\hat{K}_{LM\,i})}{\hat{K}_{LM\,i}{}^2} + \frac{\mathrm{var}(\hat{p}_{LM\,i})}{\hat{p}_{LM\,i}{}^2} \right) \right]$$

[6] **Note:** For fisheries characterized by short-duration seasons (i.e., ~ 1 month), the "monthly" estimators described in this appendix are synonymous season-total estimators.

[7] Equations 1 and 2 were modified based on a recent state–tribal evaluation of sources of bias in estimates of total Chinook encounters in mark-selective fisheries. Based on a review of relevant data, the current operational $p_{\text{LM-R}}$ (combined intentional and unintentional LM Chinook release rate) applied in the bias-corrected $\widehat{E}_i$ estimator is 0.13. See Conrad and McHugh (2008) for further detail.

Test-fishery Encounter Composition

$\hat{p}_{LM\,i}$ = the test-fishery estimate of the proportion of Chinook encounters that are legal-sized (*L*) and marked (*M*) during month *i*

$\hat{p}_{LU\,i}$ = the estimated proportion of encounters that are legal-sized (*L*) and unmarked (*U*)

$\hat{p}_{SM\,i}$ = the estimated proportion of encounters that are sublegal-sized (*S*) and unmarked (*M*)

$\hat{p}_{LU\,i}$ = the estimated proportion of encounters that are sublegal-sized (*S*) and unmarked (*U*)

For each *XY* combination (where *X* = *L* or *S* and *Y* = *M* or *U*), $\hat{p}_{XY\,i}$ and its variance is estimated as:

(3) $\hat{p}_{XY\,i} = n_{XY\,i} / n_i$, and

(4) $\text{var}(\hat{p}_{XY\,i}) = [\hat{p}_{XY\,i}(1 - \hat{p}_{XY\,i})]/(n_i - 1)$,

where n_i = the total number of fish encountered by test boats during month *i*.

Encounters by Size/Mark-status Class

$\hat{E}_{LM\,i}$ = estimated legal (*L*), marked (*M*) encounters during month *i*

$\hat{E}_{LU\,i}$ = estimated legal (*L*), unmarked (*U*) encounters during month *i*

$\hat{E}_{SM\,i}$ = estimated sublegal (*S*), marked (*M*) encounters during month *i*

$\hat{E}_{SU\,i}$ = estimated sublegal (*S*), marked (*U*) encounters during month *i*

For each *XY* combination (where *X* = *L* or *S* and *Y* = *M* or *U*) excluding *LM*, $\hat{E}_{XY\,i}$ and an estimate of its variance are obtained from:

(5) $\hat{E}_{XY\,i} = \hat{E}_i * \hat{p}_{XY\,i}$

(6) $\text{var}(\hat{E}_{XY\,i}) = \text{var}(\hat{E}_i) * \hat{p}_{XY\,i}^{\,2} + \hat{E}_i^{\,2} * \text{var}(\hat{p}_{XY\,i}) - \text{var}(\hat{E}_i) * \text{var}(\hat{p}_{XY\,i})$

B. Estimating Retained and Released Numbers by Size/Mark-status Class

Before total mortality can be estimated for each class (LM, SM, LU, SU), class-specific encounters must be separated into retention and release categories. First, given that harvest is estimated only to mark-status class for creel survey purposes (i.e., Murthy estimates or otherwise), estimates of marked and unmarked Chinook retention must be assigned to size classes (See *Apportioned Estimates of Retention to Size Classes* on subsequent page); this is done using mark-status-specific size composition data from dockside sampling (See *Dockside Observations for Apportioning Retained Catch to Class* on subsequent page). Subsequently, size/mark-status group-specific releases are estimated as the difference between class-specific encounters and retention (See *Estimating Release Numbers by Class* on subsequent page).

Dockside Observations for Apportioning Retained Catch to Class

$\hat{d}_{LMK}$ = the estimated proportion of retained (kept, *K*), marked (*M*) Chinook salmon that were legal (*L*); based on *season-wide*[8] dockside observations of marked Chinook (as is $\hat{d}_{SMK}$)

$\hat{d}_{SMK}$ = the estimated proportion of retained (kept, *K*), marked (*M*) Chinook that were sublegal (*S*)

The proportion of retained, marked fish in size class *X* (*X* = *L* or *S*) and its variance are estimated as:

$$(8) \qquad \hat{d}_{XMK} = n_{XMK} / n_{MK}$$

$$(9) \qquad \mathrm{var}(\hat{d}_{XMK}) = [\hat{d}_{XMK} * (1 - \hat{d}_{XMK})] / (n_{MK} - 1) \qquad ,$$

where n_{MK} and n_{XMK} are *season-wide* total dockside counts of marked fish and the subset of marked fish in size-class *X*, respectively.

