

2015 OCEAN SELECTIVE FISHERY SAMPLING REPORT

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1. INTRODUCTION

The Pacific Fishery Management Council (PFMC) adopted 2015 recreational and commercial troll fisheries for all salmon species in the area between Cape Falcon, Oregon and the U.S./Canada border. Recreational mark-selective fisheries (MSFs) for Chinook and coho and commercial MSFs for coho were included in all four Catch Record Card (CRC) areas of coastal Washington (Areas 1, 2, 3, and 4). Council-area fisheries were adopted based on assumptions regarding coho and Chinook abundance, distribution of stocks, Chinook age class distributions, coho mark rates, compliance with selective fishery regulations, and incidental mortality.

The PFMC adopted an ocean recreational Chinook MSF in Marine Areas 1 through 4 for the sixth consecutive year, following state-tribal agreement during the North of Falcon process. The fishery was open for 18 total days in May and June in the northern coastal areas and for 14 days in the southern coastal areas. Consistent with the Washington Department of Fish and Wildlife's (WDFW) intent of Puget Sound/Strait of Juan de Fuca Chinook MSFs as well as the prior ocean pilot Chinook MSFs, the primary goal for this selective fishery was to provide meaningful opportunity to the recreational angling public while minimally impacting ESA-listed Chinook salmon encountered in the mixed-stock ocean fisheries. WDFW's Ocean Sampling Program (OSP) continued its intensive monitoring program in all ocean ports during the season to collect data to estimate key parameters characterizing the fishery and its impacts on unmarked salmon. Sampling activities included on-water observation, a Voluntary Trip Report (VTR) system, and dockside creel sampling. Among other parameters, sampling activities 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]), *iii*) the total number of Chinook salmon released (by size/mark-status), *iv*) the coded-wire tag (CWT) and/or DNA-based stock composition of marked and unmarked Chinook mortalities, and *v*) the total mortality of marked and unmarked double index tag (DIT) CWT stocks.

Additionally, coho MSFs were adopted in 2015 for the seventeenth consecutive year, and the OSP continued its intensive monitoring program in all ocean ports. Sampling activities were identical to those employed during the Chinook MSF. Sampling activities during the coho MSF emphasized data collection needs for the estimation of: *i*) the mark rate of the targeted coho population, *ii*) the total number of coho harvested by mark-status, including an estimate of angler compliance rate with coho MSF regulations, *iii*) the total number of coho released (by mark-status), *iv*) the coded-wire tag (CWT) stock composition of landed coho, and *v*) the total mortality of marked and unmarked coho.

2. SEASON DESCRIPTION

2.1 Ocean Recreational Chinook MSF

CRC Areas 1 (from Cape Falcon, OR to Leadbetter Point, WA) and 2 (from Leadbetter Point to the Queets River) were open for all salmon except coho seven days per week from May 30 through June 12. A daily bag limit of two salmon was in effect. All retained Chinook were required to have a healed adipose fin clip, and the minimum size limit was 24 inches total length for Chinook. A total of 14 fishing days were available during this fishery.

CRC Areas 3 (from the Queets River to Cape Alava) and 4 (from Cape Alava to the U.S./Canada border) were open for all salmon except coho May 15 and 16, May 22 and 23, then seven days per week from May 30 through June 12. A daily bag limit of two salmon was in effect. All retained Chinook were required to have a healed adipose fin clip, and the minimum size limit was 24 inches total length for Chinook. A total of 18 fishing days were available during this fishery.

The fishery operated under a coastwide landed quota of 10,000 marked Chinook. **Figure 1** shows the Washington ocean CRC areas.

2.2 Ocean Recreational All-Species Fisheries (Coho Mark-Selective)

CRC Area 1: The ocean recreational fishery in CRC Area 1 was open for all salmon species seven days per week from June 13 through September 30. A daily bag limit of two salmon, one of which could be a Chinook, was in effect June 13 – August 28; the bag limit was modified in-season to two salmon from August 29 – September 30. All retained coho were required to have a healed adipose fin clip from June 13 – September 3. The fishery was modified to allow retention of unmarked coho beginning September 4 through the season with a bag limit of two salmon. The Columbia Control Zone was closed. A total of 110 fishing days were available in the area (83 days coho MSF, 27 days coho non-selective).

CRC Area 2: The ocean recreational fishery in CRC Area 2 was open for all salmon species seven days per week from June 13 through September 30. A daily bag limit of two salmon, one of which could be a Chinook, was in effect June 13 - August 14; the bag limit was modified in-season to two salmon from August 15 – September 30. From June 13 – September 3, all retained coho were required to have a healed adipose fin clip. The fishery was modified to allow retention of unmarked coho beginning September 4 with a bag limit of two salmon. A total of 110 fishing days were available in the area (83 days coho MSF, 27 days coho non-selective).

CRC Area 3: The ocean recreational fishery in CRC Area 3 was open for all salmon species seven days per week from June 13 through September 30. From October 1 - October 11, salmon fishing was open but restricted to the part of Area 3 north of 47°50'00" north latitude and south of 48°00'00" north latitude, seven days per week. A daily bag limit of two salmon plus two pink was in effect June 13 – July 23; the bag limit was modified in-season to daily bag limit of two salmon, one of which could be a Chinook, plus 2 pink from July 24 – September 30 and reverted to two salmon plus two pink October 1 - 11. From June 13 – September 3 and from October 1 -

October 11, all retained coho were required to have a healed adipose fin clip. The fishery was modified to allow retention of unmarked coho from September 4 - 30. A total of 121 fishing days were available in the area (94 days coho MSF, 27 days coho non-selective).

CRC Area 4: The ocean recreational fishery in CRC Area 4 was open for all salmon species seven days per week from June 13 through September 30. A daily bag limit of two salmon plus two pink was in effect June 13 – July 23; the bag limit was modified in-season to daily bag limit of two salmon, one of which could be a Chinook, plus 2 pink from July 24 – August 1. From August 2 – 20, no chinook retention was allowed with the exception of August 14-15 when one chinook was allowed as part of the daily bag limit. From August 21 – September 30, a daily bag limit of two salmon, one of which could be a Chinook, plus 2 pink was in effect. From June 14 – August 31, all retained coho were required to have a healed adipose fin clip. The fishery was modified to allow retention of unmarked coho September 4 – 10. A total of 110 fishing days were available in the area (103 days coho MSF, 7 days coho non-selective).

The all-species fishery operated under preseason quotas of 54,000 landed Chinook and 150,800 landed marked coho. The portions of the all-species fishery that were mark-selective for coho are described in this report.

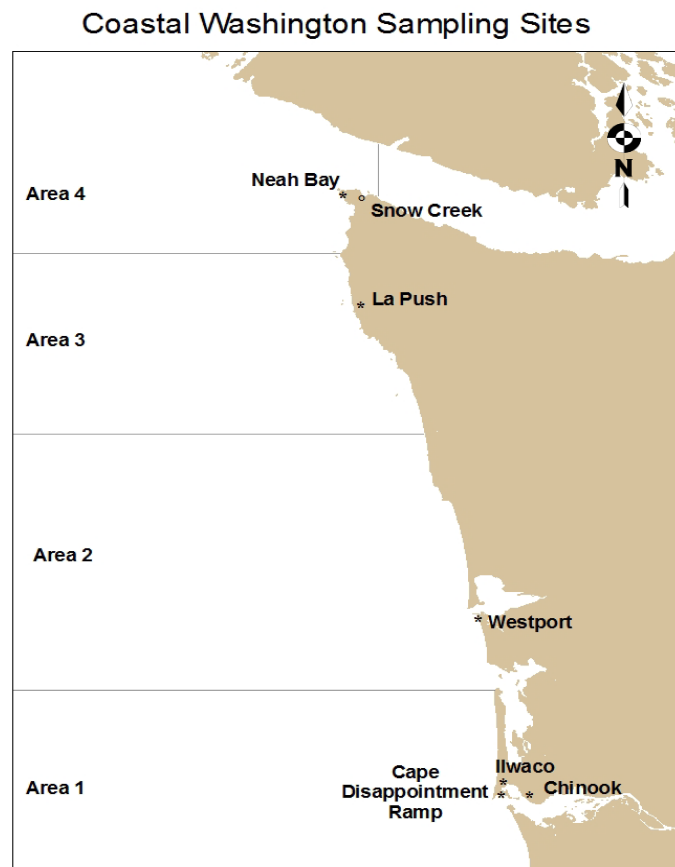


Figure 1. Map of coastal Washington showing the ocean catch record card areas (Areas 1 through 4) and major sampling sites.

2.3 Non-Treaty Commercial Troll Fisheries (Coho Mark-Selective)

The non-Treaty troll fishery was open in May and June for all salmon except coho from Cape Falcon, Oregon to the U.S.-Canada border. The sub-areas were open during this time as follows: Area 4: 43 days, Area 3: 16 days, Area 2: 56 days, and Area 1: 44 days. The fishery reopened for all salmon species except no chum retention north of Cape Alava, WA in August on July 1 for 67 available fishing days in all areas between Cape Falcon, Oregon and the U.S.-Canada border. All retained coho were required to have a healed adipose fin clip except that retention of unmarked coho was allowed from September 18-22 in the area between Cape Falcon, OR and the Queets River. Specific open dates and regulations are available in the PFMC Review of 2015 Ocean Salmon Fisheries (<http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/>).

The portion of the all-species fishery that was mark-selective for coho is described in this report.

3. METHODS

WDFW's Ocean Sampling Program (OSP) implemented a comprehensive monitoring program in all ocean ports during the Chinook and coho MSF seasons in Washington ocean CRC Areas 1-4. OSP collected data to estimate key fishery parameters characterizing the ocean MSFs and associated impacts on unmarked salmon. Sampling activities included dockside angler interviews (with catch sampling), total boat counts via exit or entrance counts at each major coastal port, direct on-the-water observations of salmon encounters during charter ride-along trips, and voluntary trip reports of completed trips provided by charter boat skippers and the angling public.

3.1 On-Board Observation

WDFW samplers conducted direct on-water observation of salmon encounters aboard charter vessels during both the recreational Chinook MSF and the recreational all-species coho MSF. Data collected aboard charter boats were used to estimate the encounter rates of Chinook by size class and mark group (legal-size and marked [LM], legal-size and unmarked [LU], sublegal-size and marked [SM], and sublegal-size and unmarked [SU]), as well as encounter rates of marked and unmarked coho, and drop-offs. In addition, samplers collected DNA samples from legal sized and sublegal sized Chinook while aboard charter vessels.

WDFW observers rode along on charter vessels and recorded all hook-ups aboard the vessel. For each hook-up, the following information was recorded: result of the hook-up (fish kept, released, or dropped off), species, mark status (marked or unmarked), and size class (legal or sublegal). A sampling protocol was established for the observers so that the most important information relative to this study was collected first. The first priority for the observers was to record the species, mark status, size category, and result of each hook-up aboard the vessel. Collection of these data enabled estimation of encounter rates for Chinook and coho by size/mark status, and drop-off numbers. The second priority was to collect DNA samples (a small non-lethal clipping from the tip of the dorsal fin), lengths, and scale samples from all Chinook during the Chinook MSF and from sublegal-sized Chinook during the all-species fishery. DNA from sublegal-sized

Chinook was prioritized above that from legal-sized Chinook when Chinook retention was not mark-selective since legal-sized fish were available on the dock as well as at sea. The third priority was to collect DNA, lengths, and scale samples from legal-sized Chinook.

Direct on-water observation of salmon encounters was the primary method used in CRC Areas 1 and 2 where charter vessel salmon fishing trips are numerous to determine mark rates, encounter rates, and drop-off rates. The Voluntary Trip Report (VTR) system (see Section 3.2 below) was the secondary method used to collect encounter data in these two areas.

In CRC Areas 3 and 4, where few charter vessels take salmon fishing trips, and those who do are very small, the VTR system was the primary method used to collect on-water encounter data; the charter ride-along method was used secondarily in these areas.

3.2 Voluntary Trip Reports

Selective fishery encounter statistics were also acquired through Voluntary Trip Reports that WDFW samplers distributed and collected from the angling public in all ocean CRC Areas. The VTR form is designed to capture information identical to that collected by on-board observers. Anglers complete the information on the form as they fish, minimizing recall error.

