2017 Fall Zone 4-5 Gillnet Fishery
WDFW and ODFW Observation Study Sampling Plan

Introduction

Columbia River fisheries generate millions of dollars in economic value annually, and are an integral part of the economies of Oregon and Washington. For the non-treaty commercial fishery, the fall mainstem gillnet fishery targeting hatchery and healthy wild stocks of fall Chinook is an especially important component, comprising an average of 49% of total annual ex-vessel value in recent years (ODFW 2017). Even with the economic significance of this fishery, fishery managers must still manage it to ensure that mortalities of ESA-listed fish remain within allowable limits prescribed by NOAA Fisheries. Furthermore, fishery managers must manage non-treaty fisheries so that these ESA "impacts" are shared by commercial and recreational fisheries according to allocation guidelines set forth by the states of Oregon and Washington, and according to *U.S. v Oregon* management agreements with respect to treaty fisheries. The Columbia River Harvest Reform process, initiated in 2012, has put the fall mainstem gillnet fishery under a high degree of scrutiny with regard to its "selectivity"—i.e. its capability to harvest targeted Chinook salmon, while minimizing impacts to non-target species such as steelhead and non-legal-sized sturgeon. As a result, the Oregon and Washington Fish and Wildlife Commissions have indicated the need for on-board observation of the 2017 fall mainstem gillnet fishery to verify historical incidental catch data for steelhead and sturgeon, and to build upon previous observation studies of the fall gillnet fishery. Analyses of observation data will help to inform decisions regarding future fall non-treaty commercial fisheries in the mainstem Columbia River.

Background

Mainstem gillnet fisheries targeting fall Chinook in the lower Columbia River occur from August through October, and the ESA-listed stocks that typically affect fishery planning and implementation are Lower Columbia River (LCR) wild tule fall Chinook, Snake River Wild (SRW) fall Chinook, and wild Group B summer steelhead. The degree to which each of these stocks might constrain the fishery varies annually, and depends on stock abundance, where and when the fishery occurs, as well as gillnet mesh sizes used in the fishery. To minimize impacts on ESA-listed stocks while allowing the harvest of hatchery and healthy wild stocks, the fall mainstem gillnet fishery has been managed using restrictions on mesh size, area, season timing and duration of open periods. For example, Chinook-directed fisheries are restricted to large mesh (8+ or 9+ inches) gillnets to minimize encounters with steelhead. To reduce the harvest of LCR tule Chinook, which are more prevalent early in the season and in the commercial fishing zones lower in the system, the fall gillnet fishery no longer operates in Zones 1-3 during the early fall season. The fishery during the late fall season (mid-September – October) is also restricted to the uppermost two zones downstream of Bonneville Dam (Zones 4-5), except when sufficient impacts are available to allow a Zone 1-5 fishery and/or after most LCR tules have moved into spawning tributaries. In addition, a two-week closure during the first half of September, when the abundance of upriver bright fall Chinook is highest, has helped the fall gillnet fishery avoid excessive impacts on SRW fall Chinook. Detailed descriptions of the season structures and results of past commercial fall mainstem gillnet fisheries can be found in a series of annual reports produced jointly by ODFW and WDFW staff (ODFW and WDFW 2017).

Aside from test fishing in the 1980s and early 1990s, there have been few opportunities to conduct on-board observations of the fall gillnet fisheries--primarily due to budgetary constraints. In 2009 and 2010, ODFW conducted an on-board observation study of mainstem commercial gillnet fisheries, which included the fall large-mesh fishery, fall small-mesh fishery (targeting Coho), and summer Chinook fishery (Kern et al. 2011). This study sought to update information on steelhead encounter rates, identify the best method for estimating the incidental catch of steelhead, and provide a suitable sampling design for future observation of commercial gillnet fisheries. A similar observation study of the fall gillnet fishery was conducted in 2012 by WDFW (Holowatz and McHugh 2013). WDFW's study objectives included a comparison of steelhead encounter rates to those reported in Kern et al. (2011), as well as encounter rates from historical test fishing, and estimates of the total numbers of steelhead and White Sturgeon (by size class) caught during various fall commercial gillnet fisheries in 2012. Holowatz and McHugh (2013) found a steelhead encounter rate (steelhead-to-Chinook ratio) similar to the Kern et al. (2011) and historical test fishing encounter rates; however, this comparison did not take into account any adjustment for year-specific run ratios. Kern et al. (2011) recommended additional observation of the fall gillnet fishery to collect data over a range of run sizes and fishery conditions; neither study identified summer steelhead to the stock level (Group A and Group B) during on-board observations. As Group B wild steelhead are usually the limiting steelhead stock during August and late fall fisheries, collecting more detailed steelhead data during fishery observation would provide information on the relative catch of steelhead stocks in the fall gillnet fishery.

Estimation of impacts on ESA-listed LCR tule and SRW fall Chinook stocks is relatively straightforward since the fall mainstem gillnet fishery is a full-retention fishery where both hatchery and wild Chinook are harvested. Therefore, fishery landings and coded wire tag (CWT) data can be used to estimate mortalities for these retained stocks. However, estimation of mortalities for non-retained species, such as steelhead, is more complicated, and requires a different methodology. Currently, ODFW and WDFW fishery managers use steelhead-to-Chinook ratios from historic test fishing (including the 2009-10 and 2012 fishery observation studies referenced above) adjusted for current-year run size forecasts for Chinook and steelhead and Chinook landings from the commercial fishery, to estimate total encounters of steelhead in the fall gillnet fishery. Total estimated steelhead encounters are then multiplied by the mortality rate specific to large-mesh gear in the fall (59%) to arrive at an estimate of total steelhead mortalities (Kern et al. 2011). These mortalities are apportioned into the various summer steelhead components (hatchery Group A, wild Group A, hatchery Group B, wild Group B) based on the composition of steelhead passing through the Bonneville Dam Adult Fish Facility (AFF) at specific times. Although the AFF data provide information on the approximate stock composition of steelhead caught in the fishery, collecting detailed information on steelhead catch composition (e.g. fin-mark status and stock) during fishery observation could potentially provide more accurate data for estimation of impacts to the various steelhead components, assuming that sample sizes are sufficient.

Objectives

The objectives for the 2017 fall mainstem gillnet fishery observation study are:

1) Determine if the observed steelhead-to-Chinook encounter rate is significantly different from the run-size adjusted historic rate used in the fall fishery management model.

