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Integrated Biological Status Assessments Under the Wild Salmon Policy Using Standardized Metrics and Expert Judgement: Fraser River Sockeye Salmon (*Oncorhynchus nerka*) Case Studies

Évaluation de l'état biologique intégré en vertu de la Politique concernant le saumon sauvage à l'aide de paramètres normalisés et de l'avis des spécialistes : études de cas du saumon rouge du fleuve Fraser (*Oncorhynchus nerka*)

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ABSTRACT

The 24 Fraser Sockeye Conservation Units (CUs) were used as case studies to explore methods of status integration for Strategy 1 of the Wild Salmon Policy (WSP): *Standardized Monitoring of Wild Salmon Status*. Although most of these Fraser Sockeye case studies represent data rich CUs in the Pacific Region, with long time series of stock-recruitment data, a few CUs are also data limited (e.g. Chilliwack-ES only has some recent spawner abundance data).

Status integration was evaluated during a three day technical workshop, which included the development of both final integrated status for each Fraser Sockeye CU (which include one or more WSP status zones) and commentaries on the information used to assess status. For the workshop, two page standardized data summaries were produced for each Fraser Sockeye CU case study. Data summaries included WSP biological status information for a number of metrics (e.g. relative abundance, short-term trends in abundance, and long-term trends in abundance) and other biological data relevant to their interpretation. Case studies were evaluated ‘blind’, with generic labels rather than CU names. The decision to evaluate case studies ‘blind’ was made to facilitate the development of a standardized WSP status integration approach, to focus discussion on the metrics presented in Grant et al. (2011) for status integration, and to facilitate discussion between experts with detailed local and CU-specific knowledge and those with broader salmonid and status evaluation experience.

Each CU case study was evaluated first in small group sessions (four to six participants per group) and, subsequently, in plenary sessions (all 34 workshop participants). On the final day of the workshop, the integrated status for each CU, developed in the previous days’ plenary sessions, were re-visited with the goal to narrow down a CU’s status to a final single status zone (where possible), and to fine tune commentaries. Also on the final day of the workshop, CU names were revealed to provide participants with the opportunity to introduce any specific supplementary information that might support a change in integrated status designation or that could be added to the CU status commentaries.

Integrated status results from this workshop complete WSP status determinations for Fraser Sockeye, which follows up on the recently published exploration of uncertainty in WSP status metrics for these CUs. Final statuses for the 24 Fraser Sockeye CUs included the following: seven Red, four Red/Amber, four Amber, two Amber/Green, five Green, one “Data Deficient”, and one “Undetermined”. Detailed status results amongst groups and expert commentary (which identified key metrics and associated data that guided these status determinations) are also summarized, and are necessary for CU status interpretation in WSP Strategy 4: Integrated Strategic Planning.

Although each group moved through the CU summary information in different sequences, there was considerable similarity amongst groups regarding which considerations drove their final status determinations.

RÉSUMÉ

Les 24 unités de conservation (UC) du saumon rouge du fleuve Fraser ont servi d'études de cas dans l'examen des méthodes d'intégration de l'état pour la Stratégie 1 de la Politique concernant le saumon sauvage (PSS) : *Contrôle normalisé de la situation du saumon sauvage*. Dans la plupart des études de cas portant sur le saumon rouge du fleuve Fraser, les UC de la région du Pacifique sont documentées par un riche ensemble de données, notamment des séries de données de stock-recrutement collectées de longue date; cependant, pour certaines UC, on dispose de peu de données (p. ex., seules quelques données récentes sur l'abondance des reproducteurs sont disponibles pour Chilliwack-DE).

L'intégration de l'état a été évaluée pendant un atelier technique de trois jours, qui visait notamment à mettre au point les désignations d'état intégré définitives pour chaque UC du saumon rouge du fleuve Fraser (comprenant une ou plusieurs zones d'état de la PSS) et à commenter les renseignements utilisés pour évaluer l'état. Pour l'atelier, on a produit des sommaires de données normalisés de deux pages pour chaque UC du saumon rouge du fleuve Fraser. Ces documents contenaient des renseignements sur l'état biologique de la PSS pour plusieurs paramètres (p. ex., abondance relative, tendances de l'abondance à court et à long terme) et d'autres données biologiques pertinentes pour leur interprétation. Les études de cas ont été évaluées en aveugle et, pour ce faire, portaient des titres génériques et non le nom des UC. La décision a été prise d'évaluer les études de cas en aveugle pour élaborer une méthode normalisée d'intégration de l'état selon la PSS, pour axer la discussion sur les paramètres présentés dans Grant *et al.* (2011) aux fins d'intégration de l'état et pour faciliter la discussion entre spécialistes jouissant d'une connaissance précise de certaines UC en particulier et ceux ayant une expérience plus large des salmonidés et de l'évaluation de l'état.

On a d'abord évalué les études de cas de chaque UC dans des séances en petits groupes (quatre à six participants) et, par la suite, dans des séances plénières (avec les 34 participants à l'atelier). Le dernier jour de l'atelier, on a réexaminé l'état intégré de chaque UC, mis au point pendant les séances plénières des jours précédents, afin de réduire l'état de chaque UC à une seule zone d'état définitif si possible, et de préciser les commentaires sur l'état. Le dernier jour de l'atelier également, les noms des UC ont été présentés pour donner aux participants la possibilité d'ajouter toute information qui pourrait étayer la nécessité de modifier la désignation de l'état intégré ou que l'on pourrait ajouter aux commentaires sur l'état de l'UC.

Les résultats relatifs à l'état intégré obtenus lors de cet atelier complètent les déterminations des états de la PSS pour le saumon rouge du fleuve Fraser, faisant suite à une analyse publiée récemment sur les incertitudes entourant les paramètres d'état de la PSS pour ces UC. Les états définitifs des 24 UC du saumon rouge du fleuve Fraser se répartissaient comme suit : sept Rouge, quatre Rouge/Ambre, quatre Ambre, deux Ambre/Vert, cinq Vert, un « Données insuffisantes » et un « Indéterminé ». Les résultats détaillés de l'état de chaque groupe et les commentaires des spécialistes (qui ont défini les paramètres clés et les données connexes ayant orienté la détermination des états) sont aussi résumés séparément et sont nécessaires pour interpréter l'état des UC dans la Stratégie 4 de la PSS.

Bien que chaque groupe ait pris connaissance des sommaires concernant les UC selon des séquences différentes, on a constaté une forte similitude entre les facteurs qui ont amené les groupes à déterminer les états définitifs.

1 INTRODUCTION

The biological status of each Wild Salmon Policy (WSP) Conservation Unit (CU) is evaluated using a number of metrics (Holt et al. 2009), which could each indicate a different WSP status zone from Red (poor status) to Green (healthy status). For example, the WSP metric for recent trend in abundance could indicate a CU's status is poor, while conversely, the long-term trend metric could indicate the same CU's status is healthy. In cases where metric information is contradictory, provision of this metric-specific status information alone does not provide complete scientific advice to fisheries management. Instead, a final step that synthesizes all metric and status-related information into a final integrated status for each CU, and provides expert commentary on this information, is necessary as inputs into fisheries management processes to prioritize assessment activities and management actions (Table 1).

A number of Action Steps identified for WSP Strategy 1 (Standardized Monitoring of Wild Salmon Status) have recently been completed, and the results from this work are foundational to this final status integration step. First, Pacific Salmon CUs, as the fundamental biological unit required to maintain salmon biodiversity, have been identified (Holtby & Ciruna 2007). Subsequently, a suite of metrics that fall into four classes of indicators (abundance, trends in abundance, distribution and fishing mortality) were recommended for WSP biological status evaluations (Figure 2; Holt et al. 2009); these WSP metric recommendations were based on analysis from a number of publications (Holt 2009; Porszt 2009; Holt 2010; Holt & Bradford 2011; Porszt et al. 2012). To assess each CU's WSP biological status, a number of metrics are selected from this suite of possible metrics, depending on the data availability and applicability to a particular CU. Status for each selected metric is evaluated by comparing the biological state of the CU to metric-specific lower and upper benchmarks, which delineate, respectively, the Red (poor status) to Amber, and Amber to Green (healthy status) WSP status zones (Table 2; Figure 1).

One of the first groups of CUs to be evaluated under WSP Strategy 1 is Fraser Sockeye Salmon (*Oncorhynchus nerka*) (Grant et al. 2011). Although most of these CUs are data rich, with long time series of stock-recruitment data, a few Fraser Sockeye CUs are also data limited (e.g. Chilliwack-ES only has some recent spawner abundance data). Wild Salmon Policy Strategy 1, Action Steps 1.1 (the identification of CUs), 1.2 (the development of criteria to assess CUs and identify benchmarks to represent biological statuses), and 1.3 (CU status assessment), were adapted and updated specifically for 22 current and 2 *de novo* Fraser Sockeye CUs (Grant et al. 2011). For Fraser Sockeye CUs, WSP indicators used to evaluate uncertainty in biological status included abundance (one metric) and trends in abundance (three metrics) (Grant et al. 2011). The relative-abundance metric, in particular, was evaluated across a range of benchmarks (estimated across different model forms and probability levels), which compared two different calculations of the average recent abundance (geometric versus arithmetic mean) against paired sets of upper and lower benchmarks. The fishing mortality class of indicator described in Holt et al (2009) was not used in Fraser Sockeye status evaluations, as this indicator is only used when abundance data are not available. In the case of Fraser Sockeye, however, all CUs have a relatively complete time series of escapement and recruitment data. The WSP distribution class of indicator comprises a CU's freshwater spawning distribution only, and was not assessed for Fraser Sockeye because escapement enumeration methods generally do not provide the flexibility to assess distributional changes through time. Further, Fraser Sockeye CUs occupy a relatively small freshwater distribution, limited to their rearing lakes or spawning rivers, compared to species such as the Fraser Pink (odd year) CU that occupies the entire Fraser watershed (Holtby & Ciruna 2007). Therefore, current WSP distribution metrics are considered not as relevant to Fraser Sockeye CUs, compared to other species of Pacific salmon.

Since several metrics (abundance and trends in abundance) were used to assess status for each Fraser Sockeye CU, and uncertainties in abundance benchmarks were considered (Grant et al. 2011), different metrics could indicate divergent biological statuses ranging from Red to Green, depending on the CU. Therefore, integration of the statuses for each metric and across uncertainties in abundance benchmarks for each Fraser Sockeye CU is a useful final step in Strategy 1 (Action Step 1.3: CU status assessment).

For Pacific Salmon CUs, WSP biological status integration methods have not previously been developed. Although other organizations also integrate biological status across multiple criteria, such as the Committee of Endangered Wildlife in Canada (COSEWIC) and the World Conservation Union (IUCN), their approaches are not specific to Pacific Salmon and, therefore, rely on different criteria (i.e. metrics) to assess status, and use a combination of status designation guidelines and expert judgment to assign a risk category. Within DFO, a synoptic approach is being developed to use similar (but not identical) metrics to the WSP to assess the status of all 450+ CUs simultaneously. This approach does not make any definitive conclusions on status, but rather is a rapid prioritization tool. Since the synoptic assessment statuses are not equivalent to WSP statuses, and integration approaches are designed to be rapid and automatic, these approaches cannot be applied to the more comprehensive WSP status assessments. Another project, which specifically explores WSP status integration, is being conducted as part of a thesis project through the School of Resource and Environmental Management at Simon Fraser University (E. Brunet, SFU, pers. comm.). The goal of this thesis project, however, is not to develop decision rules for WSP status integration or to integrate status for specific CUs, but to use broad hypothetical scenarios to evaluate expert choice when integrating status across metrics.

In the absence of existing WSP-specific status integration approaches, a Canadian Science Advisory Secretariat (CSAS) technical workshop (comprised of Pacific Salmon Stock Assessment experts) was conducted to explore WSP status integration using Fraser Sockeye CUs as case studies. An additional goal of the workshop was to finalize integrated statuses for the 24 Fraser Sockeye CUs. For each CU, the final integrated status could include one status zone, or a combination of status zones, and commentary on the information used to assess status. The current paper provides the following details on WSP status integration using Fraser Sockeye CUs as case studies:

1) Status Integration Workshop design process;
2) final Status Integration Workshop approach;
3) standardized data summaries used for the status integration workshop process;
4) Fraser Sockeye CU integrated status designations;
5) Fraser Sockeye CU status commentaries;
6) broadly applicable guidelines for interpreting status information for Pacific Salmon CUs;
7) status integration recommendations for future processes;

This Research Document and the associated Proceedings (DFO 2012 a) and Science Advisory Report (DFO 2012 b) are intended to document the workshop planning process and what transpired specifically at the workshop (e.g. results, recommendations, etc.). Therefore, any commentary relating to aspects that were not recorded or discussed in plenary sessions at the workshop itself could not be addressed within the context of this paper (e.g. proposed additional analyses).

