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A Synoptic Approach for Assessing the Conservation Status of Pacific Salmon on a Regional Basis

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ABSTRACT

A methodological framework is presented that provides a two-stage synoptic assessment of the conservation status of Conservation Units of Pacific salmon. The approach uses data that are readily available for most Units and is applicable across species, areas, and populations. It uses established qualitative and quantitative criteria for determining conservation status Although related to the assessment of biological production status as described by the Wild Salmon Policy, this framework is complimentary to the WSP. The framework was designed to be part of the annual cycle of planning for stock assessment of Pacific salmon and reporting on status as required by the WSP.

There are over 450 CUs that have been identified for Pacific Salmon (Holtby and Ciruna 2007). While assessment methods for determining the biological status of CUs (Holt et al. 2009) are close to completion these methods tend to require an extensive analytical effort. Given the number of CUs and the wide range in the availability and quality of useful information for each CU, a method or tool to rapidly approximate conservation status, and the presence of severe data limitations, is required to prioritize both assessment and management activities.

A variety of composite scoring tools are presented to assist in summary descriptions of status, including analogs of those used by COSEWIC to determine extinction risk. The method is applied to Fraser River sockeye and to southern BC chinook and the results compared to a formal status assessment (Fraser sockeye) or expert opinion on status (chinook). The approach worked well in that it replicated the results of the formal analysis and aligned well with expert opinion.

RÉSUMÉ

INTRODUCTION

The methodological framework presented below provides a two-stage synoptic[1] assessment of conservation status. The first stage is a quasi-COSEWIC assessment of conservation status and the second stage of the analysis is a simple productivity analysis. The second stage was added to address concerns that the COSEWIC criteria exaggerate extinction risks in highly productive, short-lived species such as Pacific salmon (Musick 1999). However, others argue that the criteria are appropriate (e.g. Hutchings 2001, Rice and Legacè 2007, Sadovy 2001), and that extinction risk is not exaggerated. Regardless, when survival, typically marine survival, tracks high frequency variations in ocean state occurring at small multiples (2× to 4×) of salmon generation times (2 to 5 years; Downton and Miller 1998, Francis et al. 1998, Lehodey et al. 2006, Ware 1991, 1995), variations in abundance sufficient to trigger COSEWIC criteria can occur frequently.

There are over 450 CUs that have been identified for Pacific Salmon (Holtby and Ciruna 2007). While assessment methods for determining the biological status of CUs (Holt et al. 2009) are close to completion these methods tend to require an extensive analytical effort. Given the number of CUs and the wide range in the availability and quality of useful information for each CU, a method or tool to rapidly approximate conservation status, and the presence of severe data limitations, is required to prioritize both assessment and management activities.

The design requirements for this methodology were:

1) Uses data that is readily available for as many Conservation Units (CUs) as possible;
2) Applicable synoptically with consistency across species, areas and populations;
3) Uses established qualitative and quantitative criteria for determining conservation status;
4) Precautionary, meaning that there is a high tolerance for false warnings but a low tolerance for missed danger signs;
5) All data are georeferenced and the analysis could be conducted within a GIS environment and;
6) An efficient implementation suitable for regular application (e.g. yearly) with minimal resourcing requirements.

The methodology does not purport to provide any definitive conclusions about conservation status. Rather, it is intended to be a useful prioritization tool. Nevertheless, I do use some COSEWIC metrics and their associated criteria (COSEWIC 2010), so at least some outputs could be viewed as a preliminary categorization of extirpation risk. Again, this categorization should be viewed as a prioritization tool for further research.

The Wild Salmon Policy (WSP, DFO 2005) states that management of salmon will be predicated on the establishment of two benchmarks delineating three zones of biological production status for each Conservation Unit (CU). The assessment of conservation status and hence the framework I describe is, strictly speaking, not part of the implementation of the Wild Salmon Policy (WSP; DFO 2005), although this work is anticipated by that policy (*ibid*. p. 18, para. 2), and is, for the most part, compatible with the WSP. I say “mostly” because of potential incongruences between conservation and biological production status where metrics for extirpation risk concern very small population sizes, single populations or restricted habitats. For example, it is conceivable and indeed observed that a CU comprising one small population is

[1] For definitions of this and other terms please see the glossary.

deemed "at risk" under say COSEWIC criteria (COSEWIC 2010) while being categorized as being in the GREEN zone under the WSP. The method presented here for determining conservation status and, indeed the method for establishing benchmarks do not deal with this subtlety perhaps because it is amply covered by the “case-by-case” provisions of the WSP (*ibid*. p. 18, para. 2). Regardless, this methodology should be viewed as complimentary to WSP status determinations. Roughly put, if the WSP procedures determine that a CU is in the RED zone, then the procedures described herein determine, at least in a preliminary fashion, how "deep" into that zone the CU might be.

After describing the methodology, I present the results of its application to Fraser River sockeye and southern chinook salmon. The results for sockeye are compared to the results of a recent and formal status assessment (Grant et al. 2010) of Fraser River sockeye CUs. The results for southern chinook are compared to a qualitative status assessment of Fraser River chinook CUs provided by the Area biologist.

METHODS

The analysis consists of two phases. The first phase is the quasi-COSEWIC analysis while the second is the productivity analysis. The circled numbers on a diagram of the Phase 1 methodology (Figure 1) correspond to the nine steps that are outlined below.

PHASE 1, STEP 1

The analysis begins with a snapshot of the Summary Escapement Narrative (SEN) Table of the nuSEDS ORACLE database. The snapshot is exported from ORACLE as a MS ACCESS table. The record structure of that table is shown in Table 1. The snapshot used in this analysis was taken on 8-Sep-2010. Experience with nuSEDS over the past few years indicate that data input is not complete for a return year until July or August of the following year. Output from this step is a matrix of escapements with dimensions POP_ID×year.

The POP_ID field (Table 1; a long integer) is the key value used to associate each record with a Conservation Unit in step 2. Within nuSEDS, the POP_ID captures the species, a geographical extent (i.e., location), and a run timing. These same characteristics are sufficient to associate the record with a CU. In species where there can be multiple runs at the same location (primarily sockeye and chinook), a unique POP_ID is assigned to each of the nominal runs.

Interpretation of the two presence/absence fields of the SEN record (SEN_PRESENCE_ADULT and SEN_PRESENCE_JACK; Table 1) is problematic. First, it is doubtful that jacks and adults can be reliably distinguished without examining scales, so for most records the JACK fields indicate only whether small fish were seen. Second, the apparent absence of fish is meaningful only within the context of the timing of the count(s), the type of count, and the abundance of the fish. For example, the description “none observed” could mean “none were observed but the inspection was for another species and no fish of this species would ordinarily be observed”, “none were observed but it is unlikely we would have seen a few fish anyway” (a probable scenario for cryptic species like coho or for all species in glacial or dystrophic (black-water) systems or even “none were observed but none have ever been seen” (a surprisingly frequent entry for all species!) While it is possible that presence/absence could be resolved by a careful inspection of each summary record by someone familiar with the species, area and enumeration history, such scrutiny would violate the first, second, and sixth design requirements. Consequently, escapements of zero were always assumed meaningless and were set to the missing value. It was also necessary to verify that the presence fields were correct since records with numeric estimates of abundance are present with either a blank presence field or an entry indicating not inspected or none observed. Such records were programmatically corrected by assuming that the presence of a numerical estimate always indicated that an inspection had occurred and that fish were present.

The vexing question of what to do about enhancement is ignored and all fish returning to a site were included at least in phase 1. There are several reasons for this. First, enhancement activities are not recorded in nuSEDS prior to version 2 (early 2000's) and after that only partially. It would be possible in many instances to discover what the numbers prior to version 2 represent (e.g. were fish removed for brood stock included?) but not without considerable effort in finding and interpreting old records. Second, no estimates of the number of enhanced fish in the escapement are available— even nuSEDS ver. 2 records only the number of fish removed from the escapement. Generally, it would be very difficult to separate wild-spawned from enhanced fish (i.e., artificially spawned) in the escapement unless all enhanced fish were somehow marked and estimates of the marked proportion were made. In retrospect, such separation would be impossible. Third, nuSEDS does not contain any indication of enhancement additions to any population and DFO's database of enhancement activities is not actively maintained or generally available. Consequently, without a great deal of additional effort it would is impossible to know whether enhanced fish are likely or not to be present in any escapement record. Finally, the tacit position of the Department is that enhanced fish are biologically and ecologically equivalent to wild-spawned fish (i.e., they are indefinitely interchangeable), and so should be included at face value in the escapement and consequently in any evaluations of conservation and biological production status. Obviously such a position conflicts with the WSP (DFO 2005) taken at face value since enhanced fish are not wild by definition and one would presume should not be included in the determination of at least biological production status. However, the definition of "wild" cannot be practicably operationalized, meaning that wild and non-wild fish cannot be distinguished in the wild. The inability to practicably distinguish wild from non-wild fish could be handled by treating any CU where there is regular enhancement is, by definition, not a CU and no assessment of status is required under either the WSP or the Species At Risk Act (Canada 2002). A more flexible treatment would be to assume that notwithstanding the policy definition of "wildness", the degree of enhancement permissible is a public policy decision and that status assessment should include all fish within a CU regardless of their mating system provided that the source of broodstock was (mostly) native to the CU. The second treatment is used in this framework.

Pink salmon records require special treatment because nuSEDS does not distinguish the even- and odd-year races. First, a a field is added to the SEN records to indicate whether the record applies to an even or odd year (= ANALYSIS_YR modulus 2, giving the value 0 for even-year and 1 for odd-year pink). For odd-year records 100,000 is added to the nuSEDS POP_ID and for even-year records 200,000 is added.

Following any necessary corrections to the SENS records and the extra manipulations for pink, they are assembled into two time series of POP_ID×year, one for presence/absence, the other for escapement (TS::nuSEDS). The presence/absence time series were not used in the subsequent determination of status but are nevertheless available. The proportion of SENS records that have presence indicated but no numeric estimate has been increasing since about 2000. Thus, some CUs that do not have sufficient information to determine conservation status could have presence/absence information that with further work might yield something useful.

PHASE 1, STEP 2

Step 2 involves mapping each population to a CU and some merging of population records. Output from this step is the nested array TS::RAW consisting of matrices of POP_ID×year nested within CU.

In some areas (primarily the Fraser River) there has been some confusion about the assignment of SENS to runs and hence to populations and consequently reassignment of SEN records to the correct POP_ID is required. This confusion manifests as the sudden appearance of a second run (i.e., population) at a particular site. Often, the run disappears after a few years. Holtby and Ciruna (2007) examined this problem and concluded that these instances represented uncritical acceptance of variations in run timing as evidence of two distinct runs. Such records were corrected by mapping the new population onto the old one (i.e., by merging the SEN records) and discarding the new POP_ID.

Over the 60-year period covered by nuSEDS there have been changes in the level of aggregation or disaggregation applied to some populations. In some cases, populations enumerated separately had been combined and vice versa. In those situations, separate populations were always mapped onto either a new POP_ID or onto the existing POP_ID that represented the most aggregated of the populations. However, inn at least one situation, the sockeye of Great Central and Sproat Lakes, each of which is a distinct CU, escapement estimates were combined through much of the record. In those situations, combined records were mapped to a POP_ID that was the only "population" of a "place-holder" CU. All reassignments are handled through the "mapping" field of the DECODER database.

Both of these manipulations are handled programmatically through the DECODER database (see Appendix 1). This insures that any changes to the CUs or populations are immediately reflected in all of the analyses whenever they are refreshed.

Using the information about CUs and populations stored in the DECODER database, each time series is georeferenced, and is associated with the various adaptive zones that the system lays within, whether it is considered an indicator population, and with its enhancement history to the extent known. Through the georeference, each time series is also associated through the GEOLOC database with an extensive range of climatological, physiographic, hydrological and land-use attributes as detailed by Holtby and Ciruna (2007).

In this step, populations added to nuSEDS since the last iteration are detected and added to the DECODER and GEOLOC databases. To be added to the to the DECODER database, a novel POP_ID must have associated with it at least one record indicating the presence of the particular species. A large percentage (>10%) of nuSEDS POP_IDs do not have any associated records indicating the presence of fish. However, all novel sites are added to the GEOLOC database regardless of fish presence.

Finally in this step, the escapement values are $\log_{10}$ transformed (remember that zero as an escapement has been disallowed.) and all empty cells are replaced by -999, the missing value flag used throughout all of the VBA code.

PHASE 1, STEP 3

In this step the individual population time series are filtered to disallow series that do not meet a set of requirements for the minimum number of observations and their distribution through time. enforced in this step are arbitrary. Because of the methods used to average across systems and across time within a CU it is desirable to insure that all populations included in the analysis have observations spread across time. It is unlikely that the populations regularly censused were a random selection from all populations within a CU. Abundant populations and likely productive populations would have been favored because of their importance to fisheries. In sparsely populated areas, populations closer to communities may have been favored over more remote populations, possibly biasing the sample toward more heavily exploited populations. There is probably temporal bias as well. If productivity varied over time, as we know it does, then coverage of the smaller or least productive populations likely ceased during periods of low productivity. Finally, if resources for assessment were systematically reduced, as they have been since the mid-1980's, then the reductions likely would have been to coverage of the smaller and/or least productive populations. Consequently, it is desirable to retain as many populations as possible within the filtered dataset to minimize the potential biases associated with using only "indicator" populations, so named because they have been consistently counted for long periods. To accomplish this, minimal requirements were set for the total number of observations as a proportion of the maximum possible (0.25), and for a minimum number of observations in the last 3 generations (3) at least one of which had to have been made within last generation. For pink salmon only, because the generation time is one observation, one observation was required within the last three generations (i.e., at least one of the three possible observations).

When any scheme to subsample populations or to subsample observations for a single population is proposed a variety of opinions about the "best" method is soon on offer. An approach often chosen is the "indicator" stream. Typically, this is a large population (and hence commercially and/or sociologically important one) that has been regularly counted. For some species (chinook and coho), size and sociological importance often entail, especially in the south coastal areas of B.C. extensive enhancement. For some purposes requiring accurate estimates of population specific catch, the use of indicator streams is advisable mainly because most of the catch is likely to be of that population so errors in the estimates of catch are likely to be relatively small. For determining status, the use of indicator streams might not be advisable. First, the use of large populations probably biases any analysis of status by preferentially selecting productive populations, especially if they are enhanced. Second, the conservation value of small populations goes unrecognized. Third, the assumption that "indicator" populations indicate anything but themselves has seldom been tested.

PHASE 1, STEP 4

In Step 3 "missing" observations in TS::RAW were estimated using an EXCEL implementation of the algorithm of Brown (1974)(. The algorithm interpolates missing values in the population × year matrices of logged escapements nested by CU in TS::RAW. Output from this step is the nested array of log transformed escapement time series TS::MV. The estimation of missing observations is necessary to the estimation of total escapement to a CU. For CUs with only one population TS::MV is identical to TS::FILT.

PHASE 1, STEP 5

In step 4 the logged escapements in TS::FILT are transformed in a variety of ways for subsequent use in the status determinations.

First, back-casting, generational running averages were calculated and output as the nested array TS::RAW. The calculation for an individual population is:

$$RA_i = \frac{1}{n_i} \sum_{j=0..g-1} E_{i-j} \text{ ,}$$

where RA_i is the running average for year i, E_{i-j} is the escapement in the year i-j, g is the integer (generation length in years), and n_i is the number of observations in the interval i-g+$1..i$. If n_i was 0 or 1 then RA_i was set to the missing value. For pink salmon whose generation length is 2 years, RA_i was set to the missing value only if n_i was zero. A running average is usually calculated by taking the mean of values centered on the value being calculated. Back-casting calculation means that there are no boundary problems for the last observations in the time series, a desirable characteristic for status calculations involving predominantly the most recent observations.

Time series of escapement as a proportion of the mean escapement (MnP) were calculated for each population in the TS::RAW nested array:

$$MnP_i = \frac{X_i}{\bar{X}} \text{ ,}$$

where X_i was the value of either the RAW escapement in year i and $\bar{X}$ was the mean of the population time series. Output of these calculations was the nested array TS::MnP.

Standardized normal deviates (Z-scores) for each population in the TS::RAW nested array:

$$ZScr_i = \frac{\left(X_i - \bar{X}\right)}{SD} \text{ ,}$$

where X_i was the RAW escapement in year i and $\bar{X}$ and *SD* were the mean and standard deviation, respectively, of the population time series. Out of these calculations was the nested array TS::ZScr.