Samplers distributed VTRs on every sampled day in all sampled ports. Samplers approached anglers preparing to depart for fishing or after returning from fishing, explained the purpose of the VTR and how to complete it, and encouraged anglers to record all encounters and return the form to a dockside sampler at the end of the fishing day. Anglers could also mail these forms to the WDFW Region 6 office postage-paid. Additionally, office staff contacted anglers by phone or mail who regularly complete VTRs prior to the season and provided blank VTRs.

In 2013, a new, simpler VTR form was developed to meet the needs of north coast charter boats that do not have sufficient time while fishing to complete the traditional VTR form. The new forms ask anglers simply to tally encountered salmon in the appropriate species/size class/mark status/result of encounter category, ie for each species, kept legal marked, kept legal unmarked, released legal marked, released legal unmarked, kept sublegal marked, kept sublegal unmarked, released sublegal marked, or released sublegal unmarked. They are also asked to tally drop offs and kept/released pink. These new forms, which received positive angler feedback in 2013 and 2014, were distributed more widely in 2015; north coast, Westport, and Ilwaco charter skippers along with private boat anglers with a history of completing traditional VTRs were given binders with these forms. Traditional VTRs were distributed to all other anglers.

3.3 Dockside Sampling

Dockside samplers were stationed in the four major landing ports for the ocean fisheries: Neah Bay (including Snow Creek Resort), La Push, Westport, and Ilwaco (including the port of Chinook and the Columbia River North Jetty). The recreational fisheries in each port were sampled a minimum of 4 to 5 days per week, with weekend (Saturday, Sunday, and holidays) and weekday days (non-holiday Monday through Friday) stratified. Typically, all weekend days

and a randomly-selected 3 of 5 weekdays were sampled. Total fishery catch and effort estimates were generated by the OSP using three types of data obtained during dockside sampling: effort counts, interview data, and examination of catch. Each is described below.

Effort Counts

On each sample day, a total recreational boat count was obtained either by counting boats exiting the port or entering the port. A minimum of 20% of the boats returning to the port within each boat type (charter and private) was sampled. An exit count (a count of boats leaving the port) typically began at 4:30AM and continued through the end of the sampling day (exact time was port-specific). An entrance count (a count of boats entering the port) usually began near 8:00AM and continued through dusk. Whether OSP samplers conducted exit or entrance counts varied based on specific considerations for each port. Regardless of the method used, this effort count, taken on every sampled day, provided the total counts of charter and private boats to which sample data were expanded.

Angler Interviews and Catch Sampling

WDFW samplers stationed in coastal ports collected catch and effort information during dockside angler interviews from boats returning from fishing. Information collected during each sample included number of anglers, target species, area fished, landed catch by species, mark status of landed salmon, identification and recovery of coded wire tags, and angler estimates of released salmon by species and mark status and of released groundfish by species. Additionally, dockside samplers collected DNA samples, lengths, and scale samples from landed Chinook as time allowed.

3.4 Estimating Catch and Effort

3.4.i Estimated Stratum Totals (Primary Stage)

Combined (total) catch estimates are typically stratified by weekend/holiday and weekday. In some strata, every day is sampled. In those strata the combined estimates are simply sums of the daily catches. In other strata, where some days are not sampled, the average catch per day over all sampled days is multiplied by the number of days in the stratum to estimate the total catch.

Let:

- a = the marine catch area,
- i = trip type,
- t = Weekend/holiday or Weekday stratum,
- N_t = the number of days in stratum t ,
- T_t = collection of all days in stratum t ,
- n_t = the number of days sampled in stratum t ,
- S_t = collection of sampled days in stratum t (when $S=T$, $n=N$),
- Y_{taik} = estimated catch (or effort) on day k for stratum t in area a from trip type i ,

C_{tai} = catch for stratum t in area a from trip type i ,

Then

$$\hat{C}_{tai} = N_t \frac{\sum_{k \in S_t} \hat{Y}_{taik}}{n_t}$$

with estimated variance (see Thompson 1992, p. 129):

$$\hat{V}(\hat{C}_{tai}) = \frac{N_t(N_t - n_t)}{n_t} \frac{\sum_{k \in S_t} (\hat{Y}_{taik} - \hat{\bar{Y}}_{tai})^2}{n_t - 1} + \frac{N_t}{n_t} \sum_{k \in S_t} \hat{V}(\hat{Y}_{taik})$$

where

$$\hat{\bar{Y}}_{tai} = \frac{\sum_{k \in S_t} \hat{Y}_{taik}}{n_t}.$$

For strata with all days sampled, $n_t = N_t$, and the catch and variance estimators reduce to:

$$\hat{C}_{tai} = \sum_{k \in T_t} \hat{Y}_{taik}$$

and

$$\hat{V}(\hat{C}_{tai}) = \sum_{k \in T_t} \hat{V}(\hat{Y}_{taik}).$$

3.4.ii Daily Catch and Effort Estimation (Secondary Stage)

Both catch and effort are post-stratified by trip-type and area fished. Effort in terms of boat-trips is simply the sample number of boats for each trip-type and area expanded by the appropriate boat-type (charter or private) exit/entrance count. Effort in terms of angler-trips is calculated as the mean number of anglers per boat (indexed by trip-type and area) expanded by the counted total population of boats.

The total catch for a given species on a sampled day is the product of the population of boats and the estimated catch per boat, again post-stratified by trip-type and area fished. Key assumptions in the current estimation procedures are that:

- 1) All boats exiting/entering a port are included in the exit/entrance count
- 2) Exit/entrance counts are made without error

- 3) The approximate systematic sample of boats can be treated as a simple random sample
- 4) Anglers answer questions accurately and do not conceal fish

In the following discussion, subscripts referring to port and boat-type are suppressed. Let:

M_t = total exit or entrance count for a given port on day t (assumed known without error),

m_t = total boats sampled on day t ,

m_{tai} = number of boats sampled of trip type i fishing in area a on day t ,

a_{taij} = number of anglers on the j th boat from trip type i fishing in area a on day t ,

y_{taij} = number of species specific fish caught on the j th boat from trip type i in area a on day t , and

Y_{tai} = total catch of specific species caught from trip type i in area a on day t .

The estimate of the number of boat-trips of trip-type i and area a follows the procedure outlined in Lai et. al. (1991) where the proportion of boats in each category is estimated by:

$$\hat{p}_{tai} = \frac{m_{tai}}{m_t}$$

with estimated variance (see Cochran 1977, p. 52):

$$V(\hat{p}_{tai}) = \frac{\hat{p}_{tai} \cdot (1 - \hat{p}_{tai})}{(m_t - 1)} \cdot \left(\frac{M_t - m_t}{M_t} \right)$$

The estimated total boat-trips is then obtained by:

$$\hat{M}_{tai} = M_t \cdot \hat{p}_{tai}$$

with estimated variance:

$$\hat{V}(\hat{M}_{tai}) = M_t^2 \cdot \hat{V}(\hat{p}_{tai})$$

Effort expressed in terms of angler-trips is the product of the average anglers per boat-trip times the total number of boat-trips. The mean number of anglers per boat-trip (for trip-type i and fishing area a) is estimated as:

$$\hat{a}_{tai} = \frac{\sum_j a_{taij}}{m_t}$$

with variance:

$$\hat{V}(\hat{a}_{tai}) = \frac{\sum_j (a_{taij} - \hat{a}_{tai})^2}{m_t(m_t - 1)} \cdot \left(\frac{M_t - m_t}{M_t}\right)$$

Thus the estimated total number of angler-trips is:

$$\hat{a}_{tai} = M_t \cdot \hat{a}_{tai}$$

with variance:

$$\hat{V}(\hat{a}_{tai}) = M_t^2 \cdot \hat{V}(\hat{a}_{tai})$$

The catch (or number released) for a specific species on sampled day t in area a from trip type i is similarly estimated by:

$$\hat{Y}_{tai} = \frac{\sum_j y_{taij}}{m_t} M_t$$

with estimated variance:

$$\hat{V}(\hat{Y}_{tai}) = \frac{\sum_j (y_{taij} - \hat{y}_{tai})^2}{m_t(m_t - 1)} M_t(M_t - m_t)$$

This estimate and its variance differs somewhat from that described in Lai et al. (1991) since the total count, M_t (assumed to be a known quantity), is used to expand the estimated CPUE (calculated over all sampled boats) rather than the estimated boat-trips by trip-type and area fished.

3.5 Estimating Chinook Encounters and Mortalities

The overall impacts of the May - June 2015 recreational Chinook MSF in ocean CRC Areas 1-4 are characterized in terms of grand-total estimates of Chinook 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**). The method described above in section 3.4 was used to generate total estimates of angler effort, retained catch by species, and releases of all fish species except for Chinook salmon released during the Chinook MSF in Areas 1-4. To estimate Chinook salmon releases (and thus, total encounters) by size/mark group, we applied Conrad and McHugh's (2008) bias-corrected approach, the same method that the Puget Sound Sampling Unit (PSSU) has used since 2008 to estimate Chinook releases in Puget Sound Chinook MSFs (e.g., WDFW 2011).

Prior to summer 2008, PSSU had generated two different Chinook encounters estimates based on two separate estimation methods ("Method 1" and "Method 2"; see WDFW 2011 and Conrad

and McHugh 2008 for details). Method 1 estimates of total Chinook encounters were derived from the combination of dockside observations of landed catch and angler interview responses about salmon releases; thus, as Conrad and McHugh explain, the accuracy of Method 1 estimates depended heavily on the ability of anglers to correctly recall and report the number of Chinook they actually encountered and released. Method 2 estimates of Chinook encounters were obtained using the creel survey estimates of the total number of legal-size, marked Chinook harvested in combination with the on-water observation or VTR data to estimate both the total number of Chinook encounters and to apportion the encounters to four size/mark status categories (LM, LU, SM, SU). The Method 2 estimator was derived assuming that anglers retain all LM Chinook encountered; therefore, its accuracy depended on the extent to which angler behavior deviates from this idealized case. Based on their analyses and practical considerations regarding the most feasible bias correction approaches, Conrad and McHugh ultimately recommended using Method 2 with a correction for the release of legal-size marked Chinook as the preferred method for estimating total Chinook encounters in Chinook MSFs. After a thorough state-tribal technical review of Conrad and McHugh's method in August 2008, state and tribal technical representatives agreed to use this bias-corrected approach to produce a "best estimate" of Chinook encounters.

Thus, we estimated Chinook releases in the 2015 Chinook MSF as the difference between retained catch (i.e., from the dockside creel survey) and total Chinook encounters (i.e., releases = encounters – retained catch) generated using the Conrad and McHugh (2008) approach. We first divided the creel estimate of legal-marked Chinook harvest by the onboard observer-based estimate of the proportion of the fishable Chinook population that was of legal size and marked (i.e., the former "Method 2" approach; WDFW 2011). Given that this approach yields negatively biased estimates if anglers release any of the legal-marked Chinook they encounter, we then applied Conrad and McHugh's bias correction factor to account for this phenomenon (13%) and incorporated it into the estimator (See **Appendix A** for complete computational details).

We estimated total Chinook mortality resulting from the 2015 Chinook MSF 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 a selective fishing mortality (*sfm*) rate of 14% to legal (marked and unmarked) and sublegal (marked and unmarked) release totals, to estimate release mortality in the ocean (the same ocean *sfm* value used in FRAM). See **Appendix A** for a complete description of our impact estimation procedure, including formulae for total and variance estimators.

The final step of our overall impacts assessment involved comparing fishery outcomes to pre-season expectations. To do this, we compared season-total estimates of Chinook encounters and mortalities to pre-season modeled values (FRAM model run no. 2115) for each size and mark status category.

Table 3. Sampling/estimation details on target parameters associated with the overall Chinook MSF monitoring program in Washington coastal Areas 1 through 4.

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

^{1/} Under the “bias-corrected Method-2” approach, Chinook releases can be estimated only as finely as onboard observer data allow.