2 METHODS

2.1 INTERNAL DFO MEETING: INITIAL SCOPING EXERCISE

In preparation for the WSP Status Integration Workshop, a preliminary internal (DFO) meeting was held to explore WSP status integration using six unnamed Fraser Sockeye CUs as case studies. The six case studies represented the range of metrics used and statuses observed for the 24 Fraser Sockeye CUs presented in Grant et al. (2011). This meeting was not intended to provide final integrated statuses for these six CU case studies, nor develop a set of decision rules for status integration, but rather explore tools and approaches to biological status integration. The scoping meeting was held at the Pacific Biological Station on June 10, 2011 and included 15 DFO participants with technical expertise on Pacific Salmon stock assessment.

Prior to the small internal status integration meeting, interviews were conducted by meeting organizers to familiarize participants with the standardized data summaries produced for each of the six CU cases, and to solicit feedback on WSP status integration methods. Data summaries included the standardized presentation of WSP metrics and population abundance trends for each CU. At the meeting, each participant was assigned to one of three groups (5 participants per group). Each group independently worked through each case study to assign an integrated status, and to record the rationale for their final status. The meeting ended in a broader group discussion on each group's final status for each CU case study, and the similarities and differences in their status designations and approaches.

Participants agreed that the general meeting approach, using independent group work paired with broader full group plenary sessions, worked effectively to generate integrated CU statuses, and to begin to develop guidelines for status integration. Despite the variety of integration approaches used by groups, final CU statuses amongst groups converged for four out of the six CUs. For the integrated statuses developed at this meeting, groups used a combination of the individual metric results and information on abundance and productivity trends presented in the data summaries. No one metric alone was used to determine an overall status designation. For future integration processes, participants flagged a number of issues specifically related to the relative-abundance metric. First, appropriate estimation of benchmarks using model forms that consider separately, time varying productivity (i.e. Kalman filter Ricker model and smoothed Ricker model) and delay-density interactions (i.e. Larkin model), were questioned by participants. Second, the appropriate method to estimate the current abundance state of a CU (different methods of averaging the most recent four years of escapement data), used for the evaluation of abundance metric status, was also debated. As a result, meeting participants recommended further work on relative-abundance-metric benchmarks and methods for averaging current state of the CUs abundance. In addition, participants also recommended the inclusion of two additional metrics, productivity trends and absolute abundance, not included in the original WSP status evaluation toolkit (Holt et al. 2009), in future status integration processes. Overall, this smaller meeting provided the foundation for the CSAS Workshop using all 24 Fraser Sockeye CUs as case studies.

2.2 WORKSHOP ORGANIZING COMMITTEE

To build on momentum established in the smaller internal DFO meeting that explored WSP status integration, an internal organizing committee was subsequently established to support planning for the WSP Status Integration CSAS Workshop. The organizing committee included representatives from two broad categories: senior management in DFO Science and Fisheries Management sectors, and technical experts on Pacific Salmon stock assessment. Members of the organizing committee represented 11 out of the 34 workshop participants. A total of six half or full-day planning meetings occurred from September 7 through to November 11, 2011, and these meetings varied from process to technically-oriented, drawing on different components of the organizing committee complement.

From a process perspective, key issues that were addressed by the organizing committee included the following: identification of a workshop Chair, dates, venue, invitees, terms of reference, agenda, broader WSP communication pieces (e.g. biological benchmarks versus reference points, WSP Strategy 1, linkages to other WSP Strategies) and linkages to similar status processes (DFO synoptic survey, COSEWIC status designation process, and Simon Fraser's E. Brunet's thesis on WSP status integration).

From a technical perspective, key issues addressed by the organizing committee included the following: design of the standardized data packages for each CU, information included in participant binders, workshop posters, and presentations, and issues previously flagged by DFO internal status integration meeting participants on the relative-abundance metric (e.g. identification of cyclic CUs, use of Larkin model-derived benchmarks for cyclic CUs, and the appropriate approach for averaging recent generation abundances for comparison to benchmarks).

2.3 PRE-WORKSHOP INTERVIEWS

Prior to the CSAS workshop, participants were offered a pre-workshop interview. Through the interviews, participants learned exactly what to expect from the workshop (format, available data, and templates to be used), and organizers found out what to expect from participants (e.g. concerns about process and questions about technical details). The main advantage of conducting pre-workshop interviews was to minimize the time spent at the workshop orienting participants to background materials and process, in order to focus workshop time on the actual status evaluations. Interviews were also an additional communication tool, which was built upon using other media (posters, binder tabs, and presentations) at the actual workshop.

Prior to the interview, participants received via email six electronic PDF files, which included the following:

1) a workshop outline: one page on the general approach of break-out group and plenary sessions to evaluate status integration methods and final Fraser Sockeye CU integrated statuses;
2) Status Integration Workshop Terms of Reference (See Appendix A in DFO 2012 a);
3) case study template: standardized information sheet to be filled in by each group during the break-out group session, to document their status integration decision-making process (see Appendix E of DFO 2012 a);
4) status results template: used by meeting organizers to record final status integration results, which include individual group statuses, final plenary status, and rationale for status (see Appendix F of DFO 2012 a);
5) example CU (unnamed) data summary: to provide participants with an idea of data summary format and information;
6) guide to data summary: provides a 'road map' describing the information presented in the data summaries (Appendix 1).

For consistency amongst participant interviews, and also to facilitate synthesis of pre-workshop feedback provided by participants, most interviews were conducted by the same workshop organizer. Each interview generally followed the same order in which the documents are presented above (from 1 to 6), although the order and emphasis varied depending on the specific interests of each participant. The following questions were specifically asked of participants during their interviews: 1) how should status assessments be combined across different metrics and model assumptions; 2) how should uncertainty in abundance metrics be considered (e.g. alternative estimates of lower benchmarks); 3) how should data quality be considered in the status evaluation; and 4) how should additional information be considered in status integration? Participants' responses were recorded by the interviewer and provided to each participant after their interview for their review.

Feedback received through pre-workshop interviews greatly assisted the organizing committee with planning for the workshop. In general, respondents raised many of the same issues that were debated at the internal DFO meeting in June, and that would later come up again as challenges at the workshop. Based on responses in the pre-workshop interviews, the organizing team revised the case study data summaries, prepared additional background presentations for delivery at the workshop to clarify commonly raised question, and developed supplementary reference materials (see DFO 2012 a). The responses also helped the meeting Chair with preparing facilitation strategies.

The following process-related issues came up consistently during the interviews:

- What are the next steps following the status integration workshop? Specifically, what happens with the results of this workshop, and how frequently will status be re-assessed?
- Clarification on the difference between assessing current CU status, which incorporates a variety of information (e.g. uncertainty in estimates of biological benchmarks), and choosing a single formal benchmark for subsequent management process (such as the development of management reference points) was required. This workshop dealt with status evaluation only.
- A few respondents questioned the use of 'blind' case studies, suggesting that knowing the name of each CU up front is important to the status integration process.
- Consistency in integrated status approaches was a recurring concern amongst participants interviewed. Specifically, there were concerns regarding how consistent integrated status designations would be between the current and future expert assessment groups and also between the current WSP integration approach and other assessment processes (particularly COSEWIC, given WSP lower benchmarks are set to include a buffer to COSEWIC designations).

The following technical issues were raised consistently during the interviews:

- The broader applicability of the status integration approaches developed in the workshop was also questioned by respondents, since Fraser Sockeye CU data availability and analytical effort are high compared to most other Pacific Salmon CUs.
- Respondents also questioned how additional information (e.g. productivity pattern, total recruits pattern, habitat condition, exploitation rate, etc.), in addition to WSP metric-specific status information, would be used to develop integrated statuses.

2.4 STANDARDIZED CU DATA SUMMARIES

For the workshop, two-page standardized data summaries were produced for each Fraser Sockeye CU (Appendices 1 & 2). Data summaries represented a critical step in the status integration process, by standardizing status-related information presented for each CU. Other detailed information on CU biology or CU-specific habitat and/or ecosystem threats was excluded from these data summaries (and, therefore, from Fraser Sockeye CU status integration). This level of detail was considered by the workshop organizing committee unnecessary for WSP Strategy 1 status evaluations, but instead may be a requirement for the subsequent processes when more detailed assessments may be conducted (Table 1). The presentation of the information deemed critical by workshop organizers to status evaluations was optimized within a two-page data summary lay-out (see Appendix 1 for guide to data summaries). Constraining data summaries to two pages and using a consistent lay-out of status-related information across CUs, ensures the integration processes is efficient (participants only have to learn the lay-out once when they work through the first CU case study), and standardized (depending on data availability, the same pieces of information are provided for each CU).

Data and status results were updated from Grant et al. (2011) to include 2010 escapement information. These data summaries included the following (see Appendices 1 & 2):

- status information for up to four WSP metrics: one metric for abundance relative to biological benchmarks, one metric for long-term trend in abundance, and two metrics for short-term trend in abundance (note: relative-abundance metrics could not be evaluated for CUs without recruitment data or carrying-capacity data)
- presentation of both structural (i.e. model form) and stochastic (i.e. unexplained recruitment variation) uncertainty in estimates of biological benchmarks and the resulting uncertainty in the status indicated by the relative-abundance metric
- presentation of relative-abundance metric statuses evaluated using either geometric or arithmetic averages of recent abundances
- qualitative summary of overall data quality
- time series plots of productivity (recruits/spawner and time-varying estimates of the Ricker model productivity parameter)
- time series plots of spawner escapements
- table of absolute abundances relative to COSEWIC criteria D1 for small populations
- retrospective (historical) time series of status for each WSP metric
- supplementary plots included fishing mortality and total recruits

Data summaries were revised from the earlier version used at the June 2011 internal DFO status integration meeting, based on recommendations from participants at this internal meeting, feedback from pre-workshop interviews with participants, and subsequent organizing committee discussions. Key changes to the data summaries included treatment of salmon escapement data used in both the figures of abundance trends and in the methods used to average current escapements for the relative-abundance metric. Additional revisions to the data summaries included the addition of absolute abundance and productivity trends data and updates to the benchmark results for cyclic CUs.

Workshop organizers agreed that Pacific salmon abundance data are lognormally distributed, with spawner escapements occurring most frequently at low to moderate abundances relative to the less frequent very large abundances. Therefore, the appropriate way to view this data is in $\log_e$ scale, which down weights the less frequent large abundance years visually in plots. Plotting salmon escapement data in $\log_e$ space, therefore, does not mislead the analyst into over-emphasizing the infrequent large escapement years when interpreting abundance trends. However, in addition to presenting $\log_e$ scale escapement in the data summaries, natural scale plots were also included to avoid road blocks for workshop participants not familiar with working in $\log_e$ space and to visualize the full magnitude of fluctuations over time.

For abundance metric status evaluations, Holt et al (2009) recommended using the geometric mean of the current generation escapement, rather than the arithmetic mean. Similar to plotting abundance data in $\log_e$ scale, geometric averages are also considered more appropriate for summarizing log-normally distributed salmon abundance data. Although geometric versus arithmetic means of recent escapements are similar to one another for non-cyclic CUs, comprised of four consecutive years of relatively equal abundance, means of cyclic CU recent escapements (comprised of four consecutive years of very different abundances), are quite different between approaches. In particular, geometric means produce much lower averages compared to the arithmetic mean for cyclic CUs. There remain some questions regarding the differences in averaging four years of salmon abundances, where each year represents a relatively separate population of the same CU, rather than four unique years of changing total CU abundance. For comparison, many other species populations are spatially, not temporally isolated, and the total population is represented by the sum of all populations. For Pacific Salmon, perhaps the temporally separated populations should be similarly summed, although more work is required to address this.

In addition to discussion regarding appropriate data treatment for Fraser Sockeye CUs, the model form (i.e. Larkin model) specifically used to describe population dynamics for the cyclic CUs was also updated. Although the Larkin model has been recommended to describe population dynamics for cyclic CUs more appropriately than the typically used Ricker model, appropriate estimation of relative-abundance-metric benchmarks has been challenging given the complexity of the Larkin model, compared to the Ricker model. Larkin derived relative-abundance benchmarks were not provided in Grant et al. (2011), due to these computational challenges, however, further work was conducted in preparation for the workshop, and these benchmarks were included for specific CUs. Larkin-model derived benchmarks were provided at the workshop for seven CUs identified as cyclic.

