# Marine Area 9
# Mark-Selective Recreational Chinook Fishery,
# November 1 - 30, 2008
# and
# January 16 - April 15, 2009

## Post-season Report

## REVISED DRAFT

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## EXECUTIVE SUMMARY

The Washington Department of Fish and Wildlife (WDFW) implemented a mark-selective Chinook fishery (MSF) in Marine Area 9 for the second season during the winter 2008-09 (November 1-30, 2008 and January 16–April 15, 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 9 throughout the fishery in order to collect the data needed to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. Sampling activities included dockside creel sampling, test fishing, and aerial 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 four different access sites on 80 of the 151 days that Area 9 was open in winter 2008-09 under mark-selective harvest regulations. Samplers interviewed an estimated 36% of all participating anglers ($n$ = 2,523 angler trips) and sampled 34% of all marked Chinook harvested ($n$ = 299). Additionally, other PSSU staff conducted 20 aerial effort surveys, and spent 65 days (≈ 288 hours) on the water pursuing Chinook using test fishing methods, in support of Area 9 monitoring efforts. Based on these activities, we estimated that 7,064 angler trips were completed by private fleet anglers during winter 2008-09 in Area 9. With a CPUE of 0.13 Chinook landed per angler trip, these anglers harvested a grand total of 885 marked Chinook; they released an estimated 6,646 Chinook (3,651 marked, and 2,995 unmarked). Harvested Chinook averaged 70 cm (range: 53 to 91 cm) in total length and were larger than the legal minimum size limit (≥22 in or 56 cm TL) in most instances (dockside marked Chinook observations, 296 legal /301 total or 98%). Nearly two-thirds (64%) of all harvested individuals were 4-year olds (brood year 2005), with age-3 fish making up the majority of the remainder. In addition, 22 CWTs were recovered from harvested fish, the majority of which were from Puget Sound (73%) and Hood Canal (18%) release sites, and two CWTs (9%) were recovered from a lower Columbia River release site.

Over the season in Area 9, test fishers encountered 312 Chinook salmon; of these, 18% were legal size, and the legal-size mark rate was 84%. With a "CPUE" of 0.37 (LM Chinook encounters / angler trip), test fishers experienced more than twice the legal-marked Chinook encounter rate as did private fleet anglers. Chinook encountered by test fishers (for marked and unmarked fish combined) averaged 42 cm (range: 23 to 91 cm) in total length and as a group were predominantly 2 years in age (45% of marked and 40% of unmarked totals). Unmarked Chinook

[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.

encountered in the test fishery were predominantly one year old (45%). We estimated the overall mark rate at 64% and the size/mark-status composition at 15.4% legal-marked, 2.9% legal-unmarked, 48.4% sublegal-marked, and 33.3% 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. In total, 7,545 Chinook were encountered (retained and released) during the Area 9 fishery, with 1,001 of these being legal-marked, 172 legal-unmarked, 3,535 sublegal-marked, and 2,837 sublegal-unmarked individuals. Among released encounters, an estimated 20 legal-marked, 24 legal-unmarked, 704 sublegal-marked, and 567 sublegal-unmarked Chinook (1,315 overall) were estimated to have died due to handling and release effects. Thus, in total, 1,609 marked (55% due to direct harvest) and 604 unmarked Chinook mortalities occurred as a result of the winter 2008-09 Area 9 mark-selective fishery.

The number of fish estimated to have been impacted by the 2008-09 winter Area 9 fishery was considerably less than half of what was predicted based on Fishery Regulation Assessment Model runs (model run 2108). Whereas FRAM predicted that a total of 17,081 Chinook would have been encountered, actual encounters were estimated from creel surveys to be 44% of this value. Field data also suggested that actual legal-sized and sublegal-sized Chinook encounter rates were 18% and 60% lower, respectively, than those expected as a result of pre-season modeling.

Finally, regarding impacts of MSFs on the coded-wire tag (CWT) program, we estimated that 4 unmarked Chinook belonging to double-index tag (DIT) groups may have died due to the handling-and-release impacts of the pilot winter 2008-09 Area 9 mark-selective Chinook fishery.

## INTRODUCTION

In recent years, abundant runs of hatchery Chinook salmon (*Oncorhynchus tshawytscha*) have been 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 November 1-30, 2008 and January 16-April 15, 2009, the Washington Department of Fish and Wildlife (WDFW) implemented the second year of the mark-selective Chinook fishery in Area 9 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 9 winter selective Chinook fishery, WDFW's Puget Sound Sampling Unit was tasked with implementing an intensive monitoring program during the entirety of its winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) season. Our primary goal was to collect the data needed to estimate key parameters characterizing this fishery and its impacts on unmarked 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)

[2]The regulations specific to the winter 2008-09 Area 9 mark-selective fishery allowed for the retention of up to two legal-sized ($\geq$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 9 mark-selective fishery, and *iii*) held to a handling rule that prevented them from bringing unmarked and/or sublegal Chinook aboard their vessels.

and/or DNA-based stock composition of marked and unmarked Chinook mortalities[3], and *v*) the total mortality of marked and unmarked double 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 9 monitoring activities. 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 Area 9 is a relatively large area encompassing over 200 square miles (512 $km^2$) of marine water in central Puget Sound. Area 9 starts at the mouth of Admiralty Inlet (i.e., its northern boundary is at the Partridge Point–Point Wilson line) and extends southward to the Apple Cove Point–Edwards Point line, including the marine waters extending south from Foulweather Bluff to the Hood Canal Bridge (**Figure 1**). As is the case for other winter salmon fisheries that occur in Puget Sound, immature Chinook salmon ("blackmouth") are the predominant fish targeted and encountered by anglers fishing in Area 9 during the winter months.

### Monitoring Program Overview

Our sampling program for the Area 9 winter fishery incorporated comprehensive and complementary data collection strategies, including dockside angler interviews (with catch sampling), aerial effort surveys, test-fishery-based sampling, and voluntary reports of completed trips provided by private anglers (**Figure 2**). Given that winter 2008-09 was the first season in Area 9 in which we relied on aerial instead of boat surveys, we provide complete detail on this aspect of our design, which was used successfully during previous winter seasons in Area 7 (e.g., WDFW 2009e). For other aspects of our monitoring program, we provide only a brief review and refer the reader to WDFW (2007b or 2008b) for additional detail.

[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.

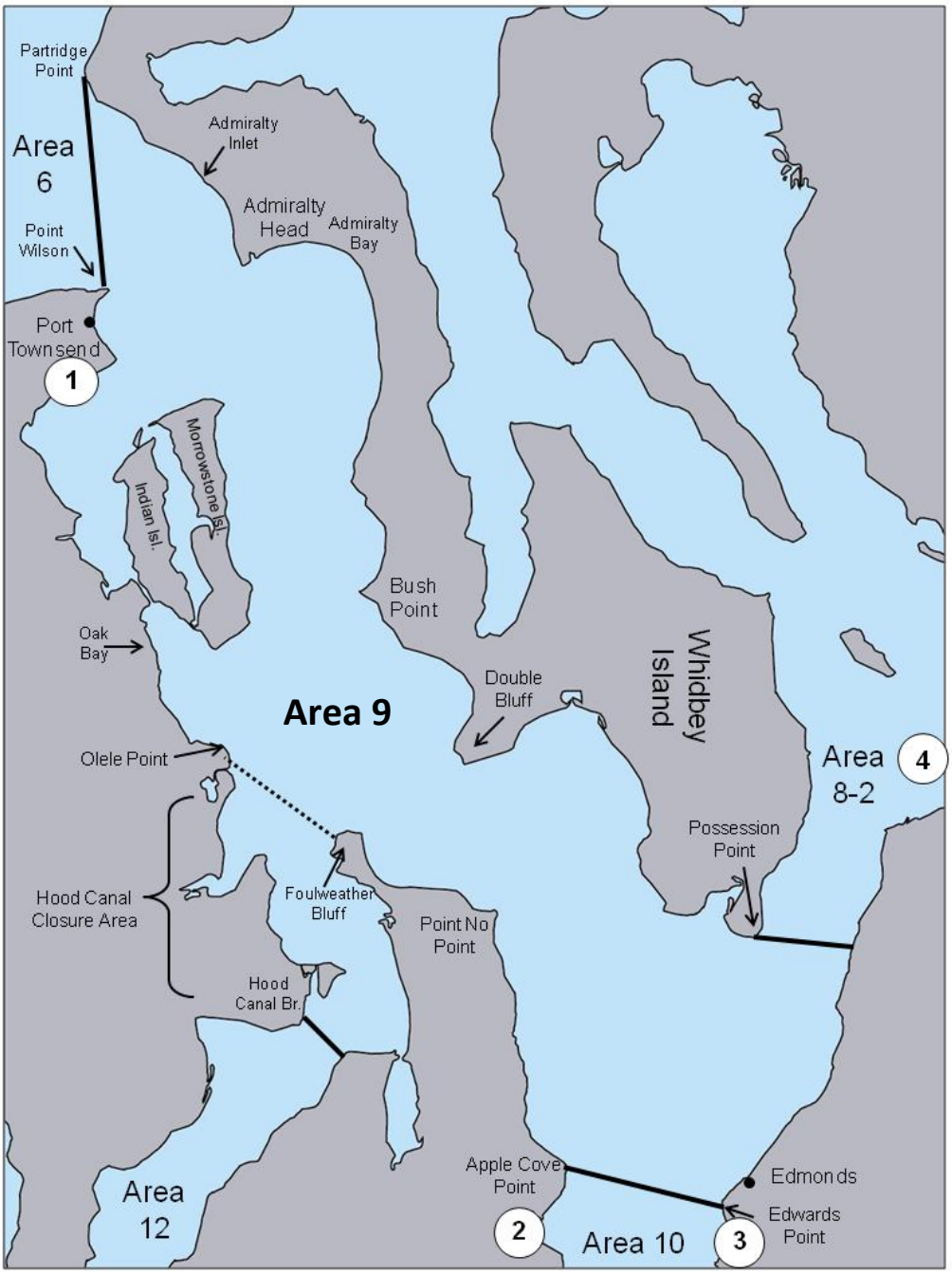


**Figure 1.** Map of Marine Catch Area 9 in Puget Sound. Open white circles correspond to the approximate location of the four public ramps or marinas where angler interviews and catch sampling occurred: 1) Port Townsend Boat Haven Ramp; 2) Kingston Public Ramp; 3) Edmonds Marina Dry Stack; and 4) Everett Ramp (Norton/10th St).

## Catch and Effort: Sampling and Estimation

We collected data on total catch (observed harvest and reported releases[4]) and total angling effort using an aerial–access design whereby: 1) catch and effort data were obtained by interviewing *all* anglers departing the fishery at four access sites that were staffed on randomly selected sample days (within Monday-Thursday and Friday-Sunday strata); 2) the fraction of total fishing effort contained in our sample frame was estimated from paired peak activity counts (i.e., boats) for sample frame sites and peak aerial boat counts (i.e., for all of Area 9) on days when both dockside sampling and aerial surveys were possible; and 3) total catch and effort estimates were obtained for all sample days by expanding sample-frame observations by the estimated sample fraction.