$\hat{d}_{LUK}$ = the estimated proportion of retained (kept, *K*), unmarked (*U*) Chinook salmon that are legal (*L*); estimated from *season-wide* dockside observations of unmarked Chinook (as is $\hat{d}_{SUK}$)

$\hat{d}_{SUK}$ = the estimated proportion of retained (kept, *K*), unmarked (*U*) Chinook that are sublegal (*S*)

The proportions of retained, unmarked fish belonging to legal and sublegal size classes and their respective variances are estimated as above (Eqns. 8 and 9) but using *season-wide* dockside observations on unmarked (*U*), not marked Chinook salmon.

Apportioned Estimates of Retention to Size Classes

$\hat{K}_{LM\,i}$ = the estimated number of legal (*L*), marked (*M*) Chinook kept in month *i*

$\hat{K}_{LU\,i}$ = the estimated number of legal (*L*), unmarked (*U*) Chinook kept in month *i*

The number of kept, marked encounters, marked fish in size class *X* (*L* or *S*) and its variance is estimated as:

$$(10) \qquad \hat{K}_{XM\,i} = \hat{d}_{XMK} * \hat{N}_{MK\,i}$$

$$(11) \qquad \mathrm{var}(\hat{K}_{XM\,i}) = \mathrm{var}(\hat{N}_{MK\,i}) * \hat{d}_{XMK}^{\,2} + \hat{N}_{MK\,i}^{\,2} * \mathrm{var}(\hat{d}_{XMK}) - \mathrm{var}(\hat{N}_{MK\,i}) * \mathrm{var}(\hat{d}_{XMK})$$

where $\hat{d}_{XMK}$ and its variance are from 7 and 8 above and $\hat{N}_{MK\,i}$ is the survey estimate of retained marked fish for month *i* defined in Eqn. 1.

$\hat{K}_{SM\,i}$ = estimated number of sublegal (*S*), marked (*M*) Chinook kept in month *i*

$\hat{K}_{SU\,i}$ = estimated number of sublegal (*S*), unmarked (*U*) Chinook kept in month *i*

[8] Due to small sample sizes for observed, harvested Chinook—particularly for sublegal and/or unmarked classes—dockside length data are pooled across the season to estimate $\hat{d}_{XYK}$.

The number of retained, unmarked fish belonging to legal and sublegal size classes is estimated according to Eqns. 10 and 11 above but using unmarked fish proportions and monthly retention estimates.

Estimating Release Numbers by Class

$\hat{R}_{LM\,i}$ = the estimated number of legal (*L*), marked (*M*) Chinook released in month *i*

$\hat{R}_{LU\,i}$ = the estimated number of legal (*L*), unmarked (*U*) Chinook released in month *i*

$\hat{R}_{SM\,i}$ = the estimated number of sublegal (*S*), marked (*M*) Chinook released in month *i*

$\hat{R}_{SU\,i}$ = the estimated number of sublegal (*S*), unmarked (*U*) Chinook released in month *i*

For each size/mark-status class (i.e., *XY* combination [*X* = *L* or *S* and *Y* = *M* or *U*]), the number of fish encountered and released is estimated as the difference between total size/mark-status class encounters ($\hat{E}_{XY\,i}$) and retention ($\hat{K}_{XY\,i}$) during month *i*. The estimator and its variance are:

$$\hat{R}_{XY\,i} = \hat{E}_{XY\,i} - \hat{K}_{XY\,i} \quad (12)$$

$$\mathrm{var}(\hat{R}_{XY\,i}) = \mathrm{var}(\hat{E}_{XY\,i}) + \mathrm{var}(\hat{K}_{XY\,i}) \quad (13)$$

C. Estimating Total (and Class-specific) Monthly and Season-wide Mortality

The application of assumed mortality rates (See *Assumed Mortality Rates for Retained and Released Chinook* below) to class-specific estimates of total retention and releases constitutes the final step in quantifying mark-selective fishery impacts.