These CUs for the set of cyclic case studies were selected based on a combination of three considerations: relative goodness-of-fit for Larkin-type models compared to Ricker-type models, expert opinion on the life history of each CU, and visual inspection of the observed patterns in abundance. Our classification into seven highly cyclic CU and 17 non-cyclic CUs was considered a pragmatic approach by the DFO stock assessment biologists & scientists who participated in the workshop planning process, and is supported by the following additional considerations:

- The question asked of participants was a broad one *“How does a highly cyclic pattern in abundance affect your interpretation of status information?”* rather than the more narrow *“Which SR model fits best for this CU, and what is the appropriate method for estimating a lower benchmark based on this SR model?”* For example, the challenges of interpreting short-term trends, identifying a meaningful measure of generational average, or comparing observed abundances to small population benchmarks identified by COSEWIC are similar for these 7 cyclic CUs, and were much less pronounced for the other 17 CUs, regardless of SR model fitting results.
- The relative weight of evidence for Ricker-type models or Larkin-type models has been explored in numerous publications (e.g. Walters & Staley 1987, Walters and Woodey 1992, Cass and Wood 1994, Ricker 1997, DFO 2006, Peterman and Dorner 2011 & 2012), but the number of stocks where Larkin-type models fit best depends on both the length of time series and the model variations used. For example, Cass and Wood (1994) identified 8 of 19 stocks as best described by a Larkin-type model, but a more

recent analysis by Peterman and Dorner (2011 & 2012), which included the large returns in the early 2000s, found that a non-stationary Larkin model fit best for 12 of 19 stocks ,

Finally, an absolute abundance metric and updated CU productivity (recruits per spawner) trends was added to the data summaries. There are a number of Fraser Sockeye CUs that do not have recruitment data and therefore, relative-abundance metrics could not be evaluated. Since no absolute abundance metrics have been provided in the WSP status evaluation toolkit (Holt et al. 2009), absolute abundance for all Fraser Sockeye CUs was presented in the data summaries relative to COSEWIC Criterion D1 for small populations. Although productivity trends were presented in the previous version of the data summary, high (>25 recruits/spawner) productivity values were highlighted in figures (shaded grey) as potentially unrealistic and likely artefacts of data issues.

2.5 CSAS WSP STATUS INTEGRATION WORKSHOP FORMAT

Status integration, using Fraser Sockeye CUs as case studies, was evaluated in a three-day workshop that included the development of final statuses for each CU (which could include one or more WSP status zones) and commentaries for the data used to assess status. In addition, integration approaches were explored. Workshop participants included technical experts that represented several specific stock assessment areas of expertise: Fraser Sockeye CUs, other Pacific salmon CUs, fisheries management, and broader salmon research. Internal participants and external university researchers were selected by organizers to encompass this broad range of expertise. In addition, First Nations groups, non-governmental organizations (NGO's), and commercial and recreational fishing sectors were also contacted to solicit their recommendations on technical participation.

Prior to the workshop, most participants received a pre-workshop interview to review the meeting outline, the data summary layout (see preceding Data section) of one example case study (unnamed CU), and to provide feedback to organizers. During registration, when participants first arrived at the workshop, binders were provided to each participant containing supporting information in a number of tabs: Tab 1: Workshop agenda; Tab 2: WSP general background; Tab 3: WSP Strategy 1 technical background; Tab 4 COSEWIC Criteria; Tab 5: workshop presentations; Tab 6: guide to CU Data Summaries. The subsequent three tabs were left blank for three case study sets (comprised of CU standardized data summaries, and blank templates to fill out as groups work through their CU-by-CU integrated status and commentary), which were provided to each participant immediately prior to the start of each break-out session (see Appendix 2 for data summaries provided for each CU):

- **Case Study Set 1- Exploring Diversity**: this set included six non-cyclic CUs that illustrate the diversity of scenarios (i.e. conflicting messages from different metrics and differences in data availability).
- **Case Study Set 2 – Striving for Consistency:** this set included 11 non-cyclic CUs broken into two similar batches.
- **Case Study Set 3– Making Sense of Cycles:** this set included seven cyclic CUs that have exhibited persistent four year patterns of abundance; for these cases a unique model form was used to estimate abundance metric benchmarks.

Case Study Sets 1 & 2 included non-cyclic CUs that comprise the greatest number of Fraser Sockeye CUs (17 out of 24) and are most similar to other Pacific salmon CUs; non-cyclic CUs do not exhibit persistent four year patterns in abundance. In contrast, Case Study Set 3, included the seven out of 24 Fraser Sockeye CUs that exhibit relatively unique four year cyclic patterns in abundance (see end of section titled 'Standardized CU Data Summaries' for CUs identified as cyclic and rationale for this choice by the Workshop Organizing Committee). One well known example of a cyclic CU is Late Shuswap (Adams River Sockeye), which exhibits one large dominant cycle, followed by one smaller subdominant cycle and two weak cycles. Since cyclic CUs presented particular status integration challenges in the previous internal DFO workshop, due to their unique population dynamics and their use of specifically a unique (Larkin) model form in relative-abundance-metric benchmark estimation, these cases were placed at the end of the non-cyclic CU case study sets in the workshop schedule. This order was implemented (i.e. completing all non-cyclic CU case studies, prior to the cyclic CUs) so that groups could build their confidence in status integration while establishing their integration approaches, and to maintain workshop momentum as each CU's status integration was sequentially completed.

Each workshop participant was assigned to one break-out group (four to six participants per group) for the duration of the workshop. Each group was organized to include a diversity of expertise that covered Fraser Sockeye stock assessment exerts, other Pacific salmon stock assessment experts, external technical experts, and broader research scientist expertise. In addition, at least one member of the DFO workshop organizing committee was assigned to each group, to provide assistance to the group process, where required. Groups worked through each case study set to develop both integrated single status designations (where possible) and commentaries for each CU, and consistent integration approaches. Participants were instructed to not spend time evaluating the details in the underlying information or data presented, as this was previously reviewed in a separate CSAS process and results published in Grant et al (2011). Case studies were evaluated 'blind', with generic labels rather than CU names, to facilitate the development of a standardized WSP status integration approach which would be broadly applicable to other CUs (see Discussion for more details on why 'blind' approaches were adopted for this process).

For each CU, groups first recorded their integrated status on one-page templates provided for each CU (see Appendix E in DFO 2012 a). On these sheets they also indicated whether or not these integrated statuses were either group consensus (i.e. each group member agreed with their final integrated status) or were provisional (i.e. discrepancies amongst group members regarding their integrated status or group members agreed to a single integrated status with some provisions). In addition, groups also recorded the main factors (i.e. which particular metric or supplemental information) that contributed to their integrated status, comments on their group's status integration process, and, in cases where the status was provisional, an explanation of why. Groups also simultaneously recorded their integrated statuses on large tables in poster format located at the front of the room, organized by CU (rows) and group number (columns). Following each break-out group session, a plenary session with all 34 participants was conducted to record electronically, and in workshop minutes, individual group integrated statuses for each CU in the case study set, commentaries, and integration approaches, and to facilitate early discussions on across-group status integration and commentaries.

On the final day of the workshop, integrated statuses for each CU, developed in the previous day's plenary sessions, were re-visited with the goal to narrow down groups' individual integrated statuses and, as a consequence, a CU's status to a final single status zone where possible. However, if single status determination was irreconcilable between groups for certain CUs, the final integrated statuses could include the multiple status zones agreed to by the full group at the final plenary session. Also on the final day of the workshop, CU names were revealed to provide participants with the opportunity to introduce any specific supplementary information relevant to a CUs WSP status that could be used to rationalize a change to the integrated status or that could be added to the CU status commentaries.

A number of workshop details were implemented to ensure workshop productivity and efficiency. A detailed workshop agenda was provided to participants, which presented the timing of case study break-out group and plenary sessions, and breaks (see Appendix B in DFO 2012 a). Given the work being conducted by participants was challenging and required sustained efforts over a three day period, the agenda also included some quick presentations of optical illusions and trivia questions (scores were kept for first group to answer the trivia correctly over the three day workshop, and prizes were presented to the winning group on the last day of the workshop). Groups selected unique names, from a suite of possible Latin species names, with the subsequently revealed common names used for group identification in the workshop. For each case study set, blank tables were displayed at the workshop in large poster format, organized by CU (rows) and group number (columns). As groups completed their integrated statuses for a CU, they were instructed to place a coloured sticky note (Pink representing the Red status zone, Yellow representing the Amber status zone, and Green representing the Green status zone) in the appropriate row and column, representing, respectively, the CU and their group. The poster approach was used to demonstrate progress on CU status integration to participants, during this long and demanding process, and also to facilitate early comparisons of integrated statuses between groups. The workshop Chair ensured agenda timelines were adhered to and, in conjunction with three meeting facilitators, led plenary sessions to develop integrated statuses, status commentaries, and to record status integration decision rules. Group integrated statuses recorded in poster-format, were photographed and later copied into an electronic excel files. Final integrated statuses and commentaries agreed to by the full group were recorded in an electronic summary table projected at the front of the room during the final plenary sessions. A rapporteur was also assigned to the meeting to record a transcript of the meeting proceedings.

Also to ensure workshop productivity, workshop organizers identified several important communication pieces necessary to facilitate the workshop process. To remind participants of specific elements required for the status integration process, select details were synthesized from a number of publications (DFO 2005; Holtby & Ciruna 2007; Holt et al. 2009; Holt 2009; Porszt 2009; Holt & Bradford 2011; Grant et al. 2011), and presented to participants using a variety of communication tools: pre-workshop participant interviews, workshop posters, presentations, and participant binders (see DFO 2012 a for details). A ‘Common Look Common Feel’ approach was also adopted to assist with communication, which used consistent templates for the presentation of background material across media. Specific communication pieces were developed to include the following: background on the WSP (Goal and Strategies) and, specifically, Strategy 1 (Standardized Monitoring of Wild Salmon Status); the definitions of Red, Amber and Green WSP biological status zones; why status integration was required to complete WSP Strategy 1, and how these integrated status results link to subsequent WSP Strategies (particularly Strategy 4: Integrated Planning); the difference between biological benchmarks (the focus of the workshop) versus management reference points (focus of subsequent WSP Strategy 4 and related management processes); technical details regarding the data summary lay-out and metrics selected in Grant et al. (2011); specific direction to participants that the workshop purpose is not re-visit details in Grant et al. (2011), but to rather focus on the status integration step; and description of comparisons of WSP status integration work to similar biological status process both internal and external to DFO.

3 RESULTS

The Status Integration Workshop addressed both of its key objectives, as outlined in the Terms of Reference (see Appendix A in DFO 2012 a).

The first objective was to provide integrated status evaluations that include identification of relevant metric(s) used for the status determination for each of the 24 Fraser River sockeye CUs. During the combination of break-out group and plenary sessions, final integrated statuses were completed for 22 out of the 24 Fraser Sockeye CUs, including synthesis of the key pieces of information used to designate status for each CU (Table 4 & Appendix 2). For two CUs (Chilko-ES and Seton-L), participants were unable to assess status and the details are provided in the status commentaries (Appendix 2). In additional detailed status integration results for each group were also recorded.

The workshop also delivered on its second objective: to develop clearly documented guidelines for combining information from different status metrics, using Fraser River sockeye CUs as test cases. The results for this objective, however, differed from the original expectations of the workshop organizers. Originally, the afternoon of the final day of the workshop was allotted to draft a set of generally applicable decision rules (i.e. an algorithm for status integration) within a full group plenary session. However, given the priority of the workshop was to complete integrated statuses for each of the 24 Fraser Sockeye CUs, and this objective took longer than planned during the workshop, half a day of the workshop was not specifically dedicated to developing decision rules as planned. Instead, details on status integration approaches were broadly recorded by each group throughout the workshop, both on individual group templates and in full group plenary sessions (recorded in the workshop transcript and organizers notes). This information was used to record consistencies amongst groups in their use of metrics and additional information to develop integrated CU statuses.

Based on the in-depth discussions at the workshop, the case-by-case nuances in metrics used, and associated commentaries on the underlying data, it is not likely that a single prescriptive algorithm for status integration under the WSP can be developed. Rather, the CSAS workshop produced a process framework for status integration (previous section) and detailed guidelines for interpreting status-related information (See section on *Status Integration Approaches* starting on p. 13).