### *Dockside Sampling*

We collected data on total catch and total angling effort using a two-stage stratified 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 each day always being sampled) during each week of the Area 9 winter fishery. On selected sample days, we staffed access sites (i.e., public ramps, boathouses, etc.) for creel sampling. Our dockside sample frame included four moderate-to-high effort, public boat launch facilities used to access Area 9 (these were fixed sites throughout the season as part of the aerial-access design), including: Everett Ramp (Norton/10$^{th}$ St), Pt. Townsend Boat Haven Ramp, Edmonds Marina Dry Stack, and Kingston Public Ramp. In contrast to the approach we have used in other marine areas (i.e., $n = 2$ sites are randomly [non-uniform probabilities based on-the-water interviews] chosen from a sample frame; WDFW 2007b), we staffed *all* four sites on scheduled sample days. We opted to visit all sample sites on scheduled sample days so that we could maximize our sample size and minimize the degree of expansion required to obtain fishery-wide estimates of catch, effort, and angler-reported releases. Finally, given that some effort was excluded from our sample frame (i.e., private and/or low-effort access sites), we estimated sample frame coverage from aerial overflight data and accounted for this quantity in estimates of fishery-wide totals (see below and **Appendix A**).

At access sites selected for sampling on scheduled sample days, samplers interviewed *all* parties (from both fishing and non-fishing vessels) exiting the Area 9 fishery. During interviews, samplers acquired data on trip duration (time of start, time of finish), 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.

[4] In a recent 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 G**), we focus exclusively on bias-corrected "Method 2" estimates of Chinook encounters (and releases) in our review of the Area 9 fishery.

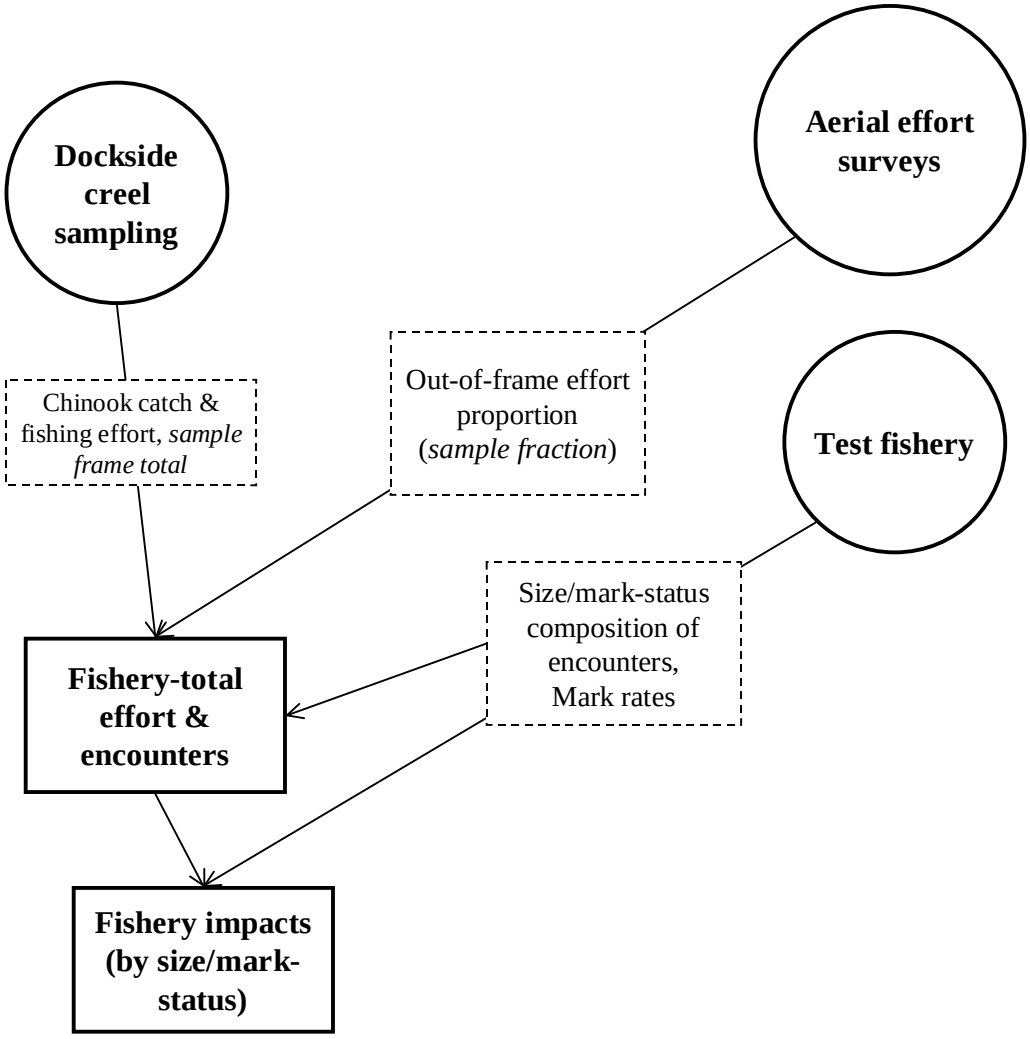


**Figure 2.** Conceptual diagram of the monitoring plan implemented in Area 9 during its winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) mark-selective Chinook season. Circles represent discrete sampling activities, dashed boxes represent parameters that are estimated using data from a given activity, and solid boxes depict key quantities estimated from the comprehensive plan. 'Encounters' includes both harvested and released Chinook salmon.

*Aerial Surveys*

Due to its vast size and complex geography, we used an aerial overflight approach to estimate total Area 9 effort and thus the proportion of effort captured in our four-site sample frame (i.e., the sample fraction [$f$ = 1 – the out-of-frame effort prop'n]). Surveys were conducted on a subset ($n$ = 20; **Appendix D**) of scheduled (i.e., dockside) sample days and were timed to coincide with the assumed period of peak activity for winter fisheries (1000-1400). Trained WDFW staff conducted the surveys from fixed-wing aircraft piloted by WDFW-enforcement or chartered personnel. For each aerial survey, samplers (aerial observers) circumnavigated the entirety of Area 9 and counted all recreational vessels observed while marking them on a map form. Aerial observers made no attempt to distinguish recreational boats as being either fishing or non-fishing in nature; however, obvious non-fishing vessels such as sail boats, commercial crabbing vessels, etc., were noted as such on forms and omitted from final counts.

Flights took approximately 0.5 hour (time over Area 9) on average and were flown at an elevation of 1,000 ft (305 m).

For each flight, we estimated the sample fraction, *f*, by pairing the aerial total boat count with the sample-frame total for boats active during the flight period (i.e., determined from interview details). We then obtained stratum-specific estimates of the mean sample fraction (and its variance) and used these values to obtain stratum- and fishery-total estimates of angling effort and landed catch (**Table 1**). The estimators (totals and variances) associated with this complemented aerial–access approach are provided in **Appendix A**. In addition, to minimize the influence of recall bias on our assessment, we estimated Chinook releases as the difference between estimated catch (i.e., 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 field 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 McHugh estimated a "correction" factor to account for this phenomenon and incorporated it into their estimator. See **Appendix B** 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 **Appendix G**.

*Voluntary Trip Reports –Charter and Private Boats*

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 9 winter 2008-09 mark-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).

In the previous (January 16-April 15, 2008) season of the Area 9 winter selective Chinook fishery, we separated charter vessels from private (non-charter) boats in generating the catch and effort estimates for Area 9 (WDFW 2009f). We used the Murthy estimator method to estimate total salmon encounters for private boats in Area 9, 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 impacts our catch estimates. From this evaluation, we determined that pooling charter and fleet data in the creel estimates would not significantly compromise estimate integrity in the Area 9 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 creel estimates for the Area 9 winter fishery in 2008-09.

## 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 winter 2008-09 mark-selective Chinook season in Area 9 (**Table 1**). Our test boat crew consisted of two WDFW technicians, each fishing with a single rod for approximately five days a week (Monday-Friday; weather permitting). 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 applicable, 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 post-season MSF reports (i.e., reports completed prior to August 2008), 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 legal-marked Chinook release 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 B** 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 no. 2108) for each size and mark-status category.

**Table 1.** Sampling/estimation details on target parameters associated with the overall winter 2008-09 Area 9 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 | 1 month | 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 | 1 month | The temporal resolution of impact estimates is constrained by that of the test-fishery encounters data. |
| Coded-wire tag (CWT) Impacts Estimation | Marked/unmarked double-index tag (DIT) encounters and mortalities | N/A | N/A | 1 month | The temporal resolution of DIT impacts is constrained by the total number of tags recovered. |

[1] Under the "bias-corrected Method-2" approach (Conrad and McHugh 2008), 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 9 mark-selective 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 November 1-30, 2008, and January 16 – April 15, 2009 season. To do this, we acquired information for all marked CWT double index tag (DIT) groups present in landed catch from the Pacific States Marine Fisheries Commission's Regional Mark Information System (RMIS) 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 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

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

10% instead of 15% (applied above to legal-sized releases) since unseen drop-off mortality (the 5% differential) is a feature common to selective and non-selective recreational Chinook fisheries.

## RESULTS & DISCUSSION

### Summary of Sampling Efforts

Ramp samplers were present at the four access sites in our sample-frame (Pt. Townsend Boat Haven Ramp, Kingston Public Ramp, Everett Ramp [Norton/10th St], and Edmonds Marina Dry Stack) for the entirety (dawn-dusk shifts) of 80 scheduled sample days (**Table 2**). Dockside efforts yielded samples of 1,084 boat trips (68% fishing, 32% non-fishing), 2,523 angler trips, and 301 landed Chinook (299 marked and 2 unmarked) throughout the fishery.

In total, we conducted 20 over-flights during the four-month fishery, and 18 of these (5 weekday, 3 Friday, and 10 weekend flights; **Appendix D**) included boats that were also sampled at the dockside sites in our sample frame. All flights occurred during periods of high activity, and viewing conditions were excellent in all cases. Over the 20 surveys, aerial observers counted between 2 and 211 (average = 54) recreational vessels in Area 9; between 1 and 82 (average = 22) of these boats returned to sites contained in our dockside sample frame (based on trip times reported during interviews).

**Table 2.** Dockside creel sampling dates for the 2008-09 Area 9 winter mark-selective fishery (November 1-30, 2008 and January 16-April 15, 2009). Shaded cells are days when dockside creel sampling was conducted at all four sample-frame sites; "A" denotes days when aerial surveys occurred; "TF" represents test-fishing days.

**November 2008**

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| | | | | | | 1 **A, TF** |
| 2 | 3 **TF** | 4 **TF** | 5 **A, TF** | 6 **TF** | 7 **TF** | 8 |
| 9 **A** | 10 | 11 | 12 **TF** | 13 **TF** | 14 **A, TF** | 15 **A** |
| 16 | 17 **TF** | 18 **A, TF** | 19 **TF** | 20 | 21 **A, TF** | 22 **A** |
| 23 | 24 **TF** | 25 **TF** | 26 **TF** | 27 | 28 | 29 |
| 30 | | | | | | |

**January 2009**

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 **TF** | 17 |
| 18 | 19 | 20 | 21 **TF** | 22 **TF** | 23 **TF** | 24 **A** |
| 25 **TF** | 26 | 27 | 28 **TF** | 29 **TF** | 30 **TF** | 31 |

**February 2009**

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| 1 **A** | 2 **TF** | 3 **TF** | 4 **TF** | 5 **TF** | 6 | 7 |
| 8 | 9 **TF** | 10 **TF** | 11 **TF** | 12 **TF** | 13 **TF** | 14 **A** |
| 15 | 16 | 17 **TF** | 18 **TF** | 19 **A, TF** | 20 **TF** | 21 **A** |
| 22 | 23 **TF** | 24 | 25 | 26 | 27 **A, TF** | 28 |

**March 2009**

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| 1 | 2 TF | 3 **TF** | 4 **TF** | 5 **TF** | 6 **TF** | 7 |
| 8 | 9 **TF** | 10 **TF** | 11 **TF** | 12 **TF** | 13 **A** | 14 |
| 15 | 16 **TF** | 17 **A** | 18 **TF** | 19 **TF** | 20 **TF** | 21 **A** |
| 22 | 23 | 24 **TF** | 25 **TF** | 26 **TF** | 27 **TF** | 28 |
| 29 **A** | 30 **TF** | 31 | | | | |

**April 2009**

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| | | | 1 | 2 **TF** | 3 **TF** | 4 **A** |
| 5 | 6 **TF** | 7 **TF** | 8 **TF** | 9 | 10 **A, TF** | 11 **A** |
| 12 | 13 **TF** | 14 | 15 **TF** | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

Based on the combination of aerial boat counts and dockside observations of boats active during flights, we estimated that on average approximately half (45%) of all Area-9 fishing effort originated from sites contained in our sample frame (**Appendix D**). At 49% and 43%, respectively, the average sample fraction was higher for weekdays than it was for weekends; these differences were not significant, however (**Appendix A**); thus, flight data were pooled across weekend and weekday strata for total estimation.