In this step values of the AUC (“Area-under-Curve”) metric for the distribution of escapement within a CU are calculated. Values of AUC are calculated for a year within a CU using the algorithm illustrated in Figure 2. If there were fewer than five populations with a valid observation in year *I* then the value of AUC_{ji} was set to the missing value, where *j* is the CU and *i* is the year. To calculate the AUC value the populations were sorted in ascending order by the magnitude of their escapement and assigned a score of (i|[1..n])/n, where *i* was the population’s rank and n is the number of populations with an observation in that year. The escapement to each population as a proportion of the total of all populations in that year was then accumulated in ascending rank order. When the cumulative proportional escapement is plotted against the ascending rank order, the area under the resulting curve is calculated. If all populations had equal escapements then the area under the curve (i.e., straight line) would be 0.5. In most CUs during periods of relative abundance the AUC values were generally around 0.425. An AUC under 0.35 was rare.

PHASE 1, STEPS 6 & 7

In the sixth step the TS::ZScr time series were averaged within year and within CU producing for each CU a time series of mean Z-scores, TS::AvgZScr. In the seventh step, the means and SDs previously calculated in step 5 as part of the creation of the TS::ZScr were averaged within each CU. The TS::ZAvgStrm time series were then reversed transformed using the mean values of the mean and SD of TS::FILT for all populations within th CU to give TS::AvgStrm. Note that the TS::AvgZScr and TS:AvgStrm are single vectors for each CU.

PHASE 1, STEP 8

In the eighth step, the TS::MV were summed by year within CU to produce TS::SumEsc$_{CU(year)}$, a nested array of escapement times series by CU.

PHASE 1, STEP 9

In this step, status scores on each metric were calculated for each CU by comparing the calculated value(s) for the CU to criterion sets. For the two calculations involving slopes (see Figure 1) the comparison period was the last three generations or 10 years, whichever was longer. The 10 year period was applicable only for pink. For the other metrics, the comparison period was the last generation. Fixed generation times were assumed for each species, which is, of course, a simplification. For metrics where the input time series had the dimensions CU(pop×year), the metric value was calculated for each population and then averaged over each CU. For time series with the dimensions CU×year, no averaging was required. A numeric filter was applied only for the slope calculations. A slope was calculated only if there were at least 5 observations available (3 for pink).

The criteria sets for each of the five metric classes (slope, MnP, ZScr, AUC, and Abund) are given in Table 2 . The status scores ranged from 6 down to 1 corresponding to increasingly severe conservation concerns. Only the criteria set for slope maps directly to COSEWIC and IUCN criteria (COSEWIC 2010, IUCN 2001). COSEWIC does not have an "extreme concern" category and neither groups has two levels of "not of concern". The additional levels were added to increase resolution at both ends of the scale. The MnP and ZScr are metrics of abundance but are not directly comparable to the absolute abundance criteria of COSEWIC and IUCN. The AUC metric of population distribution has no analog in either COSEWIC or IUCN. The comparability of the abundance criteria applied to TS::SumEsc depends on the species and CU. In some case, e.g. the sockeye CUs of the Fraser River, the nuSEDS escapements are estimates of total escapement and so the COSEWIC and IUCN criteria for abundance would apply. For the majority of CUs, however, the escapement estimates in nuSEDS are likely underestimates of escapement to the specific population and an unknown number of populations within the CU were not counted at all. In consequence, status scores involving absolute abundance are likely conservative (i.e., overstate conservation concerns) but this is in keeping with design criterion 4.

The risk levels are strictly qualitative and do not translate into quantitative extinction risks. Furthermore, within a metric there is no assurance that the 6 risk levels bear any consistent relationship to one and other. For example, a score of 1 does not mean that the extinction risk is, say, twice what a score of 2 might represent. There is no assurance that the categorical risk levels are strictly comparable between metrics. These limitations are reasonable for a prioritization tool. To the extent that two of the metrics (slope and Abund) do map directly onto accepted criteria sets does mean that the risk characterizations (Table 2) should not be ignored.

PHASE 1, STEP 10

The final step in phase 1 is to combine the individual status scores into composite status scores. Discussion of possible approaches to doing so are deferred to Step 8 of Phase 2.

PHASE 2

The information provided by Phase 1 is possibly sufficient to assign conservation status to any CU meeting the minimum data requirements and maybe the point at which any synoptic examination of status should end. Certainly, the information would be sufficient to conduct a status assessment for COSEWIC or the IUCN. However, through many iterations of a limited Phase 1 analysis (only the SLOPE, MnP, and ZScr metrics were considered) over the past nine(!) years, the number of CUs or equivalent groups that met the COSEWIC criteria for being at risk was consistently greater than 30%. For example, in the current iteration, 32% of the 91 sockeye CUs that could be assessed were declining at a rate sufficient to enter the COSEWIC at-risk category and 76% met at least one COSEWIC threshold for being at-risk. Those proportions greatly exceeded what DFO assessment biologists expected. In particular, biologists singled out the SLOPE metric as prone to giving t false positives for conservation concerns. The prevalent explanation was that many populations were decreasing from high levels of abundance in the 1980's and 1990's and that the declines although considerable and fast were simply return to the more usual historic levels of abundance.

However, this framework is intended as a prioritization tool, so false positives leading to more detailed analysis should not be of great concern unless there are large numbers of CUs seeming to be at risk. Since that indeed appears to be the case, then the prioritization tool has not accomplished much. One way of addressing the problem was to adopt a six-level risk score rather than the WSP's three-level characterization, thereby providing a risk-score with greater resolution. Another approach was to incorporate a simple measure of productivity along with estimates of exploitation rate and of hatchery contributions. Declines in abundance accompanied by adequate recruitment for replacement would suggest over-exploitation and steer further analysis into the effects of fisheries. Declines in abundance accompanied by insufficient recruitment for replacement would lead to a different response. Finally, large hatchery contributions could mask changes in productivity of wild spawners and delay appropriate responses to declines in the wild. Phase 2 is the addition of a simple productivity analysis.

There are eight steps in the Phase 2 analysis ()

PHASE 2, STEP 1 & 2

Both steps 1 and 2 correspond to the same steps in Phase 1 but extract different time series from the nuSEDS records. Whereas the total return to populations was extracted in Phase 1, in Phase 2, time series of in-river fisheries TS::nuSEDS-RF,)and hatchery boodstock removals (TS::nuSEDS-HB,) are extracted (step 1,) and associated with CUs (step 2). The TS::RAW time series from Phase 1 are imported into step 2 with the suffix "-RR" added to indicate that these are time series of total

PHASE 2, STEP 3

This is a filtering step as it was in Phase 1. In Phase 2, the filtering requirements were less restrictive: a minimum of 10 observations was required and there was no requirement for recent observations. The filtering is done for the TS::RAW-RR time series. Populations selected were copied for all three time series.

PHASE 2, STEP 4

Missing values for the TS::FILT2-RR time series were estimated using the same program code from Phase 1. Missing values in the TS::FILT-RF and –HB time series were set to zero.

PHASE 2, STEP 5

The three time series exported from steps 3 and 4 were summed by CU across years, giving three matrices with dimensions CU×year, which are exported to step 6.

PHASE 2, STEP 6

The outputs of step 6 are time series of spawner number (TS::S) and recruits•spawner^{-1} (TS::RS) both with dimension CU×brood year (). First, catch is estimated using time series of exploitation rates for each CU by return year (TS::ER,) and summed with the return to river (TS::RR) to give total returns by CU and year. The exploitation rate time series were extracted from pre-publication summary spreadsheets provided by Karl English (LGL Ltd. Sidney, BC). For CUs not covered in the report, estimates for the nearest CU with coverage were used. The estimates were for the period 1980 to 2008. Actual values for Fraser River sockeye were substituted where available (pers. com. S. Grant, DFO, New Westminister, BC). Extrapolation was not required for southern chinook but was required for smaller CUs of Fraser River sockeye. In those cases, means of CUs in the same run-timing group were used.

The time series of total returns were decomposed into total returns by brood year using vectors of adult mean age compositions (K::AGE,). The simplifying assumption was used primarily because yearly age compositions are generally not known but also because their inclusion would have greatly complicated the data processing required. A limited amount of simulation suggested that yearly variation was not important unless there were large and persistent changes in age composition, and as with mean age composition, such variation is little known.

The spawner time series were constructed from the time series of returns to river, brood stock removals and other removals (TS::RR, TS::RF, and TS::HB, respectively,). Cultured fish contribute to returns but cannot be distinguished from those produced through spawning in the wild. Rather than attempt to estimate their contribution to returns, I used a CU specific amplification factor (K::HAmp) to convert spawners in culture to spawners in the wild. In effect, this conversion increases the effective number of wild spawners and calculations of recruits per spawner should more closely track actual productivity. A factor of four was used in all instances. This is likely very conservative value and where culture was extensive, productivity was likely overestimated. Time series of recruits•spawner^{-1} were then calculated (TS::RS,) and output to step 8.

PHASE 2, STEP 7

The time series of spawners and recruits•spawner^{-1} were used to fit a simple Ricker model. From that model time series of residual ln(recruits•spawner^{-1}) were calculated (TS::RS-RSD,) and output to step 8.

PHASE 2, STEP 8

Status scores were calculated for median values and slopes of the time series of recruits•spawner^{-1} and the residuals from the Ricker model fit in step 7(Figure 3) using the criteria of Table 3. For each of the four metrics median values and slopes were calculated over the last one, two and three generations if the data were available.

PHASE 1 STEP 10 & PHASE 2 STEP 9

Composite status scoring for both phases were done simultaneously using common approaches. Both steps are outlined jointly.

There are undoubtedly a very large number of approaches to composite scoring and almost certainly no path to consensus on one "best" approach, or even whether it is advisable to do so. For example, in the so-called "Traffic Light" approach, scores on all metrics are presented simultaneously as a panel of red, amber and green squares, leaving it up to experts to assess overall status (Caddy 2002). COSEWIC appears to use a "One Strike You're Out" approach such that status can be determined by the lowest status score of any one of its criteria (COSEWIC 2010).

A composite score is derived from two or more single metric or composite scores. The only reason for using composite scoring is to encourage consistent interpretation of the available data. several approaches to generating composite scores and those approaches are described in the following paragraphs.

Min/Max (or One Strike You're Out)

The composite score is either the minimum or the maximum value of the component scores. The component scores must be on the same interpretative scale. This approach equally weights each metric and is an obvious translation of the "A" or "B" or "…" approach that is explicit in the COSEWIC assessment approach (COSEWIC 2010). It has the advantages of being simple and easily interpretable. It has the disadvantage of assuming equal weighting, which ignores the irrepressible urge to posit exceptions and to account for extraneous considerations.

Mean/Median

The composite score is either the mean or the median of the component scores. The component scores must be on the same interpretative scale. This approach equally weights each metric. It has the advantage of being simple and, for alternative estimates of the same metric, easily interpreted. For example, in this framework there are several estimates of the rate of change of abundance. A mean or median approach to a composite score could be appropriate for combining the alternatives. It has the disadvantage of assuming equal weights as does the Min/Max approach but also has the more serious difficulty of being difficult to interpret. For example, under what circumstances should a low score (or a high score) on one metric be ignored or downplayed?

Weighted Mean/Median

The composite score is a weighted combination of the component scores standardized to the original ordinal scale. The component scores do not need to be on the same interpretive scale, although if they are then a weighted composite score is "easier" to interpret. The weighting can be applied to the component metrics, or to the scores, or to both the metric and the score. For the first approach, the metric itself is weighted (e.g. change rate is given a greater weight than abundance), while for the second approach, the component scores are weighted (e.g. a lows scores are given greater weight than high scores regardless of metric). The third approach is a combination of the first two. The principal disadvantage to this overall approach is that the composite scores are often difficult to interpret because the same composite score can result from more than one combination of component scores.

"Butting"

The composite score is based on one particular component score but is altered under pre-defined or ad-hoc conditions. For example, the composite score could be based on a change rate component score but can be modified downward (i.e., toward a more concerning score) if, say, productivity is also decreasing or it is thought that habitat and thus FW survival is degrading. Experts often use this approach because it allows them to apply their experience and expertise outside of a rigid formula. That is both a strength and weakness. This approach can differently weight each metric, selectively include or exclude metrics, and mix quantitative and qualitative components. Differences in interpretative scales are dealt with by the interpreter.

Multi-Way Matrix

The composite score is read from a m×n[×p…] matrix, where each dimension is a component score with (m, n, p…) levels. This approach can differently weight each metric and each component need not be on the same interpretative scale. The "size" of the scoring matrix can grow quickly if there are more than a couple of levels for each component or if there are more than two or three components. This approach can be described as formalized "butting" and has many of the same characteristics of it. However, even when all of the components are quantitative and use the same interpretative scale, the output is always on a different and qualitative scale.

Multi-Way Binning

This approach uses a multi-way matrix to assign a "class" or "categorization" to the input data rather than a composite score. For example, binning could be used in a four-way classification with the the bin labels of "at risk now", "trouble brewing", "overexploited" and "no obvious problem". Such classifications might be more useful than composite scores as prioritization tools for CU management.

Analytical

An example of this approach is Population Viability Analysis (PVA, e.g.Busch et al. 2008, McElhany et al. 2006, McElhany et al. 2000). The data requirements and complexities of these approaches rule out their use in this rapid and synoptic framework. If PVAs were available for a fairly large set of CUs (>30) then it would be possible to statistically relate the simple metrics that I have used to estimated extinction risks and chose an appropriate scoring approach. This approach has not been pursued in this framework
The IUCN criteria (IUCN 2001) and the closely associated COSEWIC criteria (COSEWIC 2010) employ simple metrics that can be scored using the data available for many CUs. These criteria are analytical and are applied to most vertebrates including salmon. A composite score can be produced using these metrics, COSEWIC criteria, and the Min/Max method of composite scoring.

Descriptions of the composite scoring procedures

Eighteen composite scores were implemented (Table 4). The various algorithms and lookup matrices are provided in
Table 5 to Table 19. Although there has been considerable criticism of the slope metric in determining status for marine fishes and Pacific salmon (e.g. Musick 1999, Rice and Legacè 2007), I did not attempt to skew the scoring to reduce the influence of the rate of population

change. However, the code for the scoring is straightforward and is mostly executed as user-defined functions, meaning that alternate scoring could be easily implemented using the code templates in the workbooks and without having to run VBA programs. For each CU the status scores on all metrics and all of the composite scores are exported. As well, the metric values and their status scores are also available for all populations and CUs and can be examined to aid interpretation of the composite scores, à la Traffic Light approach (Caddy 2002).

Although calculated and scored, the residual and residual slope metrics were not used in determining CU status. The AUC metric was also not used because it was available for only a few of the largest CUs (i.e., those with many populations). The scores and the calculated time series are exported and can be examined should the interpreter think it useful.

CS1

CS1 uses as data scores from the three primary metrics, which are available for all data (Table 5). The algorithm weights low scores on any metric more heavily than high scores and for this reason cs1 scores tend to be higher than csMin scores for the same data but lower than csMed scores (Table 6).

CS2, CS3

Both CS2 and CS3 use csRS (for the metric recruits•spawner^{-1}) and either csSLOPE (cs2a, cs3a) or cs1 (cs2b, cs3b). For CS2, both csSLOPE and cs1 scores are lowered by low csRS scores but the reciprocal effect is much smaller (Table 7). This one sided effect of this composite score is arguably appropriate for a conservation metric as it has a sobering effect when recruitment is poor (Table 8). CS3 is more optimistic allowing high csRS scores to pull up low scores on csSLOPE and cs1 (Table 9, Table 10)

COSEWIC-C, COSEWIC

Both of these composite scores emulate COSEWIC procedures (COSEWIC 2010). COSEWIC-C gives csSLOPE and csAbsA equal weights such that moderately low scores for both input metrics result in a composite score lower than either metric alone (Table 11). The COSEWIC composite score is the minimum score of csSLOPE, csAbsA and COSEWIC-C. Although the resulting scores are among the most pessimistic of any of the composite methods (Table 12) they have the advantage of straightforward interpretation.

CS4bin, CS8bin

The two binned, composite scores (cs4bin and cs8bin, Table 4) require further explanation. The cs4bin scoring matrix puts each CU into one of four bins depending on the values of csSLOPE and $status_{CU(RS)}$ (Table 13, upper). The four bins can be simply characterized (Table 13, lower). The conditions associated with cs4Bin#2 (constant abundance and low productivity) seem contradictory but do occur in the data sets. The reason for this appears to be that whereas the slope is calculated over three generations, the productivity is the mean over the last generation. The averaging used to smooth the abundance time series reduces the influence of very recent declines.
For cs8bin a third composite score (csRelA) is added to csSLOPE and $status_{CU(RS)}$ (Table 14). With addition of relative abundance to change rate and productivity, it is possible to add more detail to the characterizations of what a CU's situation is and suggest a possible prioritization for further analysis (Table 14, lower). As such, this composite score might prove the most useful for prioritizing that work for both assessment and fisheries.

CS5
With this composite score, low scores on csSLOPE can be increased if csRS is high but there is no reciprocal effect (Table 15). The effects only appear in a few instances, for example CK-14 and CK-18 in Table 16. This composite score is similar to CS3a, b.

