# Develop the new Base Period Using Marked Landed Catches and Escapements versus Total Landed Catches and Esca, pements

## Overview

Similar to the current FRAM Chinook base period, the new base period uses CWT recoveries from marked Chinook to compute base period exploitation rates. Therefore, marked Chinook represent marked as well as unmarked components of the same stock in both the current and new base period. Unmarked exploitation rates cannot be assessed directly, because unmarked stock components are only sporadically tagged (double index groups). Even when tagged, these tags are often not recovered, because some fisheries are not electronically sampled or in the case of mark-selective fisheries unmarked Chinook are not retained.

For the current base period, CWT recoveries were related to total catches and total escapements to compute exploitation rates. Due to the influence of mark-selective fisheries, the new base period relates CWT recoveries to marked catches and marked escapement. Using total catches in mark-selective fisheries would necessitate time consuming changes to calibration algorithms as well as the calibration database in order to relate recoveries to encounters rather than landed catches and to incorporate mark-selective fishing parameters. Both systems (marked or total) assess impacts in mark selective fisheries. It could be argued that the marked frame of reference is preferable, because it necessitates fewer parameter estimates, which are each associated with a variance. To decide whether to use total versus marked data, we need an assessment of the magnitude of the error from both approaches.

## Relevant Calibration Algorithms

* Compute a production expansion factor

$$EscExpFact\_{s}= \frac{ActualEscapement\_{s}}{CWTEscapement\_{s}}$$

* Compute Expanded Catch

$$EscExpandedCWTCatch\_{s,a,f,t}= EscExpFact\_{s }\* CWT\_{s,a,f,t}$$

* Compute catch for a fishery and time step by summing over stocks and ages

$$CWTCatch\_{f,t}= \sum\_{s,a}^{}EscExpandedCWTCatch\_{s,a,f,t}$$

* Deal with the difference between actual catch and CWT estimated catch
	+ For most Puget Sound fisheries CWTCatch is again expanded to sum to the actual catch

$$(1)FisheryExpFact\_{f,t}= \frac{ActualCatch\_{f,t}}{CWTCatch\_{f,t}}$$

$\left(2\right)Fish\&EscExpandedCWTCatch\_{s,a,f,t}= EscExpandedCWTCatch\_{s,a,f,t}\* FisheryExpFact\_{f,t}$

$$\left(3\right)CWTCatch\_{f,t}= \sum\_{s,a}^{}Fish\&EscExpandedCWTCatch\_{s,a,f,t}$$

* + For most of the remaining fisheries, if CWTCatch < Actual Catch, CWTs are not expanded, but CWTCatch/ActualCatch becomes the model stock proportion. If CWTCatch > Actual Catch recoveries are adjusted as previously described.