## Fishery Characteristics

*Estimates of Fishing Effort and Catch*

An estimated 7,064 angler trips were completed by private fleet anglers during the winter 2008-09 Area 9 mark-selective Chinook fishery (**Table 3**). Anglers harvested a grand total of 885 estimated marked Chinook (and 14 unmarked) and released an additional 6,646 Chinook (3,651 marked, and 2,995 unmarked).

*Characteristics of Harvested Chinook*

*Length and Age*.—During the course of the Area 9 winter fishery, 299 (294 legal, 5 sublegal) retained marked Chinook salmon were sampled at dockside (**Table 4)**; in addition, 2 unmarked Chinook were sampled at dockside (all were legal size). All of these fish were measured and examined for the presence of a CWT. Harvested Chinook ranged from 53 to 91 cm and averaged 70 cm (SD = 7 cm) in total length (**Figure 3**). Overall, the majority (296/301 or 98.3%) of Chinook harvested were of legal size ($\geq$22 in or 56 cm TL).

While scales were collected from all 301 sampled Chinook, only 276 (274 ad-marked and 2 unmarked) of these could be aged (**Appendix E**). Over half (64%) of all aged Chinook were 4 years old (brood year 2005), and 95% of aged individuals were subyearlings upon

outmigration from freshwater. The remaining age samples were primarily from brood year 2006 (age 3.1 = 33% of total).

*CWT Samples*.—We recovered a total of 22 coded-wire tags from the 299 retained marked Chinook salmon that were examined as part of our dockside sampling efforts (**Table 5**; **Appendix F**). The majority of CWT fish were from Puget Sound (73%) and Hood Canal (18%) release sites, with the remaining 9% coming from a lower Columbia River production facility. In addition, 12 of the CWTs recovered were associated with a double-index tag (DIT) group (See **Overall Fishery Impacts**: *Estimated CWT-DIT Impacts* for estimated unmarked-DIT mortality results).

**Table 3.** Estimates of total fishing effort and total salmon catch (harvest and reported releases) during the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective fishery. Values may not add exactly due to rounding error. AD = marked (i.e., adipose-clipped), UM = unmarked.

| Month | Stat Week | Start Date | End Date | Est. Effort | | Est. Retained Chinook | | Est. Released Chinook [1/] | | Total Est. Chinook Encounters |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Boats | Anglers | AD | UM | AD | UM | |
| Nov | 44 | 01-Nov | 02-Nov | 294 | 614 | 61 | 0 | 411 | 477 | 950 |
| | 45 | 03-Nov | 09-Nov | 138 | 265 | 10 | 0 | 66 | 76 | 152 |
| | 46 | 10-Nov | 16-Nov | 265 | 515 | 58 | 0 | 395 | 458 | 912 |
| | 47 | 17-Nov | 23-Nov | 221 | 420 | 107 | 0 | 724 | 840 | 1,671 |
| | 48 | 24-Nov | 30-Nov | 510 | 932 | 95 | 5 | 642 | 740 | 1,481 |
| **Subtotal: November 1-30, 2008** | | | | **1,427** | **2,745** | **330** | **5** | **2,238** | **2,592** | **5,165** |
| **Variance:** | | | | 10,098 | 38,596 | 838 | 13 | 540,321 | 727,742 | 2,804,695 |
| **Standard Error:** | | | | 100 | 196 | 29 | 4 | 735 | 853 | 1,675 |
| **CV (%):** | | | | 7% | 7% | 9% | 73% | 33% | 33% | 32% |
| **95% CI:** | | | | 1,230-1,624 | 2,360-3,130 | 273-387 | 2-12 | 797-3,679 | 920-4,264 | 1,883-8,448 |
| **Month** | **Stat Week** | **Start Date** | **End Date** | **Est. Effort** | | **Est. Retained Chinook** | | **Est. Released Chinook [1/]** | | **Total Est. Chinook Encounters** |
| | | | | **Boats** | **Anglers** | **AD** | **UM** | **AD** | **UM** | |
| Jan - Apr | 3 | 16-Jan | 19-Jan | 214 | 423 | 81 | 2 | 206 | 58 | 347 |
| | 4 | 20-Jan | 25-Jan | 111 | 231 | 33 | 0 | 85 | 25 | 143 |
| | 5 | 26-Jan | 01-Feb | 153 | 285 | 47 | 0 | 119 | 35 | 200 |
| | 6 | 02-Feb | 08-Feb | 301 | 574 | 91 | 0 | 231 | 67 | 390 |
| | 7 | 09-Feb | 16-Feb | 401 | 876 | 108 | 0 | 275 | 80 | 463 |
| | 8 | 17-Feb | 22-Feb | 229 | 471 | 75 | 0 | 190 | 55 | 320 |
| | 9 | 23-Feb | 28-Feb | 138 | 271 | 48 | 0 | 122 | 36 | 206 |
| | 10 | 02-Mar | 08-Mar | 103 | 190 | 24 | 0 | 61 | 18 | 103 |
| | 11 | 09-Mar | 15-Mar | 63 | 109 | 2 | 0 | 6 | 2 | 9 |
| | 12 | 16-Mar | 22-Mar | 138 | 280 | 13 | 7 | 33 | 3 | 56 |
| | 13 | 23-Mar | 29-Mar | 39 | 63 | 0 | 0 | 0 | 0 | 0 |
| | 14 | 30-Mar | 05-Apr | 214 | 389 | 22 | 0 | 56 | 16 | 94 |
| | 15 | 06-Apr | 12-Apr | 87 | 155 | 11 | 0 | 28 | 8 | 47 |
| | 16 | 13-Apr | 15-Apr | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| **Subtotal: Jan 16-Apr 15, 2009** | | | | **2,195** | **4,319** | **555** | **9** | **1,413** | **403** | **2,380** |
| **Variance:** | | | | 8,339 | 29,497 | 2,293 | 1 | 83,752 | 9,979 | 215,055 |
| **Standard Error:** | | | | 91 | 172 | 48 | 1 | 289 | 100 | 464 |
| **CV (%):** | | | | 4% | 4% | 9% | 11% | 20% | 25% | 19% |
| **95% CI:** | | | | 2,016-2,374 | 3,982-4,655 | 462-649 | 7-11 | 846-1,980 | 207-599 | 1,471-3,289 |
| **Season Total:** | | | | **3,622** | **7,064** | **885** | **14** | **3,651** | **2,995** | **7,545** |
| **Variance:** | | | | 18,437 | 68,093 | 3,131 | 14 | 624,073 | 737,721 | 3,019,750 |
| **Standard Error:** | | | | 136 | 261 | 56 | 4 | 790 | 859 | 1,738 |
| **CV (%):** | | | | 4% | 4% | 6% | 27% | 22% | 29% | 23% |
| **95% CI:** | | | | 3,356-3,888 | 6,553-7,575 | 776-995 | 6-21 | 2,103-5,200 | 1,312-4,679 | 4,140-10,952 |

[1/] 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.

**Table 4.** Summary of total length samples collected from retained Chinook during dockside angler interviews in the winter 2008-09 Area 9 mark-selective Chinook fishery, November 1-30, 2008 and January 16-April 15, 2009.

| | Number Sampled November | | |
|---|---|---|---|
| **Mark Type** | **Legal-size** | **Sublegal-size** | **Total** |
| Marked | 87 | 1 | 88 |
| Unmarked | 0 | 0 | 0 |
| **Subtotal November:** | **87** | **1** | **88** |
| | **Number Sampled January-April** | | |
| **Mark Type** | **Legal-size** | **Sublegal-size** | **Total** |
| Marked | 207 | 4 | 211 |
| Unmarked | 2 | 0 | 2 |
| **Subtotal Jan-April:** | **209** | **4** | **213** |
| **Season Total** | **296** | **5** | **301** |

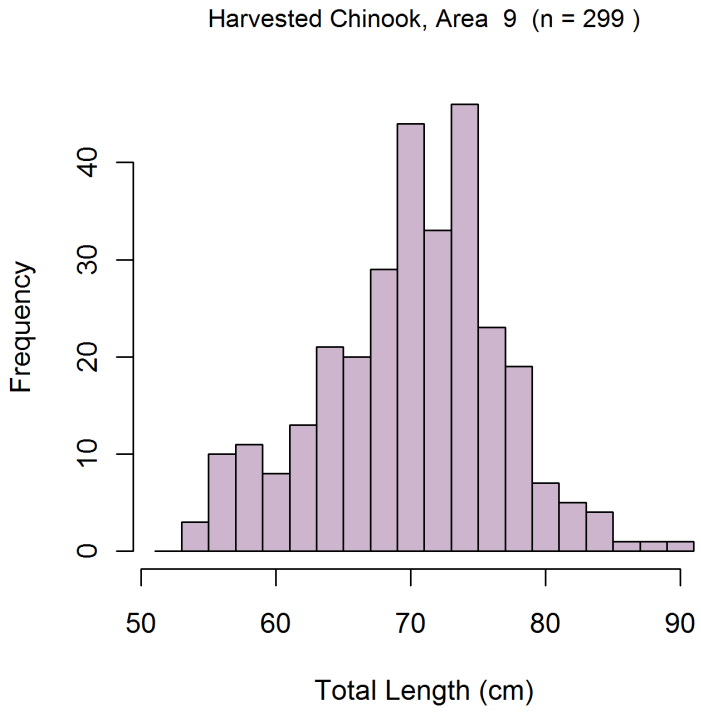


**Figure 3.** Length-frequency distribution for marked Chinook harvested during the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

**Table 5.** Summary of coded-wire tags recovered from Chinook salmon harvested during the winter 2008-09 Area 9 mark-selective Chinook fishery. The field "# DITs" corresponds to the number of tags that belonged to double-index tag groups.

| Release Region | Release Site | Rearing Location | CWTs Recovered | No. DITs |
|---|---|---|---|---|
| Lower Columbia River | Spring Creek | Spring Creek NFH | 2 (9.1%) | 2 |
| Hood Canal | Finch Creek | Hoodsport Hatchery | 1 (4.5%) | |
| | Purdy Creek | George Adams Hatchery | 3 (13.6%) | 3 |
| Puget Sound-Central | Big Soos Creek | Unreported | 1 (4.5%) | 1 |
| | Green River | Icy Creek Hatchery | 3 (13.6%) | |
| | Grovers Creek | Grovers Creek Hatchery | 3 (13.6%) | 3 |
| Puget Sound-North | Friday Creek | Samish Hatchery | 2 (9.1%) | 2 |
| | Skagit River | Unreported | 1 (4.5%) | |
| | Whitehorse Springs | Whitehorse Pond | 1 (4.5%) | |
| Puget Sound-South | Chambers Creek | Garrison Hatchery | 1 (4.5%) | |
| | Chambers Creek | Lakewood Hatchery | 1 (4.5%) | |
| | Clear Creek | Nisqually Hatchery | 1 (4.5%) | 1 |
| | Cowskull Acclimation Pond | Cowskull Acclimation Pond | 1 (4.5%) | |
| | Voight Creek | Voight Creek Hatchery | 1 (4.5%) | |
| | | **Grand Total** | **22** | **12** |

[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

*Fishing Time and Gear Type*

In total, test fishers spent 65 days and 287.8 hours on the water pursuing Chinook salmon during the Area 9 2008-09 winter fishery (**Table 6**). Given that the majority (94%) of the interviewed anglers who successfully encountered Chinook salmon reported doing so while trolling with downriggers, test fishers also pursued Chinook using this method the majority of the time (98%), while they spent the remaining 2% of their test fishing time using the weight-and-bait method (**Table 7**).