3.1 GROUP-SPECIFIC RESULTS

Following break-out-group and plenary sessions, group results were recorded to capture the range of perspectives on each CU's final integrated status (Table 3; Appendix 2). Despite differences in broad integration approaches between groups, there was consistency in the considerations of metrics and supplemental information used to designate status (see section on *Status Integration Approaches* on p.13). Specifically, 14 out of 24 CUs were assigned identical statuses, and one CU was designated data deficient by all groups (Table 3). The remaining nine CUs were designated different integrated statuses by individual groups, although all groups collectively agreed on a single (Red, Amber or Green) or blended (Red/Amber or Amber/Green) final integrated status for eight of these CUs (Table 4). Only one CU (Seton-L) could not be reconciled into a single or blended integrated status. Generally CUs that indicated a consistent status across metrics and supplemental information (for example, Cultus-L and Harrison River-River-Type; see Appendix 2) resulted in the most consistent integrated statuses amongst groups (Table 3). In contrast CUs that indicated contradictory statuses across metrics and additional information (for example, Seton-L and Francois-Fraser-S) (see Appendix 2) resulted in the most divergence amongst groups and individual group members.

3.2 FINAL INTEGRATED STATUS

In the final plenary discussions, participants reached broad agreement on integrated statuses for 22 of the 24 CUs (Table 4). The 24 Fraser Sockeye CUs are ordered in Table 4 using their final integrated statuses, with CUs designated Red (poorest status) located at the top of the table to CUs designated Green (best status) at the bottom. Sixteen out of the 24 CUs were reconciled between groups in the final plenary session to a single WSP status. There were six CUs where final integrated statuses included two status zones. Both the Chilko-S and Lillooet-Harrison integrated Green statuses were flagged as provisional by participants, given these CUs have exhibited declining productivity and spawner abundance trends in recent years. The Taseko-ES Red integrated status was also flagged as provisional, given spawner escapement data for this CU are an index of abundance only and, therefore, this status designation was considered more uncertain. The integrated status of Chilko-ES was designated data deficient, as this CU does not have independent abundance data from the larger Chilko-S CU. Since the Chilko-ES CU contributes less than 10% to the total Chilko-ES/Chilko-S aggregate abundance, the aggregate status was assumed to represent the larger Chilko-S component. The integrated status of Seton-L was undetermined since final statuses amongst groups were widely divergent and remained unresolved through the final day's plenary session.

Most groups questioned the relative-abundance-metric benchmarks used for cyclic CUs (identified as cyclic in Table 4). Since this analytical issue could not be resolved at the workshop, participants agreed to exclude these metrics for cyclic CU status evaluations during the final day's plenary session. The resulting integration approaches were similar to those developed for non-cyclic CUs with no recruitment data, and therefore, no relative-abundance metric benchmarks. Participants pointed out that this still left more information for status assessments than what is available for many other Pacific Salmon CUs.

3.3 STATUS COMMENTARIES

In addition to providing final integrated statuses for each CU (which can comprise one to two status zones) (Table 4), expert interpretation of the summary data used to integrate status was recorded as status commentaries (Appendix 2). These commentaries provide the details underlying the final decisions on status designations, which varied even amongst CUs with identical integrated statuses. These details will be important when Strategy 1 (Standardized Monitoring of Wild Salmon Statuses) results are linked to Strategy 4 (Integrated Strategic Planning). Status zones alone do not provide an indication of which factors are driving their designation, which would influence subsequent WSP steps (e.g. Table 1).

Status commentaries are presented in Appendix 2 (with the CU name identified) in the same order workshop participants viewed the case studies during the workshop (from one to 24). This order should assist participants in reconciling their group's and personal notes with those presented in Appendix 2. This CU order further provides the background on the sequence of case studies presented to participants at the workshop. The information presented in these commentaries are compiled from information recorded during the final day's plenary sessions both electronically in files projected at the front of the room, and also from the meeting transcript. The data summaries and notes from individual group's sheets were also used to expand on this information, where appropriate. Following the commentaries for each CU are the data summaries used by participants during the workshop to integrate CU status. These data summaries, therefore, provide the foundation for the commentaries provided in the current report.

3.4 STATUS INTEGRATION APPROACHES

Expert opinion on status integration and associated commentaries were elicited from participants through a combination of smaller break-out group and full participant plenary sessions. Each group was able to develop a consistent approach to integrate status information across individual metrics and supplementary information for Fraser Sockeye CUs. The process was likened to checking a patient for symptoms, starting with key vital signs (i.e. various metrics), and then scanning for other signs of any underlying problems (i.e. supplemental information). Not all groups completed evaluations of all 24 CUs, but each CU was evaluated by several groups. While their broad approaches to integration differed, groups incorporated the following considerations in some form:

1. *Relative-abundance WSP metrics (which compares the 2007-2010 total spawner escapements to relative-abundance-metric benchmarks estimated across different model forms and different probability levels representing, respectively, structural uncertainty and stochastic, unexplained recruitment variation, uncertainty)*

   For non-cyclic CUs with recruitment data, one key piece of information relied upon by all groups was the WSP relative-abundance metric. This metric often was a driver of integrated status determinations, particularly if a CU's relative-abundance-metric status was consistent across all benchmarks (i.e. across all models and probability levels presented) (Illustration A below). In these cases, absolute abundance was generally not given a high weight. In contrast, if a CU's relative-abundance metric included multiple status zones (Illustration B below), then groups frequently used the status indicated by the median (50%) probability level benchmarks, rationalized the selection of one particular model form (based on the presence or absence of systematic productivity trends in the Ricker 'a' productivity parameter), and relied more heavily on other metrics and status-related information (including absolute abundance) to determine status. The use of benchmarks and statuses across probability levels, and not simply focusing on the median (50 percent probability level), represented a sensitivity analysis of status described by the relative-abundance metric, which describes uncertainty in the model fit to the data.

   A. Example CU where relative-abundance-metric statuses are identical across probability level and model form (see Appendix 1 for details)

	Geometric					p	Arithmetic				
	10	25	50	75	90		10	25	50	75	90
Rick1950	G	G	G	G	G		G	G	G	G	G
Rick1970	G	G	G	G	G		G	G	G	G	G
Rick1990	G	G	G	G	G		G	G	G	G	G
SmRick1950	G	G	G	G	G		G	G	G	G	G
RBRick1950	G	G	G	G	G		G	G	G	G	G

   B. Example CU where relative-abundance-metric statuses vary across probability level and model form (see Appendix 1 for details)

	Geometric					p	Arithmetic				
	10	25	50	75	90		10	25	50	75	90
Rick1950	A	A	A	A	A		A	A	A	A	A
Rick1970	A	A	A	A	R		A	A	A	A	A
Rick1990	A	A	R	R	R		A	A	A	R	R
SmRick1950	A	A	A	R	R		G	G	G	G	A
RBRick1950	A	R	R	R	R		G	A	A	R	R

   In cases where relative-abundance-metric statuses varied across model forms, CU productivity trends were used to justify the selection of particular model forms. If a CU exhibited systematic productivity trends (indicated by the figures in the data summaries on time varying Ricker 'a' productivity parameter), then a model form that considers time-varying productivity was selected (truncated-Ricker, smoothed-Ricker and recursive-Bayesian Ricker model forms). If a CU exhibited no systematic productivity trends, then a standard full time series Ricker model form was selected.

   Relative-abundance-metric benchmarks were given a lower weight (or flagged in status commentaries for further evaluation) if productivity figures indicated high outliers (> 20 recruits/spawner) in the recruits-per-spawner time series, which may contribute to biased low benchmarks and, therefore, optimistic statuses for this metric (note: although this was assumed at the workshop, the effect of productivity outliers on relative-abundance benchmarks remains untested, and further work is required to evaluate this assumption). In addition, relative-abundance-metric benchmarks were compared to COSEWIC Criteria D1 for small populations, and if close to benchmarks for these criteria (i.e. 250 & 1,000) this metric was also flagged as potentially producing optimistic status evaluations for a particular CU and given a lower weight in the integrated status.

2. *Short-Term Trends in Abundance WSP metric (which compares last three generation trends in abundance to benchmarks)*

   This metric was generally considered in conjunction with other WSP metric results and status-related information. First, given many Fraser Sockeye CUs went through a period of high production (in many cases the highest abundances on their time series) in the 1990s, the recent trends in abundance reflect returns to average abundance for these CUs. Therefore, in these cases, the short-term trend metric generally was not weighted highly in status evaluations, given considerations of both the spawner abundance time series and recent years' absolute abundances.

   Participants also felt that while this short-term (escapement) trend metric reflects the current state of the CU (the response to all threats), these trends can be manipulated by human intervention (changes to fishing mortality) and, therefore, may mask intrinsic biological trends (such as survival rates). For this reason, participants typically relied on a CU's intrinsic productivity trends (Ricker 'a' productivity parameter values whenever they were available, which removes density-dependence due to changing spawner abundances from CU productivity) to indicate status more than short-term escapement trends.

   However, even if both short-term trends and productivity trends indicated poor status, if both relative-abundance-metric statuses (across probability levels and model forms) and/or absolute abundance information indicated a consistently higher status, then the recent trend information was given a lower weight in status designations. In these cases, however, participants frequently flagged recent trends in abundance and productivity as something important to monitor closely, given the integrated status could deteriorate in the near future if these trends persist. Conversely, if short-term trends and productivity trends indicated a poor status and relative- or absolute-abundance metrics in recent years were low, then all indicators together supported a lower status designation.

3. *Long-Term Trends in Abundance WSP metric (which compares last generation spawner abundances to the long-term time series)*

   If relative-abundance WSP metric status information was available for a CU, the long-term trend WSP metric was generally given almost no weight in status evaluations. Statuses indicated by the long-term-trend metric were considered optimistic, given the early time series is confounded by higher exploitation rates for Fraser Sockeye CUs, which is a consideration when interpreting the status indicated by these metrics (see Porszt et al. 2012). Similarly, the long-term metric is not informative for some CUs, such as channel-operated systems (increased production after channels were initiated in the 1960's/1970's) and *de novo* CUs (new hatchery-origin CUs returning from an earlier extirpated state), where the historical escapement time series does not reflect the natural state of the system.

   If relative-abundance-metric status information was not available for a CU, the long-term metric was given some weight in status evaluations. In these cases, however, absolute abundance information was given a higher relative weight and linked to the WSP long-term trend metric status. Given that statuses produced by the long-term trend WSP metric were considered optimistic, this metric was more likely to influence status evaluations if it indicated a lower status (Amber or Red), versus a good status (Green), and was again linked to absolute abundance information.

4. *Absolute abundance metric (absent from Holt et al. 2009 as a recommended metric, therefore COSEWIC Criteria D1 for small populations of <1,000 were used to identify CU risk to extirpation on this metric)*

Groups frequently relied on absolute abundance to evaluate a CU's integrated status, particularly when relative-abundance metrics were not available or, when available, if statuses were inconsistent across probability levels and model forms. If one to four of a non-cyclic CU's recent years (2007 – 2010) total spawner escapements fell below the COSEWIC Criteria D1, this would typically drive a lower integrated status designation (Illustration C below). In contrast, if none of the four recent years fell below the COSEWIC Criteria D1, then this would typically drive a higher integrated status designation (Illustration D below). Either of these drivers of status designations would be strengthened by whether or not any years on the entire time series fell below the COSEWIC Criteria D1 designation.

C. Example CU where absolute abundance throughout the time series falls below COSEWIC Criteria D1 (incl. last 4 yrs) (see Appendix 1 for details)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	2,109	1,522	1,522
Med	560	161	571
Min	22	22	63

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
> 5000	0	0	0
2500–5000	0	0	0
1000–2500	12	1	1
500–**1000**	20	2	1
250–500	12	0	0
0–**250**	17	9	2

Small Population Benchmarks (COSEWIC Criterion D1)

D. Example CU where no absolute abundances on the time series fall below COSEIWC Criteria D1 (see Appendix 1 for details)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	2,125,393	2,125,393	2,125,393
Med	276,194	496,146	255,898
Min	15,141	90,273	131,678

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
> 5000	61	12	4
2500–5000	0	0	0
1000–2500	0	0	0
500–**1000**	0	0	0
250–500	0	0	0
0–**250**	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

For cyclic CUs, weak (low abundance) versus dominant (high abundance) cycles influenced how absolute abundance information was interpreted. If a weak cycle year specifically fell below COSEWIC Criteria D1 in recent years, this alone did not drive a lower status designation if the dominant cycle year abundance was relatively high.

In cases where the recent trends in abundance metric indicated a Red status and recent productivity trends were decreasing, high absolute abundances in recent years were also used to justify a better integrated status.