3.6 CWT Impacts

To understand the potential effects of the 2015 ocean recreational Chinook MSF on the CWT program, we estimated the total number of marked and unmarked double index tagged (DIT) Chinook mortalities that may have occurred during the course of the fishery. To do this, we acquired information for all marked CWT 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 Pacific Salmon Commission’s Selective Fisheries Evaluation Committee–Analytical Work Group (SFEC-AWG 2002) to estimate the number of unmarked DIT fish encountered¹. We subsequently estimated the number of these fish that may have died due to hook-and-release impacts using an *sfm* analogous to that used in FRAM modeling. Given our interest in characterizing the impacts of MSF regulations on the CWT program and not recreational fishing in general, we used an *sfm* of 14% in all unmarked-DIT mortality calculations. The *sfm* value of 14% did not include unseen drop-off mortality (assumed to be 5% in FRAM) because drop-off mortality occurs in both selective and non-selective recreational Chinook fisheries.

¹ For all unmarked-DIT encounters and mortalities calculations, we relied on the unmarked-to-marked abundance ratio (λ) estimated for DIT groups at the time of juvenile release.

We estimated Chinook encounters and mortalities for each recovered DIT individually and then summed estimates for each hatchery, brood year, and area based on the methods described by SFEC-AWG 2002. Thus, the estimated number of unmarked mortalities was calculated as:

$$\hat{U}_a^{MSF} = \lambda^{REL} \hat{M}_a^{MSF} sfm$$

with associated variance:

$$Var(\hat{U}_a^{MSF}) \approx (\lambda^{REL})^2 sfm^2 \hat{M}_a^{MSF} \frac{1-s}{s}$$

where:

- sfm = selective fishing mortality rate (14%, *excludes drop-off mortality*),
- $U_{a,i}^{MSF}$ = aged a unmarked DIT mortalities from stock i in the selective fishery,
- $M_{a,i}^{MSF}$ = aged a marked DIT mortalities from stock i in the selective fishery,
- s = sampling rate of the catch,
- λ^{REL} = unmarked-to-marked ratio *at release* for fish in a DIT group
- $Var(U_{a,i}^{MSF})$ = variance of $U_{a,i}^{MSF}$.

In addition to estimating unmarked-DIT mortalities, we pooled all CWTs (DIT and otherwise) recovered during the fishery and, based on this total, report the proportional contribution (unexpanded recoveries) of different hatcheries to the total Chinook harvest (See CWT Results below).

4. RESULTS IN 2015 CHINOOK MARK SELECTIVE RECREATIONAL FISHERY

4.1 Dockside Sampling Results

WDFW dockside samplers interviewed an estimated 48% of all anglers fishing in Washington CRC Areas 1 through 4 during the 2015 Chinook MSF; a total of 1,552 anglers in 449 boat trips were enumerated in-sample (**Table 2**). In addition, an estimated 47% (539) of all Chinook harvested in Washington ocean areas were sampled, and 80 coded wire tags (CWTs) were collected. (**Table 2**).

Estimates of Fishing Effort and Chinook Catch

An estimated 3,312 angler trips (3,207 from Washington, 105 from Oregon) were completed by private and charter anglers during the 2015 coastwide Chinook MSF. These anglers harvested a total of 1,171 Chinook coastwide (1,135 WA, 36 OR) (**Table 3**). Landed Chinook catch totaled 12% of the overall fishery quota of 10,000.

A total of 2,496 Chinook encounters were estimated in Washington waters during the 2015 Chinook MSF for CRC Areas 1 through 4 combined (**Table 4**). This total consisted of an estimated 1,135 retained (1,131 marked, 4 unmarked) and 1,361 released (498 marked, 863 unmarked) Chinook.

CWT Samples

Of a total of 72 readable CWTs were recovered from Chinook sampled dockside during the 2015 Chinook MSF in Washington CRC Areas 1 through 4. Observed (unexpanded) stock composition results for these in-sample tag recoveries are presented by area in **Tables 5A** through **5D** for Areas 1 through 4, respectively.

In Area 1, samplers recovered a total of 24 readable CWTs, 33% of the CWTs recovered in all four areas combined. The majority of these recoveries (92%) were from the Columbia River, with 67% from Upper Columbia River hatcheries, 13% from Lower Columbia River hatcheries and 13% from Snake River hatcheries. The remaining recoveries were from California (8%) hatcheries (**Table 5A**). None of the CWT recoveries in Area 1 were from double index tag (DIT) release groups.

In Area 2, samplers recovered a total of 39 readable CWTs, 54% of the CWTs recovered in all four areas combined. The majority of these recoveries (90%) were from Columbia River hatcheries, with 39% from Upper Columbia River hatcheries, 21% from Central Columbia River hatcheries, 21% from Lower Columbia River hatcheries, and 10% from Snake River hatcheries. The remaining recoveries were from California (8%) and Oregon (3%) hatcheries (**Table 5B**). Six of the CWT recoveries in Area 2 were from DIT release groups.

In Area 3, samplers recovered a total of 2 readable CWT, 3% of the CWTs recovered in all four areas combined. Both recoveries were from Central Columbia River hatcheries, and 1 was from a DIT release group.

In Area 4, samplers recovered a total of 7 readable CWTs, 10% of the CWTs recovered in all four areas combined. Of these recoveries, 58% were from Columbia River hatcheries, with 43% from Upper Columbia River hatcheries and 14% from Snake River hatcheries. The remaining recoveries were from Washington (29%) and British Columbia (14%) hatcheries (**Table 5D**). One of the CWT recoveries in Area 4 was from a DIT release group.

Table 4. Dockside sampling statistics during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4.

	Boats Sampled	Sample Rate	Anglers Sampled	Sample Rate	Landed Chinook Sampled	Sample Rate	Coded wire tags collected
Area 4	102	42%	254	40%	86	43%	7
Area 3	14	53%	50	47%	4	55%	2
Area 2	264	43%	966	46%	306	41%	39
Area 1	69	68%	282	72%	143	78%	24
Total WA	449	45%	1,552	48%	539	47%	72

Table 5. Estimates of total fishing effort and number of Chinook retained during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4.

	Total Boat Trips	Total Angler Trips	Estimated Chinook Retained		
			Marked	Unmarked	TOTAL
Area 4	243	630	197	3	200
Area 3	27	106	7	0	7
Area 2	616	2,080	744	0	744
Area 1	102	390.12	183	1	184
TOTAL WA	987	3,207	1,131	4	1,135
TOTAL OR	N/A	105	36	0	36
Season Total:	987	3,312	1,167	4	1,171
Variance: 1/	950	14,545	5,416	3	5,419
WA Standard Error:	31	121	74	2	74
WA CV (%):	3%	4%	7%	47%	6%
WA 95% CI:	927-1,047	2,970-3,443	987-1,276	1-10	991-1,279

^{1/} Variance estimates are unavailable for Oregon statistics.

Table 6. Total estimates of fishing effort and the number of Chinook retained and released by mark status and by week, during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4 combined.

Open Dates	Stat Week	Stratum Start Date	Stratum End Date	Effort		Retained Chinook		Released Chinook 1/		Chinook Encounters Total
				Boats	Anglers	AD	UM	AD	UM	
May 15 - June 12, 2015 (See area-specific regs)	20	15-May	16-May	57	250	39	0	17	30	86
	21	22-May	23-May	56	161	40	0	18	31	88
	22	30-May	31-May	390	1,238	516	1	227	394	1,137
	23	1-Jun	7-Jun	372	1,191	416	0	183	319	917
	24	8-Jun	12-Jun	113	368	121	3	53	90	268
Season Total:				987	3,207	1,131	4	498	863	2,496
Variance:				950	14,545	5,416	3	36,519	14,424	60,875
Standard Error:				31	121	74	2	191	120	247
CV (%):				3.1%	3.8%	6.5%	47.4%	38.4%	13.9%	9.9%
95% CI:				927-1,047	2,970-3,443	987-1,276	1-10	123-872	628-1,099	2,012-2,980

^{1/} Released Chinook were estimated as the difference between total Chinook encounters generated using the bias-corrected "Method 2" estimator (see Conrad and McHugh 2008) and creel-based estimates of retained Chinook.

Table 7. Summary of coded-wire tags recovered from Chinook salmon harvested in Washington coastal areas during the 2015 recreational Chinook MSF. The field “Number DITs” corresponds to the number of tags that belonged to double-index tag groups. Percentages in parentheses indicate the proportional contribution (unexpanded recoveries) of different hatcheries to the total Chinook harvest.

Table 5A. Area 1 CWT recoveries.

Release Domain	Release Region	Release Site	Rearing Location	CWTs Recovered	No. DITs
Columbia River (91.7%)	Upper Columbia R (above McNary Dam; excludes Snake River) (66.7%)	CHELAN R 47.0052	CHELAN FALLS HATCHERY	4 (16.7%)	0
		COLUMBIA NEAR WELLS	WELLS HATCHERY	7 (29.2%)	0
		ENTIAT R 46.0042	ENTIAT NFH	1 (4.2%)	0
		SIMILKAMEEN R 490325	SIMILKAMEEN HATCHERY	1 (4.2%)	0
		WENATCHEE R 45.0030	DRYDEN POND	1 (4.2%)	0
		LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	2 (8.3%)	0
	Lower Columbia River (mouth to Bonneville Dam) (12.5%)	SANTIAM R S FK	SOUTH SANTIAM HATCH	1 (4.2%)	0
		DETROIT RES (SANTIAM	MARION FORKS HATCH	1 (4.2%)	0
		N FK RESERV (CLACKAM	CLACKAMAS HATCHERY	1 (4.2%)	0
	Snake River (12.5%)	SNAKE R@PITT. LNDG	LYONS FERRY HATCHERY	1 (4.2%)	0
LUKE'S GULCH A F		NPT HATCHERY	1 (4.2%)	0	
SNAKE L.MON-LTL GOOS		LYONS FERRY HATCHERY	1 (4.2%)	0	
CA (8.3%)	Central California Coast (4.2%)	SAN PABLO BAY NET PENS	FEATHER R HATCHERY	1 (4.2%)	0
	Sacramento River	COLEMAN NFH	COLEMAN NFH	1 (4.2%)	0
Total				24	0

Table 5B. Area 2 CWT recoveries.

Release Domain	Release Region	Release Site	Rearing Location	CWTs Recovered	No. DITs
Columbia River (89.7%)	Upper Columbia R (above McNary Dam; excludes Snake River) (38.5%)	SIMILKAMEEN R 490325	SIMILKAMEEN HATCHERY	2 (5.1%)	0
		COLUMBIA NEAR WELLS	WELLS HATCHERY	7 (17.9%)	0
		WENATCHEE R 45.0030	DRYDEN POND	1 (2.6%)	0
		CHELAN R 47.0052	CHELAN FALLS HATCHERY	5 (12.8%)	0
	Central Columbia River (Bonneville Dam to McNary Dam) (20.5%)	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	3 (7.7%)	0
		SPRING CR 29.0159	SPRING CR NFH	5 (12.8%)	5
	Lower Columbia River (mouth to Bonneville Dam) (20.5%)	BIG CR (LWR COL R)	BIG CR HATCHERY	1 (2.6%)	1
		MCKENZIE R 1	MCKENZIE HATCHERY	3 (7.7%)	0
		COWLITZ R 26.0002	COWLITZ SALMON HATCH	2 (5.1%)	0
		CLACKAMAS R	CLACKAMAS HATCHERY	1 (2.6%)	0
Snake River (10.3%)	MOLALLA R	MARION FORKS HATCH	1 (2.6%)	0	
	CAPTAIN JOHNS PD	LYONS FERRY HATCHERY	2 (5.1%)	0	
	LYONS FERRY REL.SITE	LYONS FERRY HATCHERY	1 (2.6%)	0	
OR (2.6%)	Northern Oregon Coast (2.6%)	SNAKE R@PITT. LNDG	LYONS FERRY HATCHERY	1 (2.6%)	0
		TRASK R	TRASK R HATCHERY	1 (2.6%)	0
CA (7.7%)	Central California Coast (5.1%)	SANTA CRUZ HARBOR NET PEN	FEATHER R HATCHERY	1 (2.6%)	0
		WICKLAND OIL NET PEN	FEATHER R HATCHERY	1 (2.6%)	0
	Sacramento River (2.6%)	COLEMAN NFH	COLEMAN NFH	1 (2.6%)	0
Total				39	6

Table 5C. Area 3 CWT recoveries.