*Chinook Encounters and Mark Rates*

In total, test fishers encountered 312 Chinook salmon as a result of their 65 days and 287.8 hours of fishing. Legal-size Chinook made up 18% of the sample, and the majority of these were adipose fin clipped (legal-size Chinook mark rate: 84%; **Table 6**). The overall mark rate ([LM+SM]/total encounters) was 64%. With a "CPUE" (i.e., LM Chinook *encounters* / angler trip) of 0.37, test fishers experienced over twice the encounter rate as private fleet anglers (0.13 LM Chinook encounters/angler trip).

**Table 6.** Composition of test fishery Chinook encounters and associated mark-rate and size/mark-status proportion estimates for the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery. Variances associated with size/mark-status proportions and mark rates are provided in parentheses.

| Stat Week | Fishing Effort | | Legal | | Sublegal | | Total |
|---|---|---|---|---|---|---|---|
| | Days | Hours Fished | AD | UM | AD | UM | |
| **44** | 1 | 4.8 | 2 | 0 | 7 | 9 | 18 |
| **45** | 5 | 25.9 | 1 | 0 | 29 | 49 | 79 |
| **46** | 3 | 15.9 | 2 | 0 | 8 | 11 | 21 |
| **47** | 4 | 20.5 | 5 | 0 | 25 | 9 | 39 |
| **48** | 3 | 16.1 | 3 | 1 | 7 | 11 | 22 |
| **Nov 2008 Total** | **16** | **83.2** | **13** | **1** | **76** | **89** | **179** |
| **Size/mark-status composition:** | | | 0.073 (0.000) | 0.006 (0.000) | 0.425 (0.001) | 0.497 (0.001) | |
| **Legal size mark rate:** | | | 0.93 (0.005) | | | | |
| **Overall mark rate:** | | | 0.50 (0.001) | | | | |
| **3** | 1 | 3.5 | 1 | 0 | 0 | 0 | 1 |
| **4** | 3 | 9.5 | 4 | 2 | 2 | 0 | 8 |
| **5** | 4 | 17.9 | 5 | 1 | 6 | 2 | 14 |
| **6** | 4 | 18.3 | 6 | 2 | 2 | 1 | 11 |
| **7** | 5 | 17.5 | 6 | 1 | 2 | 0 | 9 |
| **8** | 4 | 14.9 | 1 | 1 | 3 | 0 | 5 |
| **9** | 2 | 10.7 | 1 | 1 | 4 | 2 | 8 |
| **10** | 5 | 23.1 | 2 | 0 | 5 | 2 | 9 |
| **11** | 4 | 18.7 | 2 | 0 | 12 | 1 | 15 |
| **12** | 4 | 10.1 | 0 | 0 | 3 | 0 | 3 |
| **13** | 4 | 20.6 | 3 | 0 | 11 | 1 | 15 |
| **14** | 3 | 18.0 | 2 | 0 | 14 | 2 | 18 |
| **15** | 4 | 16.7 | 2 | 0 | 8 | 4 | 14 |
| **16** | 2 | 5.3 | 0 | 0 | 3 | 0 | 3 |
| **Jan 16-Apr 15, 2009 Total** | **49** | **204.6** | **35** | **8** | **75** | **15** | **133** |
| **Size/mark-status composition:** | | | 0.263 (0.001) | 0.060 (0.000) | 0.564 (0.002) | 0.113 (0.001) | |
| **Legal size mark rate:** | | | 0.81 (0.004) | | | | |
| **Overall mark rate:** | | | 0.83 (0.001) | | | | |
| **Season Total** | **65** | **287. 8** | **48** | **9** | **151** | **104** | **312** |
| **Size/mark-status composition:** | | | 0.154 (0.000) | 0.029 (0.000) | 0.484 (0.001) | 0.333 (0.001) | |
| **Legal size mark rate:** | | | 0.84 (0.002) | | | | |
| **Overall mark rate:** | | | 0.64 (0.001) | | | | |

**Table 7.** Fishing methods employed by private recreational anglers (from dockside interviews, based on number of boat trips sampled, n = 620) and test fishers (based on hours fished, n =288) during the Area 9 2008-09 winter (November 1-30, 2008 and January 16-April 15, 2009) mark-selective Chinook fishery.

| Statistical Week | DR | | WB | | Diver | | Jig | |
|---|---|---|---|---|---|---|---|---|
| | Tst Boat | Private | Tst Boat | Private | Tst Boat | Private | Tst Boat | Private |
| 44 | 100.0% | 94.9% | 0.0% | 3.8% | 0.0% | 1.3% | 0.0% | 0.0% |
| 45 | 100.0% | 92.3% | 0.0% | 3.8% | 0.0% | 3.8% | 0.0% | 0.0% |
| 46 | 72.3% | 88.9% | 27.7% | 5.6% | 0.0% | 0.0% | 0.0% | 5.6% |
| 47 | 100.0% | 94.4% | 0.0% | 1.9% | 0.0% | 1.9% | 0.0% | 1.9% |
| 48 | 100.0% | 98.2% | 0.0% | 1.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| 3 | 0.0% | 93.8% | 100.0% | 3.1% | 0.0% | 0.0% | 0.0% | 3.1% |
| 4 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 5 | 100.0% | 88.6% | 0.0% | 5.7% | 0.0% | 0.0% | 0.0% | 5.7% |
| 6 | 100.0% | 89.7% | 0.0% | 7.4% | 0.0% | 0.0% | 0.0% | 2.9% |
| 7 | 100.0% | 92.5% | 0.0% | 7.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| 8 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 9 | 100.0% | 93.1% | 0.0% | 6.9% | 0.0% | 0.0% | 0.0% | 0.0% |
| 10 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 11 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 12 | 100.0% | 95.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 4.4% |
| 13 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 14 | 100.0% | 94.3% | 0.0% | 2.9% | 0.0% | 0.0% | 0.0% | 2.9% |
| 15 | 100.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 16 | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **Total** | **97.6%** | **94.2%** | **2.4%** | **3.5%** | **0.0%** | **0.5%** | **0.0%** | **1.8%** |

Furthermore, we observed that the Chinook encounter rates in the test fishery (the four mark/size group proportions --LM, LU, SM, and SU) were quite different when comparing subtotals from the November 1-30, 2008 period versus that for the January 16-April 15, 2009 period of the Area 9 winter fishery –e.g., the proportion of legal-marked Chinook was 0.07 in November 2008, whereas it was 0.23 for the January-April 2009 time period (**Table 6**). Consequently, we conducted chi-square ($\chi^2$) tests to evaluate whether or not the frequency of observations for the four mark/size groups differed significantly for the November 2008 period compared to the January-April 2009 period. Results of the chi-squared test showed that the frequency of observations for the four mark/size groups differed significantly between the two time periods ($\chi^2$= 62.7707, df = 3, $P$ = 1.503e-13).

Thus, we treated the November 2008 and January 16 through April 15, 2009 time periods as two separate sub-seasons (two strata) within the overall Area 9 winter selective season. For the November 2008 time period, dockside interview data (creel estimates) and test fishery results (size/mark status composition) from the month of November 2008 were applied in generating total-Area Chinook encounter estimates (**Table 3**) and associated impact estimates for the period from November 1-30, 2008. Likewise, for the January through April 2009 stratum, dockside interview data and test fishery size/mark status composition results obtained from January 16 through April 15, 2009 were used to generate total-Area Chinook encounter estimates and associated impact estimates for the January-April time period.

Based on the voluntary trip reports (VTRs) returned by private-boat anglers ($n$ = 79 angler trips and 130 encounters total; **Table 8**) participating in the Area 9 winter fishery, test fishers observed mark rates that were consistent with those experienced by the fleet. Anglers reported 31 legal-size marked encounters on VTRs, yielding the same legal-size mark rate (84%) as observed in the test fishery. The overall mark rate (legal and sublegal fish combined) was slightly lower in the test fishery (64%) compared to the mark rate from VTRs (73%).

We compared test fishery and VTR data sources to evaluate whether or not the frequency of observations in the four size/mark status categories of Chinook encounters (i.e., legal or sublegal size classes and marked or unmarked groups) differed significantly between the two data sources. Results of chi-squared tests showed that the four size/mark status group proportions were significantly different for season-total VTR data versus season-total test fishery data ($\chi^2 = 8.2$, df = 3, $P = 0.042$). In contrast, for VTR data versus the test fishery data from the January through April 2009 sampling period only, the size/mark status group comparisons from the two data sources were not significantly different ($\chi^2 = 5.8$, df = 3, $P = 0.121$; **Table 8**).

**Table 8.** Total Chinook encountered (retained and released) by private-boat anglers reporting their catch on voluntary trip reports (VTRs) compared to test fishery results, with estimates of legal, sublegal, and overall mark rates, during the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

| Time Period | Data source | Effort & Sample Size | Legal | | Sublegal | | | Mark Rates | |
|---|---|---|---|---|---|---|---|---|---|
| | | | AD | UM | AD | UM | Total | Overall | Legal |
| **Nov 2008** | **Test Fishery** | 16 days, 32 Angler Trips | 13 | 1 | 76 | 89 | 179 | 0.50 | 0.93 |
| | **Private VTR** | 11 1-trip VTRs, 21 Angler Trips | 3 | 2 | 36 | 15 | 56 | 0.70 | 0.60 |
| | **Pooled data** | 53 Angler Trips | 16 | 3 | 112 | 104 | 235 | 0.545 | 0.842 |
| | Size/mark-status composition: | | 0.068 (0.000) | 0.013 (0.000) | 0.477 (0.001) | 0.443 (0.001) | | | |
| **Jan 16-Apr 15 2009** | | | **Legal** | | **Sublegal** | | | **Mark Rates** | |
| | **Data source** | **Effort & Sample Size** | **AD** | **UM** | **AD** | **UM** | **Total** | **Overall** | **Legal** |
| | **Test Fishery** | 49 days, 98 Angler Trips | 35 | 8 | 75 | 15 | 133 | 0.83 | 0.81 |
| | **Private VTR** | 34 1-trip VTRs, 58 Angler Trips | 28 | 4 | 28 | 14 | 74 | 0.76 | 0.88 |
| | **Pooled data** | 166 Angler Trips | 63 | 12 | 103 | 29 | 207 | 0.802 | 0.840 |
| | Size/mark-status composition: | | 0.304 (0.001) | 0.058 (0.000) | 0.498 (0.001) | 0.140 (0.001) | | | |
| **Entire Season** | **All Data Pooled** | 219 Angler Trips | 79 | 15 | 215 | 133 | 442 | 0.665 | 0.840 |
| | Size/mark-status composition: | | 0.179 (0.000) | 0.034 (0.000) | 0.486 (0.001) | 0.301 (0.000) | | | |

*Chinook Size and Age*

For marked and unmarked groups combined, the size (total length) of Chinook encountered by test fishers ranged from 23 to 91 cm and averaged 42 cm (SD = 16). Between groups, marked Chinook averaged slightly larger (mean = 45; **Figure 4**) than unmarked Chinook (mean = 35; **Figure 4**) but this 10 cm difference in size was not significant (two-sample t-test: $t$ = -0.08 df = 310, $P$ = 0.938). At 69 cm, the average size of legal-marked Chinook encountered by test fishers was similar to that for Chinook sampled in the private fleet's catch at dockside (i.e., 70 cm). Based on 282 readable scales (176 AD, 106 UM) collected from Chinook encountered in the test fishery, nearly three-quarters (66% AD, 85% UM) of all marked and unmarked individuals present in the targeted pool of Chinook were less than 3.1 years old (**Appendix E**).