2) Collect stock-specific encounter rate data for steelhead, and assess the suitability of stock-specific catch estimates for future evaluation of the fishery.

3) Compare the observed immediate mortality rate for steelhead to the historic rate and that reported in Kern et al. (2011).

4) Collect encounter rate data for sturgeon, and assess the suitability of catch estimates by size class and area (e.g. inside vs. outside sturgeon sanctuary) for future evaluation of the fishery.

Methods

Study Area

The early fall mainstem gillnet fishery currently proposed in 2017 will be limited to Zones 4 and 5. Therefore, the observation study area will range from the downstream end of Zone 4, at the mouth of the Lewis River (RM 87), to the upstream end of Zone 5 at the Beacon Rock commercial fishing deadline (RM 142, Figure 1). Zone 4 is approximately 45 river miles in length, and Zone 5 is approximately 11 river miles long. Zone 4 is also more tidally influenced than Zone 5, and this can affect when fish tend to be caught, and therefore, when and how long fishers choose to fish. Because fishery participants at the lower end of Zone 4 have the first opportunity to intercept fall Chinook migrating up the mainstem Columbia, fishing vessels are usually more concentrated there.

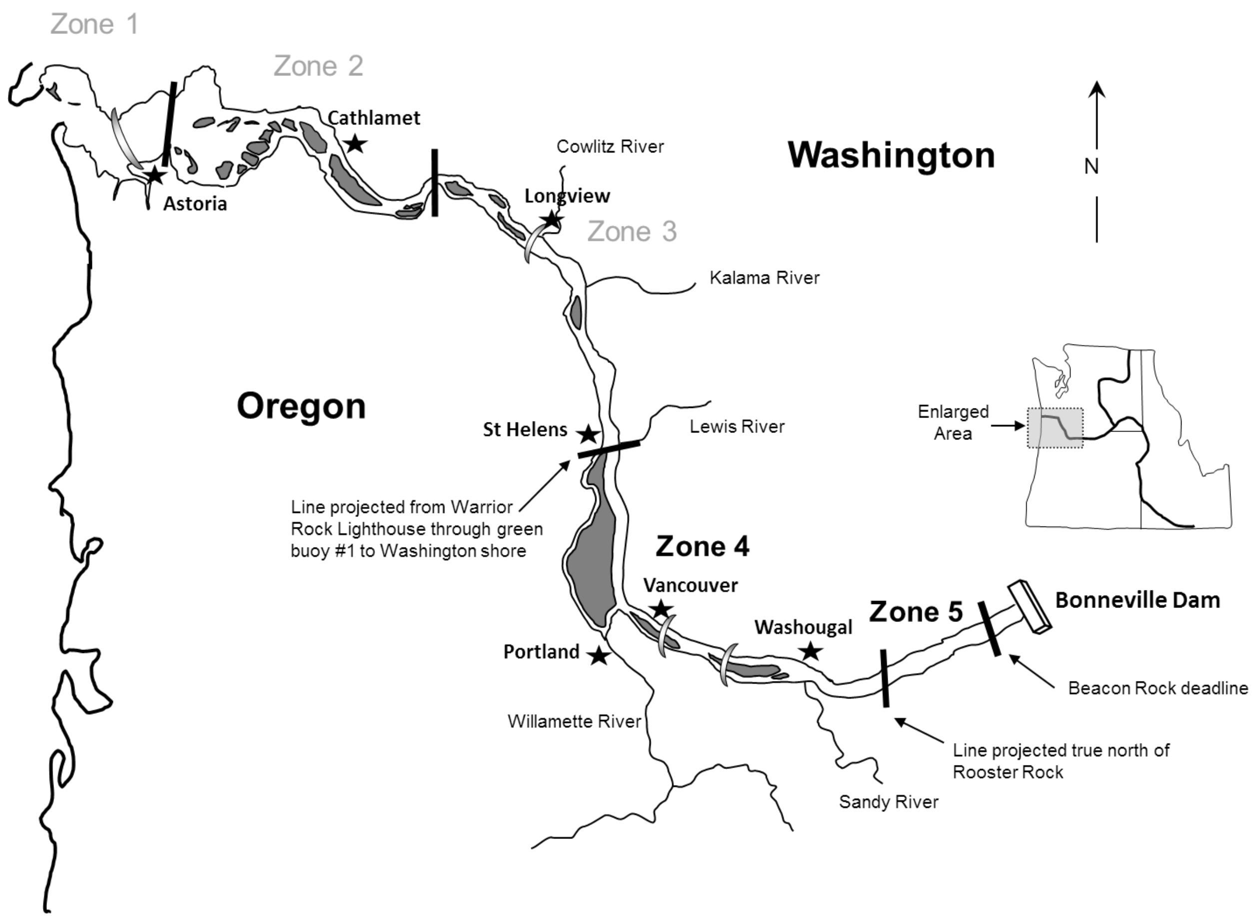

Figure 1. Non-treaty commercial fishing zones of the mainstem lower Columbia River.

Precision of Estimates under Various Levels of Sampling Effort

Data from the 2009 fall gillnet observation study were used to develop simulations exploring the expected precision of steelhead and sturgeon bycatch estimates in the proposed 2017 Zone 4-5 fall gillnet fishery. The Zone 4-5 fishery was simulated by generating daily Chinook, steelhead, and sturgeon catch numbers for an approximate number of boats expected to participate in the 2017 fishery. Catch data for each species were simulated using the distribution of catch-per-drift from observation of the 2009 Zone 4-5 fishery. Because no stock information was recorded for steelhead in the 2009 data, the catch-per-drift distribution for total steelhead catch was split according to their proportions in the 2017 forecast. The 2009 data did include catch-per-drift distributions for each of three sturgeon size classes (sublegal, legal, overlegal), so these groups were modeled directly from the 2009 data. Observation of the fishery was simulated by taking a random sample of the simulated catch data from a subset of the simulated fleet. The number of observers was varied from two to the total number of boats in the fleet (complete census). Sample data in each simulation were used to calculate total steelhead handle using the ratio estimator employed by Columbia River fisheries managers. To estimate stock-specific steelhead encounters, the simulated sample data were used to estimate the proportion of each stock group in the total steelhead handle estimate. For total sturgeon handle estimates, a ratio estimator was used for each size class. Multiple sources of uncertainty that affect estimates of steelhead and sturgeon handle were incorporated into simulations, including uncertainty in estimating the steelhead- and sturgeon-to-Chinook ratios, uncertainty in the Chinook catch estimate, and uncertainty in estimating the proportions of the steelhead stock groups from the sampled catch. Simulations were repeated 1,000 times for each number of observers. Considering the limited amount of data available to model this fishery, these simulations were not intended to predict the number of steelhead or sturgeon that might be handled in the 2017 fishery, but rather to explore the relationship between the sampling level of the fleet and the bias and precision of resulting steelhead and sturgeon handle estimates.