CS6
In this composite score, csSLOPE interacts with csAbsA as it does in COSEWIC-C but with

CS7
In this composite score csSLOPE is adjusted lower if recruitment is low or if recruitment is trending lower (Table 19). In general, this composite score is difficult to interpret and the effects seem small in the example dataset that was examined (Table 20).

DATA HANDLING AND SOFTWARE REQUIREMENTS

Once the SEN records are exported from nuSEDS as MS Access tables, all of the analyses are conducted in MS EXCEL v2007 or later. Later versions of EXCEL are required because the row limitations of earlier versions of EXCEL (< ≈ 65500) are exceed by the number of records for chum and coho salmon. However, earlier versions of the programs were run in EXCEL v2002 by splitting the nuSEDS records in half for step 1 of both Phase 1 and 2. All subsequent steps are easily handled in earlier versions of EXCEL since no new features were used. However, all pivot tables require reconstructing if the workbooks are retrograded.

All of the calculations and data manipulations are provided either as user-defined functions written in VBA or as procedures and functions called from a shell programs, also written in VBA. The shell programs must be run manually (i.e., by opening the VBA editor and then running the outermost procedure, which then calls other procedures and organizes the output). Five separate workbooks () are required for a complete analysis of each species, although odd-year and even-year pink are combined as are lake-type and river-type sockeye. Some copying of processed data matrices is required between the workbooks. That copying could be avoided if the intermediate results were stored in temporary databases that were loaded as necessary. Sadly, such finesse is well beyond my very modest programming skills.

I have briefly looked into the possibility of moving the analysis into OpenOffice, an open-source suite that includes a spreadsheet. This would be possible but would require extensive modification of the code as the object models of the two programs are quite different and OpenOffice lacks some of the finesse of EXCEL. Rewriting the programs to run in a database would require even more extensive restructuring as would moving to the R statistical programming language. As well, using the programs outside of spreadsheets would likely require skill sets that are not common.

RESULTS

The performance of the framework was examined by comparing the various composite scores to independent analytical and qualitative summaries of CU status for Fraser River sockeye and for southern chinook.

There are 39 CUs of sockeye currently recognized in the Fraser River drainage (Table 21). Of those, two are actively being recovered (Alouette and Coquitlam), four are possibly extirpated and six require validation, leaving 27 extant CUs. Of the 39 CUs, six are river-types. Grant et al. (2010) have published status assessments for 26 of the extant CUs, although two were combined with other CUs giving 24 assessments. Those assessments were part of Wild Salmon

Policy implementation so the status categories are cast in terms of the three zones of biological production status mandated by the WSP (DFO 2005). The WSP status of the CUs ranges from those clearly in the RED zone (2) to those clearly in the GREEN zone (3). The WSP status five of the CUs is unknown because of data limitations but Grant et al. suggest that because of the small numbers of mature animals they would likely be classifiable as "at-risk" under COSEWIC criteria. The status of the remaining 13 CUs is ambiguous since their scores on the metrics used (Holt 2009) were heterogeneous. However, because of generally declining productivity Grant et al. concluded that their status would be adversely affected if current trends continued (Grant et al. 2010).

Comparison of the scoring on the four primary metrics is shown as 2×2 contingency tables (Table 23). Slope is most straightforward metric to compare and both analyses gave very similar results (Table 23A). Productivity is the most difficult to compare because the scores from Grant et al. (2010) were taken from the narrative and are qualitative. The scores of Grant et al. are lower than those here (Table 23D). This is not surprising because quite different characterizations were used. Whereas, I considered productivity to be of concern only if over a generation it averaged well below replacement, in the published analysis, productivities that were trending downward and were approaching replacement were considered poor. That difference is appropriate given the differences in focus between the two studies. Comparison of scores for relative abundance and absolute abundance (Table 23B, C, respectively) indicate that the published scores are lower than those in this study. Again, this is appropriate because abundances that are low from a production perspective can be adequate from a conservation perspective.

When the CUs are arrayed with all of the composite status scores (Table 24 & Table 25), sense can only be brought to the wash of color by sorting on an easily interpretable composite variable. In both tables I used the COSEWIC composite. It immediately becomes apparent that SLOPE and in some instances (e.g. Widgeon) csAbsA are the key metrics in guiding our interpretations of at least conservation status. Surprisingly, when the CUs are sorted on COSEWIC the synoptic status summary aligns very well with that produced through more formal analysis (comparison in Table 25).

The two binning composite scores (cs4bin and cs8bin) may provide some useful insights into the causes of the apparent declines in Fraser River sockeye (Table 26). When sorted with the COSEWIC composite, the "at-risk" composite scores (2 & 3) align well with the four high priority bins. The binning process correctly identifies situations, such as Widgeon, where small populations that are technically at high-risk because of their size, might not be high priorities for assessment because of their relative health. One aspect of this analysis that is particularly interesting is the suggestion that recruitment overfishing and not low productivity might have an important role in the observed declines for the majority of high-risk CUs (11 of 17, Table 26).

In southern British Columbia there are 35 chinook CUs, of which 17 are in the Fraser River basin (Table 27). Of these, there are sufficient data to do the full synoptic analysis on 26 of them, and a partial analysis on four There is expert opinion on the Fraser River CUs in the form of a priority ranking and other expert opinions on three CUs outside of the Fraser (
Table 28).

There appear to be productivity problems in the majority of the CUs, worrisome declines in about half of them, but abundance problems only in a few (Table 29). When the COSEWIC composite score, the priority derived from the cs8bin score and the expert opinion are arrayed together (Table 30), the synoptic scoring and the expert opinion are in near perfect agreement. There are minor differences in the priorities assigned through the binning and the expert.

However, unlike Fraser River sockeye, productivity was, in general below replacement and overfishing was identified as a contributing factor to declines in only a few CUs (Table 30).

DISCUSSION AND CONCLUSIONS

The objective of the synoptic approach is to assist in the prioritization of assessment activities by providing a sketch of the conservation status of CUs across the region. The methodology is simple and, with the exception of the exploitation rate times series, uses readily available data. The simple comparisons that I have done here indicate that this approach can replicate much more rigorous analytical work as well as corroborate expert opinion. Another important feature of the approach is that it provides information on conservation status that is consistent across species and areas. That consistency is important if regional assessment planning is to be pursued.

Although this tool is not claimed to provide a definitive statement of conservation status, it does make extensive use of established COSEWIC criteria and applies them to what is arguably the best dataset that we have at least on a regional scale. One might anticipate that the results of this work could not be easily dismissed, even if they are intended only to lead into more formal analyses. At the very least, the limited analysis that I have presented here suggest the magnitude of the conservation problem that we might be facing. For example, there are 35 chinook CUs in southern British Columbia. There are data to run this analysis on 30 of them. Of those 57% may be at risk, while only 27% appear secure. For sockeye in the Fraser, the situation may be worse, with perhaps as many as 73% of the 29 assessable CUs at risk.

Another aspect of status determination is the determining the cause or causes of declines serious enough to cross conservation thresholds. Adverse “ocean conditions” are usually cited by management agencies as the prime suspect in a decline. Other interest groups cite habitat damage (e.g. logging or agricultural water withdrawals) or loss (alternate land uses, e.g. Bradford and Irvine 2000, Nehlsen et al. 1991), quality of fresh water (e.g. agriculture runoff, Hendry et al. 2003), over-fishing (usually a result of mixed-stock fisheries, e.g. Holtby and Finnegan 1997), climate change (e.g. Anderson 1997, Beamish et al. 1999, Crozier and Zabel 2006, Eaton and Scheller 1996) and, recently, sea-lice associated with net-pen fish farms (e.g. the Broughton Archipelago Hume 2007, Krkošek et al. 2007a, Krkošek et al. 2007b, Kumar 2010).

Of these factors, excessive exploitation in mixed-stock fisheries was a primary factor motivating the Wild Salmon Policy (DFO 1998, 2005). Any examination of conservation status should examine at least cursorily, the exploitation history of a CU. Except in the situations where there is known, localized damage to habitat (e.g. an ice dam on the Taku or a landslide on the Fraser), examination of habitat factors will be, at best, indirect. The primary reason for this is that there are no current synoptic studies of water and riparian habitat quality. Even if there were, their utility is doubtful because the links between what we might measure in such surveys and what determines fish survival and production are, at best, tenuous (e.g. Bradford 1999, Kocik and Ferreri 1998). Despite the myriad models that are available relating habitat characteristics to productive capacity or standing crop (e.g. Fausch et al. 1988), it is simply habitat quantity and connectedness and not “quality” that have been shown to determine production (e.g. Isaak et al. 2008, Rosenfeld 2003). The simple binning of CU status based on abundance, trends in abundance and apparent productivity (cs4bin and cs8bin) suggested that for Fraser sockeye, recruitment overfishing was playing some role in the ongoing declines. In contrast, overfishing did not appear as important as declining survival for southern chinook. That is one outcome of this exercise that is worth further investigation.

The methodology has several attractive properties. It makes use of the readily available nuSEDS data and uses it at face value. This makes the method very efficient since the only preparation required are simple database manipulations. Three averaging methods are used to produce alternative time series of abundance (escapement) for CUs that have multiple populations. The three time series make different assumptions about how to weight the abundance of individual populations within a CU. The method is synoptic and all CUs are treated identically (i.e., consistently). The criteria used to determine conservation status are those of COSEWIC with some adaptations to make them applicable to the specific characteristics of what are essentially indices of abundance rather than absolute abundance. Since the analyses are not intended to be definitive but precautionary, disputes over the specific criterion values used are avoided (or at least avoidable). This is because the intent is to identify CUs that are potentially at risk and not definitely at risk. In other words, if a CU is identified as a concern then it should be considered at-risk unless a more detailed analysis provides a compelling case to the contrary. With experience, the criteria can be tuned to minimize "false" alarms while maintaining a small or near-zero incidence of misses.

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Table 1: Details of the Spawning Enumeration Narrative or SEN records output from the nuSEDS database. The analysis steps are: "Decode" used to initially assign the record to a population within a CU. Thereafter, the POP_ID field is used for "ID"; The fields marked "PA" and "Esc" used in phase 1 of the analysis; Those fields along with those marked "Prod" are used in phase 2 of the analysis; "Future" fields would be useful in further development of the analysis. Details are provided in the text.

Field	**Definition**	**Analysis step**
DESCR	Concatenation of population name and analysis year	–
PROJECT	New projects are created each year, but can be created at anytime to group data. E.g. South Coast Enumeration (2003).	–
AREA	This is the sub-district. In most cases sub-districts are the same as statistical areas. They mainly differ for streams that eventually drain into the Fraser and for large areas that have been split up and thus have a/b/c... designations. E.g. Statistical area 03 has two subdistricts 3A and 3B.	–
GEOGRAPHICAL_EXTNT_OF_ESTIMATE	This is the name of the waterbody or portion of a waterbody that bounds the population as shown on any given SEN	Decode
GAZETTED_NAME	Provincially recognized name for the waterbody	Decode
LOCAL_NAME_1	Commonly known name for the waterbody	Decode
LOCAL_NAME_2	Second most commonly known name fro the waterbody	Decode
WATERSHED_CDE	45 digit hierarchical provincial code unique to the waterbody and its watershed	Decode
WATERBODY_ID	This is a combination of 5 digits that uniquely identify a GIS polygon and four characters that uniquely describe a provincial watershed group.	–
RAB_CDE	Discontinued Resource Analysis Branch Code unique to each waterbody.	Decode
TIME_SERIES	This describes a group of estimates over time that have similar precision/accuracy and utility. Historic estimates that were imported from nuSEDS1 were all given a default time series because their metadata were unknown.	–
SPECIES	self explanatory	Decode
POPULATION	Default naming originates from previous databases as a concatenation of stream name, sub-district, species and run type. This is the most important piece of data that all the other SEN data fields refers to.	–
START_DTT	This is the time stream inspections began e.g. 2000-10-15 means that the first inspection for this season's estimate started on October 15 2000.	Future
END_DTT	This is the time stream inspections ended e.g. 2000-11-15 means that the last inspection for this season's estimate started on November 15 2000.	Future
ESCAPEMENT_ANALYST	Person responsible for estimate(s) on this SEN.	–
ANALYSIS_YR	This is the year that the estimate is for. Surveys may have continued into the following calendar year.	ESC; Prod

Field	Definition	Analysis step
ACCURACY	This is the ability of a measurement to match the actual value of the quantity being measured. Some historical estimates that were imported had reliability data originating from SEDS that may appear here.	–
PRECISION	This is the ability of a measurement to be consistently reproduced, or put another way, the number of significant digits to which a value has been reliably measured.	–
RELIABILITY	This field was added for the inclusion of historical data from an external source. It is the level of reliability that the person placed in their annual estimate of adults. Since this was only recorded for some historical BC16s it will not be visible in all cases. Values are low, medium low, medium, medium high and high.	–
INDEX_YN	This indicates whether the estimates are for a portion of the population. This is usually due by purposely limiting enumeration to a portion of the spawning habitat or a portion of the duration of the run.	Future
ESTIMATE_STAGE	Preliminary SENs are the first drafts of summary estimate documents. Source data may be incomplete and their accuracy has not been verified. Significant changes from Preliminary estimates are probable. Near Final SENs are based on data that have been verified for completeness and accuracy. Further analysis may take place. Final data verification and analysis have not been completed. Minor changes in Near Final estimates are possible. Final SENs are released after all data have been incorporated into the analyses and all verification steps have been completed. Changes are not anticipated.	–
ESTIMATE_ CLASSIFICATION	This categorizes estimates based on their levels of accuracy and precision. See the Estimate Classification Key for standard definitions. There are three other classifications that belong to SENs whose source data were migrated from the regional MSAccess SILBC16 database (definitions extracted from that user manual). RELATIVE: CONSTANT MULTI-YEAR METHODS and RELATIVE: VARYING MULTI-YEAR METHODS: "This is the case with survey methods restricted to a fraction of the spawning habitat and/or a fraction of the spawning period. There are various types of relative abundance estimates depending on the survey method, the level of standardization of the methods, and the sampling effort. For our purpose we have retained one type based on between-year consistency of the method where there are two levels." NO SURVEY THIS YEAR: "stream was not inspected for that species this year"	Future
NO_INSPECTIONS_USE D	This is the number of stream inspection logs that are linked to the SEN or were used in the analysis. E.g. 10 stream inspections and a fixed site survey may have been done in the season, but only 7 stream inspections and the fence counts will be used to produce the annual estimate(s), and only these are linked to the SEN.	Future

Field	Definition	Analysis step
ESTIMATE_METHOD	There are several standard methods to chose from. Addition/Subtraction - simple addition or subtraction to provide an estimate. Should be used in conjunction with activity types Adjustment/Calibration and Summary observations. E.g. a population aggregate, the sum of two or more populations, would require the linking of two or more SENs and straight summation of the estimates. Multiplication/Division - simple multiplication or division to summary estimates. This method should be used in conjunction with activity type Adjustment/Calibration. E.g. E.g. An annual estimate that was arrived at by Peak Live Plus Dead analysis can be adjusted by some factor to make it equivalent to a Time Series estimate that uses AUC calculations. Area Under the Curve - Combining a series of point estimates for abundance to create an estimate for the annual abundance. This is done by determining the total area under a curve of abundance by time then dividing by the survey life (the average length of time that an individual is available to be observed alive i.e. is still within the survey area and is not dead). Peak Live Plus Dead - Examine point estimates for abundance, determine the survey when the maximum live count observed; sum the live and dead counts for that survey to create the annual estimate. Peak Live Plus Cumulative Dead - Examine point estimates for abundance, determine the survey when the maximum live count observed. Sum the live count for that survey with the cumulative total of the dead counts prior to and including that survey to create the annual estimate. Fixed Site Census - Combining one or more raw observations into a single estimate (e.g. add all daily fence observation SIL to create a single annual estimate). Mark and Recapture - Petersen - Use capture and re-capture SIL data to determine an abundance estimate with the Petersen calculation. Mark and Recapture - Jolly-Seber - Use capture and re-capture SIL data to determine an abundance estimate with the Jolly-Seber calculation. Redd Count - Using counts of redds from SILs and multiplied by a factor such as 2. Lake Expansion - expanding the dead recoveries by the recovery effort Cumulative New - N/A	Future
CMNT	Explanations of analysis method used as well as general comments	Future
STREAM_ARRIVAL_ DT_FROM	This is the start date when the fish first arrive in the water body described on the SEN Details page. Note that the spawn run timings are paired so that Arrival, Start, Peak, and End each have beginning and end date values to represent a date range. The following definition applies to SENs whose source data were migrated from the regional MSAccess SILBC16 database applying mainly to areas 11 to 27, and Fraser chinook/coho, all from 1995 to 2001: "is defined as the month and days (period) that 5% of the fish arrived in the stream. If the number at peak spawning is known, you can identify any of your counts that correspond to 5% of that value. If so the date you made this observation will correspond to the arrival date."	Decode