Assumed Mortality Rates for Retained and Released Chinook

m_K = retention mortality rate, 100% for all retained Chinook (reincarnation is rare among fishes)
sfm_L = release mortality rate for legal (*L*) Chinook, assumed to be a constant 15%
sfm_S = release mortality rate for sublegal (*S*) Chinook, assumed to be a constant 20%

Retention-mortality Estimates

$\hat{M}_{LMK\,i}$ = estimated mortality due to legal (*L*), marked (*M*) Chinook harvest in month *i* (=$\hat{K}_{LM\,i}$).

$\hat{M}_{LUK\,i}$ = estimated mortality due to harvest of legal (*L*), unmarked (*U*) Chinook in month *i* (=$\hat{K}_{LU\,i}$).

$\hat{M}_{SMK\,i}$ = estimated mortality due to harvest of sublegal (*S*), marked (*M*) Chinook in month *i* (=$\hat{K}_{SM\,i}$).

$\hat{M}_{SUK\,i}$ = estimated mortality due to harvest of sublegal (*S*), marked (*M*) Chinook in month *i* (=$\hat{K}_{SU\,i}$).

Release-mortality Estimates

$\hat{M}_{LMR\,i}$ = estimated post-release mortality for legal (*L*), marked (*M*) Chinook in month *i*

$\hat{M}_{LURi}$ = estimated post-release mortality for legal (*L*), unmarked (*U*) Chinook in month *i*

$\hat{M}_{SMRi}$ = estimated post-release mortality for sublegal (*S*), marked (*M*) Chinook in month *i*

$\hat{M}_{SURi}$ = estimated post-release mortality for sublegal (*S*), unmarked (*U*) Chinook in month *i*

All class-specific (*XY* [*X* = *L* or *S*, *Y* = *M* or *U*]) release mortality estimates are obtained from:

(14) $\hat{M}_{XYRi} = \hat{R}_{XYi} * sfm_Y$

(15) $\text{var}(\hat{M}_{XYRi}) = \text{var}(\hat{R}_{XYi}) * sfm_Y^{\,2}$

Season-wide Total and Class-specific Mortality Estimation

$\hat{M}_{total}$ = total season-wide Chinook salmon mortality; this parameter and its variance [$\text{var}(\hat{M}_{total})$] are computed as the sum of all monthly retention and release mortality estimates [i.e., $\hat{M}_{total} = \sum_{i=1}^{\max i}(\hat{M}_{XYKi} + \hat{M}_{XYRi})$] and variances [$\text{var}(\hat{M}_{total}) = \sum_{i=1}^{\max i}[\text{var}(\hat{M}_{XYKi}) + \text{var}(\hat{M}_{XYRi})]$], respectively, for all four size/mark-status groups (*X* = *L* or *S*, *Y* = *M* or *U*). Season total estimates for subgroups of interest (e.g., unmarked, sublegal Chinook, $\hat{M}_{SU-total}$) are obtained by summing monthly estimates (and variances) across the season for just that group.

D. Characterizing Precision of Estimates

The precision of estimates generated from creel surveys and the preceding fishery impact estimation scheme is characterized using estimates of a parameter's standard error (*SE*), coefficient of variation (*CV* or relative standard error), and approximate 95% confidence interval. For any parameter estimate $\hat{\theta}$ (e.g., $\hat{M}_{total}$, $\hat{K}_{LMi}$, $\hat{E}_i$, etc.), these metrics are estimated using:

(16) $SE(\hat{\theta}) = \sqrt{\text{var}(\hat{\theta})}$

(17) $CV(\hat{\theta}) = [SE(\hat{\theta})/\hat{\theta}]*100$

(18) $CI = \hat{\theta} \pm 1.96 * SE(\hat{\theta})$

Figure A1. (*On following page*) Graphical representation of the approach used to estimate monthly encounters and mortalities by size/mark-status category in mark-selective Chinook fisheries. Boxes depict abundance estimates (encounters, mortalities) whereas the mathematical operations depicted on intermediate connector lines are estimator formulae yielding quantities found in subsequent boxes (moving from left to right). Parameter definitions, complete formulae, and variances are defined in the preceding pages. For short-duration fisheries (~ 1 month or less), monthly and season-total values are equivalent; for all others, season-total impacts are equivalent to the sum of monthly impact estimates (and variances).