Simulation results indicated that estimates of Group B steelhead handle under the established ratio estimator may be relatively imprecise when considering both the limited resources available for sampling and the logistical constraints of observing the fishery (Figures 2 and 3). Estimates with data from 10-20 observers could have confidence limits of approximately 10 – 60 fish for hatchery B steelhead (Figure 2) or 5 – 50 fish for wild B steelhead (Figure 3). Point estimates of total B steelhead handle could also be considerably biased with fewer than 10 observers. With more than 10 observers, there appeared to be diminishing returns in terms of bias (i.e., an inflection point in the blue line). While meaningful gains in precision appear to continue up to 16 or 18 observers, some level of bias in the estimate is likely to persist (Figures 2 and 3). Much of the uncertainty in these estimates stems from uncertainty in estimating the proportions of the steelhead stock groups, because in most simulations, few (if any) B steelhead were observed. For the more abundant Group A steelhead and White Sturgeon size classes, total handle can be estimated more precisely (Figure 4, Figure 5). Estimates of total handle for these groups also exhibited less bias at lower observation levels in these simulations.

Visualizing the proportion of simulations in which zero Group B steelhead were observed versus sampling effort illustrates the difficulty in estimating catch based on a rare event (i.e., Group B steelhead encounters; Figure 6). In these simulations, the average "true" total handle was 19 wild B steelhead. With fewer than 14 observers in a fleet of 120 boats, zero wild B steelhead were observed in over 20% of the simulations. To ensure that at least one wild B steelhead was observed in 95% of the simulations required a minimum of 25 observers. It is also important to note that the catch data used to develop these simulations came from 2009, when the total steelhead run size was nearly five times larger than the forecast in 2017 (587,000 vs. 119,000). If pre-season run size forecasts turn out to be correct, and catch rates in the fishery are related to abundance, encounters of Group B steelhead could be even sparser than portrayed in these simulations. This would result in even greater uncertainty in handle estimates for Group B hatchery and wild steelhead.

In these simulations, catches of steelhead, sturgeon, and Chinook were modeled as independent. In reality, ratio estimators will perform better (i.e., less biased; improved precision) if catch of the other species are correlated with Chinook catch (where Chinook catch is the predictor variable). However, in the 2009 data used to develop simulations, Chinook catch was only weakly correlated with steelhead (Pearson's correlation: 0.28) and sturgeon catch (Pearson's correlation: 0.21 – 0.32); thus, any realized improvement in precision over these simulations would likely be marginal.

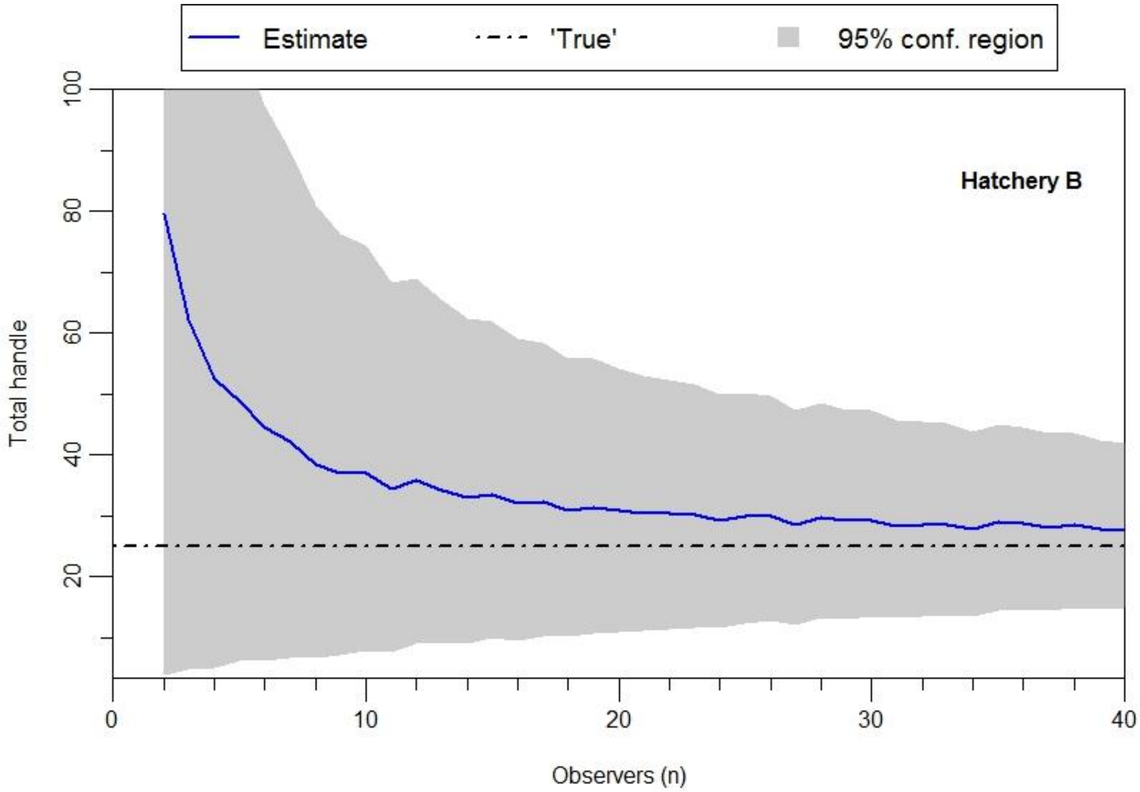

Figure 2. Simulated estimates of total hatchery origin Group B steelhead handle with 2 - 40 observers.