Release Domain	Release Region	Release Site	Rearing Location	CWTs Recovered	No. DITs
Columbia River (100%)	Central Columbia River (Bonneville Dam to McNary Dam) (100%)	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	1 (50%)	0
		SPRING CR 29.0159	SPRING CR NFH	1 (50%)	1
Total				2	1

Table 5D. Area 4 CWT recoveries.

Release Domain	Release Region	Release Site	Rearing Location	CWTs Recovered	No. DITs
BC (14.3%)	Fraser River – Thompson River (14.3%)	R-Chilliwack R	H-Chilliwack River H	1 (14.3%)	0
WA (28.6%)	Hood Canal (14.3%)	FINCH CR 16.0222	HOODSPORT HATCHERY	1 (14.3%)	0
	Mid Puget Sound (14.3%)	GROVERS CR HATCHERY	GROVERS CR HATCHERY	1 (14.3%)	1
Columbia River (57.7%)	Upper Columbia R (above McNary Dam; excludes Snake River) (42.9%)	CHELAN R 47.0052	CHELAN FALLS HATCHERY	1 (14.3%)	0
		COLUMBIA NEAR WELLS	WELLS HATCHERY	1 (14.3%)	0
		METHOW R 48.0002	CARLTON ACCLIMATION POND	1 (14.3%)	0
	Snake River (14.3%)	SNAKE L.MON-LTL GOOS	LYONS FERRY HATCHERY	1 (14.3%)	0
Total				7	1

4.2 On-water Observations of Chinook Encounters

On-Board Observer Data

WDFW's observer staff conducted 11 on-the-water catch surveys onboard charter boats during the 2015 Chinook MSF. Observers recorded a total of 29 encountered Chinook salmon in all four ocean areas combined. The size/mark status composition of these Chinook encounters is presented in **Table 6**. The following size/mark group composition was estimated from 29 encounters of known size/mark status: 83% LM, 7% LU, 10% SM, and 0% SU.

These estimated size/mark group proportions based on onboard observer data were combined with those estimated from VTR data and used in subsequent impact estimation steps, as discussed further in the section below titled *Estimated Chinook Encounters and Mortalities* (see **Table 10** and **Appendix A**). The decision to combine these data was based on *i*) the short duration of the fishery and the limited numbers of fish encountered during on-water observer trips, *ii*) the potential for differences in fishing patterns between charter and private vessels and the desire to represent both patterns, and *iii*) the lack of representation of catch in Areas 1, 3 and 4 in the observer data.

DNA Results

Chinook DNA samples were collected only by onboard observers who had access to both marked and unmarked Chinook encounters during the 2015 Chinook MSF. A total of 26 DNA samples were collected from legal sized Chinook and 3 from sublegal sized Chinook during the fishery (**Table 7**).

Voluntary Trip Report (VTR) Data

Additional on-the-water encounters data were provided via angler-completed VTRs. Dockside samplers collected 25 completed and useable VTRs containing 138 Chinook encounters (**Table 8**). Chinook encounters of unknown size and/or unknown mark status are excluded in determining the size/mark status composition results based on VTR data, but no unknown size or mark status Chinook were recorded during this fishery. The following size/mark group composition was estimated from these 138 useable encounters: 46% LM, 25% LU, 14% SM, and 16% SU. The VTR data were used in conjunction with observer data in subsequent fishery-wide impacts estimation steps (i.e., **Appendix A**).

We also combined the onboard observer- and VTR-based encounters data to compare observed (field-estimated) mark rates in each area with preseason FRAM-predicted values. The combined onboard observer and VTR data indicated mark rates of 71% for legal sized Chinook and 50% for sublegal sized Chinook coast-wide (**Table 9**).

Table 8. Summary of on-water Chinook encounters data by size and mark group, collected by WDFW observers sampling onboard charter boats during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4.

Total Observer Trips	OBSERVER DATA									
	LEGAL SIZED			SUBLEGAL SIZED			UNKNOWN SIZE			
	Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	
Area 4	0	0	0	0	0	0	0	0	0	0
Area 3	0	0	0	0	0	0	0	0	0	0
Area 2	6	24	2	0	3	0	0	0	0	0
Area 1	5	0	0	0	0	0	0	0	0	0
TOTAL	11	24	2	0	3	0	0	0	0	0
Size/Mark Comp 1/	82.8%	6.9%	-	10.3%	0.0%	-	-	-	-	-

^{1/} Chinook encounters of unknown size and/or unknown mark status were excluded in determining the overall size/mark status composition.

Table 9. Number of Chinook DNA samples collected by WDFW observers onboard charter vessels during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4.

	LEGAL SIZED			SUBLEGAL SIZED		
	Marked	Unmarked	Total	Marked	Unmarked	Total
Area 4	0	0	0	0	0	0
Area 3	0	0	0	0	0	0
Area 2	24	2	26	3	0	3
Area 1	0	0	0	0	0	0
TOTAL	24	2	26	3	0	3

Table 10. Summary of on-water Chinook encounters by size class and mark status, as reported on angler-completed voluntary trip reports (VTRs) during the 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4.

Total VTRs Collected	VOLUNTARY TRIP REPORT DATA									
	LEGAL SIZED			SUBLEGAL SIZED			UNKNOWN SIZE			
	Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	
Area 4	11	13	10	0	6	9	0	0	0	0
Area 3	3	3	1	0	1	1	0	0	0	0
Area 2	8	15	5	0	2	5	0	0	0	0
Area 1	3	32	18	0	10	7	0	0	0	0
TOTAL	25	63	34	0	19	22	0	0	0	0
Size/Mark Comp 1/	45.7%	24.6%	-	13.8%	15.9%	-	-	-	-	-

^{1/} Chinook encounters of unknown size and/or unknown mark status were excluded in determining the overall size/mark status composition based on VTR data.

Table 11. Estimated mark rates for legal- and sublegal-sized Chinook during 2015 recreational Chinook MSF in Washington CRC Areas 1 through 4, based on onboard observer and VTR data combined, compared with FRAM preseason predicted values.

	LEGAL SIZED			SUBLEGAL SIZED			FRAM preseason projected mark rate (legal sized)
	Marked	Unmarked	Mark Rate	Marked	Unmarked	Mark Rate	
Area 4	13	10	57%	6	9	40%	85%
Area 3	3	1	75%	1	1	-	85%
Area 2	39	7	85%	5	5	50%	64%
Area 1	32	18	64%	10	7	59%	80%
TOTAL	87	36	71%	22	22	50%	

4.3 Overall Fishery Impacts

Estimated Total Chinook Encounters and Mortalities

We derived size/mark-status group-specific estimates of Chinook encounters from a combination of the dockside sampling results (i.e., retained harvest estimates presented in **Tables 2 and 4**) and the on-water observer and VTR based size/mark-status composition data (**Tables 6 and 8**; see **Appendix A** for computational details). In total, we estimated that anglers fishing in Washington CRC Areas 1 through 4 (combined) encountered 1,300 LM, 538 LU, 329 SM, and 329 SU Chinook during the 2015 Chinook MSF (**Table 10**). Given the estimates of harvest and the assumed selective fishing mortality (*sfm*) mortality rate of 0.14 for both legal-sized and sublegal-sized Chinook, these encounters translated into a total of 1,326 estimated Chinook mortalities (1,135 retained and 191 released; 1,155 LM, 79 LU, 46 SM, and 46 SU) in ocean CRC Areas 1 through 4 combined (**Table 10**). Of the total estimated mortalities, 85% were attributed to retention of legal-size marked Chinook.

FRAM versus Creel Comparison

Field estimated Chinook encounters and mortalities are compared with those projected in the final preseason FRAM model run (FRAM number 2115) in **Tables 11 and 12**. These comparisons are illustrated in **Figure 2**. FRAM projections include encounters and mortalities in Oregon waters; however, field estimated total encounters and mortalities are not available for Oregon waters. Oregon landed catch comprised 3% of the total landed catch in the ocean Chinook MSF. Both field estimates of encounters and mortalities were less than those projected in preseason FRAM model run 2115 for both legal and sublegal marked and unmarked Chinook (**Tables 11 and 12, Figure 2**).

Estimated CWT-DIT Impacts

Of the 72 decoded CWTs recovered during the 2015 Chinook MSF in Areas 1-4 combined, a total of 8 belonged to 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 ratio (λ) at juvenile release for each applicable hatchery of origin and brood year, and we used this value to estimate total unmarked DIT encounters for the entirety of the 2015 selective Chinook fishery in the four areas. In total, we estimated that 15 unmarked-DIT Chinook were encountered during the fishery. Given an assumed *sfm* rate of 0.14 for the estimated unmarked

DIT fish that were encountered and released, we estimate that 2 unmarked DIT fish may have died as a result of the 2015 Chinook MSF(**Table 13**).

Summary of ocean Chinook MSFs in ocean areas north of Cape Falcon

Table 14 summarizes effort, retained and released Chinook catch, and total Chinook encounters in the ocean Chinook MSFs since their inception in 2010. The 2015 fishery produced the lowest effort, retained catch, and total encounters in the history of this fishery thus far.

Table 12. Summary of the fishery impact estimates for the 2015 recreational Chinook MSF in Washington coastal Areas 1 through 4.

Size/Mark Group	Encounters	Number Retained	Number Released	Release Mortality Rate	Release Mortality	Total Mortality	Variance	SE	95% CI	CV (%)
Legal Marked	1,300	1,131	169	0.14	24	1,155	6,028	78	1,003-1,307	7%
Legal Unmarked	538	4	534	0.14	75	79	182	13	52-105	17%
Sublegal Marked	329	0	329	0.14	46	46	104	10	26-66	22%
Sublegal Unmarked	329	0	329	0.14	46	46	104	10	26-66	22%
TOTAL ALL GROUPS	2,496	1,135	1,361	0.14	191	1,326	6,417	80	1,169-1,483	6%

Table 13. Comparison of modeled (FRAM model run #2115) and estimated total Chinook encounters in the 2015 recreational Chinook MSF in Washington coastal Areas 1 through 4.

Data Source	Group	Total			Landed Only (WA + OR)
		Encounters ^{1/}	Legal	Sublegal	
FRAM Encounters (WA and OR)	Unmarked	10,410	5,503	4,907	110
	Marked	20,831	11,367	9,464	9,890
	Total	31,241	16,870	14,371	10,000
	% Marked	67%	67%	66%	99%
Estimated (Creel) Encounters (WA only)	Unmarked	867	538	329	4
	Marked	1,629	1,300	329	1,167
	Total	2,496	1,838	658	1,171
	% Marked	65%	71%	50%	100%

^{1/} Field estimates of Chinook encounters by size class and mark status are not available for Oregon waters; landed catch includes Oregon.

Table 14. Comparison of modeled (FRAM model run #2115) and estimated total Chinook mortalities in the 2015 recreational Chinook MSF in Washington coastal Areas 1 through 4.

Mortality Category	FRAM Chinook Mortalities (WA + OR)			Estimated Chinook Mortalities ^{1/} (WA only)		
	Unmarked	Marked	Total	Unmarked	Marked	Total
Total (Landed + Released)	1,552	11,421	12,973	125	1,237	1,362
Released Legal	755	206	961	75	24	98
Released Sublegal	687	1,325	2,012	46	46	92
Landed Only (WA + OR)	110	9,890	10,000	4	1,167	1,171

^{1/} Field estimates of Chinook mortalities by size class and mark status are not available for Oregon waters; landed catch includes Oregon.