Absolute abundance was also linked to the WSP long-term trend metric, particularly in cases where the long-term trend metric was Green in status and absolute abundance was high, both combined supported a higher WSP integrated status zone (i.e. Amber or Green) even if recent trends and productivity indicated a lower status.

Similarly, if absolute abundance was low (for some recent years falling below COSEWIC Criteria D1), then even positive short-term trend statuses (Green or Amber) and recent increases in abundances did not over-ride the poor status designated by absolute abundance.

COSEWIC Criteria D1 was also used to evaluate relative-abundance-metric benchmarks. If benchmarks were small, relative to these criteria, then the status indicated by relative-abundance metrics was given a lower weight in status considerations.

5. *Productivity Trends (presented in data summaries)*

   In cases where relative-abundance-metric statuses were inconsistent across model forms and probability levels, systematically decreasing productivity trends (indicated by the Ricker '*a*' parameter value), were used to justify the selection of a time-varying productivity model (truncated-Ricker, smoothed Ricker, and recursive-Bayesian Ricker forms) to indicate status for this metric. In cases where relative-abundance metric statuses were consistent across model forms and probability levels, this model selection step was not conducted by participants.

   Productivity information also was used to evaluate whether or not there were a number of high outliers in the stock-recruitment time series (recruits/spawner > 20), which was used by participants to flag relative-abundance-metric benchmarks and statuses and/or assign a lower weight to these metrics in status evaluations. Relative-abundance-metric benchmarks were given a lower weight (or flagged in status commentaries for further evaluation) if productivity figures indicated high outliers (> 20 recruits/spawner) in the recruits-per-spawner time series, which may contribute to biased low benchmarks and, therefore, optimistic statuses for this metric (note: although the assumption that high productivity years represent biased stock-recruitment data, and therefore, may affect benchmarks remains untested, and further work is required to evaluate this assumption).

   Productivity trends were also used in conjunction with recent productivity information (productivity below replacement in recent years) and the WSP short-term trend metric. In particular, this information may not change a high status designation for CUs with consistently high relative-abundance metric and absolute abundance information, however this information would flag a CU for further monitoring (such as Chilko-S and Lillooet-Harrison-L). In contrast, for CUs without consistent statuses across relative-abundance metrics or for CUs with not relative-abundance metrics, this information combined would drive status designations.

6. *Fishing Mortality and Return Trends (presented in data summaries)*

   Fishing mortality and return trend figures, not included in the original data summaries for each CU case study, were requested by participants on the first day of the workshop. Participants felt that the estimation of the short-term and long-term trend metrics that relied on spawner escapement data is confounded by fishing mortality in particular.

   For the short-term trend metric, if both abundance (i.e. spawner escapement) and fishing mortality was decreasing in recent years, this combination of trends was flagged for particular CUs in their status commentaries. Specifically, if abundance is decreasing, despite decreases in fisheries exploitation, then this would indicate the underlying mechanism of these declines is likely linked to intrinsic productivity decreases. For this reason, often productivity trends were considered more relevant in status evaluations, since this information focuses on an intrinsic characteristic of the population.

For the long-term trend metric, if fishing mortality was high early in the time series, relative to the current period (as is the case for most Fraser Sockeye CUs), then the influence of early high exploitation on the historical spawner escapement time series would result in optimistic long-term trend metrics when compared to current year's escapements. For this reason, the long-term trend metric was frequently discounted in status evaluations.

All groups struggled with interpreting the status information for cyclic CUs. The following specific considerations for cyclic CUs emerged as a practical compromise, pending further analyses:

- The Larkin model was considered more appropriate than the Ricker model for describing the spawner-recruit relationships of highly cyclic CUs. This was supported by analysts' commentary on statistical measures of model fit. (Note: statistical model comparisons were not available to participants). However, the key issue was whether or not the relative-abundance-metric benchmarks using the Larkin model were estimated correctly, which could not be resolved during the workshop. Therefore, relative-abundance metrics were excluded from final status considerations for cyclic CUs. The resulting status integration approaches were similar to those developed for non-cyclic CUs, where relative-abundance-metric benchmark estimates were not available.
- Unique considerations for cyclic CUs, given the exclusion of relative-abundance benchmarks, included considerations of trends in abundance and absolute abundances across all four cycle lines together and also separately. For non-cyclic CUs, any single year in the last four years falling below COSEWIC Criteria D1 often resulted in a lower status designation, depending on indicators from other metrics and status-related information. However, for cyclic CUs, if a single year falls below COSEWIC Criteria D1, if this year is a weak cycle year and conversely, the dominant cycle year is quite large, then this information was flagged but not weighted as much in status designations. Similarly, if a declining trend is driven by a weak cycle, although flagged as a concern, this trend was not weighted as much in status evaluations for cyclic CUs.

4 DISCUSSION

4.1 INTEGRATED STATUS OF FRASER SOCKEYE CUS

Integrated status designations and associated commentaries were developed for the 24 Fraser Sockeye CUs, to address one of the two workshop objectives outlined in the Terms of Reference: "provide integrated status evaluations that include identification of relevant metric(s) used for the status determination for each of the 24 Fraser River Sockeye CUs". Integrated status designations for Fraser Sockeye CUs cover all three WSP status zones, ranging from Red (poor) to Green (healthy) (Table 4). Although single integrated statuses were not developed for all CUs, blended statuses (i.e. Red/Amber or Amber/Green) were still useful for relative CU ranking. There were two CUs where status could not be determined, either because the CU was data deficient, or because the CU had contradictory status information that could not be resolved by workshop participants. Detailed status commentaries were also produced for each of the 24 Fraser Sockeye CUs and are documented in Appendix 2. The combination of integrated status designations and status commentaries is recommended for inputs into the subsequent Strategy 4 on strategic planning (Table 1).

Integrated statuses for the seven CUs designated Red and four CUs designated Red/Amber, represent the highest conservation concern of the 24 Fraser Sockeye CUs, and the highest priority for future assessments. These CUs tend to be naturally small in terms of abundance

(Cultus-L, Bowron-ES, Taseko-ES, Widgeon-River-Type, Nahatlach-ES, and Chilliwack-ES), occupying a smaller geographic distribution, and/or were located higher up in the watershed (Takla-Trembleur-EStu, Bowron-ES, Quesnel-S, Nadina-Francois-ES, Francois-Fraser-S, Takla-Trembleur-Stuart-S), where adults returning to their natal systems to spawn have farther to migrate (Figure 3). In order of decreasing conservation concern and assessment priority are the four Amber, two Amber/Green, and five Green CUs (Table 4). In contrast to the Red and Red/Amber designated CUs, these CUs tend to spawn lower in the watershed, both immediately upstream of Hells Gate (Shuswap, Chilko, Anderson-Seton systems) and downstream of Hells Gate (Harrison & Lillooet, and Pitt systems). The CUs in these systems also tend to have generally larger abundances and/or broader spatial distribution compared to CUs in the Red and Red/Amber designations (Figure 3).

Status designations for cyclic CUs were considered more uncertain than those for non-cyclic CUs. This is attributed to the exclusion of relative-abundance metrics from evaluations due to participants' concern over the estimation of these benchmarks using the Larkin model, and the appropriate methods to summarize recent abundance data to compare to benchmarks. Since this analytical issue could not be resolved at the workshop, participants agreed to exclude these metrics for cyclic CU status evaluations during the final day's plenary session. The resulting integration approaches were similar to those developed for non-cyclic CUs with no recruitment data, and therefore, no relative-abundance metric benchmarks. Participants pointed out that this still left more information for status assessments than what is available for many other Pacific Salmon CUs.

Appropriate estimation of relative-abundance-metric benchmarks using time-varying model forms was also debated by workshop participants. Further, a recent evaluation of Fraser Sockeye productivity trends using an alternative model form (Larkin model), in addition to the standard Ricker model, reports different productivity trends for particular CUs (Peterman & Dorner 2012) from those presented at the workshop (based on Grant et al. 2011 results). For one CU in particular (i.e. Quesnel-S, see Appendix 2 of Grant & Pestal 2012), Larkin model-derived productivity trends could influence the final integrated status and commentary.

4.2 STATUS INTEGRATION PROCESS

Expert opinion on status integration and associated commentaries were solicited through a combination of smaller break-out group and full participant plenary sessions. The advantage of this approach was that it permitted independent small group evaluation of a range of integration approaches and integrated statuses, which could then be consolidated in a series of plenary sessions with all participants. Additionally, it provided the advantage of evaluating the robustness of status determinations through comparisons of independent group results (6 in total). Although the size of the integration process, with 34 participants in a three day workshop, may not be feasible for covering all 450+ Pacific salmon CUs under the WSP, the general approach of independent versus full group work could be replicated with a smaller number of participants over a shorter period of time. Several key steps are recommended for subsequent status integration processes:

1) to ground the status integration process, the definitions of WSP status zones (Table 2; Figure 1), and the assessment actions and management drivers for CUs designated in the different status zones (Table 1), need to be clearly articulated prior to the start of these processes;
2) production of standardized data summaries for each CU using previously reviewed metric-specific status evaluations and associated data;
3) 'blind' status evaluations throughout most of the integration process to ensure a

standardized approach to status evaluations across all Pacific Salmon CUs, which focuses status integration on the consistently presented data summaries;

4) pre-workshop interviews of participants to bring them up to speed on the material and to also present possible barriers to integration success, which could then be resolved prior to meeting;

5) revealing of CU names at the end of the process to add any relevant information to the status determinations by the CU-specific experts;

6) independent evaluation of status by three or more individual (or three or more groups of) stock assessment technical experts, representing varied backgrounds (including individuals with biological expertise on different salmon species and CUs, and varied specializations in conservation and stock assessment science); selection of technical experts from both DFO and external groups such as academia, First Nations, environmental non-governmental organizations (NGOs), is recommended to provide a broad diversity of technical perspectives for the integration process.

7) as a final step, plenary synthesis of independent statuses and status commentaries;

Data summaries represented a critical step in status integration, by providing a tool for standardization and efficiency in the integration process. Detailed information on CU biology or CU-specific habitat and/or ecosystem threats were excluded from these data summaries (and, therefore, from Fraser Sockeye CU status integration). Instead, this level of detail is required in the subsequent WSP strategy on strategic planning (Strategy 4), where habitat (Strategy 2) and ecosystem (Strategy 3) information is linked to Strategy 1's status integration results and further analytical assessments (Table 1). One important component to Fraser Sockeye status assessments was the inclusion of uncertainty particularly in abundance metrics, which were presented in the foundational publication (Grant et al. 2011) and also in the data summaries. These included comparing both stochastic uncertainty (unexplained variability in recruitment) and structural uncertainty (use of different model forms to describe population dynamics, including forms that consider time varying productivity).

Although most participants agreed that 'blind' unnamed CUs was an appropriate approach for the status integration process, there remained some concerns that important information was being excluded using this approach. Organizers had debated the use of 'blind' versus named CUs prior to the workshop, and concluded that 'blind' status integration was most appropriate for a number of reasons. First, not naming CUs avoided inefficient side-tracks that might focus discussions on very specific and detailed local habitat or biological information, and specific threats to the CU, not relevant to WSP status integration process. In addition, the contribution of this additional information would vary amongst CUs, and therefore, would result in statuses that were not comparable between CUs; standardization of WSP assessments was an important consideration for choosing to use unnamed CUs in the integration process. Finally, not naming CUs was considered important to avoid any potential biases to status designations (linked to gut feelings or fisheries implications), and instead, to focus participants on the current status-related information used for WSP integration.

To alleviate some concerns regarding mostly 'blind' assessments, CU names were revealed as a last step in the integration process, to provide participants with the opportunity to introduce any specific supplementary information relevant to a CUs WSP status, which could be used to rationalize a change to the integrated status or that could be added to the CU status commentaries. Given this was the first WSP status integration process, less time was spent on this step at the expense of ensuring participants focused on completing thorough status assessments using the standardized data summaries for each CU. In the future, given efficiencies gained through experience in the current process, it is recommended that more time be allotted to this final step at the end of the integration process.

4.3 INTEGRATION GUIDELINES

The second goal for the workshop was “to develop clearly documented guidelines for combining information from different status metrics”. Details on status integration approaches were broadly recorded for each group, and status commentaries developed in the plenary discussion capture the key pieces of status information used by groups to designate statuses for each CU. Based on the in-depth discussions at the workshop and the case-by-case nuances in metrics used and associated commentaries on the underlying data, it is not likely that a single prescriptive algorithm for status integration under the WSP can be developed. Rather, the CSAS workshop produced a framework for future status integration processes (see previous section) and detailed guidelines for interpreting status-related information (See section on *Status Integration Approaches*).