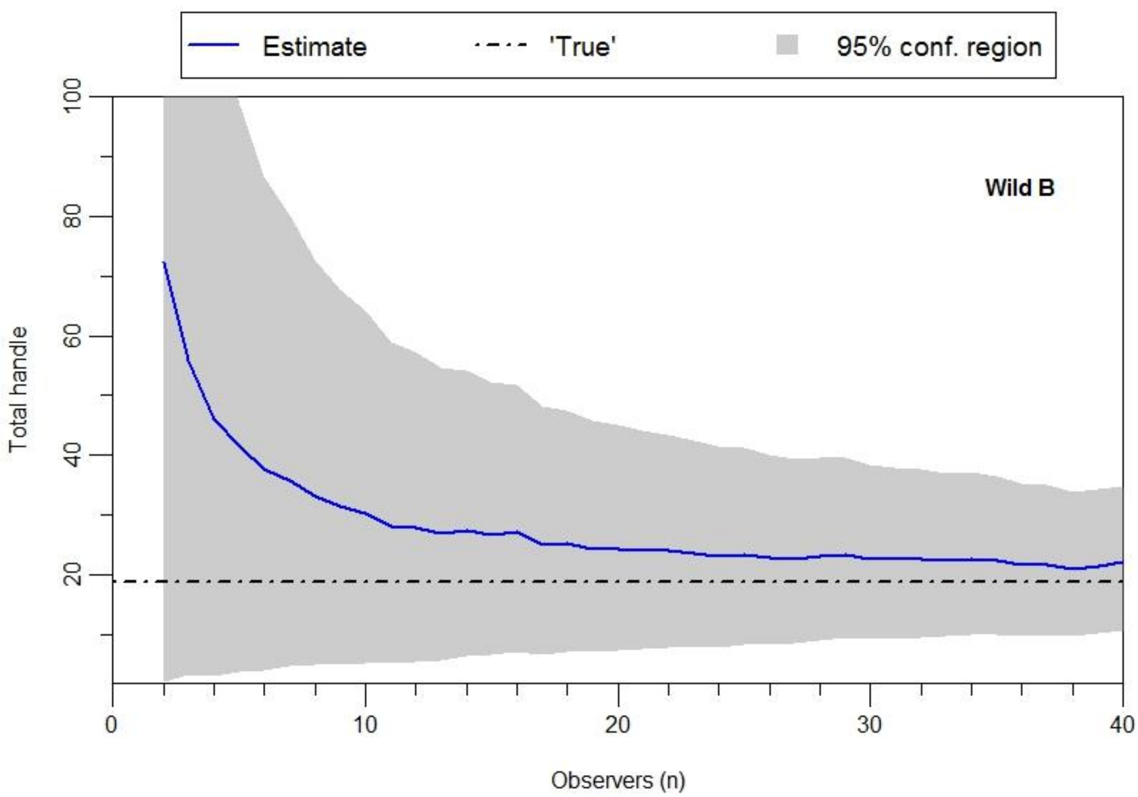

Figure 3. Simulated estimates of total natural origin Group B steelhead handle with 2 - 40 observers.

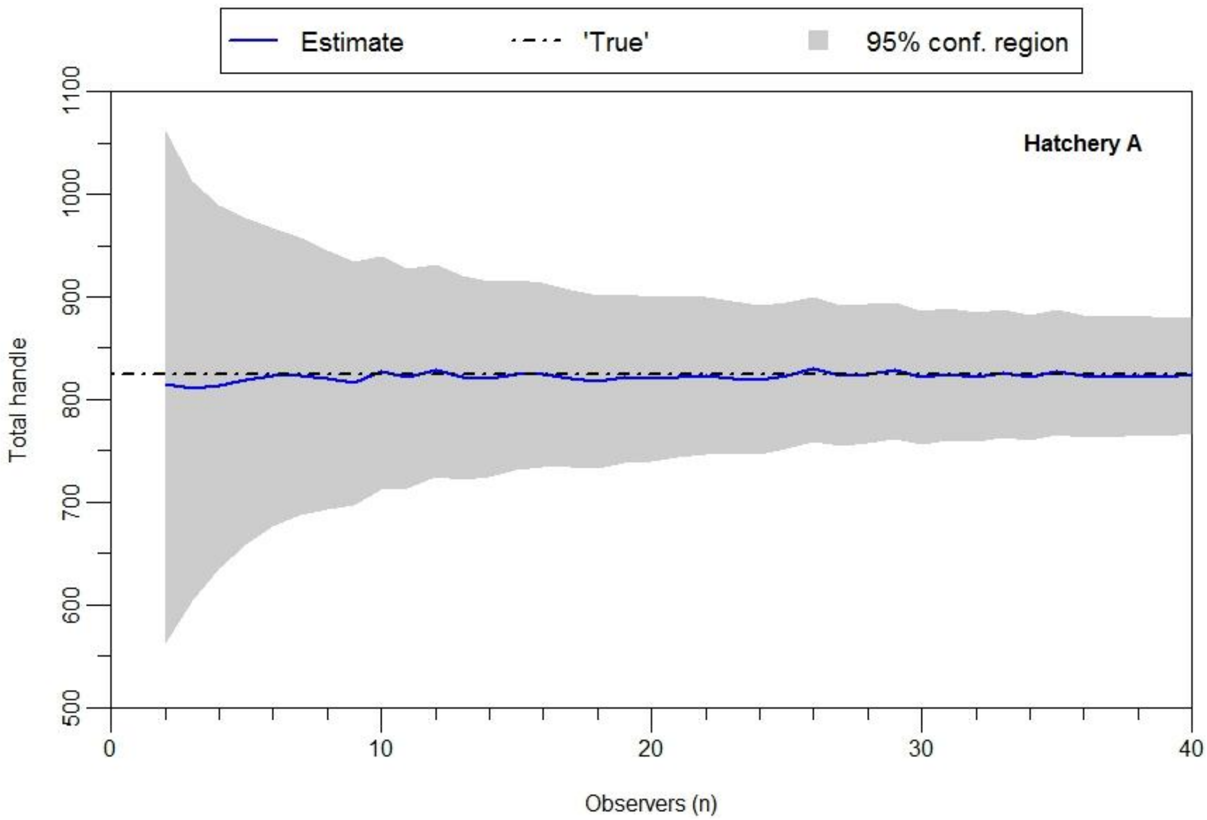

Figure 4. Simulated estimates of total hatchery origin Group A steelhead handle with 2 - 40 observers.