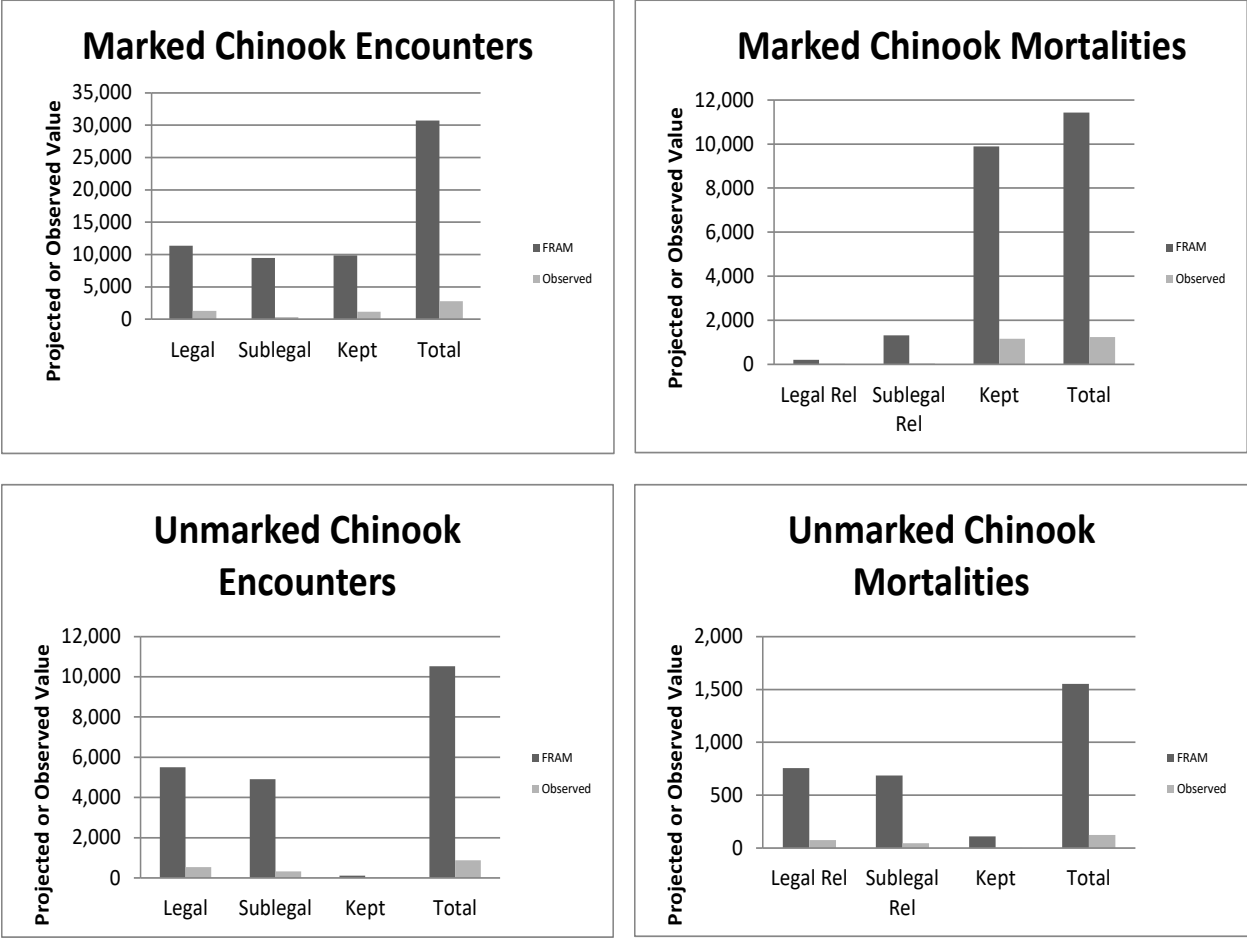


Figure 2. Comparison of modeled (FRAM model run 2115) and estimated total Chinook encounters (*top panel*) and mortalities (*bottom panel*) for the 2015 recreational Chinook MSF in Washington coastal Areas 1 through 4.

Table 15. 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 2015 recreational Chinook MSF in Washington coastal Areas 1 through 4.

Area	Hatchery	Brood Year	DITs Obs	AD DIT Harvest		UMDIT Enc	UMDIT Mortality		
				Est	var(Est)		Est	var(Est)	SE(Est)
2	BIG CR HATCHERY	2012	1	1.8	1.3	1.9	0.3	0.031	0.2
	SPRING CR NFH	2012	5	8.8	6.6	9.5	1.3	0.151	0.9
	Total		6	10.5	7.9	11.4	1.6	0.183	1.0
3	SPRING CR NFH	2012	1	2.4	3.5	2.6	0.4	0.078	0.3
	Total		1	2.4	3.5	2.6	0.4	0.078	0.3
4	GROVERS CR HATCHERY	2011	1	1.3	0.4	1.3	0.2	0.007	0.1
	Total		1	1.3	0.4	1.3	0.2	0.007	0.1
Grand Total (All WA Ocean Areas)			8	14.2	11.8	15.3	2.2	0.268	1.4

Table 16. Season-total (WA only) estimates of Chinook encounters by size/mark status, and total estimates of angler effort, summarized for all seasons to date in the recreational Chinook MSFs in Washington CRC Areas 1 through 4.

Year	Effort (Angler Trips)	Retained Chinook				Released Chinook				Total Encounters
		LM	LU	SM	SU	LM	LU	SM	SU	
2010	10,004	4,981	19	0	0	744	2,620	1,892	946	11,202
2011	4,895	2,301	35	0	0	344	1,247	2,759	1,462	8,146
2012	7,853	7,339	43	0	0	1,097	3,531	1,771	1,453	15,234
2013	7,976	2,563	23	0	0	383	2,616	2,084	1,417	9,087
2014	4,748	2,003	3	0	0	299	905	1,289	461	4,961
2015	3,207	1,131	4	0	0	169	534	329	329	2,496

5. RESULTS IN THE ALL-SPECIES COHO MARK SELECTIVE RECREATIONAL FISHERY

5.1 Dockside Sampling Results

An estimated 86,116 angler trips (79,574 from Washington, 6,542 from Oregon) were completed by private and charter anglers during the 2015 coastwide all-species coho MSF. These anglers harvested a total of 35,330 Chinook coastwide (33,564 WA, 1,766 OR) and 65,260 coho (57,851 WA, 7,409 OR). **Table 15** shows effort and catch by month and area during the 2015 coho MSF. Note that effort and catch from the non-selective fishery in September in all areas are not included in this analysis.

WDFW dockside samplers interviewed an estimated 36% of all anglers fishing from WA coastwide during the coho MSF. A total of 35% of all Chinook and 39% of all coho harvested in WA were sampled; 1,484 CWTs were collected from sampled Chinook and 2,509 were collected from sampled coho in WA ports (**Table 16**).

5.2 On-water Observation and VTR Results

Tables 17 and 18 detail on-water data collected during on-board observation and from VTRs submitted by charter and private fishing vessels. OSP observer staff combined with charter boat VTRs provided on-water catch and encounter data from a total of 125 charter boat trips during the all-species coho MSF documenting a total of 549 legal sized Chinook, 145 sublegal sized Chinook, 2,424 legal sized coho, and 41 sublegal sized coho. Dockside samplers also collected 329 completed and useable VTRs from private vessels containing 509 legal sized Chinook encounters, 164 sublegal sized Chinook encounters, 1,660 legal sized coho encounters, and 56 sublegal sized coho encounters. Mark rates calculated from onboard observer and VTR data are shown in **Table 19** and compared to pre-season FRAM coho mark rate projections.

5.3 Overall Fishery Impacts

Estimated Total Coho Encounters and Mortalities

FRAM pre-season projections of coho encounters (Washington and Oregon) in the 2015 ocean recreational all-species coho MSFs are compared with field estimated encounters in **Table 20**. **Table 21** compares total coho mortality projected pre-season by FRAM (Washington and Oregon) with field estimated coho mortality.

The overall impacts of the 2015 recreational coho MSF in ocean CRC Areas 1-4 are characterized in terms of grand-total estimates of coho encounters and mortalities and by using estimates specific to mark group (i.e., marked and unmarked). The method described in section 3.4 was used to generate total estimates of retained catch by mark group. To estimate coho salmon encounters and releases by mark group, we applied Conrad's (2012) alternative method for estimating coho encounters and release mortalities in ocean MSFs, which independently calculates charter and private vessel totals based on observer and VTR data. This method differs from that used prior to 2012.

Field estimated marked and unmarked coho retention is calculated from dockside sampling data as described in Section 3.4; note that since catch estimates are stratified by week, monthly total proportions of marked and unmarked retained estimated catch may vary slightly from monthly total proportions of marked and unmarked sampled coho. Encounters are calculated by boat type and CRC Area based on landed catch of legal sized marked coho, the proportion of observed encounters that were legal sized marked coho, and the proportion of observed encounters that were legal sized marked coho retained. Mortality was estimated for each mark group based on calculated encounters and the proportion of the legal sized coho of that mark status that were released multiplied by the PFMCO ocean *sfm* rate of 14% (Conrad, 2012).

Figure 3 summarizes the projected and field estimated coho encounters and mortality by area in the all-species fishery. Field estimates of both coho encounters and total mortality were lower than projected preseason in all Catch Areas during the coho MSF portion of the all-species fishery. Note that the portion of the all-species fisheries that were non-selective for are not included in this analysis.

Compliance

Table 22 reports compliance rates observed by dockside samplers for the recreational fisheries by area and month. Coastwide, compliance with selective fishery regulations averaged 99%, similar to that observed in the last eleven seasons.

5.4 DNA Data Collection

A total of 1,658 DNA samples were collected from Chinook by onboard and dockside samplers during the summer all-species recreational fishery, including both the coho MSF and non-selective portions of the fishery. **Table 23** describes the numbers of samples by size class, mark status, and method of collection.

Table 17. Estimates of total fishing effort and number of Chinook and coho retained during the 2015 all-species recreational fishery (coho MSF only) between Cape Falcon, Oregon and the U.S.-Canada border.

	TOTAL ANGLER TRIPS						CHINOOK RETAINED						COHO RETAINED					
	June	July	August	Sept	Oct	TOTAL	June	July	August	Sept	Oct	TOTAL	June	July	August	Sept	Oct	TOTAL
Area 4	2,111	8,761	2,345	436	-	13,653	1,471	6,198	522	28	-	8,219	213	2,142	1,270	185	-	3,810
Area 3	231	1,389	1,058	0	300	2,978	159	1,417	537	0	164	2,277	37	195	156	0	13	401
Area 2	5,257	18,629	12,162	478	-	36,526	3,031	8,053	4,610	257	-	15,951	2,346	12,821	7,301	266	-	22,734
Area 1	2,163	8,520	15,389	345	-	26,417	834	1,421	4,833	29	-	7,117	2,606	12,312	15,725	263	-	30,906
TOTAL WA	9,762	37,299	30,954	1,259	300	79,574	5,495	17,089	10,502	314	164	33,564	5,202	27,470	24,452	714	13	57,851
OREGON (Area 1)	647	2,723	3,092	80	-	6,542	242	434	1,030	60	-	1,766	732	3,764	2,872	41	-	7,409
TOTAL NOF	10,409	40,022	34,046	1,339	300	86,116	5,737	17,523	11,532	374	164	35,330	5,934	31,234	27,324	755	13	65,260
WA Variance: 1/						874,378						492,146						916,479
WA Standard Error:						935						702						957
WA CV (%):						1%						2%						2%
WA 95% CI:						77,741-81,406						32,189-34,939						55,975-59,727

^{1/} Variance estimates are unavailable for Oregon statistics.

Table 18. WA dockside sampling statistics during the 2015 all-species recreational fishery (coho MSF only) between Cape Falcon, Oregon and the U.S.-Canada border.

	Anglers Sampled	Sample Rate	Landed Chinook Sampled	Sample Rate	Landed Coho Sampled	Sample Rate	Chinook CWTs collected	Coho CWTs collected
Area 4	5,083	37%	3,263	40%	1,245	33%	390	84
Area 3	1,953	66%	1,465	64%	273	68%	95	20
Area 2	10,787	30%	4,390	28%	6,759	30%	587	868
Area 1	11,181	42%	2,791	39%	14,030	45%	412	1,537
TOTAL WA	29,004	36%	11,909	35%	22,307	39%	1,484	2,509

Table 19. On-board and VTR Chinook encounters by size class and mark status in the 2015 all-species recreational fishery (coho MSF only) between Cape Falcon, Oregon and the U.S.-Canada border.

