

Puget Sound Chinook Mark-Selective Fishery Sampling Methods

Overview

The Puget Sound Sampling Unit uses three different sampling designs to intensively monitor mark-selective Chinook fisheries (MSFs) in Puget Sound marine areas. These include the *Full Murthy Design*, *Reduced Murthy Design* and the *Aerial Access Design* (Figure 1). The sampling design used depends on area and season considerations as well as State-Tribal agreements made pre-season (Table 1).

The *Full Murthy Design* is the most intensive sampling design and is used to monitor the Areas 9 and 10 summer MSFs. Here, sampling occurs on 2 days during the Monday-Thursday time period and every Friday, Saturday and Sunday. The 2 days of sampling from the Monday-Thursday period are averaged and multiplied by 4 to create an estimate of catch for all four days. Then this estimate is added to the Friday, Saturday and Sunday estimates to provide a total estimate for the week.

The basic idea for the daily catch estimate is that we select and sample 2 ramps or exit locations on every sample day, count all the Chinook that are caught on a given day for those ramps, and expand those counts for the areas we do not sample. We conduct on-the-water interviews approximately weekly to determine where anglers will be leaving the fishery and determine how many people will exit the fishery at our sampled locations. This tells us how many Chinook came through the locations we sampled and what percentage of the anglers exited the fishery at the sampled locations. Although the mathematical formula that we use is a bit more complex, an approximation of the catch can be simplified as the number of Chinook observed at the sampled locations divided by the percentage of anglers leaving the fishery through the sampled locations.

We estimate total Chinook encounters (landed and released fish) based on the assumption that all legal-marked fish that are encountered are kept. This is done by dividing the estimate of total landed Chinook by the proportion of legal-marked fish encountered in the test fishery or reported in voluntary trip reports (VTRs).

However, this estimate is incorrect because anglers do not keep every legal-marked fish that is encountered. To correct for bias in this estimate due to intentional and unintentional releases of legal-marked fish (approximately 13% based on past studies¹), the initial estimate of total encounters is divided by 0.87.

Finally, the estimate of fishery total Chinook encounters can be apportioned into the four size/mark-status groups (legal-marked, legal-unmarked, sublegal-marked, sublegal-unmarked) by multiplying the total encounters estimate by the proportion in which each group is found in the fish population, which is estimated using information from the test fishing or VTR reports.

¹ See Conrad & McHugh (2008) for further information (<http://wdfw.wa.gov/publications/00492/>)

Sampling Activities

For all three sampling designs there are three main components required to estimate total encounters (number of fish retained and released) for a given fishery:

1) *Effort Surveys:*

- a. On-the-water Interviews (Boat Surveys) are conducted during most fisheries. During these surveys, samplers attempt to intercept all anglers on the water in a given fishery and determine where they intend to tie up or exit the fishery upon completing their trip. This provides us with a list of sites (ramps/launches) used to access the fishery as well as information on the relative amount of use (# of anglers) each site receives. Based on this information we designate a “sample-frame” of 5-6 of the highest use access sites for each fishery, from which we select sample sites for dockside creel sampling. Information from the boat surveys also allows us to estimate the total effort that originates from non-sampled sites and include it in our estimates.
- b. Aerial effort surveys are conducted in fisheries where Boat Surveys are infeasible due to large survey areas and unsafe boating conditions. During these surveys flights are conducted to count the total number of boats on the water in a fishery. The sample-frame (sites where we station samplers) consists of the four access sites expected to be of highest use in the fishery. Paired with interviews conducted at these sites, the aerial surveys provide information on the proportion of total fishery effort that originates from non-sampled sites, enabling expansion of observed dockside counts to fishery-wide totals.

2) *Dockside Creel Sampling* occurs 3 or 5 days per week, depending on the sampling design used. This provides information on effort (# of anglers), retained and released Chinook (# of marked and unmarked) and other fish species retained and released for the site on the day sampled. Selected sites are sampled from approximately dawn until dark. Empty trailers are noted as missed boats upon the sampler’s departure and get incorporated into estimates. Since effort differs on weekdays and weekends, each week is separated into weekday (Mon-Thurs) and weekend (Fri-Sun) time periods. In non-aerial survey designs, two sites from the sample-frame are selected on each sampling day. On sampling days in aerial survey areas, all four sites within the sample-frame are sampled.