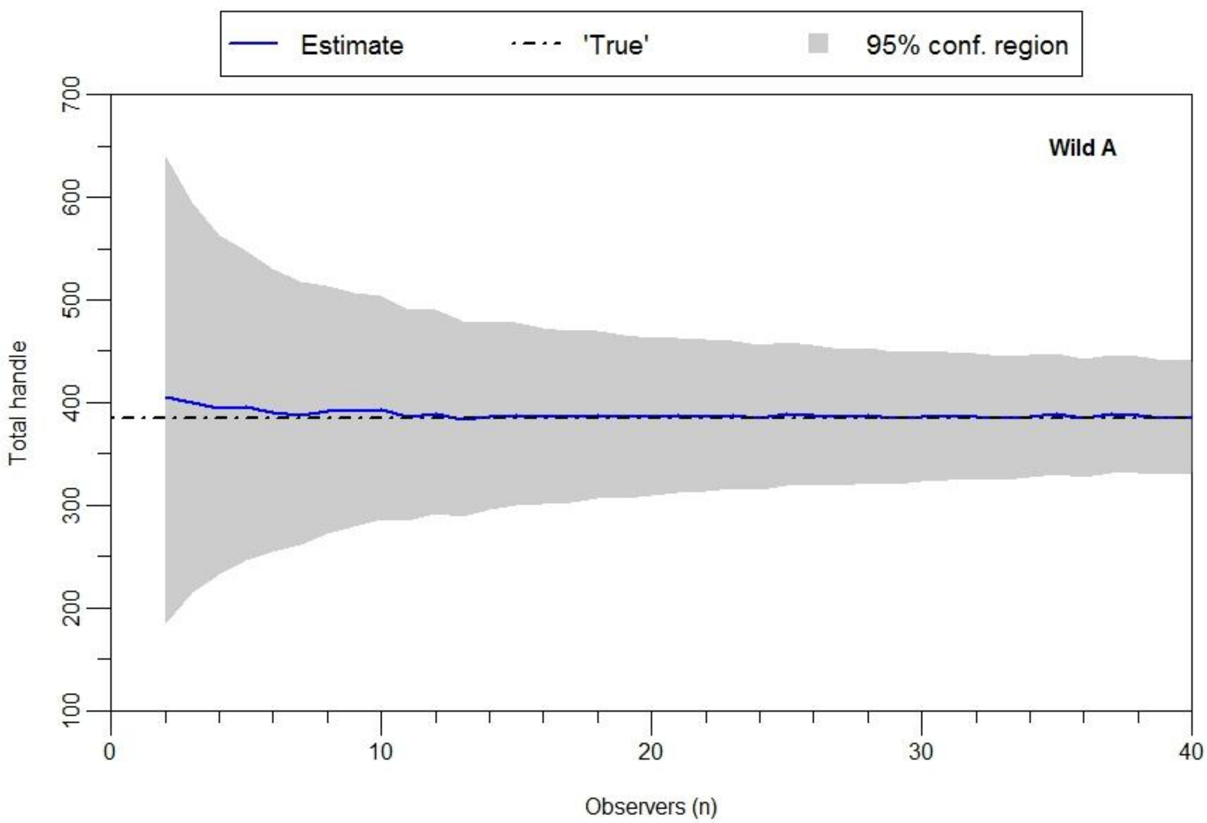

Figure 5. Simulated estimates of total natural origin Group A steelhead handle with 2 - 40 observers.

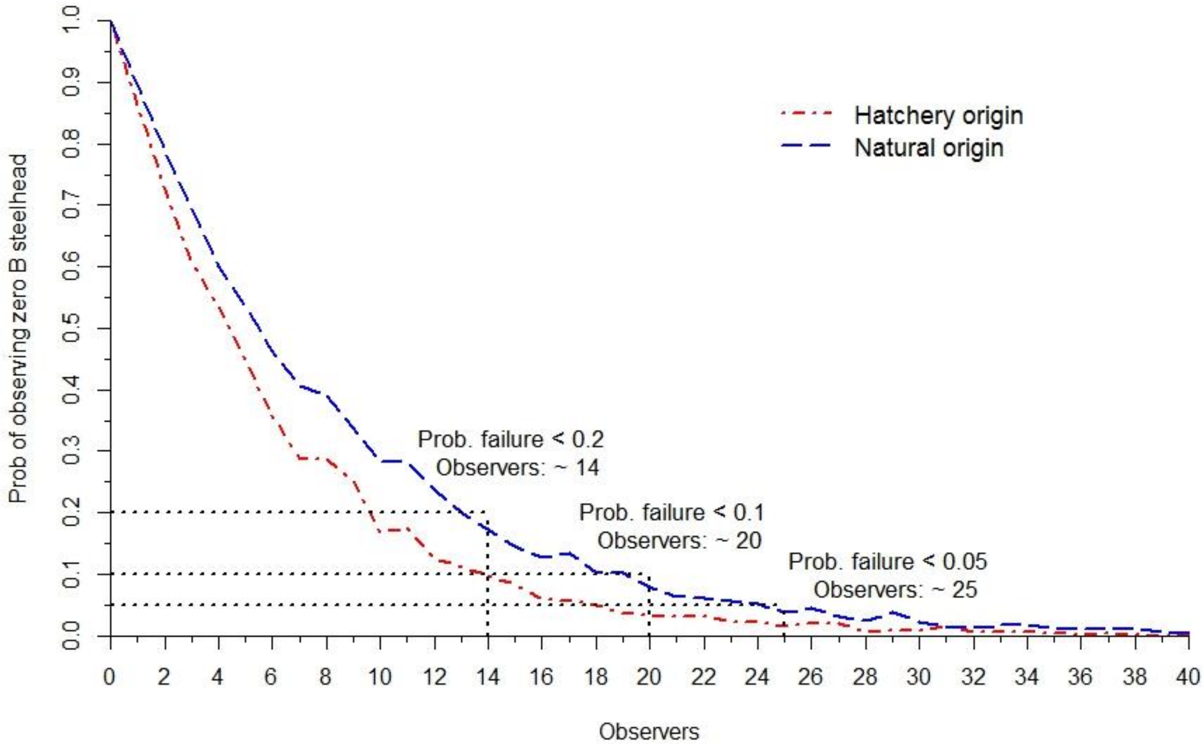

Figure 6. Probability of observing zero Group B steelhead in 1,000 simulations of the fishery with 2 - 40 observers.