		On-board observation/Charter boat VTRs						Private boat VTRs							
		Total Observer Trips/VTRs	LEGAL-SIZED			SUBLEGAL-SIZED			Total VTRs Collected	LEGAL-SIZED			SUBLEGAL-SIZED		
			Marked	Unmarked	Unknown	Marked	Unmarked	Unknown		Marked	Unmarked	Unknown	Marked	Unmarked	Unknown
Area 4	June	0	-	-	-	-	-	-	18	25	14	1	8	8	5
	July	0	-	-	-	-	-	-	18	10	14	2	11	7	8
	August	0	-	-	-	-	-	-	7	2	4	2	8	2	0
	Sept	0	-	-	-	-	-	-	11	5	5	0	0	2	0
	TOTAL	0	0	0	0	0	0	0	54	42	37	5	27	19	13
Area 3	June	1	0	5	0	0	0	0	3	4	7		0	0	0
	July	0	-	-	-	-	-	-	19	10	30	1	0	1	0
	August	0	-	-	-	-	-	-	14	7	5	0	2	1	0
	Sept	0	-	-	-	-	-	-	0	-	-	-	-	-	-
	TOTAL	1	0	5	0	0	0	0	36	21	42	1	2	2	0
Area 2	June	16	78	35	0	12	10	0	24	41	28	0	9	4	0
	July	25	96	63	0	14	11	0	61	58	40	2	14	15	2
	August	19	65	38	0	10	2	0	56	39	16	5	6	4	0
	Sept	0	-	-	-	-	-	-	0	-	-	-	-	-	-
	TOTAL	60	239	136	0	36	23	0	141	138	84	7	29	23	2
Area 1	June	5	17	7	0	14	14	0	18	26	18	0	5	14	12
	July	26	33	23	0	26	16	0	39	16	15	0	6	3	2
	August	31	64	25	0	5	11	0	40	36	18	0	0	3	2
	Sept	2	0	0	0	0	0	0	1	3	0	0	0	0	0
	TOTAL	64	114	55	0	45	41	0	98	81	51	0	11	20	16

Table 20. On-board and VTR coho encounters by size class and mark status in the 2015 all-species recreational fishery (coho MSF only) between Cape Falcon, Oregon and the U.S.-Canada border.

		On-board observation/Charter boat VTRs							Private boat VTRs						
		Total Observer Trips/VTRs	LEGAL-SIZED			SUBLEGAL-SIZED			Total VTRs Collected	LEGAL-SIZED			SUBLEGAL-SIZED		
			Marked	Unmarked	Unknown	Marked	Unmarked	Unknown		Marked	Unmarked	Unknown	Marked	Unmarked	Unknown
Area 4	June	0	-	-	-	-	-	-	18	20	36	1	0	2	0
	July	0	-	-	-	-	-	-	18	23	23	0	1	4	1
	August	0	-	-	-	-	-	-	7	2	9	0	7	1	0
	Sept	0	-	-	-	-	-	-	11	27	39	0	4	5	0
	TOTAL	0	0	0	0	0	0	0	54	72	107	1	12	12	1
Area 3	June	1	3	0	0	0	0	0	3	1	1	0	0	0	1
	July	0	-	-	-	-	-	-	19	12	20	0	0	0	0
	August	0	-	-	-	-	-	-	14	7	7	0	0	0	0
	Sept	0	-	-	-	-	-	-	0	-	-	-	-	-	-
	TOTAL	1	3	0	0	0	0	0	36	20	28	0	0	0	1
Area 2	June	16	123	131	0	1	3		24	56	80	0	2	1	0
	July	25	252	294	0	5	2		61	134	133	0	4	3	0
	August	19	223	222	0	3	4		56	102	100	1	4	5	0
	Sept	0	-	-	-	-	-	-	0	-	-	-	-	-	-
	TOTAL	60	598	647	0	9	9	0	141	292	313	1	10	9	0
Area 1	June	5	55	31	0	1	0	0	18	80	57	0	0	1	0
	July	26	342	213	0	10	4	0	39	248	130	0	4	2	0
	August	31	306	199	0	5	1	0	40	195	104	0	1	3	0
	Sept	2	21	9	0	2	0	0	1	6	6	0	0	0	0
	TOTAL	64	724	452	0	18	5	0	98	529	297	0	5	6	0

Table 21. Estimated Chinook and coho mark rates during the 2015 all-species recreational fishery (coho MSF only) by boat type and size class using onboard observer and VTR encounters.

		LEGAL SIZED CHINOOK			SUBLEGAL SIZED CHINOOK			LEGAL SIZED COHO			FRAM Projected Coho Mark Rate
		Charter	Private	Combined	Charter	Private	Combined	Charter	Private	Combined	
Area 4	June	-	64%	64%	-	50%	50%	-	36%	36%	36%
	July	-	42%	42%	-	61%	61%	-	50%	50%	51%
	August	-	33%	33%	-	80%	80%	-	18%	18%	47%
	Sept	-	50%	50%	-	0%	0%	-	41%	41%	49%
	TOTAL	N/A	53%	53%	N/A	59%	59%	N/A	40%	40%	48%
Area 3	June	0%	36%	25%	-	-	-	100%	50%	80%	58%
	July	-	25%	25%	-	0%	0%	-	38%	38%	54%
	August	-	58%	58%	-	67%	67%	-	50%	50%	55%
	Sept	-	-	-	-	-	-	-	-	-	35%
	TOTAL	0%	33%	31%	N/A	50%	50%	100%	42%	45%	50%
Area 2	June	69%	59%	65%	55%	69%	60%	48%	41%	46%	63%
	July	60%	59%	60%	56%	48%	52%	46%	50%	47%	62%
	August	63%	71%	66%	83%	60%	73%	50%	50%	50%	57%
	Sept	-	-	-	-	-	-	-	-	-	46%
	TOTAL	64%	62%	63%	61%	56%	59%	48%	48%	48%	55%
Area 1	June	71%	59%	63%	50%	26%	40%	64%	58%	61%	71%
	July	59%	52%	56%	62%	67%	63%	62%	66%	63%	69%
	August	72%	67%	70%	31%	0%	26%	61%	65%	62%	62%
	Sept	-	100%	100%	-	-	-	70%	50%	64%	60%
	TOTAL	67%	61%	65%	52%	35%	48%	62%	64%	63%	64%

Table 22. Comparison of modeled (FRAM model run #1523) and estimated total coho encounters in the 2015 ocean coho MSF.

Data Source	Area	Marked	Unmarked	Total Encounters	Landed Catch
FRAM	Area 4	15,386	16,688	32,074	14,850
	Area 3	3,846	3,832	7,678	3,709
	Area 2	54,962	45,355	100,317	52,841
	Area 1	82,983	47,465	130,448	79,400
	TOTAL	157,177	113,340	270,517	150,800
Estimated Actual Encounters	Area 4	5,520	8,243	13,762	3,810
	Area 3	447	799	1,246	401
	Area 2	23,687	25,508	49,195	22,734
	Area 1	38,918	22,688	61,606	38,315
	TOTAL	68,571	57,238	125,809	65,260
Variance:	2,438,745	2,597,186	9,774,745	916,479	
Standard Error:	1,562	1,612	3,126	957	
CV (%):	2%	3%	2%	1%	
95% CI:	65,510-71,632	54,080-60,397	119,682-131,937	63,384-67,136	

Table 23. Comparison of modeled (FRAM model run #1523) and estimated total coho mortalities in the 2015 ocean coho MSF.

Data Source	Area	Release Mortality		Drop Off Mortality 1/		Landed Catch		Total Mortality
		Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
FRAM	Area 4	130	2,391	771	872	14,501	349	19,014
	Area 3	32	550	193	200	3,629	80	4,684
	Area 2	464	6,571	2,759	2,395	51,883	958	65,030
	Area 1	700	6,990	4,169	2,547	78,380	1,020	93,806
	TOTAL	1,326	16,502	7,892	6,014	148,393	2,407	182,534
Estimated Actual Mortality	Area 4	286	1,149	276	412	3,480	329	5,932
	Area 3	8	112	22	40	389	12	583
	Area 2	151	3,571	1,184	1,275	22,610	125	28,916
	Area 1	104	3,176	1,946	1,134	38,176	138	44,675
	TOTAL	548	8,008	3,429	2,862	64,656	604	80,107
Variance:		5,238	73,302	6,097	6,493	899,181	17,298	-
Standard Error:		72	271	78	81	948	132	-
CV (%):		13%	3%	2%	3%	1%	22%	-
95% CI:		406-690	7,477-8,538	3,276-3,582	2,704-3,020	62,798-66,515	346-862	-

^{1/} Estimated drop off mortality calculated as 5% of estimated encounters.

^{2/} Variance estimates for landed catch are unavailable for Oregon

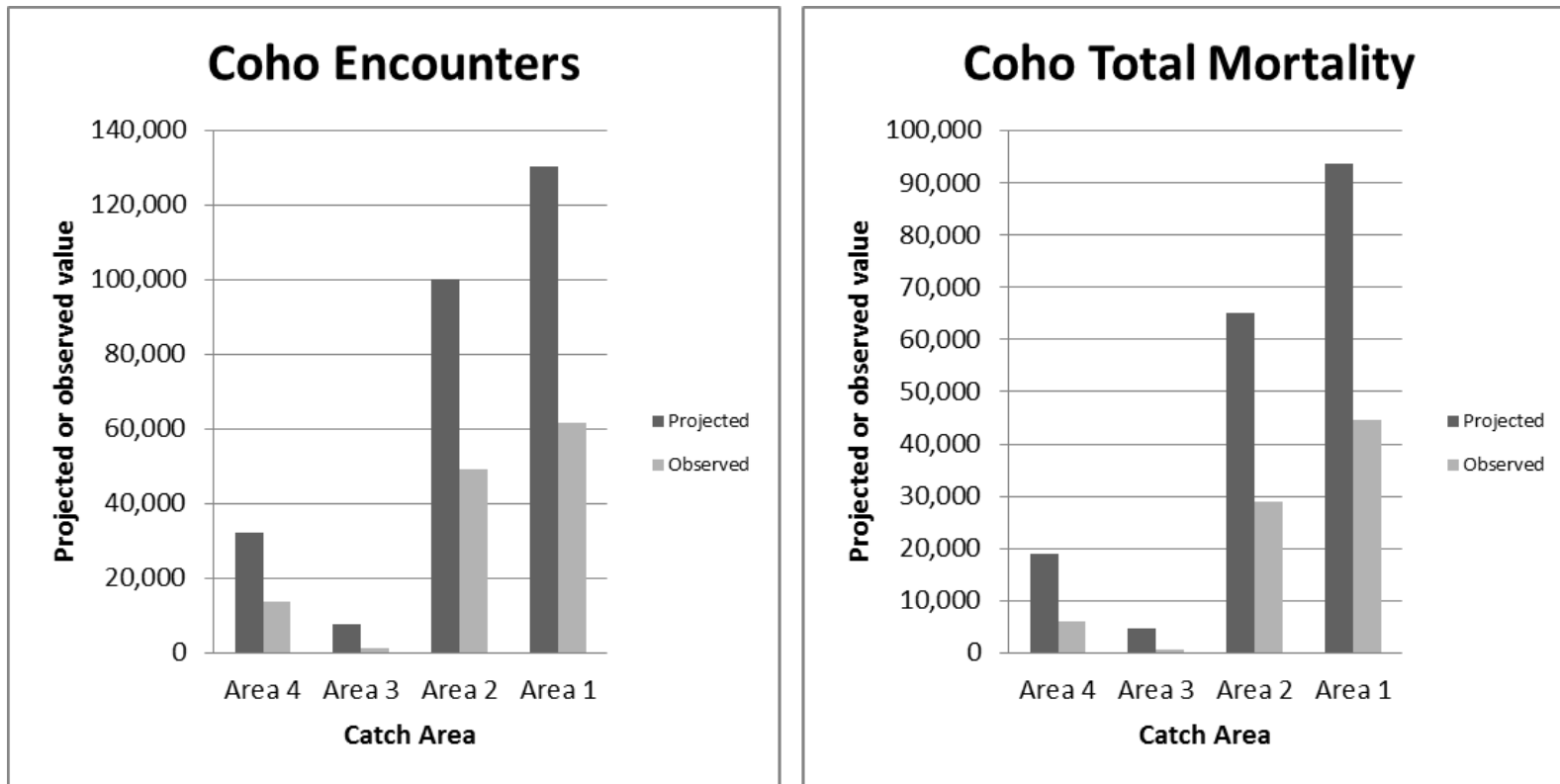


Figure 3. Comparison of modeled (FRAM model run #1523) and estimated total coho encounters and mortality in the 2015 ocean coho MSF.