## Preliminary Modeling Results

Table 1. AEQ mortalities, extreme terminal run sizes, and marine exploitation rates from a draft new base period run using “marked” versus “total” frame of reference.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   |   | **AEQ Mort** | **ETRS** | **Marine ER** |
| **Stock** | **StkName** | **Marked** | **Total** | **Marked** | **Total** | **Marked** | **Total** |
| 1 | NkSm FF | 1783 | 1798 | 1498 | 1429 | 54.3% | 55.7% |
| 3 | NFNK Sp | 733 | 755 | 1153 | 1128 | 38.9% | 40.1% |
| 7 | Skag FF | 5015 | 5305 | 13322 | 12738 | 27.4% | 29.4% |
| 11 | SkagSpY | 232 | 240 | 1081 | 1073 | 17.7% | 18.3% |
| 13 | Snoh FF | 1114 | 1152 | 3670 | 3660 | 23.3% | 23.9% |
| 15 | SnohFYr | 659 | 677 | 1335 | 1321 | 33.1% | 33.9% |
| 17 | Stil FF | 238 | 248 | 677 | 668 | 26.0% | 27.1% |
| 19 | Tula FF | 1963 | 1858 | 61 | 141 | 97.0% | 92.9% |
| 21 | MidPSFF | 5221 | 5367 | 10380 | 10271 | 33.5% | 34.3% |
| 23 | UWAc FF | 209 | 218 | 1082 | 1084 | 16.2% | 16.7% |
| 25 | SPSd FF | 3130 | 3144 | 6915 | 6835 | 31.2% | 31.5% |
| 27 | SPS Fyr | 52 | 52 | 53 | 52 | 49.8% | 50.1% |
| 31 | HdCl FF | 6900 | 7054 | 15318 | 15095 | 31.1% | 31.8% |
| 33 | HdCl FY | 56 | 56 | 90 | 88 | 38.4% | 38.7% |
| 35 | SJDF FF | 12095 | 12148 | 36827 | 35357 | 24.7% | 25.6% |
| 37 | OR Tule | 2362 | 2441 | 6581 | 6492 | 26.4% | 27.3% |
| 39 | WA Tule | 3667 | 3764 | 13487 | 13167 | 21.4% | 22.2% |
| 41 | LCRWild | 6908 | 6819 | 12541 | 12050 | 35.5% | 36.1% |
| 43 | BPHTule | 2146 | 2212 | 9127 | 9051 | 19.0% | 19.6% |
| 45 | UpCR Su | 17691 | 17706 | 39582 | 38339 | 30.9% | 31.6% |
| 47 | UpCR Br | 136696 | 131827 | 401785 | 378066 | 25.4% | 25.9% |
| 49 | Cowl Sp | 373 | 386 | 3467 | 3423 | 9.7% | 10.1% |
| 51 | Will Sp | 832 | 868 | 10934 | 10701 | 7.1% | 7.5% |
| 53 | Snake F | 6147 | 6307 | 21765 | 21490 | 22.0% | 22.7% |
| 55 | OR No F | 35056 | 33589 | 95823 | 89437 | 26.8% | 27.3% |
| 57 | WCVI Tl | 67062 | 66253 | 135809 | 127197 | 33.1% | 34.2% |
| 59 | FrasRLt | 31652 | 33214 | 153669 | 153417 | 17.1% | 17.8% |
| 61 | FrasREr | 44419 | 46117 | 174576 | 170250 | 20.3% | 21.3% |
| 63 | LwGeo S | 13130 | 13549 | 27703 | 27127 | 32.2% | 33.3% |
| 67 | LColNat | 2011 | 2060 | 6372 | 6222 | 24.0% | 24.9% |
| 69 | CentVal | 18725 | 18812 | 157440 | 157252 | 10.6% | 10.7% |
| 71 | WA NCst | 17203 | 15719 | 26298 | 24578 | 39.5% | 39.0% |
| 73 | Willapa | 13894 | 13667 | 14656 | 13635 | 48.7% | 50.1% |
| 75 | Hoko Rv | 121 | 122 | 481 | 460 | 20.1% | 21.0% |

*Catches in the “Marked Run” were modeled as quotas to match catches in “Total Run” with fish scalars set to 1. Starting cohorts in the “Total Run” reflect base period abundances. Cohorts in “Marked Run” were set to match “Total Run”. Both runs used identical model stock proportions. Mark-selective catches were converted to encounters for the “Total Run” calibration.*

Table 2. Fishery Model Stock Proportions (proportion of catch accounted for by model stocks) from “Marked” versus “Total” Calibration