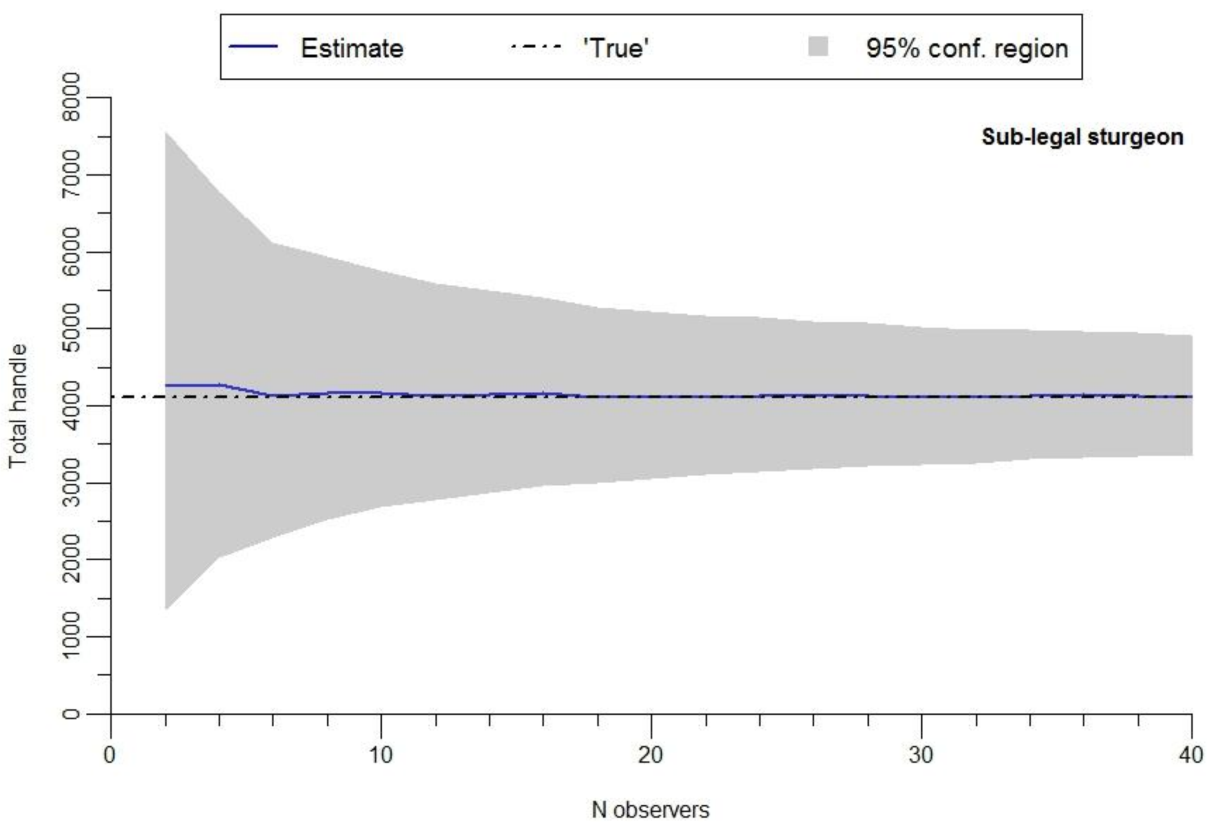

Figure 7. Simulated estimates of total sub-legal White Sturgeon handle with 2 - 40 observers.

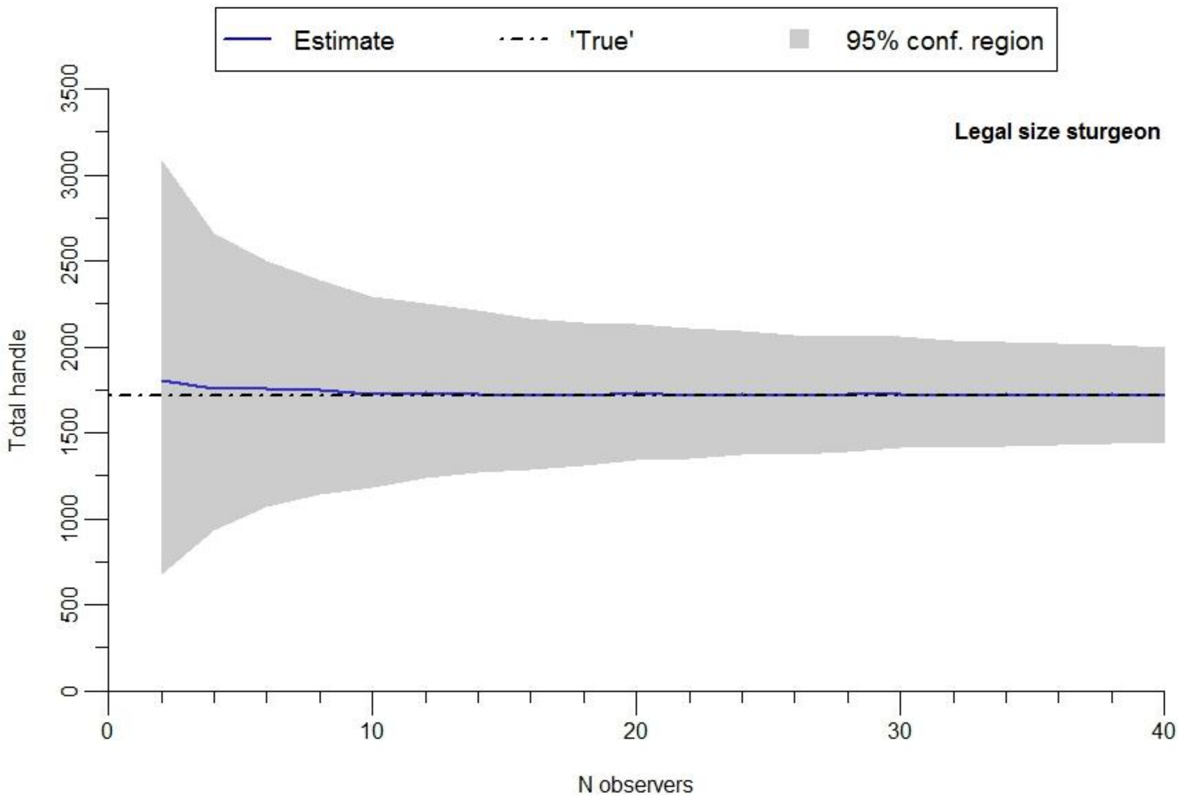

Figure 8. Simulated estimates of total legal-size White Sturgeon handle with 2 - 40 observers.