Table 24. Compliance with coho selective fishery regulations observed during dockside sampling interviews in the 2015 ocean coho MSF between Cape Falcon, Oregon and the U.S.-Canada border.

		Total Coho Sampled	Marked Coho Sampled	Unmarked Coho Sampled	% Sampled Coho Marked
Area 4	June	116	101	15	87.1%
	July	688	604	84	87.8%
	August	355	350	5	98.6%
	September	86	62	24	72.1%
	Total	1,245	1,117	128	89.7%
Area 3	June	30	29	1	96.7%
	July	111	107	4	96.4%
	August	127	124	3	97.6%
	September	5	5	0	100.0%
	Total	273	265	8	97.1%
Area 2	June	926	924	2	99.8%
	July	3,228	3,197	31	99.0%
	August	2,499	2,496	3	99.9%
	September	106	106	0	100.0%
	Total	6,759	6,723	36	99.5%
Area 1	June	2,107	2,089	18	99.1%
	July	6,552	6,535	17	99.7%
	August	5,619	5,604	15	99.7%
	September	36	34	2	94.4%
	Total	14,314	14,262	52	99.6%

Table 25. Number of Chinook DNA samples collected by onboard and dockside samplers from the 2015 ocean recreational all-species fishery (both coho MSF and non-selective), by size class, mark status, and sample type.

		On-Board Sampling						Dockside Sampling			Total Number of DNA Samples
		Legal Sized			Sublegal Sized			Legal-Sized			
		Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	Marked	Unmarked	Unknown	
Area 4	June	-	-	-	-	-	-	39	45	6	90
	July	-	-	-	-	-	-	98	111		209
	August	-	-	-	-	-	-	17	9		26
	September	-	-	-	-	-	-	10	5		15
	Total	0	0	0	0	0	0	164	170	6	340
Area 3	June	-	-	-	-	-	-	18	52		70
	July	-	-	-	-	-	-	22	23		45
	August	-	-	-	-	-	-	21	25		46
	Sept./Oct.	-	-	-	-	-	-	10	16		26
	Total	0	0	0	0	0	0	71	116	0	187
Area 2	June	18	5		2	2		67	26	2	122
	July	18	16		6	6		157	77		280
	August	7	12			1		135	56	3	214
	September	-	-	-	-	-	-	66	64	3	133
	Total	43	33	0	8	9	0	425	223	8	749
Area 1	June	2			1			55	33	2	93
	July	8	8		3	3		94	46	7	169
	August	21	4		0	0		52	28	2	107
	September							4	9		13
	Total	31	12	0	4	3	0	205	116	11	382

6. RESULTS IN THE ALL-SPECIES COHO MARK SELECTIVE NON-TREATY COMMERCIAL TROLL FISHERY

The non-Treaty commercial troll fishery harvested a total of 27,200 Chinook (24,652 WA, 2,548 OR) and 4,624 coho (2,604 WA, 2,020 OR) during the 2015 coastwide all-species coho MSF operating July 1 through September 15. **Table 24** shows catch by month and area. The fishery continued September 18-22 non-selective for coho; this report includes only the MSF portion of the fishery.

WDFW dockside samplers sampled a total of 41% of all Chinook and 38% of all coho harvested and landed in WA. Coded wire tag collections totaled 926 from Chinook and 105 from coho in WA ports (**Table 25**).

Table 26 details numbers of Chinook DNA samples collected in WA by month and area, including during the non-selective spring Chinook fishery and the entire all-species fishery. A total of 1,970 DNA samples were collected from Chinook by dockside samplers throughout the May – September non-Treaty troll fishery (1,084 in May-June, 886 in July-September).

Table 26. Total Chinook and coho retained during the 2015 all-species non-Treaty commercial troll fishery (coho mark-selective only) between Cape Falcon, Oregon and the U.S.-Canada border.

	Chinook				Coho			
	July	August	September	TOTAL	July	August	September	TOTAL
Area 4	402	104	79	585	15	13	6	34
Area 3	4,292	3,619	981	8,892	133	114	62	309
Area 2	7,916	6,108	457	14,481	539	871	216	1,626
Area 1	96	337	261	694	41	171	423	635
TOTAL WA	12,706	10,168	1,778	24,652	728	1,169	707	2,604
OREGON (Are	1,293	700	555	2,548	328	411	1,281	2,020
TOTAL NOF	13,999	10,868	2,333	27,200	1,056	1,580	1,988	4,624

Table 27. Chinook and coho sampled in WA during the 2015 all-species non-Treaty commercial troll fishery (coho mark-selective only) between Cape Falcon, Oregon and the U.S.-Canada border.

	Chinook			Coho		
	Total Sampled	Sample Rate	CWTs Collected	Total Sampled	Sample Rate	CWTs Collected
Area 4	304	52%	12	14	41%	3
Area 3	3,007	34%	177	122	39%	10
Area 2	6,538	45%	714	628	39%	77
Area 1	190	27%	23	218	34%	15
TOTAL WA	10,039	41%	926	982	38%	105

Table 28. Number of chinook DNA samples collected from the 2015 non-treaty troll fishery by size class, mark status.

		Dockside Sampling			Number of DNA Samples
		Marked	Legal-Sized		
			Unmarked	Unknown	
Area 4	May	29	12	0	41
	June	28	42	0	70
	July	0	0	0	0
	August	2	6	0	8
	September	0	0	0	0
	Total	59	60	0	119
Area 3	May	112	83	0	195
	June	-	-	0	0
	July	24	76	0	100
	August	33	133	0	166
	September	11	40	0	51
	Total	180	332	0	512
Area 2	May	139	46	0	185
	June	130	63	0	193
	July	118	60	0	178
	August	147	50	1	198
	September	0	5	0	5
	Total	534	224	1	759
Area 1	May	138	62	0	200
	June	138	62	0	200
	July	35	24	0	59
	August	33	26	0	59
	September	18	44	0	62
	Total	362	218	0	580

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APPENDICES

Appendix A. Mark-selective fishery impact estimation details for the recreational selective Chinook fishery in Washington coastal Areas 1 through 4.

Below are definitions and equations for all quantities used in estimating mark-selective fishery impacts from the combination of dockside creel survey information, on-water observer data, and/or voluntary trip report (VTR) results as applicable. The estimation sequence builds from monthly² estimators of encounters-by-class (i.e., the four size [legal, sublegal] × mark-status [marked, unmarked] groups) to season-wide impact 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. Secondly, encounters are apportioned to the appropriate size/mark-status group using encounters-composition data collected from onboard sampling on charter boats (See *Estimating Chinook 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}_{LMi} , defined on subsequent page) with an estimate of the proportion of the fishable Chinook population that is of legal size and marked (\hat{p}_{LMi} , 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., $1-p_{LM-R}$, where p_{LM-R} is the estimated legal-marked Chinook release rate)³. \hat{E}_i and its variance are estimated as:

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

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

² **Note:** For fisheries characterized by short-duration seasons (i.e., ~ 1 month), the “monthly” estimators described in this appendix are synonymous season-total estimators.

³ Equations 1 and 2 were modified based on a 2008 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_{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.

Estimating Chinook Encounter Composition

\hat{p}_{LMi} = the onboard observer (charter ride-along)-based estimate of the proportion of Chinook encounters that are legal-sized (L) and marked (M) during month i

\hat{p}_{LUi} = the estimated proportion of encounters that are legal-sized (L) and unmarked (U)

\hat{p}_{SMi} = the estimated proportion of encounters that are sublegal-sized (S) and unmarked (M)

\hat{p}_{LUI} = 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}_{XYi} and its variance is estimated as:

$$(3) \quad \hat{p}_{XYi} = n_{XYi} / n_i, \text{ and}$$

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

Where, n_i = the total number of fish encountered by the onboard observers during month i .

Encounters by Size/Mark-status Class

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

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

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

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

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

$$(5) \quad \hat{E}_{XYi} = \hat{E}_i * \hat{p}_{XYi}$$

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

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, 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*⁴ 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:

$$(7) \quad \hat{d}_{XMK} = n_{XMK} / n_{MK}$$

$$(8) \quad \text{var}(\hat{d}_{XMK}) = [\hat{d}_{XMK} * (1 - \hat{d}_{XMK})] / (n_{MK} - 1),$$

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. 7 and 8) but using *season-wide* dockside observations on unmarked (U), not marked Chinook salmon.

Apportioned Estimates of Retention to Size Classes

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

\hat{K}_{LUI} = 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:

$$(9) \quad \hat{K}_{XMi} = \hat{d}_{XMK} * \hat{N}_{MKi}$$

$$(10) \quad \text{var}(\hat{K}_{XMi}) = \text{var}(\hat{N}_{MKi}) * \hat{d}_{XMK}^2 + \hat{N}_{MKi}^2 * \text{var}(\hat{d}_{XMK}) - \text{var}(\hat{N}_{MKi}) * \text{var}(\hat{d}_{XMK})$$

where \hat{d}_{XMK} and its variance are from 6 and 7 above and \hat{N}_{MKi} is the survey estimate of retained marked fish for month i defined in Eqn. 1.

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

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

⁴ 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. 9 and 10 above but using unmarked fish proportions and monthly retention estimates.

Estimating Release Numbers by Class

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

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

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

\hat{R}_{SUi} = 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}_{XYi}) and retention (\hat{K}_{XYi}) during month *i*. The estimator and its variance are:

$$(11) \quad \hat{R}_{XYi} = \hat{E}_{XYi} - \hat{K}_{XYi}$$

$$(12) \quad \text{var}(\hat{R}_{XYi}) = \text{var}(\hat{E}_{XYi}) + \text{var}(\hat{K}_{XYi})$$

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 of 14% in ocean fisheries

sfm_S = release mortality rate for sublegal (*S*) Chinook, assumed to be a constant of 14% in ocean fisheries

Retention-mortality Estimates

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

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

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

\hat{M}_{SUi} = estimated mortality due to harvest of sublegal (*S*), unmarked (*U*) Chinook in month *i* (= \hat{K}_{SUi}).