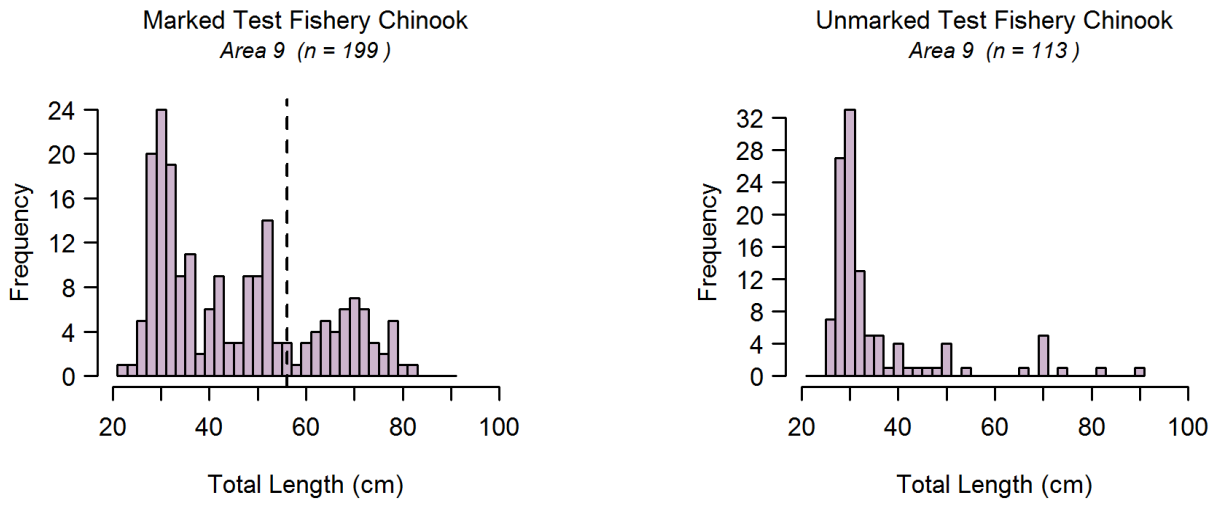


**Figure 4.** Length-frequency distributions of marked (*left panel*) and unmarked (*right panel*) Chinook encountered by test fishers during the winter 2008-09 Area 9 (November 1-30, 2008 and January 16-April 15, 2009) mark-selective Chinook fishery. Note that the vertical dashed line in the upper panel corresponds to the legal size limit (22 in or 56 cm).

*Other Fish Species Encountered*

In addition to the 312 Chinook salmon encounters described above, test fishers caught and released 129 other fish from 12 different species (Table 9). The majority of the other species encountered consisted of coho (40%) and Pacific sanddab (36%).

**Table 9.** Test fishery catches of species other than Chinook salmon during the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

| Common Name | Scientific Name | Number |
|---|---|---|
| Brown rockfish | *Sebastes auriculatus* | 1 |
| Speckled sanddab | *Citharichthys stigmaeus* | 1 |
| Copper rockfish | *Sebastes caurinus* | 2 |
| Redstripe rockfish | *Sebastes proriger* | 2 |
| Walleye pollock | *Theragra chalcogramma* | 2 |
| Pacific staghorn sculpin | *Leptocottus armatus* | 3 |
| Rock sole | *Lepidopsetta bilineata* | 3 |
| Quillback rockfish | *Sebastes maliger* | 4 |
| Lingcod | *Ophiodon elongatus* | 7 |
| Pacific cod | *Gadus macrocephalus* | 7 |
| Pacific sanddab | *Citharichthys sordidus* | 46 |
| Coho | *Oncorhynchus kisutch* | 51 |
| | **Total** | **129** |

## Overall Fishery Impacts

### *Total Encounters and Mortalities*

Based on the combination of dockside sampling results (i.e., legal-marked Chinook harvest estimates derived from data in **Table 3** and **Table 4**) and the test fishery size/mark-status composition data (**Table 6**), we estimated that that 1,001 legal-marked, 172 legal-unmarked, 3,535 sublegal-marked, and 2,837 sublegal-unmarked Chinook salmon were encountered by anglers fishing during the Area 9 winter selective fishery (**Table 10**). These encounters were comprised of an approximately 1:7.4 mix of retained (899 fish) and released (6,646 fish) Chinook salmon. Further, we estimated that 3.4 unmarked Chinook salmon and 7.6 Chinook salmon overall were handled per legal-marked fish harvested. Given the assumed mortality rates of 0.20 for sublegal- and 0.15 for legal-sized Chinook salmon, we additionally estimated that 20 legal-marked, 24 legal-unmarked, 704 sublegal-marked, and 567 sublegal-unmarked Chinook (1,315 overall) died due to handling-and-release effects; this translates into an estimated 0.7 unmarked and 0.8 marked Chinook release mortality per legal-marked Chinook retained. In total, we estimated that 2,214 Chinook (1,609 marked and 604 unmarked) mortalities occurred—41% due to direct harvest—as a result of the Area 9 winter mark-selective fishery. In addition, given the 312 (48 LM, 9 LU, 151 SM, 104 SU) Chinook caught and released in the Area 9 test fishery, an estimated 59 (37 marked, 22 unmarked) Chinook may have died as a result of our sampling activities.

### *FRAM versus Creel Comparison*

The number of fish estimated to have been impacted by the 2008-09 winter Area 9 fishery was considerably less than half of what was predicted based on pre-season modeling results. Whereas FRAM predicted that a total of 17,081 Chinook would have been encountered, creel survey data indicated that actual encounters were estimated to be 44% of this value (**Table 11**,

**Figure 5**). Field data also suggested that actual legal-sized and sublegal-sized Chinook encounter rates were 18% and 60% lower, respectively, than those expected as a result of pre-season modeling. For harvest and release mortality combined, FRAM predicted that a total of 1,156 unmarked, 9,542 marked, and 10,698 Chinook overall would die during the Area 9 winter selective season (**Table 12**, **Figure 5**), with a nearly 40:60 harvest and release mortality prediction. In contrast, creel results indicate that one-fifth as many fish may have died during the course of the fishery, with 40% of these impacts being due to marked-Chinook harvest.

**Table 10.** Summary of season-wide fishery impact estimates for the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery. Values may not add up perfectly due to rounding error.

| **Total Encounters (E):** | **7,545** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **V(E):** | **2,285,542** | | | | | | | | | |
| **Size/mark group** | **Encounters** | **No. Retained** | **No. Rel'd** | **Rel. Mort. Rate** | **Rel. Mort.** | **Total Mortality** | **Var** | **SE** | **95% CI** | **CV (%)** |
| Legal marked | 1,001 | 871 | 130 | 0.15 | 20 | 891 | 3,227 | 57 | 779 - 1002 | 6 |
| Legal unmarked | 172 | 14 | 158 | 0.15 | 24 | 37 | 99 | 10 | 18 - 57 | 27 |
| Sublegal marked | 3,535 | 14 | 3,520 | 0.20 | 704 | 718 | 19,178 | 138 | 447 - 990 | 19 |
| Sublegal unmarked | 2,837 | 0 | 2,837 | 0.20 | 567 | 567 | 22,621 | 150 | 273 - 862 | 27 |
| All groups combined | **7,545** | **899** | **6,646** | | **1,315** | **2,214** | **45,126** | **212** | **1797 - 2630** | **10** |

**Table 11.** Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook encounters for the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

| **Data Source** | **Group** | **Total Encounters** | **Legal** | **Sublegal** | **Landed Only** |
|---|---|---|---|---|---|
| FRAM Encounters | Unmark. | 5,056 | 2,271 | 2,785 | 136 |
| | Mark. | 12,025 | 4,110 | 7,915 | 3,864 |
| | Total | 17,081 | 6,381 | 10,700 | 4,000 |
| | % Mark. | 70 | 64 | 74 | 97 |
| Estimated (Creel) Encounters | Unmark. | 3,009 | 172 | 2,837 | 14 |
| | Mark. | 4,537 | 1,002 | 3,536 | 885 |
| | Total | 7,546 | 1,174 | 6,372 | 899 |
| | % Mark. | 60 | 85 | 56 | 99 |

**Table 12.** Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook mortalities for the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

| | FRAM Chinook Mortalities | | | Estimated Chinook Mortalities | | |
|---|---|---|---|---|---|---|
| **Mortality Category** | **Unmark.** | **Mark.** | **Total** | **Unmark.** | **Mark.** | **Total** |
| Total (Landed + Released) | 1,156 | 9,542 | 10,698 | 605 | 1,609 | 2,214 |
| Released Legal | 463 | 4,095 | 4,558 | 24 | 20 | 43 |
| Released Sublegal | 557 | 1,583 | 2,140 | 567 | 704 | 1,272 |
| Landed Only | 136 | 3,864 | 4,000 | 14 | 885 | 899 |

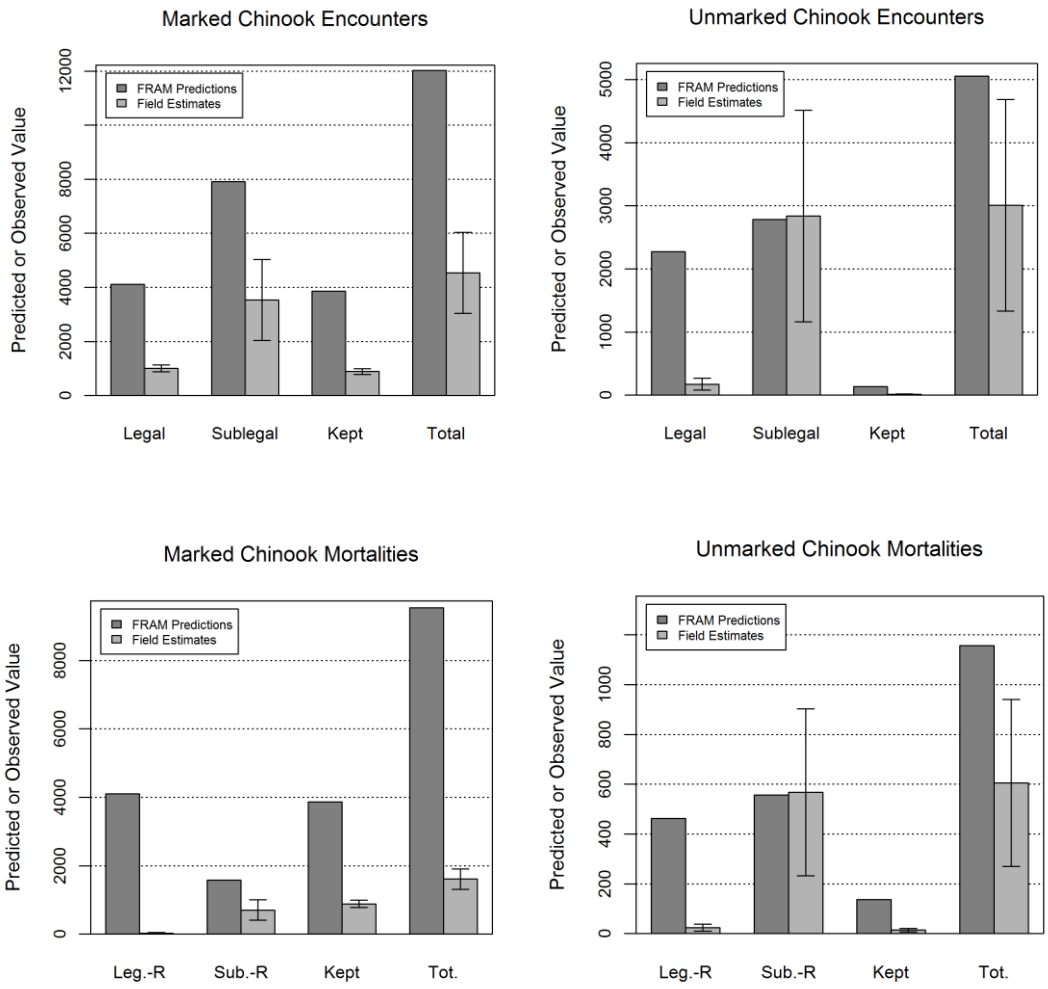


**Figure 5.** Comparison of modeled (i.e., using FRAM, model run 2108) and estimated total Chinook encounters (*upper panel*) and mortalities (*lower panel*) for the 2008-09 Area 9 winter mark-selective Chinook fishery. Error bars represent approximate 95% confidence intervals for field estimates.