While broad approaches to WSP status integration differed between groups, each group incorporated a number of considerations consistently. First, for CUs with recruitment data, one key piece of information relied upon by all groups was the WSP relative-abundance metric. This metric generally was given a higher weight in status determinations if a CU’s abundance metric status was consistent across all benchmarks (i.e. across all models and probability levels presented). In contrast, if a CUs relative-abundance metric included multiple status zones, then groups frequently used the status indicated by the median (50%) probability level benchmarks, rationalized the selection of one particular model form, and relied more heavily on other metrics to determine status. Other metrics included in the previously developed WSP toolkit used to assess Fraser Sockeye status, including recent and long-term trends in abundance, did not influence status determinations consistently, and their interpretation by groups relied heavily on trends in CU productivity (recruits/spawner), abundance (spawners and returns), and fishing mortality. Of note, metrics not included in the previously developed WSP toolkit, such as absolute abundance (compared to COSEWIC criteria) and productivity trends, were important considerations for final status determinations.

During the workshop, participants provided feedback on WSP status integration methods. Most important was the recognition that no single metric alone, in the absence of the consideration of additional metrics and supplemental biological information, drove the integrated status designation. A recent evaluation of the reliability of specifically 20 different trends in abundance metrics to indicate a population’s extirpation risk was conducted, which reported a continuum of indicator performance (Porszt et al. 2012). In this study, although long-term trends in abundance indicators generally performed better as a group than short-term trends in abundance indicators, this difference was small (<10% difference) (Porszt et al. 2012). Given the relative similarities in performance, it is important to evaluate and interpret the status results from multiple metrics, in conjunction with supplemental data and information on a population.

At the workshop, careful interpretation of statuses indicated by short-term and long-term trend in abundance metrics was recommended by participants. Since escapement data is used to evaluate these metrics (mature individuals that will contribute to the next generation are specifically used in these types of evaluations, which does not include individuals removed by fisheries or en-route migration mortalities), exploitation and habitat alteration are factors that can influence these escapement trends. For short-term trends, which is a metric used by COSEWIC and IUCN to drive their status assessments, participants felt that while these trends reflect the current state of the CU (the response to all threats), they do not necessarily indicate intrinsic biological CU trends (such as survival rates). As a result, short-term trends can lag intrinsic productivity trends, since reductions to fishing mortality can offset escapement trends in the short-term. Therefore, participants typically relied on a CU's intrinsic productivity (Ricker 'a' productivity parameter values, which remove density-dependence due to changing spawner abundances) trends to indicate status more than short-term trends.

Further to interpret short-term trend metrics, the retrospective statuses presented for WSP metrics on the second page of the CU data summaries illustrate how this metric's status changes over the course of a time series. For example, Cultus-L and Widgeon-River Type experienced a few periods in their later time series where the short-term trends in abundance metric indicated a Green status, when other indicators and information indicate otherwise. Conversely, there were a number of CUs (such as Chilko-S and others), where the short-term trend metric indicated a Red status, when all other metrics indicated an Amber or Green status, as these CUs were returning to average (relatively high) abundance following periods of exceptional production in the 1990's. In these latter cases, trends were flagged as something important to monitor, but when integrated with other metrics and escapement trend information, these poor short-term trend statuses did not drive the integrated status designations.

The long-term trends in abundance metric may also not be as relevant for CU status evaluations in cases where exploitation was high early in the time series, or human-induced habitat changes altered spawning habitat between early and late periods of the time series (such as systems where artificial spawning channels were constructed in the 1960's/70's). Since most Fraser Sockeye CUs experienced high exploitation earlier in the time series, and therefore, lower escapements than would have naturally occurred in the absence of fishing mortality, the long-term trend metric was flagged as producing optimistic statuses (since it compares the current generation escapements to this historical time series). As a result, this metric was typically not given a high weight in status evaluations, unless it indicated a poorer status (Amber or Red).

Workshop participants debated whether status evaluation should reflect only the current status, or anticipate future status based on current trends. For example, Chilko-S and Lillooet-Harrison-L, were two CUs where almost all metrics indicated a Green status, yet recent trends in abundance indicated a Red status. In these cases, the trend metric was not considered an immediate concern given high absolute and relative abundances for these CUs, and also because these CUs were returning to average following a period of exceptional production. Therefore, although short-term trends did not influence the final integrated Green status for these CUs, participants flagged these CUs as provisional due to these short-term trends. Since Green statuses for CUs do not require detailed analytical assessments and management response, participants felt it important to flag these CUs as provisional so that these decreasing trends are not ignored in the near future. These considerations are also linked to how often WSP statuses are evaluated. If statuses are assessed every year versus every ten years, this can affect how integrated statuses are designated, particularly in regards to which metrics indicate the current state of the CU (abundance metrics and long-term trends) versus where the CU is headed if current trends persist (productivity and short-term abundance trends).

5 CONCLUSIONS

This workshop on WSP status integration, which used Fraser Sockeye CUs as case studies, represents the first integration process for Pacific Salmon. This integration step builds on the considerable amount of work published in the years leading up to the workshop related to WSP Strategy 1 (Holtby & Ciruna 2007; Holt et al. 2009; Holt 2009; Porszt 2009; Holt 2010; Grant et al. 2011; Holt & Bradford 2011; Porszt et al. 2012). Status integration is expected to evolve, given lessons learned through the current workshop, and subsequent processes. In the current integration workshop, most of the Fraser Sockeye case studies represent data rich CUs (long time series of stock-recruitment data) in the Pacific Region, which are largely unrepresentative of the mostly data poor Pacific Region CUs. Although there are some examples of data poor Fraser Sockeye CUs, more examples from other species and areas are required to expand the examples currently presented. For future groups of CUs, which represent different data availabilities and metrics evaluated, future similar CSAS-supported workshops are recommended to build upon the integration methods developed in the current workshop. Further recommendations are provided below to assist with the implementation of future integration processes. After a range of CUs has been evaluated in similar processes, it may be possible to proceed with smaller expert-driven teams for status integration processes.

6 RECOMMENDATIONS

The WSP Status Integration workshop, presented in the current paper, was the first process conducted to address WSP biological status integration. As a result, there were a number of lessons learned and recommendations identified by participants that could be applied to future WSP biological status integration processes generally, and also to future Fraser Sockeye CU status integration processes specifically.

Generally applicable to all Pacific salmon WSP status integration processes are the following recommendations:

1) Further clarification on the frequency of WSP status assessments is required to ground the status integration process; for example status assessments conducted every year, versus every ten years, could influence status designations;
2) It is recommended that data summaries, which were developed for the current workshop by a technical team over a period of several months, should be consistent amongst Pacific Salmon CUs and evolve as additional CUs are assessed;
3) Short summaries for each CU should be added to each data summary, which includes the history of the CU (such as systems with artificial channels), and other information required specifically for interpretation of data summary information;
4) the addition of an absolute abundance metric in the Holt et al. (2009) WSP toolkit of metrics, and the development of associated benchmarks; in the absence of WSP absolute-abundance benchmarks, the current integration process defaulted to using COSEWIC Criteria D1 for small populations for this metric's benchmarks;
5) the addition of a productivity metric to the Holt et al. (2009) WSP status evaluation toolkit; participants used the productivity trends in status evaluations broadly, given the absence of WSP-defined lower and upper benchmarks;
6) Increased clarity was requested regarding the difference between the Ricker 'a' parameter value CU productivity time series and the recruits per effective female spawner time series, where the former removes density-dependent effects on productivity and, therefore, should reflect differences in marine and freshwater survival, rather than simply changes in spawner abundances;
7) inclusion of fishing mortality and return trends in the data summaries was recommended to assist with the interpretation of the long-term trends and short-term trend in abundance WSP metrics;
8) analytical evaluation of relative-abundance metrics based on carrying capacity data (presented in Holt et al. 2009) is required to determine extirpation risk and recovery potential, similar to evaluations conducted for relative-abundance metrics based on stock-recruitment data (i.e. Holt 2009; Holt 2010; Holt & Bradford 2011);

9) provision of model diagnostics for each model used to estimate relative-abundance-metric benchmarks; this would assist participants in evaluating the model forms most appropriate for each CU;

10) although the individual WSP benchmarks that specifically correspond to particular COSEWIC criteria include a buffer to the extirpation risk identified by COSEWIC, clarification is required regarding how WSP benchmarks should provide an overall buffer to 'being considered at risk of extinction by COSEWIC', where COSEWIC's process to determine overall extirpation risk relies on expert interpretation and integration across all individual criteria;

11) further CSAS-supported workshops are recommended for Pacific Salmon CU status integration processes, where the suite of metrics and supplementary information used to designate status differs significantly from those explored for Fraser Sockeye CUs; this would ensure consistency in process between species and different individuals conducting assessments;

Specific to future Fraser Sockeye CU WSP status integration processes are the following recommendations:

13) decisions regarding whether or not relative-abundance-metric benchmarks are required for cyclic CUs must occur; currently, cyclic CUs represent a small fraction of all 450+ Pacific Salmon CUs, so trade-offs between investing further work in relative-abundance metrics for these CUs (currently, despite months of work by an analytical internal/external group, has not resolved analytical questions related to cyclic CUs), versus using all remaining metric and supplementary information to assess status for these CUs must be considered

14) if it is decided that relative-abundance metrics are required for cyclic CUs, then there are a number of fundamental questions that present on-going challenges for these CUs: for example, are we calculating these benchmarks correctly? Do Larkin-derived benchmarks for cyclic CUs represent equivalent extirpation risk and recovery potential to Ricker-derived benchmarks for non-cyclic CUs? Does the approach for evaluating current abundance state (geometric mean) represent equivalent extirpation risk/recovery potential for cyclic CUs?

15) additional work is required to estimate productivity trends for applicable CUs using the Larkin model (rather than the Ricker model used at the workshop), which removes density-dependent cycle-line interactions from the productivity trends; the workshop proceeded using CSAS reviewed results presented in Grant et al. (2011), however, very recent work by Peterman & Dorner (2011 & 2012) and Michielsens (Pacific Salmon Commission, 2012, pers. comm.), indicate different productivity trends may occur if Larkin model forms are used for particular CUs (Quesnel is one example where Larkin-derived productivity trends do not show the same recent decreases as the Ricker-derived productivity trends, which likely would influence the final status designation for this CU); the model form used to evaluate productivity trends will be important to explore further in light of this recent research, given the high weight assigned to productivity trends in the status integration process;

16) at the workshop it was assumed that anomalously high productivity years (> 20 R/S) may indicate biased recruitment data, and therefore, potentially biased relative-abundance benchmarks; this assumption has not been tested, and therefore, further evaluation of this is recommended;

17) future work on pulling out Chilko-ES specific escapement data is recommended, so that

status can be assessed for this currently data deficient CU in the future.

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TABLES

Table 1: Guidance in the Wild Salmon Policy on assessment actions and management considerations for conservation units in the three status zones (DFO 2005: p. 17-19, 26, 32)

Status	Assessment Actions	Management Considerations
Red	"… a detailed analytical assessment will normally be triggered to examine impacts on the CU of fishing, habitat degradation, and other human factors, and evaluate restoration potential", "… detailed stock assessments will identify the reasons for the change in status". "CUs in the Red zone … will be identified as management priorities … the protection and restoration of these CUs will be primary drivers for harvest, habitat, and enhancement planning."	"Biological considerations will be the primary driver for the management of CUs with Red status". "The presence of a CU in the Red zone will initiate immediate consideration of ways to protect the fish, increase their abundance, and reduce the potential risk of loss".
Amber	"… a detailed analytical assessment may be required to input into Strategies 2 & 3.."	"Decisions about the conservation of CUs in the Amber zone will involve broader considerations of biological, social, and economic issues". "involves a comparison of the benefits from restoring production versus the costs arising from limitations imposed on the use of other CUs to achieve that restoration." "implies caution in the management of the CU"
Green	" a detailed analytical assessment of its biological status will not usually be needed"	"Social and economic considerations will tend to be the primary drivers for the management of CUs in the green zone, though ecosystem or other non-consumptive values could also be considered".