Release-mortality Estimates

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

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

\hat{M}_{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:

$$(13) \quad \hat{M}_{XYR_i} = \hat{R}_{XY_i} * sfm_Y$$

$$(14) \quad \text{var}(\hat{M}_{XYR_i}) = \text{var}(\hat{R}_{XY_i}) * sfm_Y^2$$

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

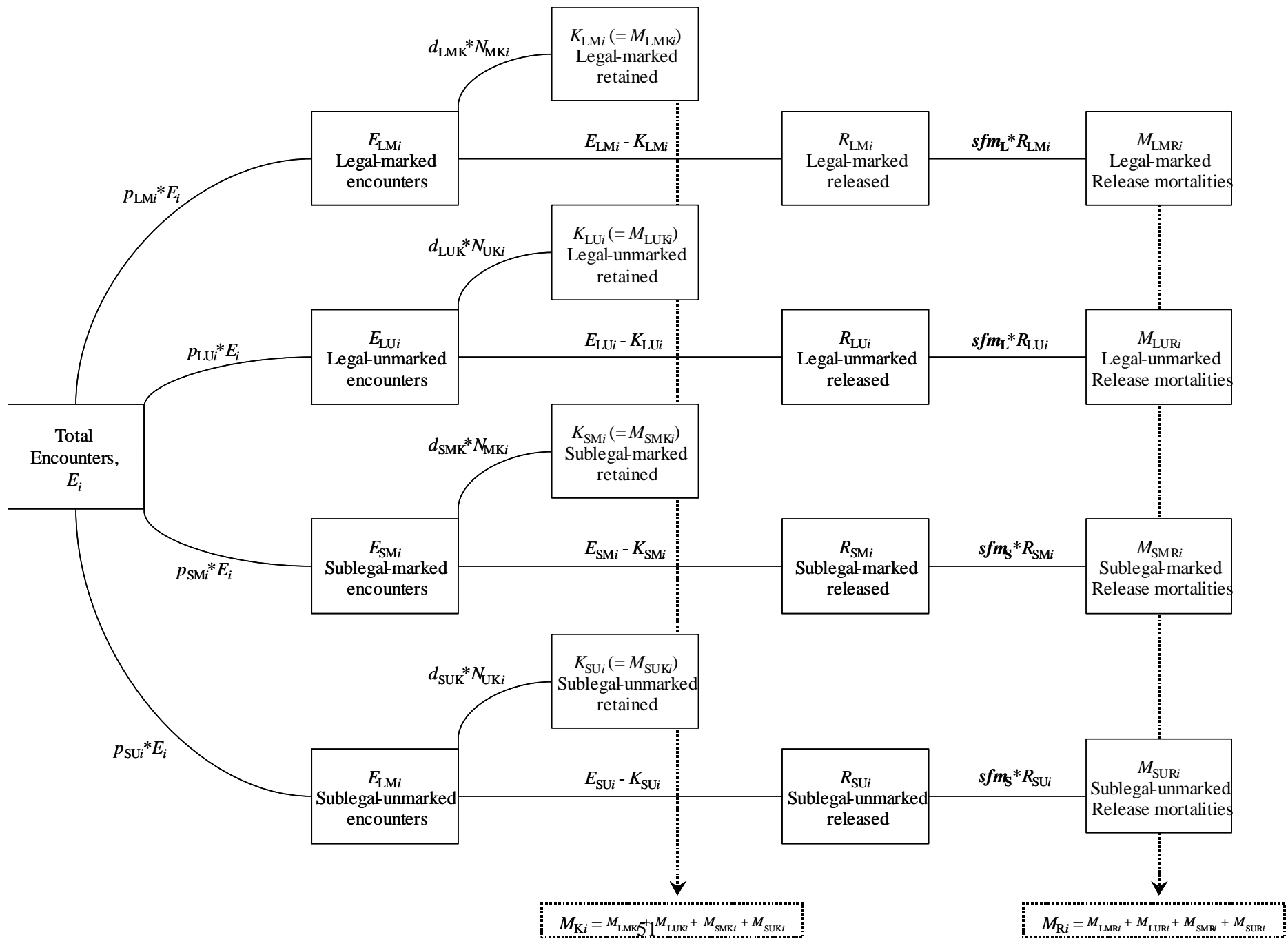
The precision of estimates generated from creel surveys and the preceding fishery impact estimation scheme is characterized using estimates of a parameter's standard error (*SE*), coefficient of variation (*CV* or relative standard error), and approximate 95% confidence interval. For any parameter estimate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

$$(15) \quad SE(\hat{\theta}) = \sqrt{\text{var}(\hat{\theta})}$$

$$(16) \quad CV(\hat{\theta}) = [SE(\hat{\theta}) / \hat{\theta}] * 100$$

$$(17) \quad CI = \hat{\theta} \pm 1.96 * SE(\hat{\theta})$$

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).



Appendix B. Coded-wire tag (CWT) recovery data collected during dockside sampling activities in the 2015 recreational Chinook MSF in Washington coastal Marine Areas 1, 2, 3 and 4.

Area	Recovery Date	Tag Code	Brood Year	Release Site	Rearing Hatchery	Release Agency	FL (cm)	Label	Recovery Mark	DIT codes
1	6-Jun-15	636283	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	78	32975	AD Fin Clp	NA
1	6-Jun-15	90672	2011	DETROIT RES (SANTIAM	MARION FORKS HATCH	ODFW	84	32976	AD Fin Clp	NA
1	6-Jun-15	55608	2012	COLEMAN NFH	COLEMAN NFH	FWS	69	32977	AD Fin Clp	NA
1	6-Jun-15	636281	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	74	32978	AD Fin Clp	NA
1	6-Jun-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	72	32979	AD Fin Clp	NA
1	7-Jun-15	90463	2011	SANTIAM R S FK	SOUTH SANTIAM HATCH	ODFW	76	32983	AD Fin Clp	NA
1	30-May-15	55409	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	69	42635	AD Fin Clp	NA
1	30-May-15	55409	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	70	42636	AD Fin Clp	NA
1	31-May-15	220220	2012	LUKE'S GULCH A F	NPT HATCHERY	NEZP	70	42637	AD Fin Clp	NA
1	4-Jun-15	636505	2012	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	68	42638	AD Fin Clp	NA
1	6-Jun-15	635685	2010	WENATCHEE R 45.0030	DRYDEN POND	WDFW	75	42639	AD Fin Clp	NA
1	30-May-15	636174	2011	SIMILKAMEEN R 490325	SIMILKAMEEN HATCHERY	WDFW	66	46101	AD Fin Clp	NA
1	31-May-15	636504	2012	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	56	46102	AD Fin Clp	NA
1	30-May-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	74	50001	AD Fin Clp	NA
1	30-May-15	60465	2012	SAN PABLO BAY NET PENS	FEATHER R HATCHERY	CDFW	65	50002	AD Fin Clp	NA
1	30-May-15	92353	2011	N FK RESERV (CLACKAM	CLACKAMAS HATCHERY	ODFW	65	50003	AD Fin Clp	NA
1	30-May-15	220322	2010	SNAKE R@PITT. LNDG	LYONS FERRY HATCHERY	NEZP	83	50004	AD Fin Clp	NA
1	30-May-15	635686	2010	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	82	50005	AD Fin Clp	NA
1	31-May-15	636370	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	73	50006	AD Fin Clp	NA
1	31-May-15	635774	2010	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	68	50007	AD Fin Clp	NA
1	31-May-15	636463	2012	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	74	50008	AD Fin Clp	NA
1	31-May-15	54793	2012	ENTIAT R 46.0042	ENTIAT NFH	FWS	59	50009	AD Fin Clp	NA
1	31-May-15	636505	2012	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	64	50010	AD Fin Clp	NA
1	3-Jun-15	636443	2011	SNAKE L.MON-LTL GOOS	LYONS FERRY HATCHERY	WDFW	60	50011	AD Fin Clp	NA
2	30-May-15	635599	2011	COWLITZ R 26.0002	COWLITZ SALMON HATCH	WDFW	72	25151	AD Fin Clp	NA
2	30-May-15	220335	2011	CAPTAIN JOHNS PD	LYONS FERRY HATCHERY	NEZP	69	25152	AD Fin Clp	NA

2	31-May-15	55407	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	66	25153	AD Fin Clp	55408
2	31-May-15	55409	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	63	25154	AD Fin Clp	NA
2	31-May-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	68	25155	AD Fin Clp	NA
2	3-Jun-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	69	25156	AD Fin Clp	NA
2	3-Jun-15	220334	2011	SNAKE R@PITT. LNDG	LYONS FERRY HATCHERY	NEZP	72	25157	AD Fin Clp	NA
2	3-Jun-15	90476	2010	CLACKAMAS R	CLACKAMAS HATCHERY	ODFW	88	25158	AD Fin Clp	NA
2	5-Jun-15	60462	2012	WICKLAND OIL NET PEN	FEATHER R HATCHERY	CDFW	69	25159	AD Fin Clp	NA
2	30-May-15	55623	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	70	32074	AD Fin Clp	55624
2	30-May-15	635691	2010	SIMILKAMEEN R 490325	SIMILKAMEEN HATCHERY	WDFW	74	32075	AD Fin Clp	NA
2	31-May-15	635668	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	62	32076	AD Fin Clp	NA
2	31-May-15	55409	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	62	32077	AD Fin Clp	NA
2	31-May-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	79	32078	AD Fin Clp	NA
2	3-Jun-15	636370	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	79	32079	AD Fin Clp	NA
2	6-Jun-15	636283	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	78	32152	AD Fin Clp	NA
2	30-May-15	635774	2010	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	83	43423	AD Fin Clp	NA
2	31-May-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	69	43424	AD Fin Clp	NA
2	31-May-15	55410	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	NA	43425	AD Fin Clp	NA
2	11-Jun-15	55623	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	77	43427	AD Fin Clp	55624
2	3-Jun-15	636282	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	69	43845	AD Fin Clp	NA
2	3-Jun-15	636416	2011	COWLITZ R 26.0002	COWLITZ SALMON HATCH	WDFW	75	43846	AD Fin Clp	NA
2	3-Jun-15	94633	2012	TRASK R	TRASK R HATCHERY	ODFW	64	43847	AD Fin Clp	NA
2	31-May-15	55407	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	73	43848	AD Fin Clp	55408
2	31-May-15	636175	2011	WENATCHEE R 45.0030	DRYDEN POND	WDFW	72	43849	AD Fin Clp	NA
2	31-May-15	636173	2011	SIMILKAMEEN R 490325	SIMILKAMEEN HATCHERY	WDFW	81	43850	AD Fin Clp	NA
2	31-May-15	55407	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	67	45141	AD Fin Clp	55408
2	31-May-15	90702	2012	BIG CR (LWR COL R)	BIG CR HATCHERY	ODFW	70	45142	AD Fin Clp	90377
2	31-May-15	90538	2010	MCKENZIE R 1	MCKENZIE HATCHERY	ODFW	78	45143	AD Fin Clp	NA
2	31-May-15	60469	2012	SANTA CRUZ HARBOR NET PEN	FEATHER R HATCHERY	CDFW	67	45145	AD Fin Clp	NA
2	31-May-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	70	45146	AD Fin Clp	NA
2	2-Jun-15	220335	2011	CAPTAIN JOHNS PD	LYONS FERRY HATCHERY	NEZP	59	51401	AD Fin Clp	NA

2	3-Jun-15	636281	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	67	51402	AD Fin Clp	NA
2	3-Jun-15	90676	2011	MCKENZIE R 1	MCKENZIE HATCHERY	ODFW	77	51403	AD Fin Clp	NA
2	5-Jun-15	90464	2011	MOLALLA R	MARION FORKS HATCH	ODFW	84	51801	AD Fin Clp	NA
2	6-Jun-15	55596	2012	COLEMAN NFH	COLEMAN NFH	FWS	65	51802	AD Fin Clp	NA
2	6-Jun-15	635773	2011	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	67	51803	AD Fin Clp	NA
2	6-Jun-15	636574	2012	LYONS FERRY REL.SITE	LYONS FERRY HATCHERY	WDFW	68	51804	AD Fin Clp	NA
2	6-Jun-15	90679	2011	MCKENZIE R 1	MCKENZIE HATCHERY	ODFW	74	51805	AD Fin Clp	NA
3	30-May-15	55407	2012	SPRING CR 29.0159	SPRING CR NFH	FWS	65	26025	AD Fin Clp	55408
3	15-May-15	55410	2012	LTL WHITE SALMON@NFH	LTL WHITE SALMON NFH	FWS	72	44023	AD Fin Clp	NA
4	9-Jun-15	211011	2011	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	74	7457	AD Fin Clp	636092
4	2-Jun-15	181971	2012	R-Chilliwack R	H-Chilliwack River H	CDFO	66	44531	AD Fin Clp	NA
4	15-May-15	635283	2010	FINCH CR 16.0222	HOODSPORT HATCHERY	WDFW	72	44801	AD Fin Clp	NA
4	2-Jun-15	636283	2011	CHELAN R 47.0052	CHELAN FALLS HATCHERY	WDFW	71	44802	AD Fin Clp	NA
4	3-Jun-15	636279	2011	METHOW R 48.0002	CARLTON ACCLIMATION POND	WDFW	55	44803	AD Fin Clp	NA
4	3-Jun-15	636444	2011	SNAKE L.MON-LTL GOOS	LYONS FERRY HATCHERY	WDFW	61	44804	AD Fin Clp	NA
4	11-Jun-15	635775	2010	COLUMBIA NEAR WELLS	WELLS HATCHERY	WDFW	83	52505	AD Fin Clp	NA