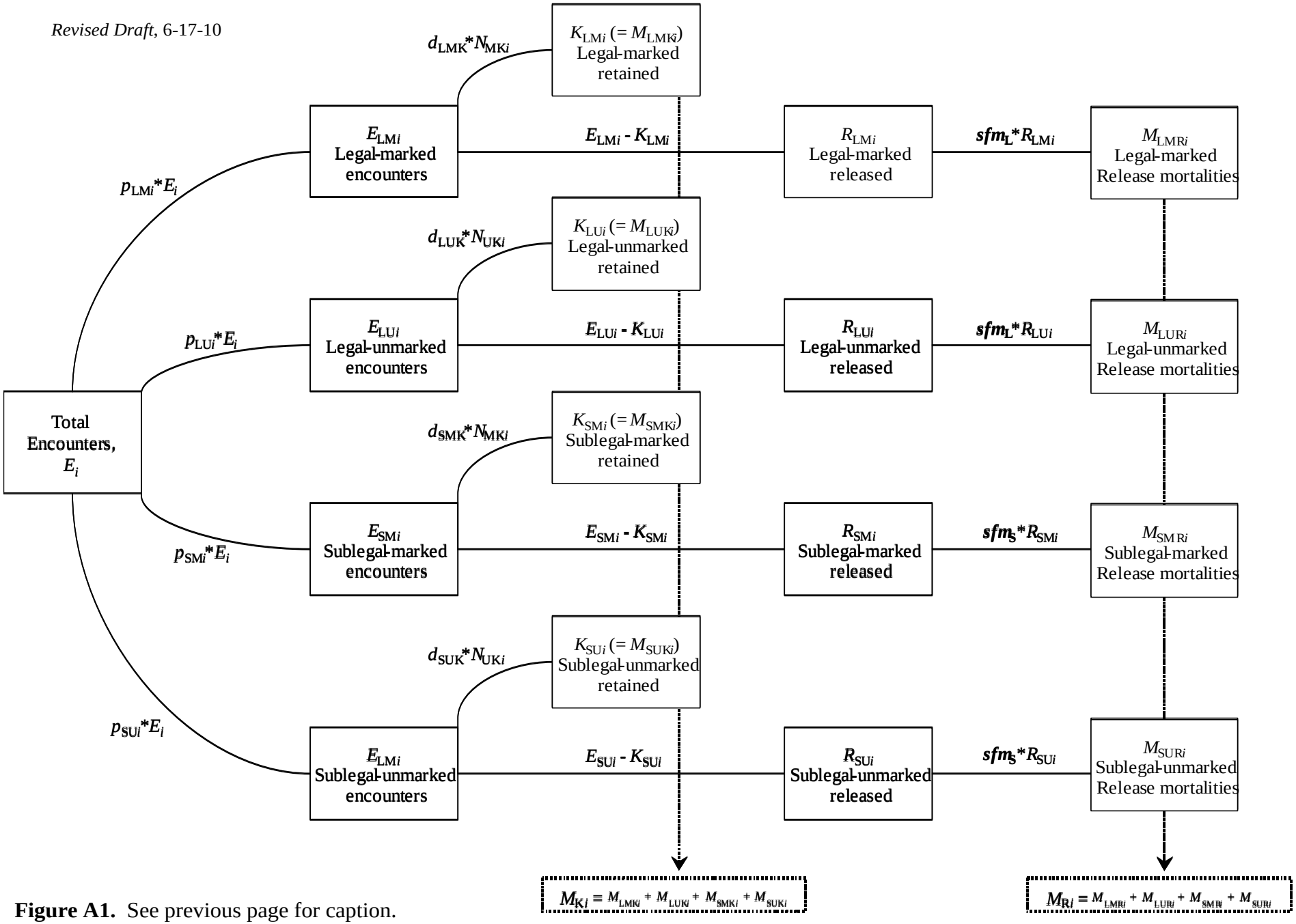

Figure A1. See previous page for caption.

Appendix B1. 2008 statistical weeks used by Washington Department of Fish and Wildlife.