Table 2: Three zones of biological status defined in the WSP (WSP p. 17 & 18)

Status		Definition
	Red	"… established at a level of abundance high enough to ensure there is a substantial buffer between it and any level of abundance that could lead to a CU being considered at risk of extinction by COSEWIC"
	Amber	"While a CU in the Amber zone should be at low risk of loss, there will be a degree of lost production. Still, this situation may result when CUs share risk factors with other, more productive units"
	Green	"identif[ies] whether harvests are greater than the level expected to provide on an average annual basis, the maximum annual catch for a CU, given existing conditions…there would not be a high probability of losing the CU"

Table 3: Summary of group results for integrated status evaluations. Status designations were labelled provisional if a group did not reach consensus. The majority view is shown below, but the number of groups with provisional status designations is also included. For example, '2 Red' for Quesnel means that two of the five groups that settled on a Red status had some dissenting views. By comparison, the '1' in the Amber column for Quesnel means that there was one group that reached a consensus designation of Amber, which could not be reconciled with the results from the other five groups through plenary discussion.

R	A	G	Conservation Unit	Cyclic	Provisional
6			Takla-Trembleur – Estu	Y	1 Red
5			Nadina-Francois-ES		2 Red
5			Taseko-ES		
5			Nahatlatch-ES		
4			Bowron-ES		
5			Cultus-L		
6			Widgeon River – River Type		
2	4		Chilliwack-ES		1 Amber
2	4		Francois-Fraser-S		1 Red
5	1		Quesnel – S	Y	2 Red
2	2		Takla-Trembleur-Stuart-S	Y	
1	5		North Barriere-ES		1 Red
1	5		Anderson-Seton – ES	Y	
2	1	2	Seton-L (de novo)	Y	1 Amber
	5		Kamloops-ES		2 Amber
	5		Harrison (U/S)-L		1 Amber
	2	2	Pitt – ES		
	1	2	Shuswap – ES	Y	
		6	Chilko-S & Chilko-ES aggregate		2 Green
		4	Lillooet-Harrison-L		1 Green
		5	Harrison (D/S)-L		
1		4	Shuswap Complex – L	Y	
		5	Harrison River – River Type		

*Table 4: Integrated status designations for the 24 Fraser River Sockeye Salmon CUs, ranked from poor (Red zone) to healthy (Green zone) status. For each CU, more commonly used stock names are presented. Cyclic CUs are also identified. * indicates provisional status designations; R/A: Red/Amber; A/G: Amber/Green; DD: data deficient; Undet: undetermined.*

	Status	Conservation Unit	Cyclic	Stock
	Red	Takla-Trembleur-EStu	cyclic	Early Stuart
	Red	Nadina-Francois-ES		Nadina
	Red*	Taseko-ES		Miscellaneous Early Summers
	Red	Nahatlatch-ES		Miscellaneous Early Summers
	Red	Bowron-ES		Bowron
	Red	Cultus-L		Cultus
	Red	Widgeon – River		Miscellaneous Lates
	R/A	Chilliwack-ES		Miscellaneous Early Summers
	R/A	Francois-Fraser-S		Stellako
	R/A	Quesnel-S	cyclic	Quesnel
	R/A	Takla-Trembleur-Stuart-S	cyclic	Late Stuart
	Amber	North Barriere-ES		Fennel & Miscellaneous Early Summer
	Amber	Anderson-Seton-ES	cyclic	Gates
	Amber	Kamloops-ES		Raft & Miscellaneous Early Summers
	Amber	Harrison (U/S)-L		Weaver
	A/G	Pitt-ES		Pitt
	A/G	Shuswap-ES	cyclic	Scotch, Seymour, Mis.Early Summers
	Green*	Chilko-S & Chilko-ES agg.		Chilko
	Green*	Lillooet-Harrison-L		Birkenhead
	Green	Harrison (D/S)-L		Miscellaneous Lates
	Green	Shuswap Complex-L	cyclic	Late Shuswap
	Green	Harrison River – River Type		Harrison
?	DD	Chilko-ES		Chilko
?	Undet	Seton-L	cyclic	Seton

FIGURES

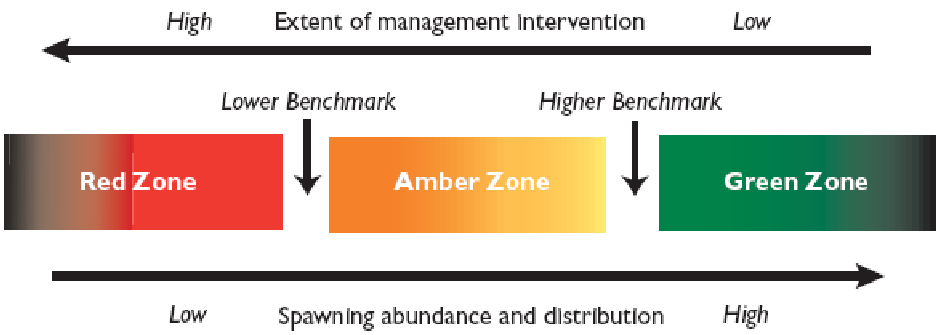


Figure 1. Wild Salmon Policy status zones (Red, Amber, and Green) delineated by lower and upper benchmarks. Increasing spawner abundance is inversely related to the extent of management intervention. Reprinted from Fisheries and Oceans Canada (2005).

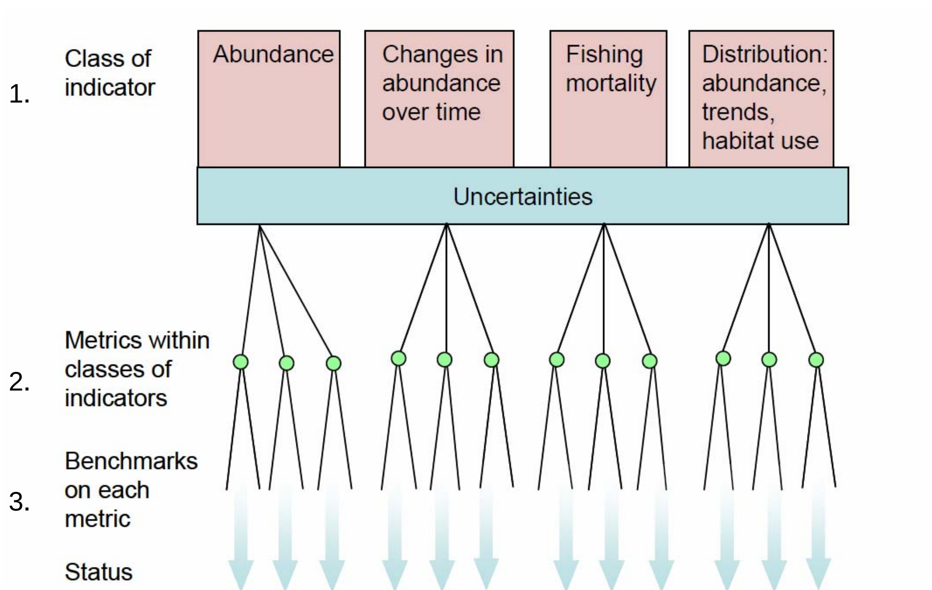


Figure 2. Hierarchy for the assessment of biological status of WSP CUs including 1) four classes of indicators, 2) quantifiable metrics within each indicator class, and 3) benchmarks on each metric. Reprinted from Holt et al. (2009).

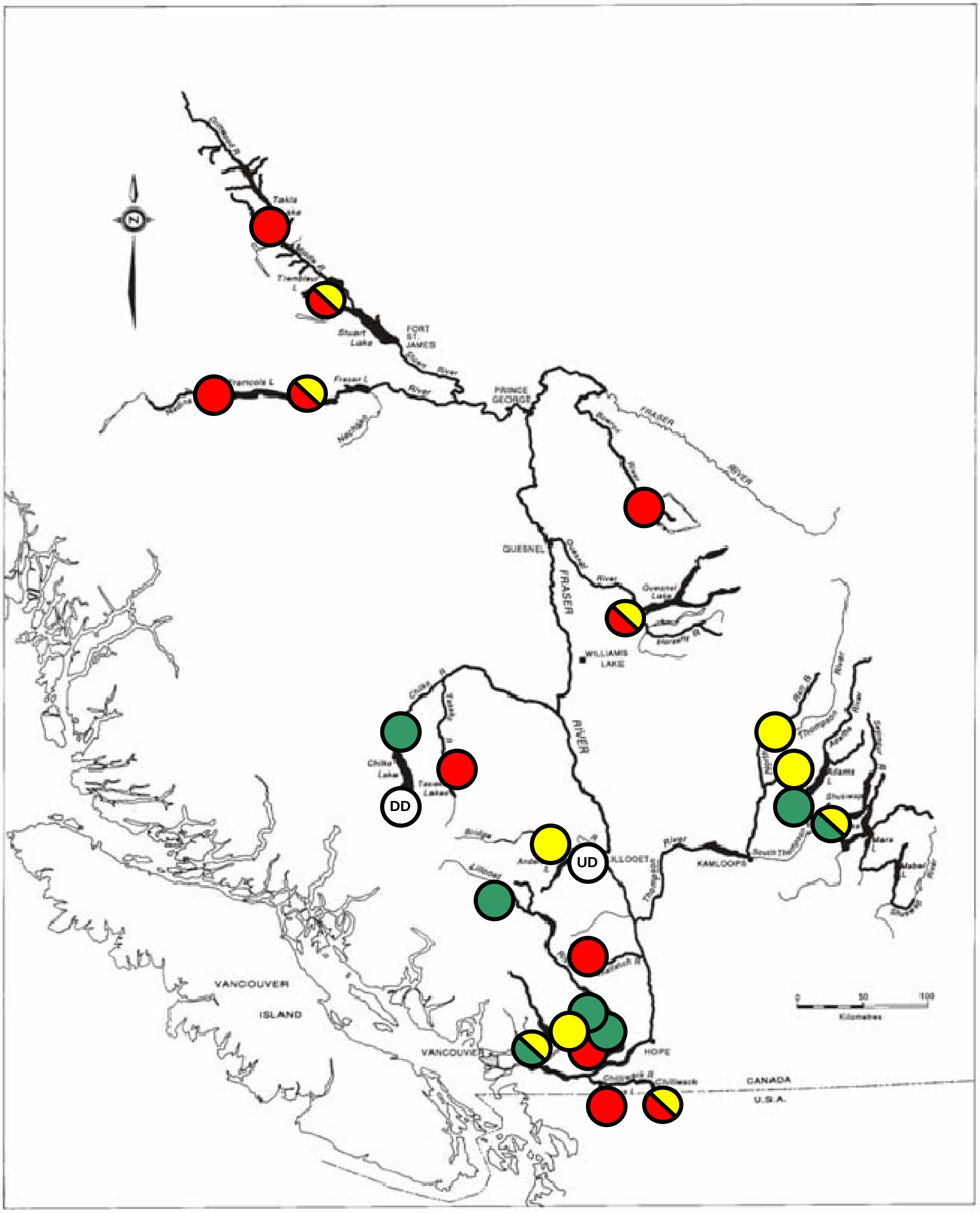


Figure 3. Map of the spawning distribution (darkened black lines) of Fraser River Sockeye CUs in south-western British Columbia with integrated statuses indicated for each cu (see preceding table 4).