Field	Definition	Analysis step
STREAM_ARRIVAL_ DT_TO	This is the end date of arriving fish to the water body described on the SEN Details page.	Decode
START_SPAWN_DT_ FROM	This is the spawning start date for a population for the current season where start means fish are beginning to pair on the spawning grounds, schools of fish may be holding (pools or mouth) and there are very few, if any, carcasses or redds. Fish are generally in the lower sections of the normal spawning area and may be bright with no fungus and have no white-coloured, eroded fins. The following definition applies to SENs whose source data were migrated from the regional MSAccess SILBC16 database applying mainly to areas 11 to 27, and Fraser chinook/coho, all from 1995 to 2001: "month and days (period) when fish are paired and redds are observed. "	Decode
START_SPAWN_DT_ TO	This is the end date of the start of spawning period. See above for the definition of this run timing period.	Decode
PEAK_SPAWN_DT_ FROM	This field records the Spawning Peak date for a population and a given season. Peak means the majority of the fish present are paired and actively spawning with few fish holding. The fish may have fungus or white-colored, eroded fins. A significant proportion of the spawning grounds should have evidence of redds and the fish should generally be distributed throughout the spawning area. The following definition applies to SENs whose source data were migrated from the regional MSAccess SILBC16 database applying mainly to areas 11 to 27, and Fraser chinook/coho, all from 1995 to 2001: "month and days (period) when the number of fish spawning reached its maximum. "	Decode
PEAK_SPAWN_DT_TO	This is the end date of the peak of spawning period. See above for the definition of this run timing period.	Decode
END_SPAWN_DT_FROM	This field records the Spawning End date for a population and a given season. End means very few fish are on the spawning grounds, few unspawned fish are holding and there are lots of carcasses. The remaining fish will likely occupy the upper reaches of the spawning area. The following definition applies to SENs whose source data were migrated from the regional MSAccess SILBC16 database applying mainly to areas 11 to 27, and Fraser chinook/coho, all from 1995 to 2001: "month and days (period) when virtually all fish have spawned in the stream."	Decode
END_SPAWN_DT_TO	This is the end date of the end of spawning period. See above for the definition of this run timing period.	Decode
BEHAVIOUR_TYP	This describes the behavior of the population at the time of assessment.	–
SEN_PRESENCE_ADULT	Values are present if adults were observed, none observed if no adults were observed during the stream inspections, not inspected if adults were not looked for, unknown if it is not known whether adults were observed during inspections or not.	PA

Field	Definition	Analysis step
SEN_PRESENCE_JACK	Values are present if jacks were observed, none observed if no jacks were observed during the stream inspections, not inspected if jacks were not looked for, unknown if it is not known whether jacks were observed during inspections or not.	PA
SEN_PRESENCE_FRY	Values are present if fry were observed, none observed if no fry were observed during the stream inspections, not inspected if fry were not looked for, unknown if it is not known whether fry were observed during inspections or not.	–
NATURALSPAWNERS	(Sexually maturing fish that have returned to the artificial / natural spawning grounds and have full potential to spawn and naturally pair.)	Prod
SEN_NATURAL_SPAWNERS_ADULT	All salmon that have reached maturity, excluding jacks (jacks are salmon that have matured at an early age).	Prod
SEN_NATURAL_SPAWNERS_JACK	These are fish that have matured at an early age and are considered precocious. They are usually distinguished from adults by their small size.	Prod
SEN_NATURAL_SPAWNERS_TOTAL	This is the sum of adult and jack natural spawners	Prod
REMOVALS-ARTIFICIALSPAWNERS	(Sexually maturing fish that have been removed from the natural environment for artificially pairing and incubation of progeny in an artificial environment for at least some portion of the incubation period. E.g. hatchery brood stock). Marine removals can be included if the fish are known to go into the waterbody associated with this SEN.	Prod
SEN_ARTIFICIAL_SPAWNERS_ADULT	All salmon that have reached maturity, excluding jacks (jacks are salmon that have matured at an early age).	Prod
SEN_ARTIFICIAL_SPAWNERS_JACK	These are fish that have matured at an early age and are considered precocious. They are usually distinguished from adults by their small size.	Prod
SEN_ARTIFICIAL_SPAWNERS_TOTAL	This is the sum of adult and jack artificial spawners	Prod
SEN_OTHER_REMOVALS	Sexually maturing fish that have returned to the artificial / natural spawning grounds and were removed from the natural environment, by humans, prior to spawning for purposes other than collection of gametes. This includes in-river fisheries and surplus hatchery removals (fish that were initially removed for enhancement purposes but were not used for enhancement).	Prod
SEN_TOTAL_RETURN_TO_RIVER	The complete accounting of sexually maturing fish that have returned to the freshwater environment. Total return to river = natural spawners + artificial spawners (e.g. hatchery brood stock) + other removals (harvest, ESSR).	Esc
SEN_UNKNOWN_RETURNS	Sexually maturing fish that have returned to the freshwater environment. It is unknown whether this estimate refers to adults or adults and jacks, or whether it refers to the total return to river or a portion of. This is the field occupied by nuSEDS V1.0 estimates and some imported data. It is not a category available to estimates created after 2001.	Esc

Field	Definition	Analysis step
SEN_NUSEDS1_ENUM_ METHOD1…6	Six fields for entering the enumeration methods used to observe fish. Values are: Bank Walk, Based on Angling Catch, Biologist/Working Group, Boat, Brood stock Removal, Dead Pitch, Electronic Counters, Electroshocking, Enumeration by Hatchery, Fence, Fixed Wing Aircraft, Float, Helicopter, Hydroacoustic Station, Other, Peak Live and Dead Count, Redd Counts, Snorkel, Spot Checks, Stream Walk, Strip Counts, Tag Recovery, Trap, Walk	Future
CREATED_BY	The person who created the SEN. Null means the SEN was created during a data upload.	–
CREATED_DTT	The date the SEN was created.	–
UPDATED_BY	The person who updated the SEN.	–
UPDATED_DTT	The date the SEN was updated.	–
ACT_ID	This is the primary key for the SEN.	–
ACY_ID	The following are data keys linking various tables within nuSEDS	–
ASA_ID	ACTIVITY_SAMPLES ID	–
STREAM_ID	GFE_ID	ID
MTP_ID	METHOD_TYPE ID	Future
PCR_ID	POPULATION_CLASS_RULE ID	–
PRJ_ID	PROJECT ID	–
POP_ID	POPULATION ID	ID
SPC_ID	SPECIES ID	Decode
SPL_ID	SAMPLE ID	–

Table 2: Criteria values for the five metrics used in determining status scores, Phase 1. The slope metric concerns the percentage decline in abundance over a species-dependent period. The criteria shown are converted to slopes and the comparisons actually made are whether the observed slope is less than or equal to the criterion value expressed as a slope.

Score and Risk characterization		Metric				
		Slope	MnP	Z-Score	Abund	AUC
1	very high risk	≥ 90%	≤ 0.0183	≤ –1.96 (2.5%)	≤ 250	≤ 0.8
2	high risk	≥ 70%	> 0.0183	> –1.96 (2.5%)	> 250	> 0.8
3	moderate risk	≥ 50%	> 0.0375	> –1.645 (5%))	>500	> 0.85
4	of concern	≥ 30%	> 0.0625	> –1.282 (10%)	>1000	> 0.9
5	not of concern	≥ 10%	> 0.125	> –0.842(20%)	>2500	> 0.925
6	not of concern	< 10%	> 0.25	> –0.253(40%)	> 5000	> 0.95

Table 3: Criteria values for the five metrics used in determining status scores Phase 2. Residuals are derived from a linear regression of ln(recruits•spawner^{-1}) on spawners. The slope metrics concerns the percentage declines over a species-dependent period of interest. The criteria shown are converted to slopes and the comparisons actually made are whether the observed slope is less than or equal to the criterion value expressed as a slope.

Score and Risk characterization		Metric		
		Slopes in ln(recuits•spawner^{-1}) & residual	ln(recuits•spawner^{-1})	residual
1	very high risk	≥ 90%	<ln(0.125)	≥–ln(2)
2	high risk	≥ 70%	< ln(0.25)	<–ln(2)
3	moderate risk	≥ 50%	< ln(0.5	<–ln(1.5)
4	of concern	≥ 30%	< ln(1)	< –ln(1.25)
5	not of concern	≥ 10%	< ln(2)	< ln(1)
6	not of concern	< 10%	≥ ln(2)	< –ln(0.5)

Table 4: Summary details of the composite scoring procedures

Name	Type	Data classes	Phase	Inputs	Algorithm	Output scores
csSLOPE	MIN/MAX	I–IV	1	$status_{CU(slope)}$ $status_{CU(slope-2)}$	MIN(inputs)	1 – 6
csMnP	MIN/MAX	I–IV	1	$status_{CU(MnP)}$ $status_{CU(MnP-2)}$	MIN(inputs)	1 – 6
csZScr	MIN/MAX	I–IV	1	$status_{CU(ZScr)}$ $status_{CU(ZScr-2)}$	MIN(inputs)	1 – 6
csRelA	MIN/MAX	I–IV	1	csMnP csZScr	MIN(inputs)	1 – 6
csAbsA	special	I–V	2	last, last 2 and last 3 generation means (of summed total returns to river)	first available input beginning with last generation	1 – 6
csMinScore	MIN/MAX	I–V	2	as available: csSLOPE csRelA csAbsA	MIN(inputs)	1 – 6
csMedScore	MEAN/MEDIAN	I–V	2	as available: csSLOPE csRelA csAbsA	MEDIAN(inputs)	1 – 6

Name	Type	Data classes	Phase	Inputs	Algorithm	Output scores
cs1	Weighted Mean (derivative)	I–IV (algorithm varies by class)	2	as available: csSLOPE csMnP csRelA csAbsA	Table 5	1 – 6
cs2a	Multiway matrix	I	2	csSLOPE $status_{CU(RS)}$	Table 7	1 – 6
cs2b	Multiway matrix	I, III	2	cs1 $status_{CU(RS)}$	Table 7	1 – 6
cs3a	Multiway matrix	I	2	csSLOPE $status_{CU(RS)}$	Table 9	1 – 6
cs3b	Multiway matrix	I, III	2	cs1 $status_{CU(RS)}$	Table 9	1 – 6
COSEWIC-C	Multiway matrix	I, III	2	csSLOPE csAbsA	Table 11	1 – 6
COSEWIC	MIN/MAX	I, III	2	csSLOPE csAbsA COSEWIC-C	MIN(inputs)	1 – 6

Name	Type	Data classes	Phase	Inputs	Algorithm	Output scores
cs4bin	BINNING	I, III (if csSLOPE is available)	2	csSLOPE $status_{CU(RS)}$	Table 13	4 bins
cs8bin	BINNING	I, III (if csSLOPE is available)	2	csSLOPE csAbsA $status_{CU(RS)}$	Table 14	8 bins
cs5	BUTTING	I, III (if csSLOPE is available)	2	csSLOPE $status_{CU(RS)}$	Table 15	1 – 6
cs6	BUTTING	I, III (if csAbsA is available)	2	csAbsA $status_{CU(RS)}$	Table 17	1 – 6
cs7	BUTTING	I, III (if csSLOPE is available)	2	csSLOPE $status_{CU(RS)}$ $status_{CU(slope\text{-}RS)}$	Table 19	1 – 6

Table 5: The algorithm for cs1. The data class indicates which three simple composite scores are available. The weighting function does not use the composite scores per se, *but the number of composite scores at each of the six possible levels. For example, for Data Classes I and II, the number at any level can be 0 to 4, while the total number at all levels is 4. The notation "#n" in the functions indicates the number of scores at the level.*

Data Class	status scores available	counts at any level	total count across all levels	weighting function
I, II	csSLOPE csRelA csAbsA	0 – 3	3	Integer(6 – (10×#1+9×#2+7×#3+4×#4)/7)
III, IV	2 of csSLOPE csRelA csAbsA	0 – 2	2	
V	only csAbsA	1	1	csAbsA

Table 6: Data matrix for csMin, cs1 and csMed using data from southern chinook. The matrix is sorted by cs1.

CU_index	CU_acro	Data class	csSLOPE	csRelA	csAbsA	csMin	cs1	csMed
CK-16	STh-BESS	I	1	4	1	1	2	1
CK-18	NTh-spr	I	1	4	2	1	2	2
CK-07	Maria	V	DD	DD	3	3	3	3
CK-14	STh-1.3	I	2	5	3	2	3	3
CK-22	CWCH-KOK	I	1	2	5	1	3	2
CK-28	SC+SFj	I	2	3	4	2	3	3
CK-06	LFR-summer	V	DD	DD	4	4	4	4
CK-08	NAHAT	II	6	4	1	1	4	4
CK-09	Portage	II	6	6	1	1	4	6
CK-10	MFR-spring	I	1	5	5	1	4	5
CK-11	MFR-summer	I	2	5	6	2	4	5
CK-17	LTh	I	2	4	6	2	4	4
CK-19	NTh-sum	I	2	6	6	2	4	6
CK-20	SC+GStr	I	6	1	6	1	4	6
CK-21	Goldstr	I	6	6	1	1	4	6
CK-31	SWVI	I	2	6	6	2	4	6
CK-32	NoKy	I	2	6	6	2	4	6
CK-04	LFR-spring	I	6	6	4	4	5	6
CK-12	UFR-spring	I	3	6	6	3	5	6
CK-24	midEVI-sum	III	DD	DD	3	3	5	3
CK-26	PuntR-sum	I	6	6	4	4	5	6
CK-30	PSJ	I	6	6	4	4	5	6
CK-33	NWVI	I	4	6	5	4	5	5
CK-03	LFR-fall	I	6		6	6	6	6
CK-13	STh-0.3	I	6	6	6	6	6	6
CK-15	STh-SHUR	I	6	6	6	6	6	6
CK-25	midEVI-fall	I	6	6	5	5	6	6
CK-27	QP-fall	I	6	6	6	6	6	6
CK-29	NEVI	I	6	6	6	6	6	6
CK-35	KLINA	III	DD	DD	6	6	6	6

Table 7: The two-way scoring matrix for composite scores cs2a (with csSLOPE) and cs2b (with cs1).

		$status_{CU(RS)}$				
		1 or 2	**3**	**4**	**5**	**6**
csSLOPE or cs1	**6**	4	4	6	6	6
	5	3	3	5	5	5
	4	2	3	4	4	4
	3	1	2	2	3	3
	1 or 2	1	1	1	1	2

Table 8: Data matrix for cs2a and cs2b using data from southern chinook. The matrix is sorted by cs1. Only CUs with valid cs2 scores are shown.

CU_index	CU_acro	Data class	csSLOPE	csRelA	csAbsA	sRS	cs1	cs2a	cs2b
CK-16	STh-BESS	I	1	4	1	1	2	1	1
CK-18	NTh-spr	I	1	4	2	6	2	1	2
CK-14	STh-1.3	I	2	5	3	6	3	2	3
CK-22	CWCH-KOK	I	1	2	5	1	3	1	1
CK-28	SC+SFj	I	2	3	4	1	3	1	1
CK-10	MFR-spring	I	1	5	5	1	4	1	2
CK-11	MFR-summer	I	2	5	6	1	4	1	2
CK-17	LTh	I	2	4	6	1	4	1	2
CK-19	NTh-sum	I	2	6	6	2	4	1	2
CK-20	SC+GStr	I	6	1	6	1	4	4	2
CK-21	Goldstr	I	6	6	1	1	4	4	2
CK-31	SWVI	I	2	6	6	1	4	1	2
CK-32	NoKy	I	2	6	6	1	4	1	2
CK-04	LFR-spring	I	6	6	4	1	5	4	4
CK-12	UFR-spring	I	3	6	6	1	5	1	4
CK-24	midEVI-sum	III	DD	DD	3	1	5	DD	4
CK-26	PuntR-sum	I	6	6	4	6	5	6	5
CK-30	PSJ	I	6	6	4	1	5	4	4
CK-33	NWVI	I	4	6	5	1	5	2	4
CK-03	LFR-fall	I	6		6	1	6	4	4
CK-13	STh-0.3	I	6	6	6	1	6	4	4
CK-15	STh-SHUR	I	6	6	6	2	6	4	4
CK-25	midEVI-fall	I	6	6	5	6	6	6	6
CK-27	QP-fall	I	6	6	6	6	6	6	6
CK-29	NEVI	I	6	6	6	6	6	6	6
CK-35	KLINA	III	DD	DD	6	1	6	DD	4

Table 9: The two-way scoring matrix for composite scores cs3a (with csSLOPE) and cs3b (with cs1).