2008 Statistical Week Calendar (Monday-Sunday)

STAT MONTH	WEEK NO.	START DATE	END DATE	STAT MONTH	WEEK NO.	START DATE	END DATE
1	1	1-Jan	6-Jan	7	27	30-Jun	6-Jul
	2	7-Jan	13-Jan		28	7-Jul	13-Jul
	3	14-Jan	20-Jan		29	14-Jul	20-Jul
	4	21-Jan	27-Jan		30	21-Jul	27-Jul
	5	28-Jan	3-Feb		31	28-Jul	3-Aug
2	6	4-Feb	10-Feb	8	32	4-Aug	10-Aug
	7	11-Feb	17-Feb		33	11-Aug	17-Aug
	8	18-Feb	24-Feb		34	18-Aug	24-Aug
	9	25-Feb	2-Mar		35	25-Aug	31-Aug
3	10	3-Mar	9-Mar	9	36	1-Sep	7-Sep
	11	10-Mar	16-Mar		37	8-Sep	14-Sep
	12	17-Mar	23-Mar		38	15-Sep	21-Sep
	13	24-Mar	30-Mar		39	22-Sep	28-Sep
4	14	31-Mar	6-Apr	10	40	29-Sep	5-Oct
	15	7-Apr	13-Apr		41	6-Oct	12-Oct
	16	14-Apr	20-Apr		42	13-Oct	19-Oct
	17	21-Apr	27-Apr		43	20-Oct	26-Oct
	18	28-Apr	4-May		44	27-Oct	2-Nov
5	19	5-May	11-May	11	45	3-Nov	9-Nov
	20	12-May	18-May		46	10-Nov	16-Nov
	21	19-May	25-May		47	17-Nov	23-Nov
	22	26-May	1-Jun		48	24-Nov	30-Nov
6	23	2-Jun	8-Jun	12	49	1-Dec	7-Dec
	24	9-Jun	15-Jun		50	8-Dec	14-Dec
	25	16-Jun	22-Jun		51	15-Dec	21-Dec
	26	23-Jun	29-Jun		52	22-Dec	28-Dec
					53	29-Dec	31-Dec

Appendix B2. 2009 statistical weeks used by Washington Department of Fish and Wildlife.

2009 Statistical Week Calendar (Monday-Sunday)

STAT MONTH	WEEK NO.	START DATE	END DATE	STAT MONTH	WEEK NO.	START DATE	END DATE
1	1	01-Jan	04-Jan	7	27	29-Jun	05-Jul
	2	05-Jan	11-Jan		28	06-Jul	12-Jul
	3	12-Jan	18-Jan		29	13-Jul	19-Jul
	4	19-Jan	25-Jan		30	20-Jul	26-Jul
	5	26-Jan	01-Feb		31	27-Jul	02-Aug
2	6	02-Feb	08-Feb	8	32	03-Aug	09-Aug
	7	09-Feb	15-Feb		33	10-Aug	16-Aug
	8	16-Feb	22-Feb		34	17-Aug	23-Aug
	9	23-Feb	01-Mar		35	24-Aug	30-Aug
3	10	02-Mar	08-Mar	9	36	31-Aug	06-Sep
	11	09-Mar	15-Mar		37	07-Sep	13-Sep
	12	16-Mar	22-Mar		38	14-Sep	20-Sep
	13	23-Mar	29-Mar		39	21-Sep	27-Sep
4	14	30-Mar	05-Apr	10	40	28-Sep	04-Oct
	15	06-Apr	12-Apr		41	05-Oct	11-Oct
	16	13-Apr	19-Apr		42	12-Oct	18-Oct
	17	20-Apr	26-Apr		43	19-Oct	25-Oct
	18	27-Apr	03-May		44	26-Oct	01-Nov
5	19	04-May	10-May	11	45	02-Nov	08-Nov
	20	11-May	17-May		46	09-Nov	15-Nov
	21	18-May	24-May		47	16-Nov	22-Nov
	22	25-May	31-May		48	23-Nov	29-Nov
6	23	01-Jun	07-Jun	12	49	30-Nov	06-Dec
	24	08-Jun	14-Jun		50	07-Dec	13-Dec
	25	15-Jun	21-Jun		51	14-Dec	20-Dec
	26	22-Jun	28-Jun		52	21-Dec	27-Dec
					53	28-Dec	31-Dec

Appendix C. Monthly sample rates (Total retained Chinook sampled [1/] / Estimated retained Chinook) in the Area 10 selective Chinook fishery, December 1, 2008 – January 31, 2009.

Time period			Estimated Retained Chinook				Number Retained Chinook Sampled [1/]				Sample Rate
Month	**Stat. Weeks**	**Dates**	**Marked**	**Un-marked**	**Unk.**	**Total**	**Marked**	**Un-marked**	**Unk.**	**Total**	
December	49-53/1	Dec 1 - Jan 4	122	0	0	122	35	0	0	35	28.7%
January	2-5	Jan 5 - Jan 31	129	0	0	129	29	0	1	30	23.3%
Season Total			**251**	**0**	**0**	**251**	**64**	**0**	**1**	**65**	**25.9%**

[1/] Number of retained Chinook sampled includes all retained Chinook inspected for CWT's, from all sites sampled during the two-month winter Area 10 fishery (i.e., the two selected sites per sampling day for creel [Murthy] estimates, plus the fish sampled as part of baseline [non-Murthy] sampling in the Area).