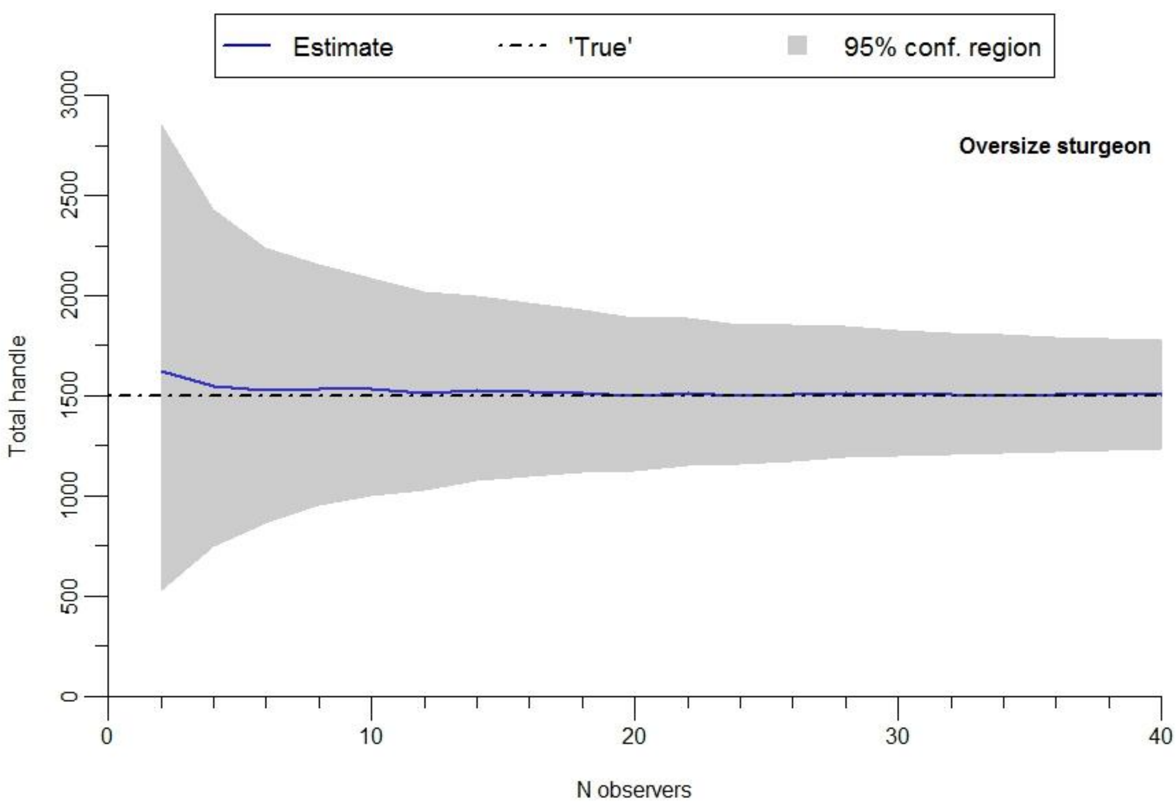

Figure 9. Simulated estimates of total overlegal White Sturgeon handle with 2 - 40 observers.

Sampling Design

The 2017 Zone 4-5 gillnet fishery is currently planned for six fishing periods (9 hours each; 9:00 pm-6:00 am) during the last two weeks of August (three periods per week; August 20-September 1). Twenty ODFW and WDFW field staff will observe a random sample of participating fishers during each of the fishing periods.

Most fishers anchor in the river well before the start of the fishery--sometimes as much as 12-24 hours prior--to ensure access to their preferred "drifts". Observers will be placed on selected fishing vessels using Department boats during daylight hours (approximately 6:00 PM-8:30 PM), just prior to the start of the fishery, and will remain on the same vessel for the duration of the fishing trip. These "dedicated" observations are analogous to the "ride-a-long" observations noted by Kern et al. (2011) and "full-trip" observations conducted by WDFW in 2012 (Holowatz and McHugh 2013). The total anticipated level of sampling effort for all currently scheduled fishing periods (120 observed fishing trips) is expected to provide a sample rate of 13-16% of all fishing trips (approximated by deliveries). A systematic random sampling design will be used to determine which commercial vessels will be observed in each fishing period. With this method, for each fishing period, a sampling interval is calculated by dividing the expected number of participating vessels by the number of available observers (e.g. 140/20 = 7; every 7th vessel encountered in the fishery area is sampled). A random start point is determined daily by randomly selecting a number between 1 and the number of the sampling interval (7 in the example). If, for example, the number "4" is randomly selected, then the 4th vessel encountered in the fishery area will receive the first observer, and observers will be placed on every 7th vessel thereafter. To ensure broad sampling of the fleet, ODFW and WDFW will maintain a list of observed vessels for each fishing period, and the same vessel will not be observed on consecutive fishing periods.

To collect accurate information on released fish, all steelhead will be brought onboard the fishing vessel for classification by the observer. Additionally, observers must be provided the opportunity to identify other released fish, including non-retained sturgeon.

Data Collection

For each observed gillnet "drift" (a single fishing effort by a vessel), the following information will be recorded:

- Date, hull number/boat name, and observer name
- Net length, depth, and mesh size
- Fishing zone
- Drift number (for the trip)
- Fishing location (geographic description--e.g. Bachelor Island, Marker 82, etc.)
- GPS coordinates (for inshore end of net at beginning of drift)
- River depth (from vessel depth sounder; for both ends of net at beginning of drift)
- Net lay-out start and stop times; net pick-up start and stop times
- Enumeration of kept catch by species (Chinook/Coho/White Sturgeon)
- Enumeration of released salmonid catch by species, fin-mark status, stock (steelhead only, Group A/B based on length), and release condition (alive/dead)
- Enumeration of released sturgeon by size class (legal, sublegal, overlegal); also Green Sturgeon
- WDFW will collect information on mortality of captured Chinook

Steelhead and Sturgeon Encounter Rates and Catch Estimates

Steelhead encounter rates will be calculated as the number of steelhead observed per retained Chinook (adults and jacks) observed--i.e. the traditional steelhead-to-Chinook ratio. Since the number of summer steelhead expected to return in 2017 is very low, hatchery and wild fish will likely need to be combined for each stock (Group A/B) to provide larger sample sizes for analyses. Post-season run sizes for hatchery and wild steelhead (by stock) will be used to apportion the estimated catch for each stock into hatchery and wild components. To compare the 2017 observed steelhead-to-Chinook ratio to the run size-adjusted historical ratio used in the 2017 fall fishery management model, we will use the aggregate ratio for all steelhead and Chinook observed during the study, and will test for a statistically significant difference between ratios.