		$\text{status}_{CU(RS)}$				
		1 or 2	**3**	**4**	**5**	**6**
csSLOPE or cs1	**6**	4	4	6	6	6
	5	4	4	6	6	6
	4	3	4	5	6	6
	3	2	3	4	5	5
	2	1	2	3	4	4
	1	1	1	2	3	3

Table 10: Data matrix for cs3a and cs3b using data from southern chinook. The matrix is sorted by cs1. Only CUs with valid cs3 scores are shown.

CU_index	CU_acro	Data class	csSLOPE	csRelA	csAbsA	sRS	cs1	cs3a	cs3b
CK-16	STh-BESS	I	1	4	1	1	2	1	1
CK-18	NTh-spr	I	1	4	2	6	2	3	4
CK-14	STh-1.3	I	2	5	3	6	3	4	5
CK-22	CWCH-KOK	I	1	2	5	1	3	1	2
CK-28	SC+SFj	I	2	3	4	1	3	1	2
CK-10	MFR-spring	I	1	5	5	1	4	1	3
CK-11	MFR-summer	I	2	5	6	1	4	1	3
CK-17	LTh	I	2	4	6	1	4	1	3
CK-19	NTh-sum	I	2	6	6	2	4	1	3
CK-20	SC+GStr	I	6	1	6	1	4	4	3
CK-21	Goldstr	I	6	6	1	1	4	4	3
CK-31	SWVI	I	2	6	6	1	4	1	3
CK-32	NoKy	I	2	6	6	1	4	1	3
CK-04	LFR-spring	I	6	6	4	1	5	4	4
CK-12	UFR-spring	I	3	6	6	1	5	2	4
CK-24	midEVI-sum	III	DD	DD	3	1	5	DD	4
CK-26	PuntR-sum	I	6	6	4	6	5	6	6
CK-30	PSJ	I	6	6	4	1	5	4	4
CK-33	NWVI	I	4	6	5	1	5	3	4
CK-03	LFR-fall	I	6		6	1	6	4	4
CK-13	STh-0.3	I	6	6	6	1	6	4	4
CK-15	STh-SHUR	I	6	6	6	2	6	4	4
CK-25	midEVI-fall	I	6	6	5	6	6	6	6
CK-27	QP-fall	I	6	6	6	6	6	6	6
CK-29	NEVI	I	6	6	6	6	6	6	6
CK-35	KLINA	III	DD	DD	6	1	6	DD	4

Table 11: The two-way scoring matrix for composite score COSEWIC-C.

		csSLOPE					
		1	**2**	**3**	**4**	**5**	**6**
csAbsA	**6**	1	2	3	4	5	6
	5	1	2	3	4	5	5
	4	1	2	2	3	4	4
	3	1	1	2	2	3	3
	2	1	1	1	2	2	2
	1	1	1	1	1	1	1

Table 12: Data matrix for the COSEWIC-C and COSEWIC composite scores using data from southern chinook. The matrix is sorted by COSEWIC. Note that the minimum score on COSEWIC is 2 not 1.

CU_index	CU_acro	Data class	csSLOPE	csAbsA	COSEWIC-C	COSEWIC
CK-10	MFR-spring	I	1	5	1	2
CK-14	STh-1.3	I	2	3	1	2
CK-16	STh-BESS	I	1	1	1	2
CK-18	NTh-spr	I	1	2	1	2
CK-21	Goldstr	I	6	1	1	2
CK-22	CWCH-KOK	I	1	5	1	2
CK-11	MFR-summer	I	2	6	2	2
CK-17	LTh	I	2	6	2	2
CK-19	NTh-sum	I	2	6	2	2
CK-28	SC+SFj	I	2	4	2	2
CK-31	SWVI	I	2	6	2	2
CK-32	NoKy	I	2	6	2	2
CK-12	UFR-spring	I	3	6	3	3
CK-04	LFR-spring	I	6	4	4	4
CK-26	PuntR-sum	I	6	4	4	4
CK-30	PSJ	I	6	4	4	4
CK-33	NWVI	I	4	5	4	4
CK-25	midEVI-fall	I	6	5	5	5
CK-03	LFR-fall	I	6	6	6	6
CK-13	STh-0.3	I	6	6	6	6
CK-15	STh-SHUR	I	6	6	6	6
CK-20	SC+GStr	I	6	6	6	6
CK-27	QP-fall	I	6	6	6	6
CK-29	NEVI	I	6	6	6	6
CK-06	LFR-summer	V	DD	4	DD	4
CK-07	Maria	V	DD	3	DD	3
CK-08	NAHAT	II	6	1	DD	2
CK-09	Portage	II	6	1	DD	2
CK-24	midEVI-sum	III	DD	3	DD	3
CK-35	KLINA	III	DD	6	DD	6

Table 13: The two-way binning matrix for composite score cs4bin. Note that the table look-up outputs a bin number, and not a composite status score per se*. The second table characterizes the CUs in each bin and provides a simple interpretation of CU status.*

		$status_{CU(RS)}$					
		1	**2**	**3**	**4**	**5**	**6**
csSLOPE	**6**	cs4bin #2			cs4bin #4		
	5						
	4						
	3	cs4bin #1			cs4bin #3		
	2						
	1						

Bin	csSLOPE	$status_{CU(RS)}$	Interpretation
cs4Bin#1	rapid decline	well below replacement	considerable risk
cs4Bin#2	constant or expanding abundance		moderate risk, rapid declines are inevitable if productivity remains low
cs4Bin#3	rapid declines	moderate to high productivity	might indicate chronic over-exploitation
cs4Bin#4	constant or expanding abundance		no concerns

Table 14: The binning matrix for composite score cs8bin. Note that the table look-up outputs a bin number, and not a composite status score per se.

For csRelA ≤ 3

		$status_{CU(RS)}$					
		1	**2**	**3**	**4**	**5**	**6**
csSLOPE	**6**	cs8bin #2			cs8bin #4		
	5						
	4						
	3	cs8bin #1			cs8bin #3		
	2						
	1						

For csRelA > 3

		$status_{CU(RS)}$					
		1	**2**	**3**	**4**	**5**	**6**
csSLOPE	**6**	cs8bin #6			cs8bin #8		
	5						
	4						
	3	cs8bin #5			cs8bin #7		
	2						
	1						

cs8bin#	$status_{CU(RS)}$	csSLOPE	csRelA	interpretation	priority
1	well below replacement	rapid decline	well below mean	at considerable risk	1
2		constant or increasing		either error, bad data or very recent drop in productivity	5
3	moderate to high	rapid decline		possibly severely and chronically over-exploited or very recent increase in productivity	2
4		constant or increasing		productive population in recovery	7
5	well below replacement	rapid decline	at or above mean	rapid decline in progress	3
6		constant or increasing		recent drop in productivity that could lead to risk	6
7	moderate to high	rapid decline		possibly over-exploitation	4
8		constant or increasing		secure	8

Table 15: The two-way butting matrix for composite score cs5. When the csSLOPE score is low, it is increased if recruitment is high.

		$status_{CU(RS)}$					
		1	**2**	**3**	**4**	**5**	**6**
csSLOPE	**6**	6	6	6	6	6	6
	5	5	5	5	5	5	5
	4	4	4	4	4	4	4
	3	3	3	3	3	4	4
	2	2	2	2	2	3	4
	1	1	1	1	1	2	3

Table 16: Data matrix for cs5 using data from southern chinook. The matrix is sorted by csSLOPE and sRS. Only CUs with valid cs5 scores are shown.

CU_index	CU_acro	Data class	csSLOPE	csAbsA	sRS	cs5
CK-10	MFR-spring	I	1	5	1	1
CK-16	STh-BESS	I	1	1	1	1
CK-22	CWCH-KOK	I	1	5	1	1
CK-18	NTh-spr	I	1	2	6	3
CK-11	MFR-summer	I	2	6	1	2
CK-17	LTh	I	2	6	1	2
CK-28	SC+SFj	I	2	4	1	2
CK-31	SWVI	I	2	6	1	2
CK-32	NoKy	I	2	6	1	2
CK-19	NTh-sum	I	2	6	2	2
CK-14	STh-1.3	I	2	3	6	4
CK-12	UFR-spring	I	3	6	1	3
CK-33	NWVI	I	4	5	1	4
CK-03	LFR-fall	I	6	6	1	6
CK-04	LFR-spring	I	6	4	1	6
CK-13	STh-0.3	I	6	6	1	6
CK-20	SC+GStr	I	6	6	1	6
CK-21	Goldstr	I	6	1	1	6
CK-30	PSJ	I	6	4	1	6
CK-15	STh-SHUR	I	6	6	2	6
CK-25	midEVI-fall	I	6	5	6	6
CK-26	PuntR-sum	I	6	4	6	6
CK-27	QP-fall	I	6	6	6	6
CK-29	NEVI	I	6	6	6	6

Table 17: The two-way butting matrix for composite score cs6. Trends in abundance interact with absolute abundance. This composite score is similar to COSEWIC-C.

		csAbsA					
		1	**2**	**3**	**4**	**5**	**6**
csSLOPE	**6**	3	4	4	5	6	6
	5	2	3	4	5	6	6
	4	2	2	2	4	5	5
	3	1	1	1	3	4	4
	2	1	1	1	2	3	3
	1	1	1	1	1	2	2

Table 18: Data matrix for cs6 using data from southern chinook. The matrix is sorted by csSLOPE andcsAbsA. Only CUs with valid cs6 scores are shown.

CU_index	CU_acro	Data class	csSLOPE	csAbsA	sRS	cs6
CK-16	STh-BESS	I	1	1	1	1
CK-18	NTh-spr	I	1	2	6	1
CK-10	MFR-spring	I	1	5	1	2
CK-22	CWCH-KOK	I	1	5	1	2
CK-14	STh-1.3	I	2	3	6	1
CK-28	SC+SFj	I	2	4	1	2
CK-11	MFR-summer	I	2	6	1	3
CK-17	LTh	I	2	6	1	3
CK-19	NTh-sum	I	2	6	2	3
CK-31	SWVI	I	2	6	1	3
CK-32	NoKy	I	2	6	1	3
CK-12	UFR-spring	I	3	6	1	4
CK-33	NWVI	I	4	5	1	5
CK-08	NAHAT	II	6	1	DD	3
CK-09	Portage	II	6	1	DD	3
CK-21	Goldstr	I	6	1	1	3
CK-04	LFR-spring	I	6	4	1	5
CK-26	PuntR-sum	I	6	4	6	5
CK-30	PSJ	I	6	4	1	5
CK-25	midEVI-fall	I	6	5	6	6
CK-03	LFR-fall	I	6	6	1	6
CK-13	STh-0.3	I	6	6	1	6
CK-15	STh-SHUR	I	6	6	2	6
CK-20	SC+GStr	I	6	6	1	6
CK-27	QP-fall	I	6	6	6	6
CK-29	NEVI	I	6	6	6	6

Table 19: The multi-way butting matrix for composite score cs7. The csSLOPE score is adjusted depending on the level and trend of productivity. In the matrix, the csSLOPE score is represented as "S".

		status$_{CU(slope-RS)}$					
		1	**2**	**3**	**4**	**5**	**6**
status$_{CU(RS)}$	**6**	S			min(6,S+1)	min(6,S+2)	
	5						
	4	max(1,S-1)			S		
	3	max(1,S-2)			max(1,S-1)	S	
	2						
	1						

Table 20: Data matrix for cs7 using data from southern chinook. The matrix is sorted by csSLOPE, sRS and sRSslope. Only CUs with valid cs7 scores are shown.

CU_index	CU_acro	Data class	csSLOPE	csAbsA	sRS	sRSslope	cs7
CK-10	MFR-spring	I	1	5	1	1	1
CK-16	STh-BESS	I	1	1	1	1	1
CK-22	CWCH-KOK	I	1	5	1	1	1
CK-18	NTh-spr	I	1	2	6	1	1
CK-11	MFR-summer	I	2	6	1	2	1
CK-28	SC+SFj	I	2	4	1	3	1
CK-17	LTh	I	2	6	1	5	2
CK-31	SWVI	I	2	6	1	5	2
CK-32	NoKy	I	2	6	1	5	2
CK-19	NTh-sum	I	2	6	2	3	1
CK-14	STh-1.3	I	2	3	6	2	2
CK-12	UFR-spring	I	3	6	1	3	1
CK-33	NWVI	I	4	5	1	5	4
CK-03	LFR-fall	I	6	6	1	4	5
CK-04	LFR-spring	I	6	4	1	5	6
CK-13	STh-0.3	I	6	6	1	5	6
CK-20	SC+GStr	I	6	6	1	5	6
CK-21	Goldstr	I	6	1	1	5	6
CK-30	PSJ	I	6	4	1	5	6
CK-15	STh-SHUR	I	6	6	2	5	6
CK-25	midEVI-fall	I	6	5	6	5	6
CK-26	PuntR-sum	I	6	4	6	5	6
CK-27	QP-fall	I	6	6	6	5	6
CK-29	NEVI	I	6	6	6	5	6

Table 21: Summary of Conservation Units of sockeye in the Fraser River drainage as found in version 3 of the CU list. The administrative categories are explained in a footnote to the table. The Fraser mnemonic is an attempt to reconcile the CU names with those used in the Fraser forecast and management documents. Details are given in a second footnote. "N sites filtered" is the number of sites remaining after the application of filters in Phase 1.

CU index	CU name	CU acronym	Administrative category†	Fraser mnemonic‡	N sites	N sites filtered
SEL-03-01	Chilliwack-Early Summer timing	Chilliwack-ES	current	ES-misc[i]	2	1
SEL-03-02	Cultus-Late timing	Cultus-L	current	L-Cultus	1	1
SEL-03-03	Harrison-downstream migrating-Late timing	Harrison-(D/S)-L	current	L-misc[m]	12	2
SEL-03-04	Harrison-upstream migrating-Late timing	Harrison-(U/S)-L	current	L-Weaver	6	2
SEL-03-05	Pitt-Early Summer timing	Pitt-ES	current	ES-Pitt	2	1
SEL-03-07	Alouette	Alouette	extirpated, recovery underway	EX	1	0
SEL-03-08	Coquitlam	Coquitlam	extirpated, recovery underway	EX	2	0
SEL-04-01	Lillooet-Late timing	Lillooet-L	current	L-Birkenhead	10	2
SEL-05-01	Kawkawa-Late timing	Kawkawa-L	extirpated	EX	NA	NA
SEL-05-02	Nahatlatch-Early Summer timing	Nahatlatch-ES	current	ES-misc[j]	2	2
SEL-06-01	Anderson/Seton-Early Summer timing	Anderson/Seton-ES	current	ES-Gates	2	2
SEL-06-02	Chilko-Early Summer timing	Chilko-ES	current	S-Chilko	1	0
SEL-06-03	Chilko-Summer timing	Chilko-S	current	S-Chilko	3	1
SEL-06-04	Francois-First Run-Early Summer timing	Francois-R1-ES	extirpated?	ES-Nadina	1	0
SEL-06-05	Francois-Second Run-Early Summer timing	Francois-R2-ES	current	ES-Nadina	4	2
SEL-06-06	Fraser-Early Summer timing	Fraser-ES	extirpated?	NI	4	0
SEL-06-07	Fraser-Summer timing	Fraser-S	current	S-Stellako	2	1
SEL-06-08	Mckinley-Summer timing	Mckinley-S	current	S-Quesnel	1	1
SEL-06-09	Nadina-Early Summer timing	Nadina-ES	extirpated?	NI	2	0
SEL-06-10	Quesnel-Summer timing	Quesnel-S	current	S-Quesnel	78	6
SEL-06-11	Seton-Late timing	Seton-L	current	L-Portage	2	1
SEL-06-12	Stuart-Early Stuart timing	Stuart-ESTU	validation required	NR[ESTU-Early Stuart]	2	0
SEL-06-13	Stuart-Summer timing	Stuart-S	current	S-Late Stuart	6	3
SEL-06-14	Takla/Trembleur-Early Stuart timing	Takla/Trembleur-ESTU	current	ESTU-Early Stuart	43	32
SEL-06-15	Takla/Trembleur-Summer timing	Takla/Trembleur-S	current	UnDISC	6	3

CU index	CU name	CU acronym	Administrative category†	Fraser mnemonic‡	N sites	N sites filtered
SEL-06-16	Taseko-Early Summer timing	Taseko-ES	current	NI	4	1
SEL-06-18	Cariboo-Summer timing	Cariboo-S	validation required	NI	2	0
SEL-06-19	Francois-Summer timing	Francois-S	validation required	NI	1	0
SEL-07-01	Bowron-Early Summer timing	Bowron-ES	current	ES-Bowron	6	1
SEL-07-02	Indian/Kruger-Early Summer timing	Indian/Kruger-ES	extirpated?	NI	1	0
SEL-09-01	Kamloops/South Thompson-Early Summer timing	Kamloops-L	proposed	ES-misc[f]	1	1
SEL-09-02	Shuswap Complex-Early Summer timing	Shuswap Complex-ES	current	ES-Scotch&ES-Seymour&ES	23	8
SEL-09-03	Shuswap Complex-Late timing	Shuswap Complex-L	current	L-Late Shuswap	65	13
SEL-10-01	Kamloops/North Thompson-Early Summer timing	Kamloops-ES	proposed	ES-Fennell&ES-Raft&ES-misc[h]	14	5
SEL-10-02	North Barriere-Early Summer timing	NBarriere-ES	extirpated	EX	NA	NA
SEL-10-03	East Barriere-Early Summer timing	EBarriere-ES	extirpated	EX	NA	NA
SER-02	Widgeon	Widgeon	current	NI	1	1
SER-03	Lower Fraser	LFR	current	L-Harrison	8	1
SER-04	Fraser Canyon	FRCany	validation required	NI	8	0
SER-05	Middle Fraser	MFR	current	NI	11	1
SER-06	Upper Fraser	UFR	validation required	NI	8	0
SER-07	Thompson	THOM	validation required	NI	2	0

† Administrative categories are:

1. Current: CU is accepted and fish are known to be present in at least one population in the CU. For most, there has been some form of enumeration.
2. Proposed: CU has been proposed and on acceptance would be categorized as "current".
3. Extirpated: All populations within an accepted CU are known to have been extirpated, usually because of a dam or other blockage.
4. Extirpated?: All populations within an accepted CU are thought to be extirpated, but there is no conclusive evidence.
5. Extirpated, recovery underway: Applies to two sockeye lakes blocked by dams but where attempts are underway to reestablish the CU using kokanee populations thought to have been derived from the anadromous populations.
6. Validation required: A catch-all for possible CUs where there are questions about the nature and persistence of the purported CU.
7. Deleted: The CU was recognized as invalid. Any valid populations within it were reassigned to another and appropriate CU.