Appendix D. Fishery-total estimates of retained and released salmon (Chinook and other species) catch in the Area 10 winter selective Chinook fishery, December 1, 2008 – January 31, 2009. Displayed Chinook harvest values are equivalent to those displayed in **Table 4**. Whereas the Chinook release estimates displayed in **Table 4** are based on the Conrad and McHugh (2008) method, values displayed here are based solely on angler-reported data. Values may not add exactly due to rounding error.

Stat Week	Est. Effort		Est. Retained Catch							Est. Releases								
			Chinook			Coho				Chinook				Coho				Unk. Salmon
	Boats	Anglers	AD	UM	Total	AD	UM	Total	Chum	AD	UM	Unk.	Total	AD	UM	Unk.	Total	
49	458	771	93	0	93	0	5	5	3	217	110	765	1,092	2	0	31	33	332
50	64	138	6	0	6	0	0	0	4	11	43	158	213	0	0	4	4	13
51	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	41	69	2	0	2	0	0	0	0	19	25	18	61	0	0	0	0	59
53/1	84	141	20	0	20	0	0	0	0	137	37	116	289	0	0	6	6	61
2	34	63	2	0	2	0	0	0	0	0	0	115	115	0	0	2	2	5
3	190	363	58	0	58	0	0	0	0	112	48	105	265	32	18	16	66	163
4	149	305	53	0	53	5	0	5	0	92	59	209	361	24	11	36	71	64
5	83	164	17	0	17	0	0	0	0	75	5	104	185	3	0	87	90	11
Total	**1,120**	**2,029**	**251**	**0**	**251**	**5**	**5**	**10**	**7**	**663**	**327**	**1,591**	**2,581**	**61**	**29**	**182**	**272**	**708**
Grand Total Summary Statistics:																		
SE:	96	168	51		51	4	3	5	4	102	66	215	247	32	11	58	67	112
CV:	8.5%	8.3%	20.4%		20.4%	73.9%	54.1%	45.8%	53.7%	15.4%	20.1%	13.5%	9.6%	52.7%	38.3%	31.9%	24.8%	15.8%
95% CI:	932-1,307	1,699-2,359	151-352		151-352	2-12	1-10	1-19	2-14	463-862	198-457	1,170-2,012	2,098-3,064	6-124	7-51	68-296	140-404	489-927

Appendix E. Summary of the total number of anglers intercepted in Area 10 during on-the-water surveys from December 1, 2008 through January 31, 2009. Grayed cells represent sites included in the dockside sample frame.

Site Name	Total Anglers (less 'Tengu' Armeni Ramp anglers)	Season Total (unadjusted) size measure	Total Anglers (with 'Tengu' Armeni Ramp anglers)	Season Total (unadjusted) size measure
Armeni Ramp	1	0.007	90	0.350
Bay Marina (Miller Bay)	0	0.000	0	0.000
Brownsville Ramp	13	0.088	13	0.051
Brownsville Marina	0	0.000	0	0.000
Des Moines Marina	0	0.000	0	0.000
Eagle Harbor Ramp	4	0.027	4	0.016
Edmonds Marina Dry Storage	19	0.129	19	0.074
Edmonds Sling	3	0.020	3	0.012
Edmonds Marina	23	0.156	23	0.089
Elliot Bay Marina	0	0.000	0	0.000
Everett Marina	0	0.000	0	0.000
Everett Ramp (Norton)	1	0.007	1	0.004
Harper Ramp	0	0.000	0	0.000
Kingston Public	19	0.129	19	0.074
Liberty Bay	0	0.000	0	0.000
Manchester	17	0.116	17	0.066
Miller Bay	0	0.000	0	0.000
Mukilteo Ramp	0	0.000	0	0.000
Narrows Marina	0	0.000	0	0.000
Point Defiance Ramp	0	0.000	0	0.000
Port Madison Marina	0	0.000	0	0.000
Port Orchard Marina	0	0.000	0	0.000
Port Orchard Ramp	4	0.027	4	0.016
Poulsbo Marina	0	0.000	0	0.000
Private Buoy/moorage	2	0.014	2	0.008
Redondo ramp	0	0.000	0	0.000
Sandt Hook (Cultus Bay)	3	0.020	3	0.012
Seacrest Boat House	12	0.082	33	0.128
Shilshole Ramp	20	0.136	20	0.078
Shilshole Marina	4	0.027	4	0.016
Winslow Ramp	2	0.014	2	0.008
Yukon Harbor Ramp	0	0.000	0	0.000
Total Anglers	**147**	**1.000**	**257**	**1.000**

Appendix F. Size measures by sample date, for sites sampled during dockside creel surveys in the Area 10 mark-selective Chinook from December 1, 2008 through January 31, 2009.