|  |  |  |  |
| --- | --- | --- | --- |
| **Fishery** | **Fishery Name** | **Mrkd %** | **Total %** |
| 1 | SEAK Troll | 208% | 93% |
| 2 | SEAK Net | 116% | 55% |
| 3 | SEAK Sport | 117% | 60% |
| 8 | BCOutSport | 262% | 143% |
| 9 | N/C BC Trl | 204% | 101% |
| 10 | WCVI Troll | 95% | 79% |
| 11 | WCVI Sport | 194% | 149% |
| 13 | N GS Sport | 74% | 132% |
| 15 | BC JDF Spt | 84% | 133% |
| 16 | NT 3:4 Trl | 82% | 80% |
| 17 | Tr 3:4 Trl | 88% | 71% |
| 18 | Ar 3:4 Spt | 73% | 78% |
| 20 | NT 2 Troll | 88% | 91% |
| 22 | Ar 2 Sport | 138% | 162% |
| 23 | NT GHb Net | 71% | 23% |
| 25 | WillapaNet | 202% | 300% |
| 26 | NT 1 Troll | 91% | 100% |
| 27 | Ar 1 Sport | 108% | 140% |
| 30 | Cen OR Trl | 104% | 53% |
| 31 | Cen OR Spt | 130% | 52% |
| 32 | KMZ Troll | 12% | 5% |
| 33 | KMZ Sport | 10% | 5% |
| 34 | So Cal Trl | 16% | 9% |
| 35 | So Cal Spt | 33% | 24% |
| 36 | Ar 7 Sport | 86% | 83% |
| 37 | NT 7:7ANet | 67% | 69% |
| 39 | 7BCDNet | 90% | 94% |
| 41 | Tr JDF Trl | 57% | 44% |
| 42 | Ar 5 Sport | 144% | 135% |
| 43 |  JDF Net | 131% | 96% |
| 45 | Ar 8-1 Spt | 67% | 66% |
| 46 |  SkagNet | 3% | 40% |
| 51 |  TulaNet | 198% | 103% |
| 53 | Ar 9 Sport | 131% | 116% |
| 54 | Ar 6 Sport | 87% | 81% |
| 56 | A 10 Sport | 126% | 118% |
| 57 | A 11 Sport | 83% | 68% |
| 61 | Tr 10A Net | 96% | 114% |
| 63 | Tr 10E Net | 15% | 16% |
| 64 | A 12 Sport | 113% | 82% |
| 65 | HC Net | 81% | 94% |
| 67 | A 13 Sport | 96% | 68% |
| 68 | SPS Net | 3% | 3% |
| 70 | 13A Net | 2% | 2% |

## Discussion

Errors in total or marked escapement estimates as well as errors in total or marked catch estimates are sources of exploitation rate differences when using the “marked” versus the “total” frame of reference. Evaluating the magnitude of error associated with each parameter and resulting impacts on the final exploitation rate calculation will facilitate the selection of an approach. It is noteworthy that estimates of marked parameters need not be less precise than the corresponding total estimates. This can be the case in places with good hatchery yet poor spawning ground escapement accounting.

Model stock proportions vary widely depending on the approach used. The differences (especially in Puget Sound fisheries with 100% model stock assumption) as well as the magnitude of the values, put into question whether either approach is suitable to estimate this important modeling parameter or whether independent estimates should be pursued. They also illustrate the great variability associated with the fishery expansion factor. Model stock proportions from the “Marked Calibration” should not be used in a FRAM run, because this parameter is applied to total landed catch. Marked and unmarked stock components in a fishery can have very different model stock proportion; i.e. some Northern fisheries may have very high marked model stock proportions, but low unmarked model stock proportions, because the local non-model stocks are predominantly un-marked. Regardless of these issues, model stock proportions can be a valuable tool for error checking the new base period.

Exploitation rates can be calculated without the use of landed catches or escapements, simply by generating a CWT based cohort reconstruction. The creators of the original base period calibration system must have found it beneficial to match CWT based catches to actual observed catches. Perhaps they were seeking to address sampling biases or felt a greater comfort with base period exploitation rates that produce estimated base period catches, or they may have simply needed a method to estimate model stock proportion. However, estimates of escapements as well as catches can be associated with variances that may be larger than any biases the original method was aiming to address. Another source of variance stems from averaging the catches as well as the escapements over all base period years and time steps. This is especially problematic when bookend fishing years, that are only capturing one or two brood years, differ significantly from the average.

In line with assessing the precision of total versus marked calibration parameters, the need for fishery expansions should also be evaluated.