‡ The Fraser mnemonics are based on the summary forecast Table 3 (Grant 2011). In addition to the Fraser forecast group mnemonics, the following notation was used:

1. EX: extirpated and therefore not included in forecasts
2. NA: not applicable, refers to deleted CUs
3. NI: not included, the CU is not included in any forecasted group

4. Misc[#]: Refers to footnote "#" of Table 3

Table 22: An interpretation of the findings and status recommendations of Grant et al. (2010) for Fraser River sockeye. The status scores for the four metrics (relative abundance, absolute abundance, slope and productivity) either were given by Grant et al. or are my interpretations of their findings. Where there is range in the status score for the abundance metrics I have generally characterized the score at the mid-point. Note that these are the biological production zones of the WSP and not necessarily the status characterizations used in the paper.

CU index	CU name	CU acronym	Degree of assessability	Total Sites	Filtered sites	Expert prioritization
CK-01	Okanagan	OK	none	1	0	Threatened (COSEWIC)
CK-02	Boundary Bay	BB	v. limited	3	0	
CK-03	Lower Fraser River-fall timing (white)	LFR-fall	full	1	1	16
CK-04	Lower Fraser River-spring timing	LFR-spring	full	5	1	13
CK-05	Lower Fraser River-Upper Pitt	LFR-UPITT	v. limited	1	0	12
CK-06	Lower Fraser River-summer timing	LFR-summer	v. limited	12	0	14
CK-07	Maria Slough	Maria	limited	1	0	8
CK-08	Fraser Canyon-Nahatlatch	NAHAT	full	1	1	9
CK-09	Middle Fraser River-Portage	Portage	full	1	1	7
CK-10	Middle Fraser River-spring timing	MFR-spring	full	22	8	3
CK-11	Middle Fraser River-summer timing	MFR-summer	full	22	9	11
CK-12	Upper Fraser River-spring timing	UFR-spring	full	40	17	5
CK-13	South Thompson-summer timing-age 0.3	STh-0.3	full	8	4	17
CK-14	South Thompson-summer timing-age 1.3	STh-1.3	full	2	1	4
CK-15	Shuswap River-summer timing-age 0.3	STh-SHUR	full	2	2	15
CK-16	South Thompson-Bessette Creek	STh-BESS	full	4	1	2
CK-17	Lower Thompson-spring timing-age 1.2	LTh	full	10	7	1
CK-18	North Thompson-spring timing-age 1.3	NTh-spr	full	7	4	10
CK-19	North Thompson-summer timing-age 1.3	NTh-sum	full	7	4	6
CK-20	South Coast-Georgia Strait	SC+GStr	full	46	3	
CK-21	East Vancouver Island-Goldstream	Goldstr	full	2	1	
CK-22	East Vancouver Island-Cowichan & Koksilah	CWCH-KOK	full	7	1	of concern
CK-23	East Vancouver Island-Nanaimo-spring timing	NanR-spr	none	1	0	
CK-24	East Vancouver Island-Nanaimo & Chemainus-summer timing	midEVI-sum	v. limited	1	0	
CK-25	East Vancouver Island-Nanaimo & Chemainus-fall timing	midEVI-fall	full	6	1	

CK-26	East Vancouver Island-Puntledge-summer timing	PuntR-sum	full	1	1	intensive recovery efforts underway
CK-27	East Vancouver Island-Qualicum & Puntledge-fall timing	QP-fall	full	21	5	
CK-28	South Coast-southern fjords	SC+SFj	full	26	5	
CK-29	Northeast Vancouver Island	NEVI	full	14	5	
CK-30	Port San Juan	PSJ	full	5	2	
CK-31	Southwest Vancouver Island	SWVI	full	60	16	
CK-32	Nootka & Kyuquot	NoKy	full	57	17	
CK-33	Northwest Vancouver Island	NWVI	full	18	2	
CK-34	Homathko	HOMATH	limited	2	0	
CK-35	Klinaklini	KLINA	limited	2	0	

Table 23: 2×2 contingency tables for the four primary metrics compared between the synoptic analysis (rows) and the assessments of Grant et al. (2010). Data deficient cells are not tabulated.

A) Slope

		slope		
		2	**4**	**6**
csSLOPE	**2**	15	0	0
	4	0	0	0
	6	0	2	6

B) Relative abundance

		relative abundance		
		2	**4**	**6**
csRelA	**2**	3	0	1
	4	1	2	2
	6	3	2	9

C) Absolute abundance

		absolute abundance		
		2	**4**	**6**
csAbsA	**2**	3	0	0
	4	2	1	1
	6	2	3	11

D) productivity

		productivity		
		2	**4**	**6**
csRS	**2**	5	0	
	4	2	0	
	6	10	0	1

Table 24: Status and composite status scores for Fraser River sockeye CUs. "DD" indicates data deficiencies. The names of some scores have been shortened to fit in the table. The two binning scores are listed in Table 26. The CUs are sorted by Data class and then COSEWIC.

CU_index	CU_acro	csSLOPE	csRelA	csAbsA	sRS	sRSslope	AUC	Data class	csMed	csMin	cs1	cs2a	cs2b	cs3a	cs3b	COSEWIC-C	COSEWIC	cs5	cs6	cs7
SEL-07-02	Indian/Kruger-ES	DD						DD	DD											
SER-04	FRCany	DD						DD	DD											
SER-06	UFR	DD						DD	DD											
SER-07	THOM	DD						DD	DD											
SEL-03-07	Alouette							DD												
SEL-03-08	Coquitlam							DD												
SEL-06-02	Chilko-ES							DD												
SEL-06-09	Nadina-ES							DD												
SEL-06-18	Cariboo-S							DD												
SEL-06-19	Francois-S	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
SEL-03-02	Cultus-L	1	3	4	3	6	DD	I	3	1	3	1	2	1	3	1	2	1	1	1
SEL-05-02	Nahatlatch-ES	1	4	4	3	6	DD	I	4	1	3	1	2	1	3	1	2	1	1	1
SEL-06-01	Anderson/Seton-ES	2	5	6	5	6	DD	I	5	2	4	2	4	4	6	2	2	3	3	4
SEL-06-03	Chilko-S	1	6	6	5	6	DD	I	6	1	4	1	4	3	6	1	2	2	2	3
SEL-06-10	Quesnel-S	1	6	6	2	2	5	I	6	1	4	1	2	1	3	1	2	1	2	1
SEL-06-11	Seton-L	2	4	4	5	1	DD	I	4	2	3	2	3	4	5	2	2	3	2	2
SEL-06-13	Stuart-S	1	6	6	5	6	DD	I	6	1	4	1	4	3	6	1	2	2	2	3
SEL-06-14	Takla/Trembleur-ESTU	1	4	6	3	6	6	I	4	1	4	1	3	1	4	1	2	1	2	1
SEL-06-15	Takla/Trembleur-S	1	3	5	4	6	DD	I	3	1	3	1	2	2	4	1	2	1	2	1
SEL-06-16	Taseko-ES	2	2	1	4	6	DD	I	2	1	2	1	1	3	3	1	2	2	1	2
SEL-07-01	Bowron-ES	1	3	4	3	6	DD	I	3	1	3	1	2	1	3	1	2	1	1	1
SEL-09-02	Shuswap Complex-ES	2	6	6	5	6	6	I	6	2	4	2	4	4	6	2	2	3	3	4
SER-02	Widgeon	6	5	2	6	1	DD	I	5	2	4	6	4	6	6	2	2	6	4	6
SEL-03-01	Chilliwack-ES	3	6	6	5	1	DD	I	6	3	5	3	5	5	6	3	3	4	4	3
SEL-03-04	Harrison-(U/S)-L	3	4	6	4	1	DD	I	4	3	4	2	4	4	5	3	3	3	4	2
SEL-06-05	Francois-R2-ES	3	6	6	6	6	DD	I	6	3	5	3	5	5	6	3	3	4	4	5
SEL-06-07	Fraser-S	3	5	6	5	6	DD	I	5	3	5	3	5	5	6	3	3	4	4	5
SER-05	MFR	6	6	4	6	1	DD	I	6	4	5	6	5	6	6	4	4	6	5	6

CU_index	CU_acro	csSLOPE	csRelA	csAbsA	sRS	sRSslope	AUC	Data class	csMed	csMin	cs1	cs2a	cs2b	cs3a	cs3b	COSEWIC-C	COSEWIC	cs5	cs6	cs7
SEL-03-03	Harrison-(D/S)-L	6	6	6	3	1	DD	I	6	6	6	4	4	4	4	6	6	6	6	4
SEL-03-05	Pitt-ES	6	6	6	2	1	DD	I	6	6	6	4	4	4	4	6	6	6	6	4
SEL-04-01	Lillooet-L	6	6	6	5	1	DD	I	6	6	6	6	6	6	6	6	6	6	6	6
SEL-09-03	Shuswap Complex-L	6	4	6	5	1	3	I	6	4	5	6	5	6	6	6	6	6	6	6
SEL-10-01	Kamloops-ES	6	6	6	6	6	6	I	6	6	6	6	6	6	6	6	6	6	6	6
SER-03	LFR	6	6	6	6	6	DD	I	6	6	6	6	6	6	6	6	6	6	6	6
SEL-09-01	Kamloops-L	6	5	3	DD	DD	DD	II	5	3	5	DD	DD	DD	DD	DD	3	DD	4	DD
SEL-06-12	Stuart-ESTU	DD	DD	1	4	6	DD	III	1	1	4	DD	4	DD	5	DD	2	DD	DD	DD
SEL-06-08	Mckinley-S	DD	6	4	DD	DD	DD	IV	5	4	5	DD	DD	DD	DD	DD	4	DD	DD	DD
SEL-06-06	Fraser-ES	DD	DD	2	DD	DD	DD	V	2	2	2	DD	DD	DD	DD	DD	2	DD	DD	DD

Table 25: Tabular comparison between the synoptic and the analytical status assessments for Fraser River sockeye. The CUs are sorted by COSEWIC and then by sRS. Status scores from Grant et al. (2010) are in italics while those from this study are bolded. Grant et al. used two different relative abundance measures (RelA1 and RelA2) and their productivity score appears as a narrative accompanying estimates of recruits·spawner^{-1} and trends of that variable.

CU_index	CU_name	**csSLOPE**	*SLOPE*	**csRelA**	*RelA1*	*RelA2*	**csAbsA**	**sRS**	**sRS-slope**	*Productivity*	**cs2a**	**cs3a**	**cs7**	**csMinScore**	**COSEWIC**	*WSP status recommendation*
SEL-03-07	Alouette	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*DD*
SEL-03-08	Coquitlam	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*DD*
SEL-06-02	Chilko-ES	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*see Chilko-S*
SEL-06-09	Nadina-ES	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*not recognized*
SEL-06-18	Cariboo-S	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*not recognized*
SEL-06-19	Francois-S	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*not recognized*
SEL-07-02	Indian/Kruger-ES	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*not recognized*
SER-04	FRCany	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*validity uncertain*
SER-06	UFR	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*validity uncertain*
SER-07	THOM	**DD**	-	**DD**	-	-	**DD**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**DD**	**DD**	*validity uncertain*
SEL-06-06	Fraser-ES	**DD**	-	**DD**	-	-	**2**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**2**	**2**	*N/A*
SEL-06-10	Quesnel-S	**1**	R	**6**	G	R	**6**	**2**	**2**	R	**1**	**1**	**1**	**1**	**2**	*dependent on future productivity*
SEL-03-02	Cultus-L	**1**	R	**3**	R	R-A	**4**	**3**	**6**	R	**1**	**1**	**1**	**1**	**2**	*@RISK*
SEL-05-02	Nahatlatch-ES	**1**	R	**4**	A	DD	**4**	**3**	**6**	DD	**1**	**1**	**1**	**1**	**2**	*@RISK(A)*
SEL-06-14	Takla/Trembleur-ESTU	**1**	R	**4**	A	R-A	**6**	**3**	**6**	R	**1**	**1**	**1**	**1**	**2**	*dependent on future productivity*
SEL-07-01	Bowron-ES	**1**	R	**3**	R	R-A	**4**	**3**	**6**	R	**1**	**1**	**1**	**1**	**2**	*@RISK*
SEL-06-12	Stuart-ESTU	**DD**	-	**DD**	-	-	**1**	**4**	**6**	-	**DD**	**DD**	**DD**	**1**	**2**	*not recognized*
SEL-06-15	Takla/Trembleur-S	**1**	R	**3**	G	R-A	**5**	**4**	**6**	R	**1**	**2**	**1**	**1**	**2**	*dependent on future productivity*
SEL-06-16	Taseko-ES	**2**	R	**2**	R	DD	**1**	**4**	**6**	DD	**1**	**3**	**2**	**1**	**2**	*@RISK(A)*
SEL-06-01	Anderson/Seton-ES	**2**	R	**5**	A-G	A	**6**	**5**	**6**	R	**2**	**4**	**4**	**2**	**2**	*dependent on future productivity*
SEL-06-03	Chilko-S	**1**	R	**6**	G	G	**6**	**5**	**6**	A-R	**1**	**3**	**3**	**1**	**2**	*dependent on future productivity*
SEL-06-11	Seton-L	**2**	R	**4**	G	A	**4**	**5**	**1**	R	**2**	**4**	**2**	**2**	**2**	*dependent on future productivity*
SEL-06-13	Stuart-S	**1**	R	**6**	G	R-A	**6**	**5**	**6**	R	**1**	**3**	**3**	**1**	**2**	*dependent on future productivity*
SEL-09-02	Shuswap Complex-ES	**2**	R	**6**	G	R-G	**6**	**5**	**6**	R	**2**	**4**	**4**	**2**	**2**	*dependent on future productivity*
SER-02	Widgeon	**6**	G	**5**	R	DD	**2**	**6**	**1**	DD	**6**	**6**	**6**	**2**	**2**	*@RISK(A)*
SEL-09-01	Kamloops-L	**6**	A	**5**	R	DD	**3**	**DD**	**DD**	DD	**DD**	**DD**	**DD**	**3**	**3**	*@RISK(A)*

CU_index	CU_name	**csSLOPE**	*SLOPE*	**csRelA**	*RelA1*	*RelA2*	**csAbsA**	**sRS**	**sRS-slope**	*Productivity*	**cs2a**	**cs3a**	**cs7**	**csMinScore**	**COSEWIC**	*WSP status recommendation*
SEL-03-04	Harrison-(U/S)-L	**3**	R	**4**	R	A	**6**	**4**	**1**	R	**2**	**4**	**2**	**3**	**3**	*dependent on future productivity*
SEL-03-01	Chilliwack-ES	**3**	-	**6**	-		**6**	**5**	**1**	-	**3**	**5**	**3**	**3**	**3**	*@RISK(A)*
SEL-06-07	Fraser-S	**3**	R	**5**	R	G	**6**	**5**	**6**	R	**3**	**5**	**5**	**3**	**3**	*dependent on future productivity*
SEL-06-05	Francois-R2-ES	**3**	R	**6**	R-G	A	**6**	**6**	**6**	A/R	**3**	**5**	**5**	**3**	**3**	*dependent on future productivity*
SEL-06-08	Mckinley-S	**DD**	-	**6**	-	-	**4**	**DD**	**DD**	-	**DD**	**DD**	**DD**	**4**	**4**	*see Quesnel*
SER-05	MFR	**6**	-	**6**	-	-	**4**	**6**	**1**	-	**6**	**6**	**6**	**4**	**4**	*validity uncertain*
SEL-03-05	Pitt-ES	**6**	G	**6**	G	G	**6**	**2**	**1**	R	**4**	**4**	**4**	**6**	**6**	*G*
SEL-03-03	Harrison-(D/S)-L	**6**	G	**6**	G	DD	**6**	**3**	**1**	DD	**4**	**4**	**4**	**6**	**6**	*G*
SEL-04-01	Lillooet-L	**6**	G	**6**	G	G	**6**	**5**	**1**	R	**6**	**6**	**6**	**6**	**6**	*G with dependence on future productivity*
SEL-09-03	Shuswap Complex-L	**6**	G	**4**	G	A-G	**6**	**5**	**1**	R	**6**	**6**	**6**	**4**	**6**	*dependent on future productivity*
SEL-10-01	Kamloops-ES	**6**	A	**6**	A	G	**6**	**6**	**6**	R	**6**	**6**	**6**	**6**	**6**	*dependent on future productivity*
SER-03	LFR	**6**	G	**6**	G	G	**6**	**6**	**6**	G	**6**	**6**	**6**	**6**	**6**	*G*

Table 26: For Fraser River sockeye, a summary of the two binning composite scores, cs4bin and cs8bin, with their respective interpretations. The one-generation mean exploitation rate and the COSEWIC composite score are tabulated. The CUs are sorted by the priority suggested in the text and by the COSEWIC composite score.