SAMPLE DATE	WEEK	SITE SIZE	SAMPLING SITE	SAMPLE DATE	WEEK	SITE SIZE	SAMPLING SITE
12/01/2008	49	0.040	Armeni Public Ramp	01/03/2009	1	0.127	Kingston Public Ramp
12/01/2008	49	0.480	Shilshole Public Ramp	01/04/2009	1	0.639	Armeni Public Ramp
12/02/2008	49	0.040	Armeni Public Ramp	01/04/2009	1	0.194	Shilshole Public Ramp
12/02/2008	49	0.480	Shilshole Public Ramp	01/05/2009	2	0.215	Armeni Public Ramp
12/05/2008	49	0.480	Shilshole Public Ramp	01/05/2009	2	0.418	Shilshole Public Ramp
12/05/2008	49	0.160	Kingston Public Ramp	01/08/2009	2	0.215	Armeni Public Ramp
12/06/2008	49	0.080	Manchester Public Ramp	01/08/2009	2	0.418	Shilshole Public Ramp
12/06/2008	49	0.480	Shilshole Public Ramp	01/09/2009	2	0.418	Shilshole Public Ramp
12/07/2008	49	0.581	Armeni Public Ramp	01/09/2009	2	0.177	Edmonds Dry Storage
12/07/2008	49	0.230	Shilshole Public Ramp	01/10/2009	2	0.420	Shilshole Public Ramp
12/10/2008	50	0.203	Armeni Public Ramp	01/10/2009	2	0.145	Kingston Public Ramp
12/10/2008	50	0.420	Shilshole Public Ramp	01/11/2009	2	0.420	Shilshole Public Ramp
12/11/2008	50	0.420	Shilshole Public Ramp	01/11/2009	2	0.159	Edmonds Dry Storage
12/11/2008	50	0.159	Edmonds Dry Storage	01/14/2009	3	0.231	Armeni Public Ramp
12/12/2008	50	0.420	Shilshole Public Ramp	01/14/2009	3	0.407	Shilshole Public Ramp
12/12/2008	50	0.145	Kingston Public Ramp	01/15/2009	3	0.231	Armeni Public Ramp
12/13/2008	50	0.073	Manchester Public Ramp	01/15/2009	3	0.165	Edmonds Dry Storage
12/13/2008	50	0.420	Shilshole Public Ramp	01/16/2009	3	0.407	Shilshole Public Ramp
12/16/2008	51	0.420	Shilshole Public Ramp	01/16/2009	3	0.110	Kingston Public Ramp
12/16/2008	51	0.159	Edmonds Dry Storage	01/17/2009	3	0.088	Manchester Public Ramp
12/17/2008	51	0.203	Armeni Public Ramp	01/17/2009	3	0.407	Shilshole Public Ramp
12/17/2008	51	0.420	Shilshole Public Ramp	01/18/2009	3	0.407	Shilshole Public Ramp
12/19/2008	51	0.073	Manchester Public Ramp	01/18/2009	3	0.165	Edmonds Dry Storage
12/19/2008	51	0.420	Shilshole Public Ramp	01/22/2009	4	0.357	Shilshole Public Ramp
12/20/2008	51	0.420	Shilshole Public Ramp	01/22/2009	4	0.148	Edmonds Dry Storage
12/20/2008	51	0.145	Kingston Public Ramp	01/23/2009	4	0.148	Edmonds Dry Storage
12/22/2008	52	0.203	Armeni Public Ramp	01/23/2009	4	0.130	Kingston Public Ramp
12/22/2008	52	0.420	Shilshole Public Ramp	01/24/2009	4	0.148	Manchester Public Ramp
12/26/2008	52	0.420	Shilshole Public Ramp	01/24/2009	4	0.357	Shilshole Public Ramp
12/26/2008	52	0.159	Edmonds Dry Storage	01/25/2009	4	0.217	Armeni Public Ramp
12/27/2008	52	0.203	Armeni Public Ramp	01/25/2009	4	0.357	Shilshole Public Ramp
12/27/2008	52	0.420	Shilshole Public Ramp	01/26/2009	5	0.345	Shilshole Public Ramp
12/28/2008	52	0.581	Armeni Public Ramp	01/26/2009	5	0.143	Kingston Public Ramp
12/28/2008	52	0.081	Kingston Public Ramp	01/29/2009	5	0.160	Manchester Public Ramp
12/29/2008	53	0.418	Shilshole Public Ramp	01/29/2009	5	0.345	Shilshole Public Ramp
12/29/2008	53	0.177	Edmonds Dry Storage	01/30/2009	5	0.160	Manchester Public Ramp