Because steelhead-to-Chinook ratios change over time (Figure 10), and to maximize the sample size, an estimate of total steelhead catch, or encounters, will be calculated for the entire Zone 4-5 season using the ratio-based expansion method utilized by current fishery managers, as well as Kern et al. (2011) and Holowatz and McHugh (2013). Steelhead encounters ($\hat{E}$) will be estimated as the product of the auxiliary variable, total Chinook harvest from landings (*K*), and the observed steelhead-to-Chinook ratio (*e*/*k*), and estimates will have an associated variance:

$$(1) \quad \hat{E} = K \cdot \frac{\sum_{i=1}^{n} e_i}{\sum_{i=1}^{n} k_i}$$

$$(2) \quad var(\hat{E}) = \frac{N(N-1)}{n(n-1)} \left(\sum_{i=1}^{n} e_i^2 + \hat{E}^2 \sum_{i=1}^{n} k_i^2 - 2\hat{E} \sum_{i=1}^{n} k_i e_i \right)$$

Where *N* is the total number of landed Chinook and *n* is the number of observed Chinook (Kern et al. 2011; Holowatz and McHugh 2013).

White Sturgeon encounter rates will be calculated for each size class using the number of sturgeon observed per retained Chinook observed. To maximize sample sizes, total sturgeon encounters for each size class will be calculated for the entire Zone 4-5 season using the same ratio-based expansion method utilized for steelhead. Because the number of vessels fishing within the sturgeon sanctuary is expected to be limited, sample size issues may preclude precise estimates of sturgeon handle within the sanctuary.

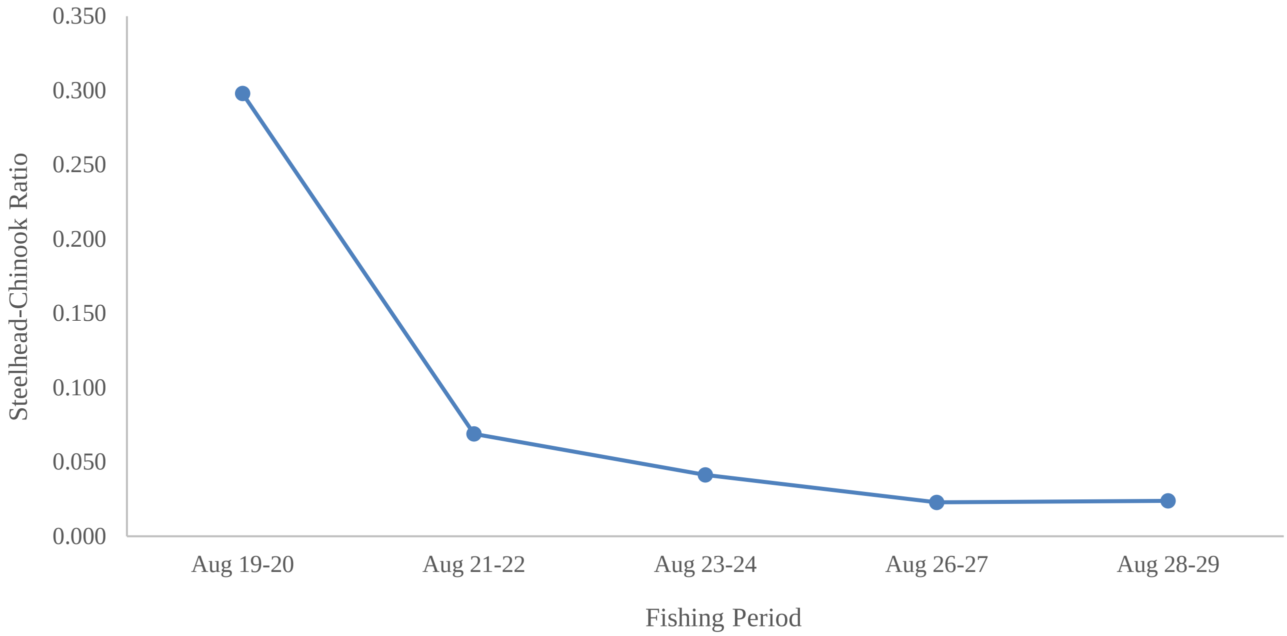

Figure 10. Observed steelhead-to-Chinook ratios from five large-mesh gillnet fishing periods in late August, 2012 (Holowatz and McHugh 2013).

Steelhead Immediate Mortality Rates

Immediate mortality rates for steelhead will be determined by dividing the number of dead steelhead observed by the total number of observed steelhead. Determination of condition (alive or dead) when the fish is brought onboard will be based on: 1) body movement, 2) attempted ventilation, and/or 3) fixation of the eye. It should be assumed that a small percentage of fish recorded by observers as "dead" based on these criteria may recover; however, without the use of live boxes on vessels, immediate mortality rate estimates should be viewed as conservative. Predation-related mortalities will be excluded from the sample so that mortality rates are not confounded by non-gear related factors. For comparison to the aggregate historic gear-specific immediate mortality rate and the immediate mortality rate reported in Kern et al. (2011), we will use the aggregate mortality rate for all steelhead observed during the study.

References

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Kern, J.C., G. Whisler, and T. Neill. 2011. Improving monitoring methods for estimation of non-retained salmonids encountered in summer and fall Columbia River commercial fisheries. ODFW Final Report for NOAA Contract NA09NMF4270090. Clackamas, Oregon. 32 pp.

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<http://www.dfw.state.or.us/agency/commission/minutes/17/01_jan/Exhibit%20D_Attachment%201_Agenda%20Item%20Summary_DRAFT%20Updated%201-12-17.pdf>

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