CU_index	CU_name	1genER	1genR•S^{-1}	COSEWIC	cs4Bin	interpretation	cs8Bin	interpretation	priority
SEL-06-16	Taseko-ES	32%	0.82	2	3	possibly over-exploited	3	possibly severely and chronically over-exploited or very recent increase in productivity	2
SEL-03-02	Cultus-L	17%	0.69	2	1	considerable risk	5	rapid decline in progress	3
SEL-05-02	Nahatlatch-ES	35%	0.61	2	1	considerable risk	5	rapid decline in progress	3
SEL-06-10	Quesnel-S	37%	0.44	2	1	considerable risk	5	rapid decline in progress	3
SEL-06-14	Takla/Trembleur-ESTU	10%	0.69	2	1	considerable risk	5	rapid decline in progress	3
SEL-07-01	Bowron-ES	48%	0.61	2	1	considerable risk	5	rapid decline in progress	3
SEL-06-01	Anderson/Seton-ES	33%	1.53	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-03	Chilko-S	35%	1.15	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-11	Seton-L	33%	1.93	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-13	Stuart-S	56%	1.48	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-15	Takla/Trembleur-S	56%	0.87	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-09-02	Shuswap Complex-ES	35%	1.58	2	3	possibly over-exploited	7	possibly over-exploited	4
SEL-03-01	Chilliwack-ES	10%	1.16	3	3	possibly over-exploited	7	possibly over-exploited	4
SEL-03-04	Harrison-(U/S)-L	16%	0.84	3	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-05	Francois-R2-ES	36%	2.70	3	3	possibly over-exploited	7	possibly over-exploited	4
SEL-06-07	Fraser-S	37%	1.04	3	3	possibly over-exploited	7	possibly over-exploited	4
SEL-03-03	Harrison-(D/S)-L	25%	0.68	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6
SEL-03-05	Pitt-ES	22%	0.57	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6
SER-02	Widgeon	12%	2.17	2	4	no concerns	4	productive population in recovery	7

SER-05	MFR	12%	2.84	4	4	no concerns	8	secure	8
SEL-04-01	Lillooet-L	27%	1.40	6	4	no concerns	8	secure	8
SEL-09-03	Shuswap Complex-L	34%	1.35	6	4	no concerns	8	secure	8
SEL-10-01	Kamloops-ES	35%	2.64	6	4	no concerns	8	secure	8
SER-03	LFR	12%	7.11	6	4	no concerns	8	secure	8
SEL-06-06	Fraser-ES	48%	DD	2	DD	no data	DD	no data	?
SEL-06-12	Stuart-ESTU	10%	D	2	DD	no data	DD	no data	?
SEL-09-01	Kamloops-L	34%	DD	3	DD	no data	DD	no data	?
SEL-06-08	Mckinley-S	37%	DD	4	DD	no data	DD	no data	?
SEL-03-07	Alouette	27%	DD	DD	DD	no data	DD	no data	?
SEL-03-08	Coquitlam	27%	DD	DD	DD	no data	DD	no data	?
SEL-06-02	Chilko-ES	48%	DD	DD	DD	no data	DD	no data	?
SEL-06-09	Nadina-ES	48%	DD	DD	DD	no data	DD	no data	?
SEL-06-18	Cariboo-S	56%	DD	DD	DD	no data	DD	no data	?
SEL-06-19	Francois-S	37%	DD	DD	DD	no data	DD	no data	?
SEL-07-02	Indian/Kruger-ES	48%	DD	DD	DD	no data	DD	no data	?
SER-04	FRCany	12%	DD	DD	DD	no data	DD	no data	?
SER-06	UFR	12%	DD	DD	DD	no data	DD	no data	?
SER-07	THOM	12%	DD	DD	DD	no data	DD	no data	?

Table 27: Summary of Conservation Units of chinook from British Columbia, south of Cape Caution as found in version 3 of the CU list. The administrative categories are explained in a footnote to the table. The Outlook Group is used by salmon stock assessment in the annual outlook.

CU index	CU name	CU acronym	Administrative category†	Outlook group	N sites	N sites filtered
CK-01	Okanagan	OK	current	(N)Okanagan	1	0
CK-02	Boundary Bay	BB	current	Georgia Strait Fall (wild and small hatchery operations)	3	0
CK-03	Lower Fraser River-fall timing (white)	LFR-fall	current	Fall – lower Fraser natural	1	1
CK-04	Lower Fraser River-spring timing	LFR-spring	current	Early spring – lower Fraser	5	1
CK-05	Lower Fraser River-Upper Pitt	LFR-UPITT	current	Early spring – lower Fraser	1	0
CK-06	Lower Fraser River-summer timing	LFR-summer	current	Summer – lower Fraser	12	0
CK-07	Maria Slough	Maria	current	Summer – lower Fraser	1	0
CK-08	Fraser Canyon-Nahatlatch	NAHAT	current	(N)Fraser Canyon	1	1
CK-09	Middle Fraser River-Portage	Portage	current	(N)Fraser Canyon	1	1
CK-10	Middle Fraser River-spring timing	MFR-spring	current	Spring – upper & mid-Fraser, North Thompson	22	8
CK-11	Middle Fraser River-summer timing	MFR-summer	current	Summer – upper & mid-Fraser, North Thompson	22	9
CK-12	Upper Fraser River-spring timing	UFR-spring	current	c[30,32]	40	17
CK-13	South Thompson-summer timing-age 0.3	STh-0.3	current	Late summer – South Thompson	8	4
CK-14	South Thompson-summer timing-age 1.3	STh-1.3	current	Late summer – South Thompson	2	1
CK-15	Shuswap River-summer timing-age 0.3	STh-SHUR	current	Late summer – South Thompson	2	2
CK-16	South Thompson-Bessette Creek	STh-BESS	current	Late summer – South Thompson	4	1
CK-17	Lower Thompson-spring timing-age 1.2	LTh	current	Spring – lower Thompson	10	7
CK-18	North Thompson-spring timing-age 1.3	NTh-spr	current	Spring – upper & mid-Fraser, North Thompson	7	4
CK-19	North Thompson-summer timing-age 1.3	NTh-sum	current	Summer – upper & mid-Fraser, North Thompson	7	4
CK-20	South Coast-Georgia Strait	SC+GStr	current	Georgia Strait Fall (wild and small hatchery operations)	46	3
CK-21	East Vancouver Island-Goldstream	Goldstr	current	Georgia Strait Fall (wild and small hatchery operations)	2	1
CK-22	East Vancouver Island-Cowichan & Koksilah	CWCH-KOK	current	Georgia Strait Fall (wild and small hatchery operations)	7	1
CK-23	East Vancouver Island-Nanaimo-spring timing	NanR-spr	current	Georgia Strait Spring and Summer	1	0

CU index	CU name	CU acronym	Administrative category†	Outlook group	N sites	N sites filtered
CK-24	East Vancouver Island-Nanaimo & Chemainus-summer timing	midEVI-sum	current	Georgia Strait Spring and Summer	1	0
CK-25	East Vancouver Island-Nanaimo & Chemainus-fall timing	midEVI-fall	current	Georgia Strait Fall (wild and small hatchery operations)	6	1
CK-26	East Vancouver Island-Puntledge-summer timing	PuntR-sum	current	Georgia Strait Spring and Summer	1	1
CK-27	East Vancouver Island-Qualicum & Puntledge-fall timing	QP-fall	current	Georgia Strait Fall (large hatchery operations)	21	5
CK-28	South Coast-southern fjords	SC+SFj	current	Johnstone Strait area including mainland inlets	26	5
CK-29	Northeast Vancouver Island	NEVI	current	Johnstone Strait area including mainland inlets	14	5
CK-30	Port San Juan	PSJ	current	WCVI-wild	5	2
CK-31	Southwest Vancouver Island	SWVI	current	WCVI-wild	60	16
CK-32	Nootka & Kyuquot	NoKy	current	WCVI-wild	57	17
CK-33	Northwest Vancouver Island	NWVI	current	WCVI-wild	18	2
CK-34	Homathko	HOMATH	current	Johnstone Strait area including mainland inlets	2	0
CK-35	Klinaklini	KLINA	current	Johnstone Strait area including mainland inlets	2	0

† For details of these codes see the footnote to Table 21.

Table 28: Expert prioritization of conservation concerns for some southern chinook CUs. The degree of assessability is based on the availability of recent data (last 3 generations).

CU index	CU acronym	Degree of assessability	Expert prioritization†
CK-01	OK	none	List by COSEWIC as Threatened
CK-02	BB	none	
CK-03	LFR-fall	full	16
CK-04	LFR-spring	full	13
CK-05	LFR-UPITT	none	12
CK-06	LFR-summer	v. limited	14
CK-07	Maria	v. limited	8
CK-08	NAHAT	limited	9
CK-09	Portage	limited	7
CK-10	MFR-spring	full	3
CK-11	MFR-summer	full	11
CK-12	UFR-spring	full	5
CK-13	STh-0.3	full	17
CK-14	STh-1.3	full	4
CK-15	STh-SHUR	full	15
CK-16	STh-BESS	full	2
CK-17	LTh	full	1
CK-18	NTh-spr	full	10
CK-19	NTh-sum	full	6
CK-20	SC+GStr	full	
CK-21	Goldstr	full	
CK-22	CWCH-KOK	full	of concern
CK-23	NanR-spr	none	
CK-24	midEVI-sum	limited	
CK-25	midEVI-fall	full	
CK-26	PuntR-sum	full	intensive recovery efforts underway
CK-27	QP-fall	full	
CK-28	SC+SFj	full	
CK-29	NEVI	full	
CK-30	PSJ	full	
CK-31	SWVI	full	
CK-32	NoKy	full	
CK-33	NWVI	full	fisheries controls in place to limit exploitation
CK-34	HOMATH	none	
CK-35	KLINA	limited	

†For Fraser River CUs, R. Bailey. COSEWIC has assessed Okanagan chinook (COSEWIC 2006). Information on status of Cowichan chinook was provided by A. Tompkins.

Table 29: Status and composite status scores for southern chinook CUs, sorted by Data class and the COSEWIC composite score. "DD" indicates data deficiencies. The names of some scores have been shortened to fit in the table. The two binning scores are listed in Table 26.

CU index	CU acro	csSLOPE	csRelA	csAbsA	sRS	sRSslope	AUC	Data class	csMed	csMin	cs1	cs2a	cs2b	cs3a	cs3b	COSEWIC-C	COSEWIC	cs5	cs6	cs7
CK-01	OK	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
CK-02	BB	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
CK-05	LFR-UPITT	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
CK-23	NanR-spr	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
CK-34	HOMATH	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD
CK-10	MFR-spring	1	5	5	1	1	6	I	5	1	4	1	2	1	3	1	2	1	2	1
CK-11	MFR-summer	2	5	6	1	2	6	I	5	2	4	1	2	1	3	2	2	2	3	1
CK-14	STh-1.3	2	5	3	6	2	DD	I	3	2	3	2	3	4	5	1	2	4	1	2
CK-16	STh-BESS	1	4	1	1	1	DD	I	1	1	2	1	1	1	1	1	2	1	1	1
CK-17	LTh	2	4	6	1	5	6	I	4	2	4	1	2	1	3	2	2	2	3	2
CK-18	NTh-spr	1	4	2	6	1	DD	I	2	1	2	1	2	3	4	1	2	3	1	1
CK-19	NTh-sum	2	6	6	2	3	DD	I	6	2	4	1	2	1	3	2	2	2	3	1
CK-21	Goldstr	6	6	1	1	5	DD	I	6	1	4	4	2	4	3	1	2	6	3	6
CK-22	CWCH-KOK	1	2	5	1	1	DD	I	2	1	3	1	1	1	2	1	2	1	2	1
CK-28	SC+SFj	2	3	4	1	3	DD	I	3	2	3	1	1	1	2	2	2	2	2	1
CK-31	SWVI	2	6	6	1	5	3	I	6	2	4	1	2	1	3	2	2	2	3	2
CK-32	NoKy	2	6	6	1	5	3	I	6	2	4	1	2	1	3	2	2	2	3	2
CK-12	UFR-spring	3	6	6	1	3	6	I	6	3	5	1	4	2	4	3	3	3	4	1
CK-04	LFR-spring	6	6	4	1	5	DD	I	6	4	5	4	4	4	4	4	4	6	5	6
CK-26	PuntR-sum	6	6	4	6	5	DD	I	6	4	5	6	5	6	6	4	4	6	5	6
CK-30	PSJ	6	6	4	1	5	DD	I	6	4	5	4	4	4	4	4	4	6	5	6
CK-33	NWVI	4	6	5	1	5	DD	I	5	4	5	2	4	3	4	4	4	4	5	4
CK-25	midEVI-fall	6	6	5	6	5	DD	I	6	5	6	6	6	6	6	5	5	6	6	6

CU index	CU acro	csSLOPE	csRelA	csAbsA	sRS	sRSslope	AUC	Data class	csMed	csMin	cs1	cs2a	cs2b	cs3a	cs3b	COSEWIC-C	COSEWIC	cs5	cs6	cs7
CK-03	LFR-fall	6		6	1	4	DD	I	6	6	6	4	4	4	4	6	6	6	6	5
CK-13	STh-0.3	6	6	6	1	5	DD	I	6	6	6	4	4	4	4	6	6	6	6	6
CK-15	STh-SHUR	6	6	6	2	5	DD	I	6	6	6	4	4	4	4	6	6	6	6	6
CK-20	SC+GStr	6	1	6	1	5	DD	I	6	1	4	4	2	4	3	6	6	6	6	6
CK-27	QP-fall	6	6	6	6	5	6	I	6	6	6	6	6	6	6	6	6	6	6	6
CK-29	NEVI	6	6	6	6	5	4	I	6	6	6	6	6	6	6	6	6	6	6	6
CK-08	NAHAT	6	4	1	DD	DD	DD	II	4	1	4	DD	DD	DD	DD	DD	2	DD	3	DD
CK-09	Portage	6	6	1	DD	DD	DD	II	6	1	4	DD	DD	DD	DD	DD	2	DD	3	DD
CK-24	midEVI-sum	DD	DD	3	1	1	DD	III	3	3	5	DD	4	DD	4	DD	3	DD	DD	DD
CK-35	KLINA	DD	DD	6	1	5	DD	III	6	6	6	DD	4	DD	4	DD	6	DD	DD	DD
CK-07	Maria	DD	DD	3	DD	DD	DD	V	3	3	3	DD	DD	DD	DD	DD	3	DD	DD	DD
CK-06	LFR-summer	DD	DD	4	DD	DD	DD	V	4	4	4	DD	DD	DD	DD	DD	4	DD	DD	DD

Table 30: For southern chinook, a summary of the two binning composite scores, cs4bin and cs8bin, with their respective interpretations. The one-generation mean exploitation rate and the COSEWIC composite score are tabulated. The CUs are sorted by the expert priority ranking for Fraser River chinook.