SAMPLE DATE	WEEK	SITE SIZE	SAMPLING SITE	SAMPLE DATE	WEEK	SITE SIZE	SAMPLING SITE
01/02/2009	1	0.215	Armeni Public Ramp	01/30/2009	5	0.143	Edmonds Dry Storage
01/02/2009	1	0.418	Shilshole Public Ramp	01/31/2009	5	0.345	Shilshole Public Ramp
01/03/2009	1	0.418	Shilshole Public Ramp	01/31/2009	5	0.143	Edmonds Dry Storage

Appendix G. Age composition of retained Chinook from dockside samples (n=60 readable scale samples) and encountered Chinook in the test fishery (n=142 samples) in the Area 10 mark-selective Chinook fishery, December 1, 2008 - January 31, 2009.

Source	Mark-status Group	Age Composition								
		Month	**1.1**	**2.1**	**2.2**	**3.1**	**3.2**	**4.1**	**4.2**	**Total**
Dockside survey	AD	Dec	0	4	0	23	0	0	0	27
		Jan	0	0	0	7	0	24	2	33
		Total	**0**	**4**	**0**	**30**	**0**	**24**	**2**	**60**
		Percent	0%	7%	0%	50%	0%	40%	3%	100%
Test Fishery	AD	Dec	26	13	13	18	1	0	0	71
		Jan	0	13	0	8	4	3	0	28
		Total	**26**	**26**	**13**	**26**	**5**	**3**	**0**	**99**
		Percent	26%	26%	13%	26%	5%	3%	0%	100%
Test Fishery	UM	Dec	22	5	3	3	0	0	0	33
		Jan	1	8	0	1	0	0	0	10
		Total	**23**	**13**	**3**	**4**	**0**	**0**	**0**	**43**
		Percent	53%	30%	7%	9%	0%	0%	0%	100%

[1/] AD = Adipose fin-clipped (marked); UM = Adipose fin intact (unmarked).
[2/] Gilbert-Rich age notation, "Total Age". "Age at outmigration", inclusive of time spent in incubation.

Appendix H. Coded-wire tag recoveries from Chinook salmon landed during the Area 10 winter 2008- 2009 mark-selective Chinook fishery from December 1, 2008 through January 31, 2009.

RecovDate	TagResult	TagCode	Brood Yr	ReleaseSite	RearingHatchery	ReleaseAgency	DIT	FKL cm	RecovMark	ReleaseMark	Label
Dec 2 2008	Decoded Tag	210671	2005	KALAMA CR 11.0017	KALAMA CR HATCHERY	NISQ		62	AD Fin Clp	AD Fin Clp	54951
Jan 17 2009	Decoded Tag	632979	2005	CHAMBERS CR 12.0007	GARRISON HATCHERY	WDFW		59	AD Fin Clp	AD Fin Clp	50097
Jan 18 2009	Decoded Tag	633882	2006	BIG SOOS CR 09.0072	SOOS CREEK HATCHERY	WDFW	DIT: 633883	54	AD Fin Clp	AD Fin Clp	50098
Jan 23 2009	Decoded Tag	633372	2005	BIG SOOS CR 09.0072		WDFW	DIT: 633371	69	AD Fin Clp	AD Fin Clp	57716

Appendix I. Season-total estimates of Chinook encounters by size/mark status, and total estimates of angler effort, summarized for all seasons to date of the Area 10 winter mark-selective Chinook fishery.

Area	Season Dates	Effort (Angler Trips)	Retained Chinook				Released Chinook				Total Encounters
			LM	LU	SM	SU	LM	LU	SM	SU	
10	December 1, 2007 - January 31, 2008	2,544	539	21	96	0	80	163	1,860	361	3,120
10	December 1, 2008 - January 31, 2009	2,029	247	0	4	0	37	36	1,010	462	1,796