3) *Test fishery or Voluntary Trip Report (VTR)* data are used to provide information on the composition of the four size and mark-status groups (Legal-Marked, Legal-Unmarked, Sublegal-Marked, Sublegal-Unmarked) present in the population of fish being encountered. This information is used independently of dockside sampling data and ***does not*** result in double-counted fish.

Estimation Example

To demonstrate how all of these pieces of information come together, below we provide a simplified example demonstrating the estimation of effort (# anglers), Chinook catch and total Chinook encounters for a Monday-Thursday period during which one site is sampled on two randomly selected days. ***Please note that this is a simplified example for informational purposes only.*** In actuality, at least two sites are sampled on every sample day (e.g., 1 northern site and 1 southern site in Area 9 summer fisheries), resulting in more complex estimation equations. For full details on sampling procedures and estimation methods see please reference WDFW’s Methods Report for Monitoring Mark-Selective Recreational Chinook Fisheries in the Marine Catch Areas of Puget Sound (<http://wdfw.wa.gov/publications/01357/>).

Dockside Creel Sampling Data:

Monday - Port Townsend		Wednesday - Everett Ramp	
Anglers	30	Anglers	40
Landed Chinook	20	Landed Chinook	20

Test Fishery Data

	# Fish	Proportion
Legal-AD	50	0.50
Legal-UM	20	0.20
Sublegal-AD	20	0.20
Sublegal-UM	10	0.10
Total	100	

Boat Survey Data:

Site	Anglers	Site-Weight	
Fort Casey/Keystone	20	20 / 100 = 0.20	
Mukilteo	10	10 / 100 = 0.10	
Everett	40	40 / 100 = 0.40	
Port Townsend	25	25 / 100 = 0.25	
Kingston	5	5 / 100 = 0.05	In-Sample Proportion
Total In-Frame (Sampled sites)	100		100/150 = 0.67
Total Out-of-Frame (Non-sampled sites)	50		
Total Anglers	150		

Daily Estimates: To estimate the number of anglers on Monday we take the number of anglers sampled on Monday at Port Townsend (30) and divide by the proportion of “in-sample” (within sample-frame) effort from Port Townsend (0.25). This gives us an estimate of 120 anglers that fished out of the 5 sample-frame sites. To estimate total anglers on Monday for the whole fishery, including non-sampled sites, we divide the 120 in-sample anglers by the proportion of total effort that originated from the 5 sample-frame sites (0.67) generating an estimate of 180 anglers.

By the same methods we estimate:

$$\text{Total Landed Chinook on Monday} = (20 / 0.25) / 0.67 = 120$$

$$\text{Total Anglers on Wednesday (sampling from Everett Ramp)} = (40 / 0.40) / 0.67 = 150$$

$$\text{Total Landed Chinook on Wednesday (sampling from Everett Ramp)} = (20 / 0.40) / 0.67 = 75$$

Weekday Estimates: To estimate effort and catch across the whole time period (Mon-Thurs) we combine the daily estimates from the two days sampled and multiply by the ratio of (N/n) where “N” is the total number of days in the time period (4) and “n” is the number of days sampled (2):

$$\text{Total Anglers} = (180 + 150) \times (4 / 2) = 660; \text{Total Landed Chinook} = (120 + 75) \times (4 / 2) = 390$$

Total Encounters: Initially, we calculate an estimate of total Chinook encounters based on the assumption that all legal-marked fish that are encountered are kept. This is done by dividing the estimate of total landed Chinook (390) by the proportion of legal-marked fish encountered in the test fishery or reported in VTRs (0.50), as follows:

$$\text{Total Encounters} = 390 / 0.50 = 780 \text{ (uncorrected estimate)}$$

However, this estimate is incorrect because anglers do not keep every legal-marked fish that is encountered. To correct for bias in this estimate due to intentional and unintentional releases of legal-marked fish (approximately 13% based on past studies), the initial estimate of total encounters is divided by 0.87.

$$\text{Bias-corrected Total Encounters} = 780 / 0.87 = 897 \text{ total Chinook encounters.}$$

Encounters by size/mark group: The estimate of total Chinook encounters can be apportioned into the four size and mark-status groups by multiplying it by the proportions of the four groups from the test fishing/VTR data.