*Estimated CWT-DIT Impacts*

Of the 22 coded-wire tags recovered during the Area 9 fishery, 12 belonged to double-index tag (DIT) release groups (**Table 13**). Based on the release details associated with these tags and their unmarked sister groups, we obtained an estimate of the unmarked-to-marked release ratio ($\lambda$) 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 9 winter fishery. In total, we estimated that 40 unmarked-DIT Chinook were caught and released during the fishery, 33% of which were of Grovers Creek Hatchery origin (brood year 2005) and 23% of which were of George Adams Hatchery origin (brood years 2005 and 2006). Given an *sfm* rate of 0.10, we estimate that as many as four of the unmarked-DIT Chinook may have died as a result of Area 9 winter mark-selective fishery.

**Table 13.** 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 9 mark-selective Chinook fishery from November 1-30, 2008 and January 16-April 15, 2009. AD = marked (i.e., adipose-clipped), UM = unmarked.

| Hatchery | Brood Year | DITs Obs'd | AD DIT Harvest | | UM DIT Enc. | UM DIT Mortality | | |
|---|---|---|---|---|---|---|---|---|
| | | | Est. | var(Est.) | | Est. | var(Est.) | SE(Est.) |
| George Adams Hatchery | 2005 | 2 | 6.45 | 15.05 | 6.45 | 0.65 | 0.15 | 0.54 |
| | 2006 | 1 | 2.64 | 4.33 | 2.91 | 0.29 | 0.05 | 0.23 |
| Grovers Creek Hatchery | 2005 | 3 | 10.26 | 25.77 | 13.39 | 1.34 | 0.44 | 1.13 |
| Nisqually Hatchery | 2005 | 1 | 3.81 | 10.72 | 4.29 | 0.43 | 0.14 | 0.37 |
| Samish Hatchery | 2005 | 2 | 4.84 | 6.98 | 4.40 | 0.44 | 0.06 | 0.34 |
| Soos Creek Hatchery | 2005 | 1 | 3.81 | 10.72 | 3.91 | 0.39 | 0.11 | 0.34 |
| Spring Creek NFH | 2006 | 2 | 4.84 | 6.98 | 4.84 | 0.48 | 0.07 | 0.37 |
| **TOTAL** | | **12** | **36.67** | **80.55** | **40.19** | **4.02** | **1.02** | **3.30** |

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# APPENDICES

**Appendix A.** Total estimators for the aerial–access sample design.

**A. Estimating daily-, stratum-, and season-total fishery parameters**

Total fishing effort (in angler trips and boat trips) and Chinook encounters (harvested and/or released, by mark-status group) were estimated for each sampled day *i* in each stratum *j* (*j* = Monday-Thursday and Friday-Sunday strata, by week) by expanding dockside sample-frame totals to the non-sampled fraction of the fishery. First, dockside-frame totals ( $y_{ij}^{(ds)}$ ) were computed for each parameter (effort, catch, or reported releases) by summing observations from sampled sites (*k* = 1, 2, 3, or 4 [Port Townsend Ramp, Kingston Ramp, Edmonds Marina Dry Stack, and Everett Ramp]):

(1) $$y_{ij}^{(ds)} = \sum_{k=1}^{4} y_{ijk}$$

Given that *all* four dockside sample-frame sites were sampled for the entirety of *every* scheduled sample day, $y_{ij}^{(ds)}$ was taken as a census total with zero variance. Combining $y_{ij}^{(ds)}$ with an estimate of the fraction of area-wide effort encompassed by sampled sites ( $\bar{f}_j$ , described below) estimated from flight data, daily fishery-wide totals were estimated according to:

(2) $$\hat{Y}_{ij} = \frac{y_{ij}^{(ds)}}{\bar{f}_j}$$ , with variance

$$\text{var}(\hat{Y}_{ij}) = (y_{ij}^{(ds)})^2 \text{ var}(\frac{1}{\bar{f}_j})$$

For the weekend stratum (Fri-Sun), during which 100% daily coverage was achieved, stratum totals were taken as the sum of daily values estimated by Equation 2; the variance about stratum totals was taken as the sum of daily variances defined above, where $\text{var}(\frac{1}{\bar{f}_j})$ is estimated according to the parametric approach described below (Equation 5). Totals were estimated for the weekday (Mon-Thurs) stratum according to:

(3) $$\hat{Y}_j = N_j \frac{\sum_{i=1}^{n_j} \hat{Y}_{ij}}{n_j}$$, with variance

$$\text{var}(\hat{Y}_j) = N_j \left( \frac{N_j - n_j}{n_j} \right) \frac{\sum_{i=1}^{n_j} (\hat{Y}_{ij} - \bar{Y}_j)^2}{n_j - 1} + \frac{N_j}{n_j} \sum_{i=1}^{n_j} \text{var}(\hat{Y}_{ij})$$

where $N_j$ and $n_j$ are the total and sampled number of days in stratum *j*, respectively, and $\bar{Y}_j$ is the mean daily total for sampled days in stratum *j*.

## B. Estimating the sample fraction from aerial and dockside survey data

### 1. *Conceptual overview*

We estimated the fraction of area-wide effort encompassed by our dockside sample frame using a parametric statistical approach derived by Wan-Ying Chang, WDFW-Fish Program biometrician (unpublished memo). To do this, we viewed $f_{ij,}$ the true fraction of area-wide effort encompassed by the dockside sample frame, as a fixed unknown parameter; we also considered $\hat{f}_{ij}$, the fraction estimated from any given aerial survey, to vary as a function of flight time according to a specified probability distribution model (described below), with mean equal to $f_{ij}$. We further assumed that $\hat{f}_{ij}$ was independent and identically distributed (i.i.d.) across all days within relevant blocks. Based on these assumptions, we constructed a sampling distribution for $\bar{f}_j$ using data from days when both dockside and aerial surveys were conducted (by stratum *j*, if appropriate). Additionally, we derived an estimator for the variance of fishery totals (i.e., $\hat{Y}_{ij}$, Equation 3) that was consistent with $\bar{f}_j$'s sampling distribution.

There are two main advantages of this compared to other estimation approaches. First, depending on the distributional model chosen for $\bar{f}_j$, this parametric approach provides an analytical basis for computing the bias associated with $\hat{Y}_{ij}$ estimates. This information is needed to understand the quality of estimates, particularly given the potential for bias in ratio estimates in small sample-size cases (e.g., Cochran 1977). Second, using the parametric approach frees us from assuming that sampled and non-sampled angling parties have identical activity patterns within a given day. Given the difficulties associated with sampling the latter group, this assumption is more difficult to test than the i.i.d. assumption described above. Despite these advantages, additional analytical work (e.g. simulations) will likely be needed to fully understand the reliability of the present estimation method under different distributional assumptions.

### 2. *Computing individual $f_{ij}$ estimates and defining stratum boundaries*

On all days *i* within stratum *j* when both aerial and dockside surveys occurred, $f_{ij}$ was estimated according to

$$\hat{f}_{ij} = \frac{X_{ij}}{m_{ij}}, \tag{4}$$

where $m_{ij}$ is the aerial boat count and $X_{ij}$ is the number of boats counted during the aerial survey that ended their trips at sampled access sites, and were fishing at the time of the survey, as discerned from reported trip start and end times. Once all $\hat{f}_{ij}$ values were available, we assessed whether stratum-specific (weekday and weekend; i.e., $\bar{f}_j$) or pooled (i.e., $\bar{f}$) sampling distributions were supported by the data collected during the season. Though our power was limited (<10% where evaluated), a variety of statistical comparisons indicated that

$\bar{f}_j$ s were relatively homogeneous across strata ($P > 0.20$ for *t*, Mann-Whitney *U*, and median tests [Zar 1999]); thus, to maximize our sample size, we pooled data across weekend and weekday strata and constructed a single $\bar{f}_j$ sampling distribution.

*3. Estimating* $\bar{f}_j$ *and* $\text{var}(\frac{1}{\bar{f}_j})$

We estimated $\bar{f}_j$ simply as the arithmetic mean of $\hat{f}_{ij}$ s computed for the season. To estimate the variance of its reciprocal, $\text{var}(\frac{1}{\bar{f}_j})$, we assumed that $\hat{f}_{ij}$ s are i.i.d. Gamma($\alpha$,$\beta$) random variables; therefore $\bar{f}_j$ ~ Gamma($n\alpha$,$n\beta$), where $\alpha$ and $\beta$ are the distribution's shape and scale parameters, respectively, and *n* is the number of flights that occurred during the season. The Gamma distribution was chosen for modeling $\bar{f}_j$ for two reasons: 1) an expression for the bias in total estimates produced by Equation 2 can be easily derived under this distributional assumption, 2) this distribution can accommodate skewness or mimic a normal distribution, while simultaneously keeping a positive range. With sample $\alpha$ and $\beta$ values obtained using the Shenton and Bowman "almost unbiased" estimators (Johnson et al. 1994), $\text{var}(\frac{1}{\bar{f}_j})$ was estimated as:

$$\text{var}\left(\frac{1}{\bar{f}_j}\right) = \left[\beta^2\left(\alpha - \frac{1}{n}\right)^2(n\alpha - 2)\right]^{-1} \quad (5)$$

and $\alpha$ and $\beta$ were estimated as:

$$\hat{\alpha} = \frac{n-3}{2nR_n} + \frac{n+1}{6n} - \frac{(n+1)R_n}{18n} - \frac{(4n^2-10n+4)R_n^2}{135n(n+3)} \quad (6)$$

$$\hat{\beta} = \bar{f}_j\left[\frac{2nR_n}{n-1} - \frac{2nR_n^2}{2(n-1)} + \frac{4n(n+1)R_n^3}{9(n-1)(n+3)} - \frac{2n(7n^2-60n+7)R_n^4}{135(n-1)(n+3)(n+5)}\right]$$

where $R_n$ is:

$$R_n = \log\left[\frac{\bar{f}_j}{\sqrt[n]{\prod_{i=1}^{n}\hat{f}_{ij}}}\right] \quad (7)$$

Finally, given a Gamma distributional assumption, the relative bias ([expected – observed]/expected) in total estimates obtained from Equation 2 was computed using:

$$Bias = \frac{1}{n\alpha - 1}\cdot 100 \quad (8)$$

Given the data collected during the Area 9 winter 2008-09 fishery (**Appendix D**), we estimated $\alpha$ and $\beta$ parameters for the November 1-30, 2008 period at 7.39 and 0.034, respectively, and we estimated $\alpha$ and $\beta$ parameters for the January 16-April 15, 2009 period at 7.72 and 0.047, respectively. Given the $n = 8$ flights that occurred during the November 2008

period, and the $n$ = 12 flights that occurred during the January 16-April 15, 2009 period, the $\alpha$ estimates indicate that the estimates for each time period may suffer from a slight negative bias (2.3% in November 2008 and 1.2% in January-April 2009).