CU_index	CU_acro	1genER	1genR/S	COSEWIC	cs4Bin	interpretation	cs8Bin	interpretation	priority	experts
CK-02	BB	DD	DD	DD	DD	no data	DD	no data	?	?
CK-23	NanR-spr	45%	DD	DD	DD	no data	DD	no data	?	?
CK-34	HOMATH	46%	DD	DD	DD	no data	DD	no data	?	?
CK-01	OK	DD	DD	DD	DD	no data	DD	no data	?	Threatened (COSEWIC)
CK-28	SC+SFj	46%	0.76	2	1	considerable risk	5	rapid decline in progress	3	?
CK-31	SWVI	73%	0.62	2	1	considerable risk	5	rapid decline in progress	3	?
CK-32	NoKy	37%	0.62	2	1	considerable risk	5	rapid decline in progress	3	?
CK-22	CWCH-KOK	60%	0.85	2	1	considerable risk	5	rapid decline in progress	3	of concern
CK-21	Goldstr	51%	0.64	2	2	moderate risk	2	either error, bad data or very recent drop in productivity	5	?
CK-24	midEVI-sum	45%	DD	3	DD	no data	DD	no data	?	?
CK-30	PSJ	37%	0.50	4	2	moderate risk	6	recent drop in productivity that could lead to risk	6	?
CK-33	NWVI	37%	0.89	4	2	moderate risk	6	recent drop in productivity that could lead to risk	6	?
CK-26	PuntR-sum	51%	1.00	4	4	no concerns	8	secure	8	intensive recovery efforts underway
CK-25	midEVI-fall	45%	1.10	5	4	no concerns	8	secure	8	?
CK-35	KLINA	46%	DD	6	DD	no data	DD	no data	?	?
CK-20	SC+GStr	51%	0.85	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6	?
CK-27	QP-fall	51%	1.09	6	4	no concerns	8	secure	8	?
CK-29	NEVI	46%	1.00	6	4	no concerns	8	secure	8	?
CK-17	LTh	47%	0.54	2	1	considerable risk	5	rapid decline in progress	3	1

CU_index	CU_acro	1genER	1genR/S	COSEWIC	cs4Bin	interpretation	cs8Bin	interpretation	priority	experts
CK-16	STh-BESS	45%	0.94	2	1	considerable risk	1	at considerable risk	1	2
CK-10	MFR-spring	30%	0.81	2	1	considerable risk	5	rapid decline in progress	3	3
CK-14	STh-1.3	66%	1.01	2	3	possibly over-exploited	3	possibly severely and chronically over-exploited or very recent increase in productivity	2	4
CK-12	UFR-spring	31%	0.85	3	1	considerable risk	5	rapid decline in progress	3	5
CK-19	NTh-sum	34%	0.96	2	1	considerable risk	5	rapid decline in progress	3	6
CK-09	Portage	29%	DD	2	DD	no data	DD	no data	?	7
CK-07	Maria	29%	DD	3	DD	no data	DD	no data	?	8
CK-08	NAHAT	29%	DD	2	DD	no data	DD	no data	?	9
CK-18	NTh-spr	39%	1.16	2	3	possibly over-exploited	3	possibly severely and chronically over-exploited or very recent increase in productivity	2	10
CK-11	MFR-summer	27%	0.77	2	1	considerable risk	5	rapid decline in progress	3	11
CK-05	LFR-UPITT	30%	DD	DD	DD	no data	DD	no data	?	12
CK-04	LFR-spring	13%	0.84	4	2	moderate risk	6	recent drop in productivity that could lead to risk	6	13
CK-06	LFR-summer	27%	DD	4	DD	no data	DD	no data	?	14
CK-15	STh-SHUR	58%	DD	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6	15
CK-03	LFR-fall	25%	DD	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6	16
CK-13	STh-0.3	55%	0.81	6	2	moderate risk	6	recent drop in productivity that could lead to risk	6	17

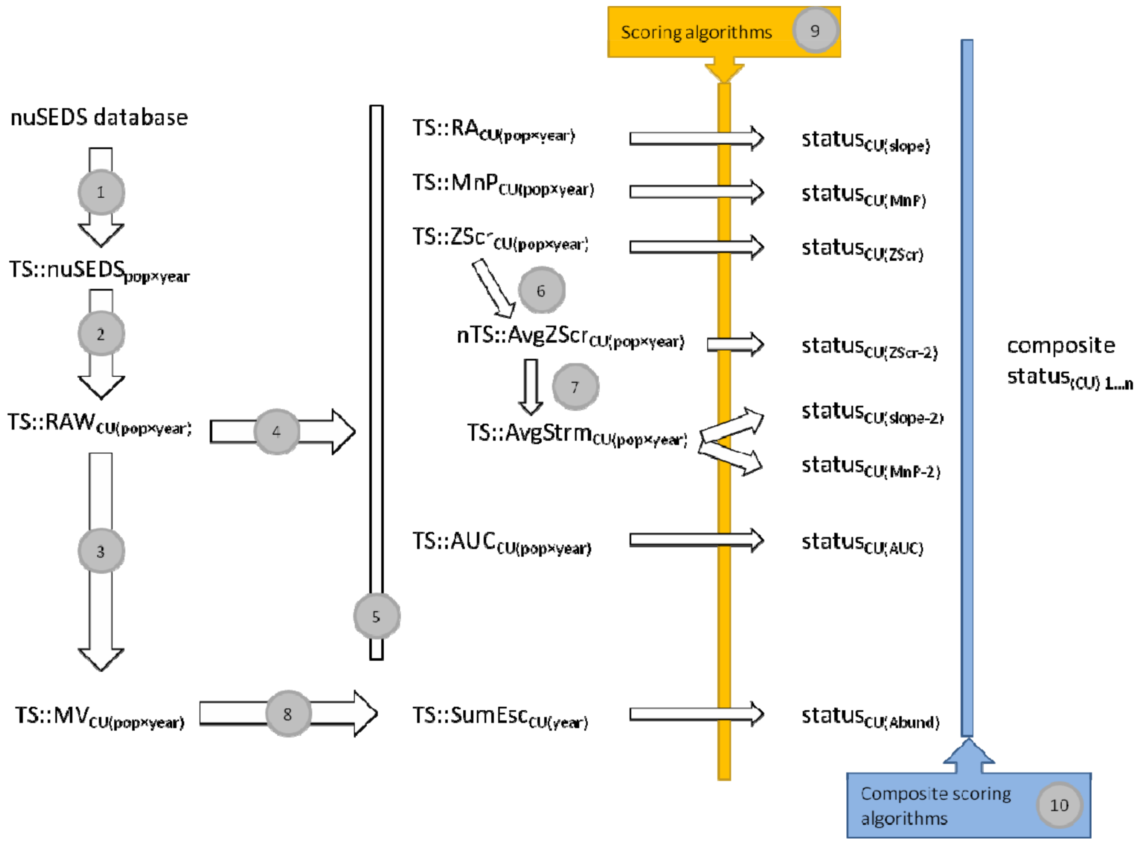

Figure 1: A diagram of the Phase 1 methodology. The numbers within the black circles correspond to the 11 steps. "TS::XXX" indicates a named nested array of time series with the dimensions indicated in the subscript. All time series are of length "year". After extraction from the nuSEDS database the data is arrayed in a matrix of dimensions pop×year (step 1), where pop is the population or POP_ID. The matrix is then The CU associated with each POP_ID is then determined effectively nesting the pop×year matrices within CU (step 2). Steps 3 through 8 involve various transformations and manipulations of the "RAW" escapement data. In step 9 a value of a time series specific metric is calculated and in step 10 that value is compared to sets of status criteria to determine a status score. The various status scores are then combined in step 11 to produce an overall status score.

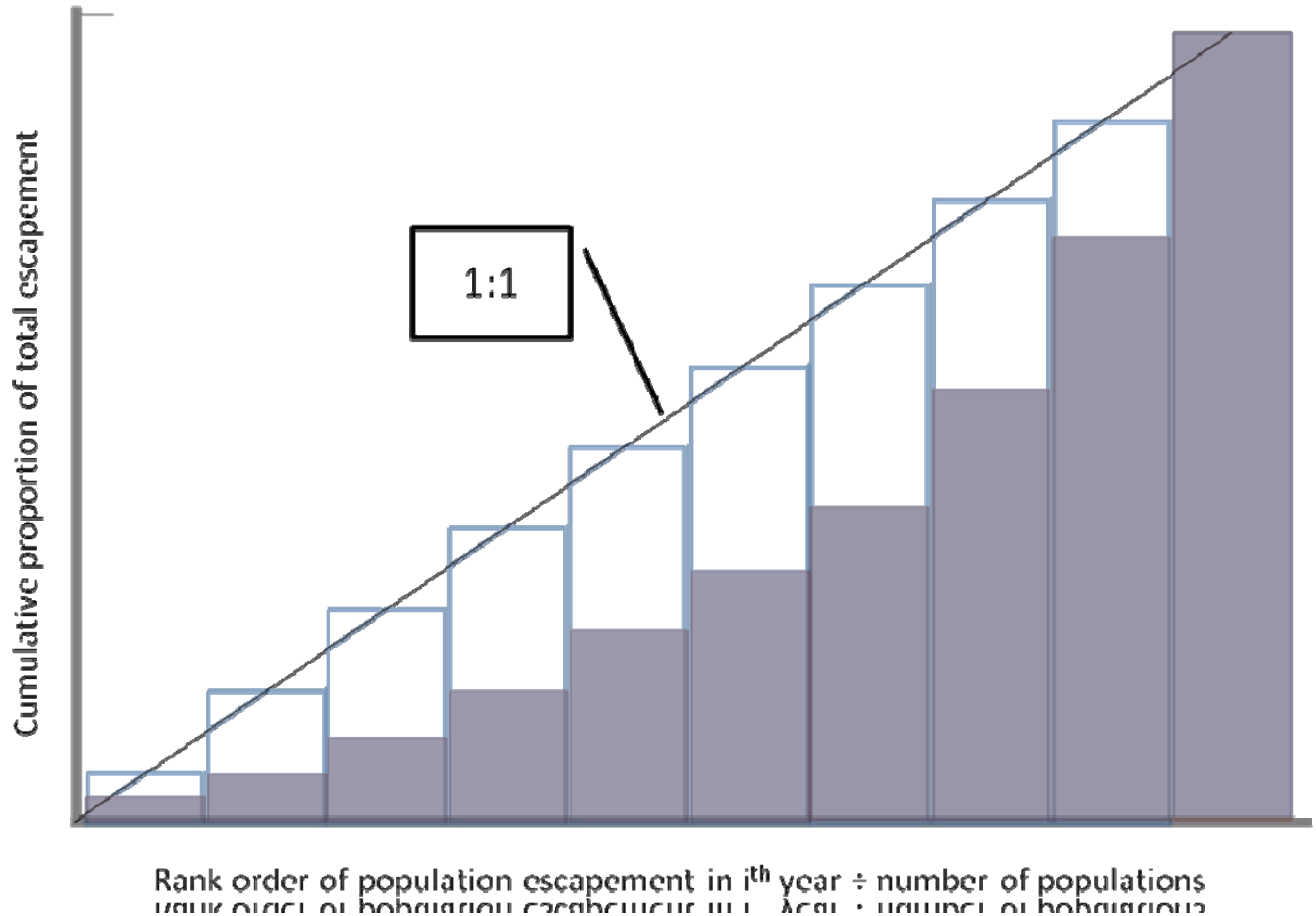

Figure 2: A diagram illustrating the calculation of the AUC metric of population magnitude distribution. In the CU illustrated there are 10 populations in the ith year. The blue bars represent the hypothetical situation where all populations are of equal escapement and the dimensionless sum of the areas of the rectangles is 0.5. The superimposed red bars show a situation where the CU escapement is concentrated in a few populations. The summed area of the rectangles is about 0.35.

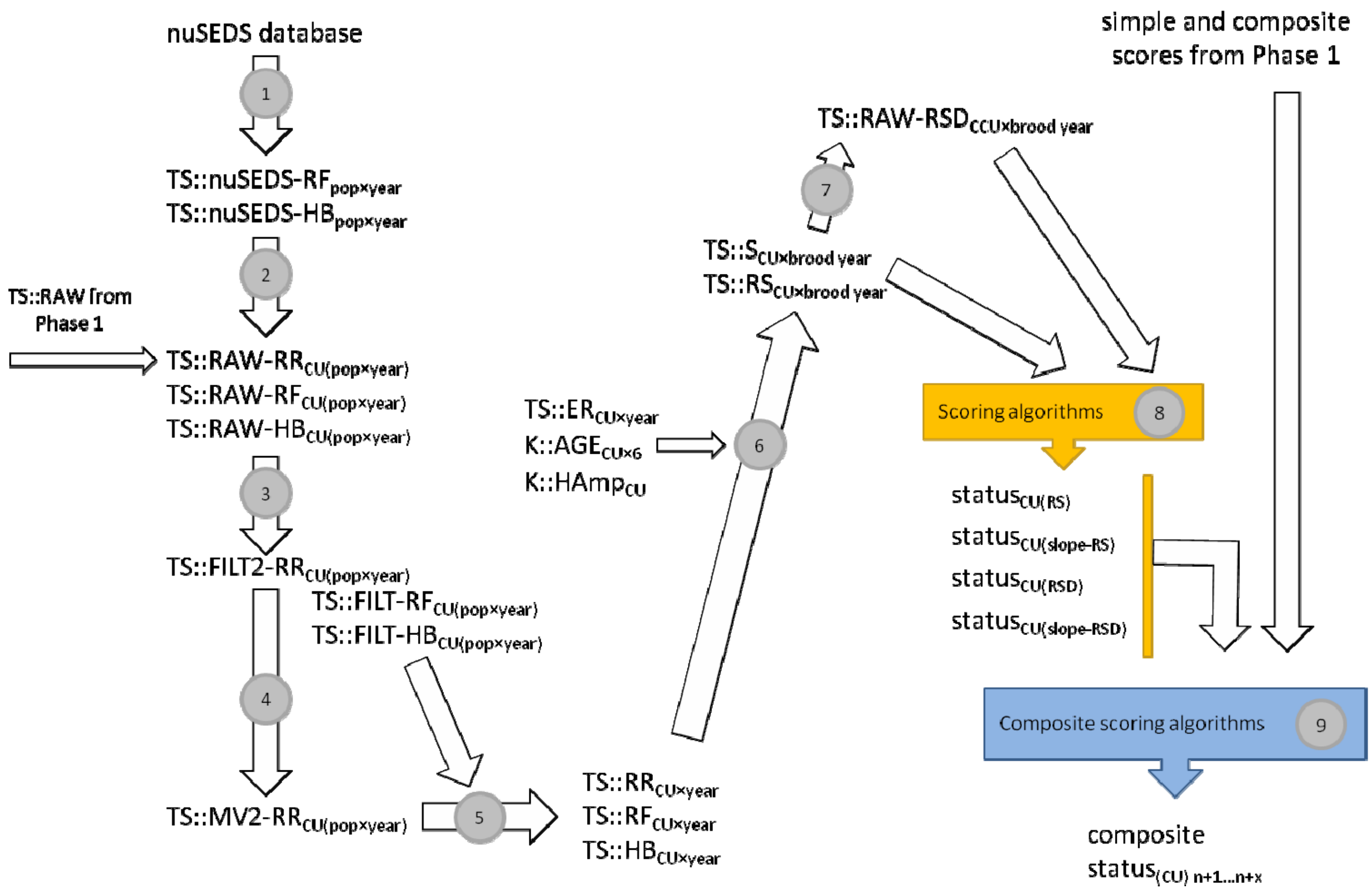

Figure 3: A diagram of the Phase 2 methodology. The numbers within the black circles correspond to the 9 steps described in the text.

Conservation Unit: The sub-specific grouping of Pacific salmon populations that is the basis of conservation under Canada's Wild Salmon Policy . The method for describing the Conservation Units and a preliminary list of CUs in British Columbia is available in Holtby and Ciruna 2007. A list of CUs for the Yukon Territory has been developed (L. B. Holtby, in prep.) and will be included in a revised list of CUs in Canada (expected release is 3rd quarter 2010, contact author for further information).

Conservation Status: Qualitative level of risk of extirpation using the COSEWIC categories of "Endangered", "Threatened", "Special Concern" & "Not At Risk" (COSEWIC 2010)*. CUs for which there are insufficient data to determine conservation status are identified as "Data Deficient".*

COSEWIC: Committee on the Status of Endangered Wildlife in Canada. Under the aegis of the Species at Risk Act SARA; Canada 2002, COSEWIC advised the Governor in Council on the conservation status of wildlife in Canada including Pacific salmon. COSEWIC has established procedure and criteria for evaluating status COSEWIC 2010, including guidelines for recognizing assessable units below the species level COSEWIC 2005.

nuSEDS: The Salmon Escapement Database System (v2, Fisheries & Oceans Canada, Pacific Biological Station, Nanaimo, BC V9T 6N7).

Productivity Analysis: An examination of the temporal trends in recruits per spawner and the residuals of the observed recruits per spawner from those expected by a simple production model (Ricker).

Synoptic: A study in which all subjects, in this case Pacific salmon CUs in Canada, are examined simultaneously the same types of data collected over a similar period of time using the same metrics and criteria.