$$\text{Legal-AD} = 897 \times 0.50 = 449$$

$$\text{Legal-UM} = 897 \times 0.20 = 179$$

$$\text{Sublegal-AD} = 897 \times 0.20 = 179$$

$$\text{Sublegal-UM} = 897 \times 0.10 = 90$$

Full Murthy Sampling Design

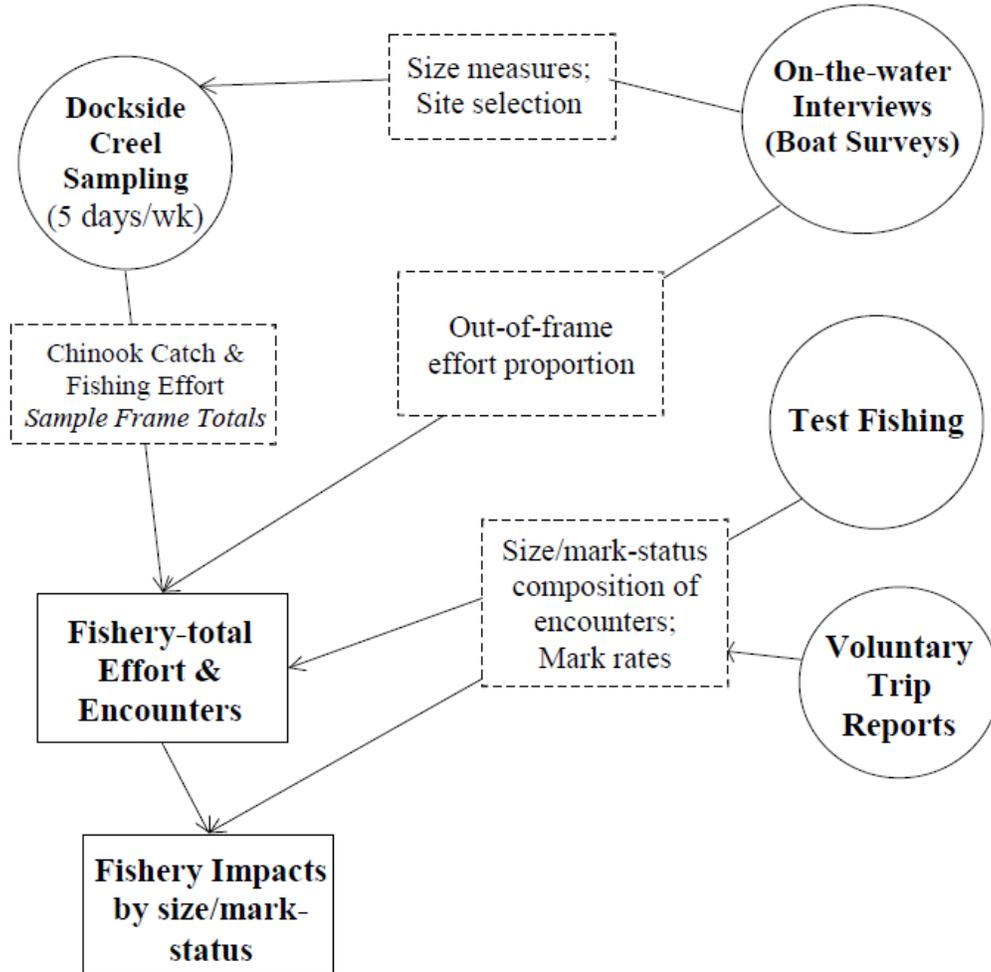


Figure 1. Conceptual diagram of the *Full Murthy Sampling Design*. Circles represent discrete sampling activities, dashed boxes represent parameters that are estimated using data from a given activity, and solid boxes depict key quantities estimated from the comprehensive plan. The *Reduced Murthy Sampling Design* is identical to the *Full Murthy*, except only three days per week are sampled instead of five and test fishing may or may not occur. The *Aerial Access Design* is identical to the *Reduced Murthy*, except boat surveys are replaced by aerial effort surveys.

Table 1. List of the sampling design used to monitor each of the Chinook MSFs in Puget Sound

Sampling Design	Fishery
Full Murthy Design	Summer Fisheries in Areas 9 & 10
Reduced Murthy Design	Summer Fisheries in Areas 5 & 11; Winter Fisheries in Areas 8-1, 8-2, 10 & 11
Aerial Access Design	Winter Fisheries in Areas 6, 7 and 9
Baseline Sampling only	Summer Fisheries in Areas 6, 12 and 13; Winter Fisheries in Area 12