## C. Assumptions required for unbiased estimation of fishery parameters

*Statistical Assumptions*

1) The sample fraction estimated for any given day ( $\hat{f}_{ij}$ ) varies as a function of flight time following a Gamma probability distribution function with a mean equal to the true fraction;
2) All days within temporally defined strata have independent and identical probability distributions of $\hat{f}_{ij}$ ; this assumption applies to all days of the fishery if the mean sample fraction is estimated on a season-total level.

*Behavioral and Sampling Assumptions*

1) Salmon encounters (kept and released) per unit effort do not differ for anglers accessing the fishery from sampled and non-sampled access sites.
2) Party size (i.e., anglers/boat) does not differ for fishing vessels accessing the fishery from sampled and non-sampled sites.
3) The proportion of total recreational boating activity due to fishing is similar for parties accessing the fishery from sampled and non-sampled access sites.
4) Dockside samplers interview all boating parties active during flights that return to sampled sites, and aerial observers see all boats present in the area during flight surveys. Both sampling components are free from systematic errors in observation.
5) The proportion of total area-wide fishing effort returning to sampled sites (i.e., $\bar{f}_j$ ) does not differ between days when flights are and are not possible (i.e., "good" vs. "poor" weather days).

## **Appendix B.** 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 assessed 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 ( $\hat{E}_i$ , 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*

$\hat{E}_i$ = 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 $\hat{E}_i$ if anglers release any of the legal-marked Chinook that they encounter, the $\hat{E}_i$ 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]. $\hat{E}_i$ and its variance are estimated as:

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

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

[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 $\hat{E}_i$ 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:

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

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

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:

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

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

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*

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

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

$\hat{M}_{SUR\,i}$ = 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) $\hat{M}_{XYR\,i} = \hat{R}_{XY\,i} * sfm_{Y}$

(15) $\text{var}(\hat{M}_{XYR\,i}) = \text{var}(\hat{R}_{XY\,i}) * sfm_{Y}^{\,2}$

*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., $\hat{M}_{total} = \sum_{i=1}^{\max i} (\hat{M}_{XYK\,i} + \hat{M}_{XYR\,i})$ ] and variances [ $\text{var}(\hat{M}_{total}) = \sum_{i=1}^{\max i} [\text{var}(\hat{M}_{XYK\,i}) + \text{var}(\hat{M}_{XYR\,i})]$ ], 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., $\hat{M}_{total}$ , $\hat{K}_{LM\,i}$ , $\hat{E}_{i}$ , 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).

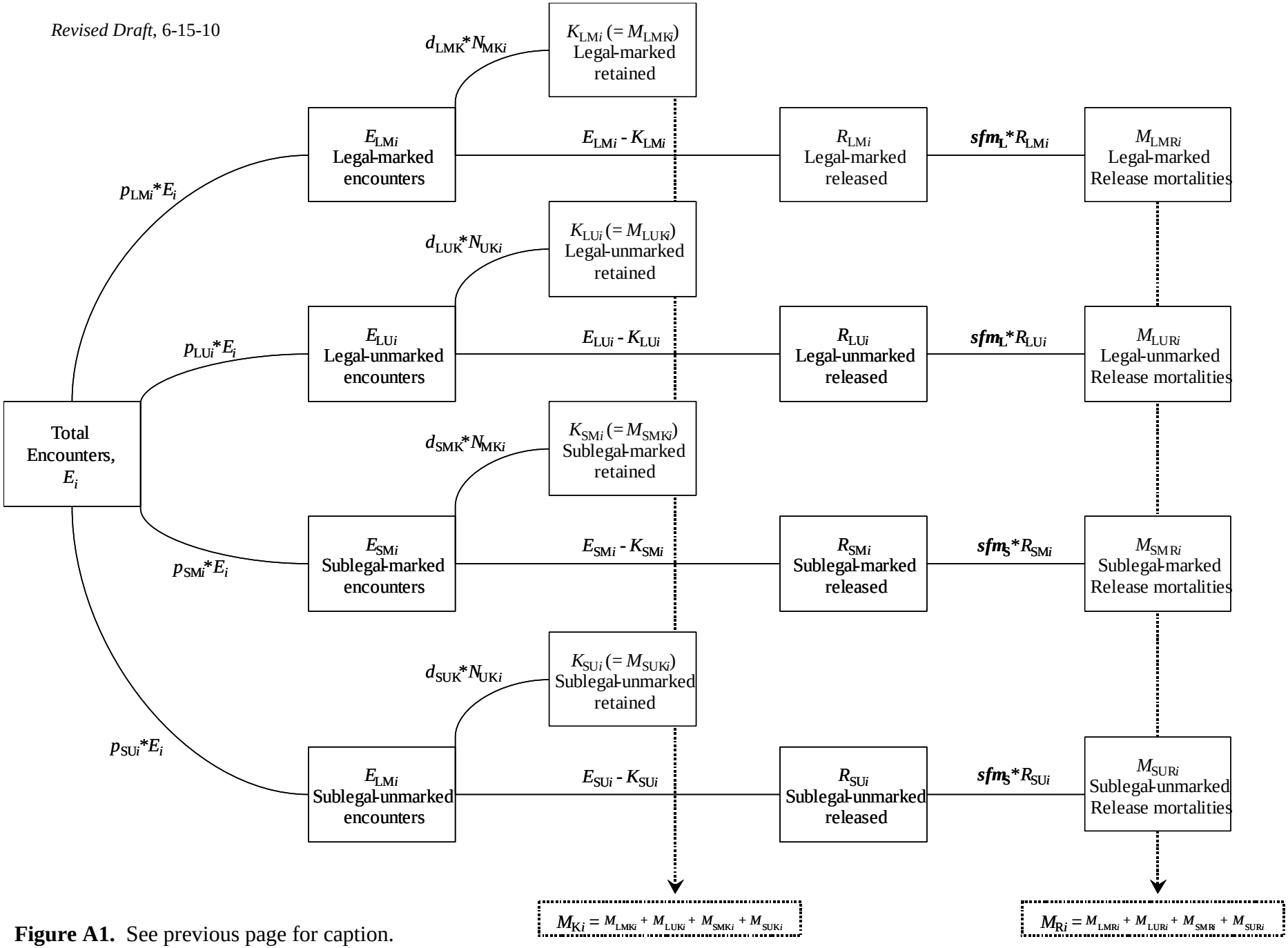


**Figure A1.** See previous page for caption.

**Appendix C**. Monthly sample rates (Total retained Chinook sampled [1/] / Estimated retained Chinook) in the winter 2008-09 Area 9 mark-selective Chinook fishery, November 1-30, 2008 and January 16-April 15, 2009.

| Time period | | | Estimated Retained Chinook | | | Number Retained Chinook Sampled [1/] | | | Sample Rate |
|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Stat. Weeks** | **Dates** | **Marked** | **Un-marked** | **Total** | **Marked** | **Un-marked** | **Total** | |
| November | 44-48 | Nov 1 - Nov 30 | 330 | 5 | 335 | 88 | 0 | 88 | 26.2% |
| January | 3-5 | Jan 16 - Feb 1 | 161 | 2 | 163 | 73 | 1 | 74 | 45.4% |
| February | 6-9 | Feb 2 - Mar 1 | 322 | 0 | 322 | 122 | 0 | 122 | 37.9% |
| March | 10-13 | Mar 2 - Mar 29 | 39 | 7 | 46 | 13 | 1 | 14 | 30.2% |
| April | 14-16 | Mar 30 - Apr 15 | 33 | 0 | 33 | 3 | 0 | 3 | 9.1% |
| **Season Total** | | | **885** | **14** | **899** | **299** | **2** | **301** | **33.4%** |

[1/] Number of retained Chinook sampled includes all retained Chinook inspected for CWT's, from all sites sampled during the winter 2008-09 Area 9 fishery (i.e., the four sample-frame sites included in the creel estimates, plus the fish sampled as part of baseline sampling in the Area).

**Appendix D.** Summary of aerial overflight and dockside data used to estimate the fraction of Area 9 effort captured in the four-site sample frame during the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery. See Appendix A for computational details and notation.

| Survey Date | Stratum | Aerial Survey Details | | | Dockside Sampling Details | | | Sample Fraction, $f_{ij}$ |
|---|---|---|---|---|---|---|---|---|
| | | Start Time | End Time | Total Boats, $m_{ij}$ | Total Boats, $\Sigma y_{ijk}$ | Fishing Boats | Active Boats, $X_{ij}$ | |
| 01-Nov | Weekend | 10:25 | 10:53 | 211 | 95 | 77 | 82 | 0.389 |
| 05-Nov | Weekday | 10:38 | 11:09 | 17 | 16 | 7 | 10 | 0.588 |
| 09-Nov | Weekend | 10:32 | 11:07 | 51 | 32 | 15 | 21 | 0.412 |
| 14-Nov | Friday | 10:24 | 10:48 | 54 | 25 | 13 | 15 | 0.278 |
| 15-Nov | Weekend | 10:35 | 11:03 | 94 | 52 | 29 | 35 | 0.372 |
| 18-Nov | Weekday | 11:48 | 12:26 | 5 | 9 | 2 | 3 | 0.600 |
| 21-Nov | Friday | 10:35 | 11:08 | 2 | 0 | 0 | 0 | 0.000 |
| 22-Nov | Weekend | 10:32 | 11:02 | 71 | 37 | 26 | 29 | 0.408 |
| November Stratum Summary Statistics: | | | Mean | 63 | 33 | 21 | 24 | 0.381 |
| | | | SD | 8.01 | 4.85 | 5.07 | 4.98 | 0.07 |
| | | | CV (%) | 12.7% | 14.6% | 24.0% | 20.4% | 17.5% |
| 24-Jan | Weekend | 10:42 | 11:00 | 34 | 25 | 19 | 20 | 0.588 |
| 01-Feb | Weekend | 10:44 | 11:09 | 40 | 25 | 19 | 19 | 0.475 |
| 14-Feb | Weekend | 10:27 | 10:45 | 166 | 99 | 75 | 77 | 0.464 |
| 19-Feb | Weekday | 11:03 | 11:21 | 11 | 8 | 6 | 6 | 0.545 |
| 21-Feb | Weekend | 10:42 | 11:13 | 102 | 40 | 26 | 28 | 0.275 |
| 27-Feb | Friday | 10:42 | 10:57 | 25 | 12 | 7 | 8 | 0.320 |
| 13-Mar | Friday | 10:36 | 10:54 | 16 | 20 | 13 | 13 | 0.813 |
| 17-Mar | Weekday | 11:13 | 11:28 | 3 | 2 | 1 | 1 | 0.333 |
| 21-Mar | Weekend | 10:43 | 11:10 | 67 | 49 | 37 | 39 | 0.582 |
| 04-Apr | Weekend | 10:33 | 10:48 | 58 | 33 | 19 | 19 | 0.328 |
| 10-Apr | Friday | 10:40 | 10:56 | 28 | 16 | 10 | 10 | 0.357 |
| 11-Apr | Weekend | 10:40 | 11:03 | 29 | 16 | 14 | 14 | 0.483 |
| Jan-April Stratum Summary Statistics: | | | Mean | 48 | 29 | 21 | 21 | 0.464 |
| | | | SD | 6.34 | 4.62 | 4.17 | 4.24 | 0.04 |
| | | | CV (%) | 13.1% | 16.1% | 20.3% | 20.0% | 9.6% |

**Appendix E.** Age composition of retained (dockside samples) and encountered (test fishery samples) Chinook salmon, during the winter 2008-09 mark-selective Chinook fishery in Area 9 (November 1-30, 2008 and January 16-April 15, 2009).

| Source | Mark-status group [1/] | Age Composition [2/] 1.1 | 2.1 | 2.2 | 3.1 | 3.2 | 4.1 | 4.2 | 5.1 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Dockside samples [3/] | AD | 0 | 2 | 0 | 91 | 5 | 166 | 9 | 1 | 274 |
| | | 0.0% | 1.0% | 0.0% | 33.0% | 2.0% | 61.0% | 3.0% | 0.0% | |
| Test Fishery | AD | 36 | 67 | 13 | 27 | 9 | 22 | 2 | 0 | 176 |
| | | 20.0% | 38.0% | 7.0% | 15.0% | 5.0% | 12.0% | 1.0% | 0.0% | |
| Test Fishery | UM | 48 | 16 | 26 | 4 | 5 | 7 | 0 | 0 | 106 |
| | | 45.0% | 15.0% | 25.0% | 4.0% | 5.0% | 7.0% | 0.0% | 0.0% | |

[1/] AD = Adipose fin-clipped (marked); UM = Adipose fin in tact (unmarked).

[2/] Gilbert-Rich age notation, "Total Age". "Age at outmigration", inclusive of time spent in incubation.

[3/] In addition, two retained unmarked Chinook that were sampled during dockside interviews (not shown in the above table) were determined to be age 4.1.

**Appendix F.** Coded-wire tag recoveries from Chinook salmon sampled during dockside angler interviews in the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery.

| Recovery Date | Tag Code | BY | ReleaseSite | RearingHatchery | Release Agency | DIT Code(s) | FL (cm) | Label |
|---|---|---|---|---|---|---|---|---|
| 11/30/2008 | 633372 | 2005 | BIG SOOS CR 09.0072 | | WDFW | 633371 | 70 | 54630 |
| 11/24/2008 | 632979 | 2005 | CHAMBERS CR 12.0007 | GARRISON HATCHERY | WDFW | | 56 | 54629 |
| 02/21/2009 | 633472 | 2005 | CHAMBERS CR 12.0007 | LAKEWOOD HATCHERY | WDFW | | 71 | 54967 |
| 11/01/2008 | 633286 | 2005 | CLEAR CR 11.0013C | NISQUALLY HATCHERY | NISQ | 210681 | 55 | 51391 |
| 04/05/2009 | 210688 | 2006 | COWSKULL ACCLIM POND | COWSKULL ACCLIM POND | PUYA | | 55 | 57717 |
| 02/04/2009 | 633382 | 2005 | FINCH CR 16.0222 | HOODSPORT HATCHERY | WDFW | | 72 | 57042 |
| 01/17/2009 | 633369 | 2005 | FRIDAY CR 03.0017 | SAMISH HATCHERY | WDFW | 633368 | 59 | 49534 |
| 02/21/2009 | 633369 | 2005 | FRIDAY CR 03.0017 | SAMISH HATCHERY | WDFW | 633368 | 70 | 54925 |
| 02/14/2009 | 633467 | 2005 | GREEN R 09.0001 | ICY CR HATCHERY | WDFW | | 64 | 57046 |
| 02/06/2009 | 633467 | 2005 | GREEN R 09.0001 | ICY CR HATCHERY | WDFW | | 61 | 54924 |
| 01/18/2009 | 633467 | 2005 | GREEN R 09.0001 | ICY CR HATCHERY | WDFW | | 68 | 57715 |
| 11/01/2008 | 633285 | 2005 | GROVERS CR 15.0299 | GROVERS CR HATCHERY | SUQ | 210682 | 67 | 57713 |
| 02/06/2009 | 633285 | 2005 | GROVERS CR 15.0299 | GROVERS CR HATCHERY | SUQ | 210682 | 67 | 57043 |
| 11/01/2008 | 633285 | 2005 | GROVERS CR 15.0299 | GROVERS CR HATCHERY | SUQ | 210682 | 60 | 57028 |
| 02/14/2009 | 633366 | 2005 | PURDY CR 16.0005 | GEORGE ADAMS HATCHRY | WDFW | 633365 | 77 | 50662 |
| 11/01/2008 | 633366 | 2005 | PURDY CR 16.0005 | GEORGE ADAMS HATCHRY | WDFW | 633365 | 72 | 54628 |
| 02/13/2009 | 633875 | 2006 | PURDY CR 16.0005 | GEORGE ADAMS HATCHRY | WDFW | 633876 | 54 | 49670 |
| 02/14/2009 | 210677 | 2005 | SKAGIT R 03.0176 | | WDFW | | 73 | 50663 |
| 02/28/2009 | 052577 | 2006 | SPRING CR 29.0159 | SPRING CR NFH | FWS | 053484 | 59 | 50264 |
| 01/18/2009 | 052577 | 2006 | SPRING CR 29.0159 | SPRING CR NFH | FWS | 053484 | 54 | 54922 |
| 04/03/2009 | 633375 | 2005 | VOIGHT CR 10.0414 | VOIGHTS CR HATCHERY | WDFW | | 71 | 57215 |
| 02/14/2009 | 210684 | 2005 | WHITEHORSE SPRINGS | WHITEHORSE POND | COOP | | 81 | 50661 |

**Appendix G.** Fishery-total estimates of retained and released salmon (Chinook and other species) catch for the winter 2008-09 (November 1-30, 2008 and January 16-April 15, 2009) Area 9 mark-selective Chinook fishery. Displayed Chinook harvest values are equivalent to those displayed in **Table 3**. Whereas the Chinook release estimates displayed in **Table 3** 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. AD = marked (i.e., adipose-clipped), UM = unmarked, UNK = unknown mark status.

| Stat Week | Est. Effort | | Est. Retained Catch | | | | | | | Est. Releases | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boats | Anglers | Chinook | | | Coho | | | Chum | Chinook | | | | Coho | | | | Chum | Unk. Salmon |
| | | | Mark | Unmark | Total | Mark | Unmark | Total | | Mark | Unmark | Unk. | Total | Mark | Unmark | Unk. | Total | | |
| 44 | 294 | 614 | 61 | 0 | 61 | 2 | 0 | 2 | 0 | 512 | 330 | 1,335 | 2,177 | 7 | 0 | 56 | 63 | 0 | 697 |
| 45 | 138 | 265 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 34 | 17 | 294 | 345 | 19 | 7 | 12 | 39 | 0 | 163 |
| 46 | 265 | 515 | 58 | 0 | 58 | 0 | 0 | 0 | 0 | 197 | 85 | 432 | 714 | 5 | 5 | 44 | 53 | 0 | 289 |
| 47 | 221 | 420 | 107 | 0 | 107 | 0 | 0 | 0 | 0 | 223 | 107 | 350 | 680 | 5 | 2 | 51 | 58 | 0 | 468 |
| 48 | 510 | 932 | 95 | 5 | 100 | 0 | 0 | 0 | 0 | 369 | 175 | 1,260 | 1,804 | 15 | 7 | 75 | 97 | 0 | 367 |
| 3 | 214 | 423 | 81 | 2 | 83 | 0 | 0 | 0 | 0 | 101 | 60 | 79 | 239 | 7 | 0 | 0 | 7 | 0 | 5 |
| 4 | 111 | 231 | 33 | 0 | 33 | 0 | 0 | 0 | 0 | 27 | 9 | 49 | 85 | 0 | 0 | 2 | 2 | 0 | 0 |
| 5 | 153 | 285 | 47 | 0 | 47 | 4 | 0 | 4 | 0 | 44 | 5 | 11 | 60 | 9 | 0 | 0 | 9 | 0 | 16 |
| 6 | 301 | 574 | 91 | 0 | 91 | 0 | 0 | 0 | 0 | 38 | 45 | 117 | 200 | 3 | 2 | 13 | 18 | 0 | 17 |
| 7 | 401 | 876 | 108 | 0 | 108 | 0 | 0 | 0 | 0 | 68 | 21 | 35 | 123 | 25 | 4 | 7 | 36 | 0 | 0 |
| 8 | 229 | 471 | 75 | 0 | 75 | 0 | 0 | 0 | 0 | 55 | 31 | 22 | 107 | 0 | 2 | 4 | 7 | 2 | 20 |
| 9 | 138 | 271 | 48 | 0 | 48 | 0 | 0 | 0 | 0 | 37 | 31 | 33 | 100 | 0 | 2 | 2 | 4 | 0 | 24 |
| 10 | 103 | 190 | 24 | 0 | 24 | 0 | 0 | 0 | 0 | 63 | 28 | 39 | 131 | 0 | 7 | 4 | 11 | 0 | 4 |
| 11 | 63 | 109 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 24 | 9 | 28 | 61 | 4 | 7 | 4 | 15 | 0 | 0 |
| 12 | 138 | 280 | 13 | 7 | 20 | 0 | 0 | 0 | 0 | 50 | 9 | 24 | 83 | 2 | 0 | 0 | 2 | 0 | 7 |
| 13 | 39 | 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 4 | 7 | 48 | 4 | 4 | 0 | 9 | 0 | 11 |
| 14 | 214 | 389 | 22 | 0 | 22 | 0 | 0 | 0 | 0 | 61 | 48 | 35 | 144 | 4 | 7 | 0 | 11 | 0 | 8 |
| 15 | 87 | 155 | 11 | 0 | 11 | 0 | 0 | 0 | 0 | 41 | 11 | 28 | 81 | 0 | 0 | 9 | 9 | 0 | 0 |
| 16 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **3,622** | **7,064** | **885** | **14** | **899** | **7** | **0** | **7** | **0** | **1,983** | **1,023** | **4,177** | **7,183** | **109** | **57** | **284** | **450** | **2** | **2,094** |
| **Grand Total Summary Statistics:** | | | | | | | | | | | | | | | | | | | |
| **Var** | 18,437 | 68,093 | 3,131 | 14 | 3,145 | 10 | | 10 | | 26,360 | 8,044 | 131,734 | 166,138 | 482 | 47 | 102 | 973 | 0.001 | 53,719 |
| **SE** | 136 | 261 | 56 | 4 | 56 | 3 | | 3 | | 162 | 90 | 363 | 408 | 22 | 7 | 10 | 31 | 0.031 | 232 |
| **CV** | 3.7% | 3.7% | 6.3% | 27.0% | 6.2% | 46.8% | | 46.8% | | 8.2% | 8.8% | 8.7% | 5.7% | 20.0% | 12.0% | 3.6% | 6.9% | 1.5% | 11.1% |
| **95% CI** | 3,356-3,888 | 6,553-7,575 | 776-995 | 6-21 | 789-1,009 | 2-12 | | 1-13 | | 1,665-2,301 | 847-1,199 | 3,466-4,888 | 6,384-7,982 | 6-124 | 44-70 | 264-303 | 389-511 | 2-2 | 1,639-2,548 |

**Appendix H.** 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 9 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 | |
| 9 | January 16 -April 15, 2008 | 6,887 | 1,333 | 3 | 72 | 0 | 195 | 304 | 1,288 | 375 | 3,570 |
| 9 | Nov 1 - 30, 2008 and January 16 - April 15, 2009 | 7,064 | 871 | 14 | 14 | 0 | 130 | 158 | 3,520 | 2,837 | 7,545 |