APPENDIX 1: GUIDE TO CU DATA SUMMARIES

Introduction

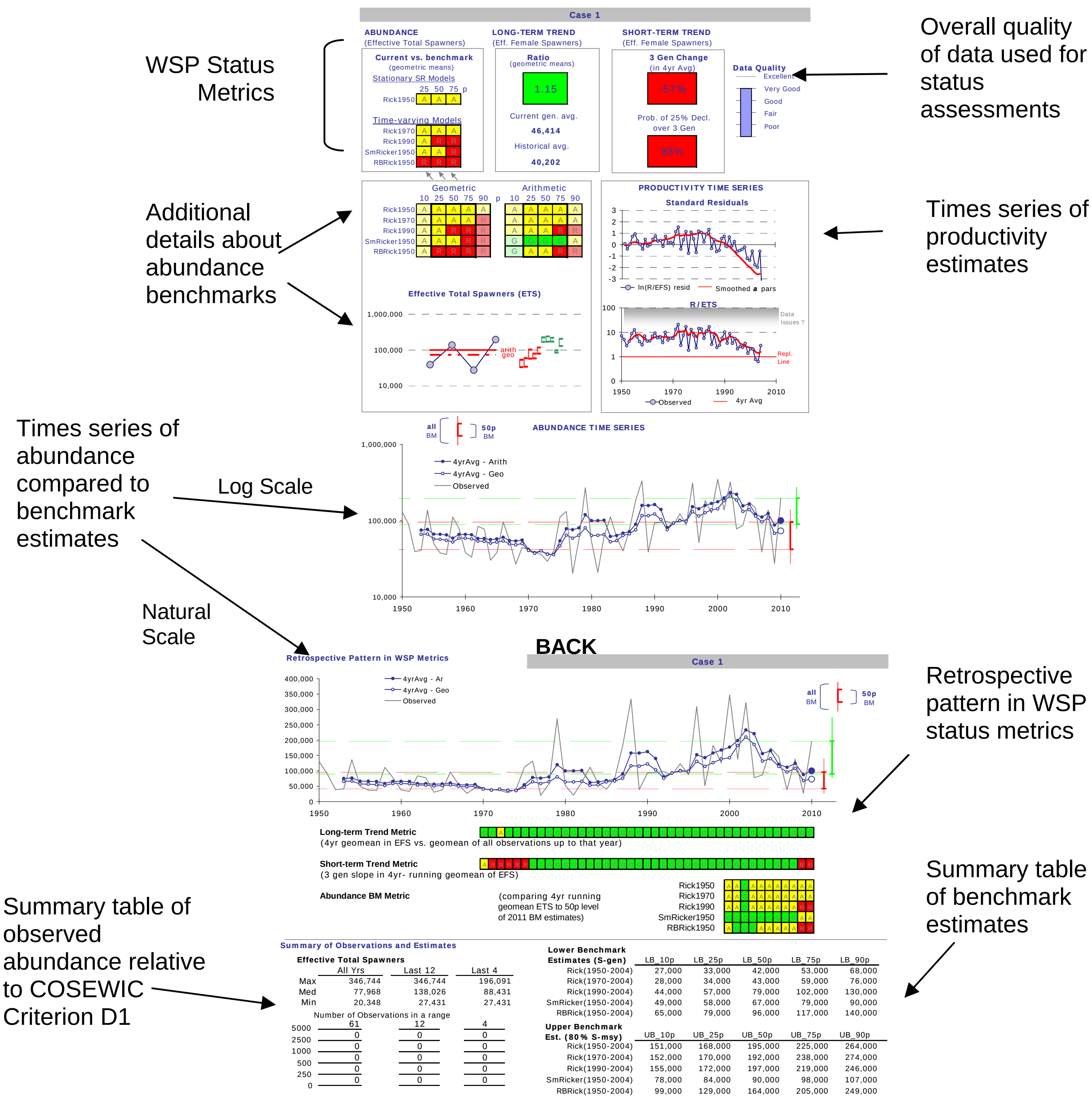
Workshop participants received a data summary for each CU to support their discussions. This guide explains the key pieces of information presented in these data summaries.

Purpose of Data Summaries

- Standardized summary of available data by CU; all data have been updated from Grant et al. (2011) to include one additional year (2010) of data.
- Emphasis on status metrics in Grant et al (2011), with additional information provided as context.
- Data summaries were modified based on feedback by workshop participants, and those revised summaries are appended in Appendix 2.

Overview

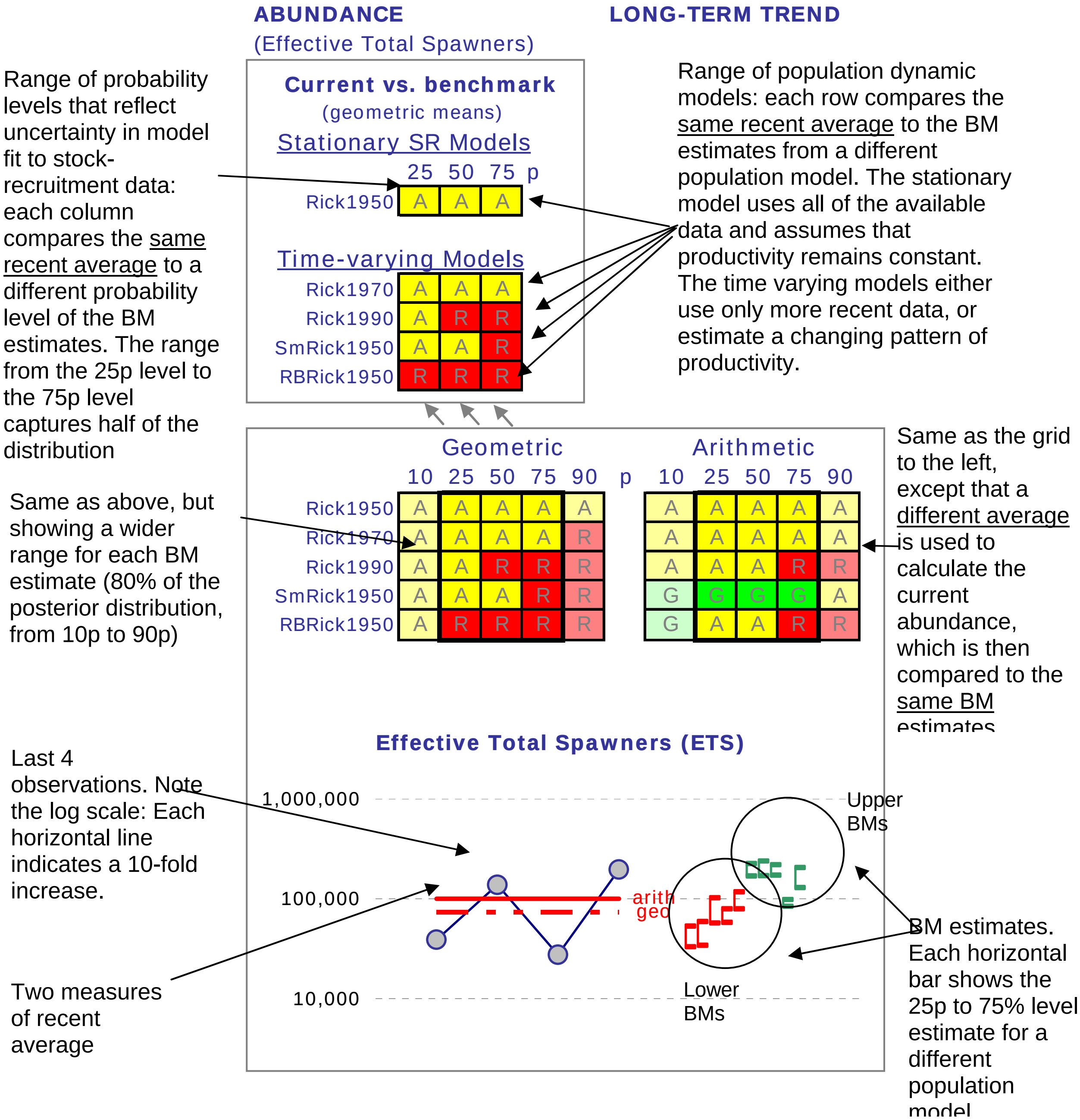
FRONT



Section 1: Comparison to Abundance Benchmarks

Key Point: This metric compares the average abundance of the most recent generation to estimates of the lower benchmark (Sgen) and upper benchmark (80% Smsy) for each CU. WSP status is Red if the last generation abundance is below the lower benchmark, Green if it is above the upper benchmark , and Amber if it is between the lower and upper benchmarks.

Key Challenge: How to integrate uncertainty in benchmarks (and resulting status assessments) for each CU that includes 1) across alternative population dynamic models (rows in benchmark tables); and 2) across probability levels that reflect uncertainty in the model fit to the data (columns in benchmark tables).

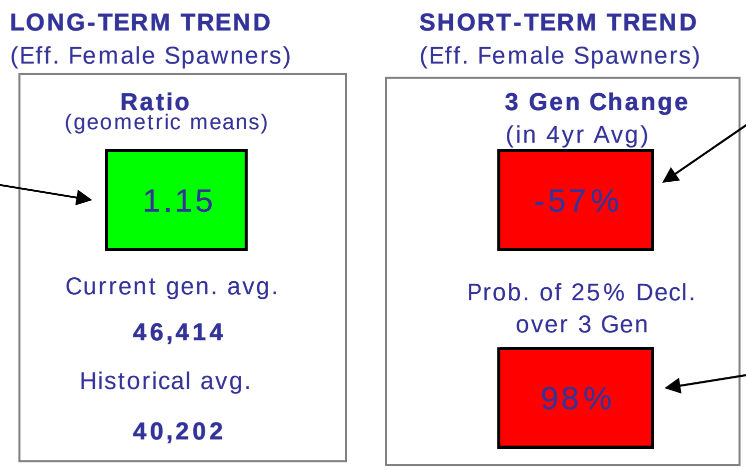


Section 2: Trend Metrics

Key Point: These metrics assess recent trends in abundance over the last three generations (up to 2010) and long-term trends (current generation average abundance relative to the long-term average abundances).

Key Challenge: Interpreting <u>both</u> metrics together.

Ratio of current average over historical average

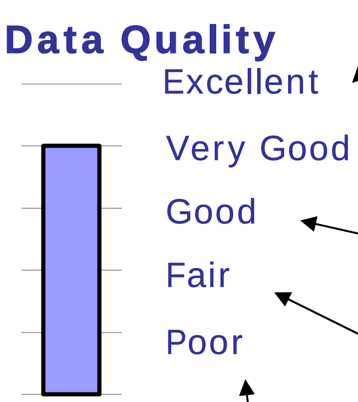


Slope over the last 12 yrs in 4yr running average of log(EFS), converted back into an absolute change. A 57% decrease means that the 4yr average now is less than half what it was 3 generations ago.

Supporting information: shows the probability that the recent (last 3 generations) trends slope has declined 25% or more, given uncertainty in the slope estimate due to variability in the observations.

Section 3: Data Quality

Overall quality of data used in status evaluations.



An unbreached fence estimate with extremely high accuracy given an almost complete census of counts.

an estimate of high reliability using mark recapture methods, DIDSON methods, or near-complete fence counts that have relatively high accuracy and precision. Visual surveys that have been calibrated with local fence programs;

Four or more visual inspections with good visibility;

An estimate using two or more visual inspections that occur during peak spawning where fish visibility is reasonable; methodology and data quality varies across the time series in terms of good to poor quality;

an estimate with poor accuracy due to poor counting conditions, few surveys (one or two in a given year), incomplete time series, etc.;

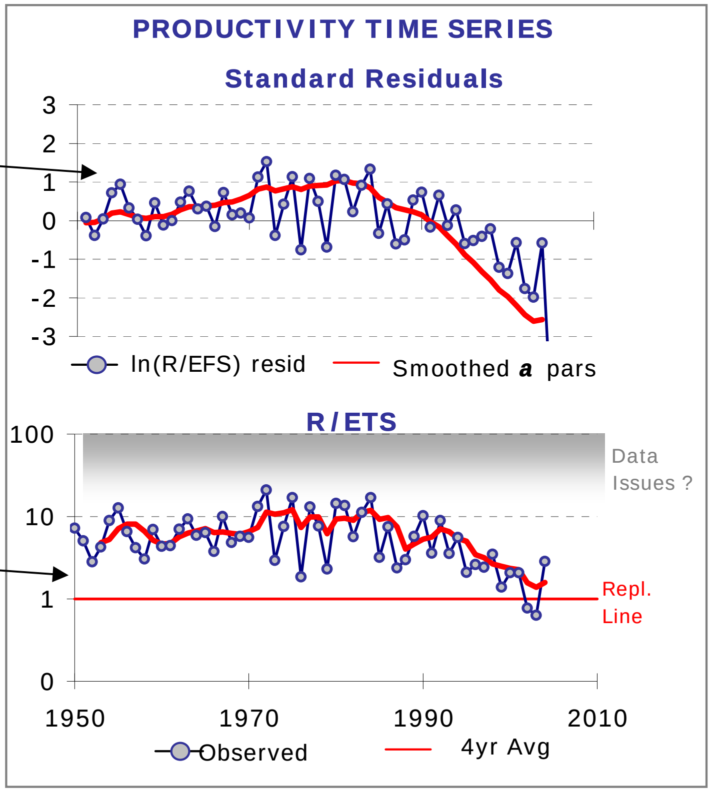
Section 4: Productivity patterns

Key Point: Observed productivity (recruits / spawner) can show pronounced trends over time.

Key Challenge: Should this information be considered in the evaluation of status, and if so, how?

The points show standardized deviations from the long-term average ln(R/EFS), which is independent of population models. Years with positive deviations had higher than average productivity. The red line shows an estimated pattern in the productivity parameter for a Ricker model.

Points show the raw estimates of productivity over time, and the red line shows a running 4yr average. Note the log scale, such that each horizontal line marks a 10-fold increase. If R/ETS is less than 1, the population failed to replace itself in that generation. R/ETS larger than about 20 are probably due to biased estimates.



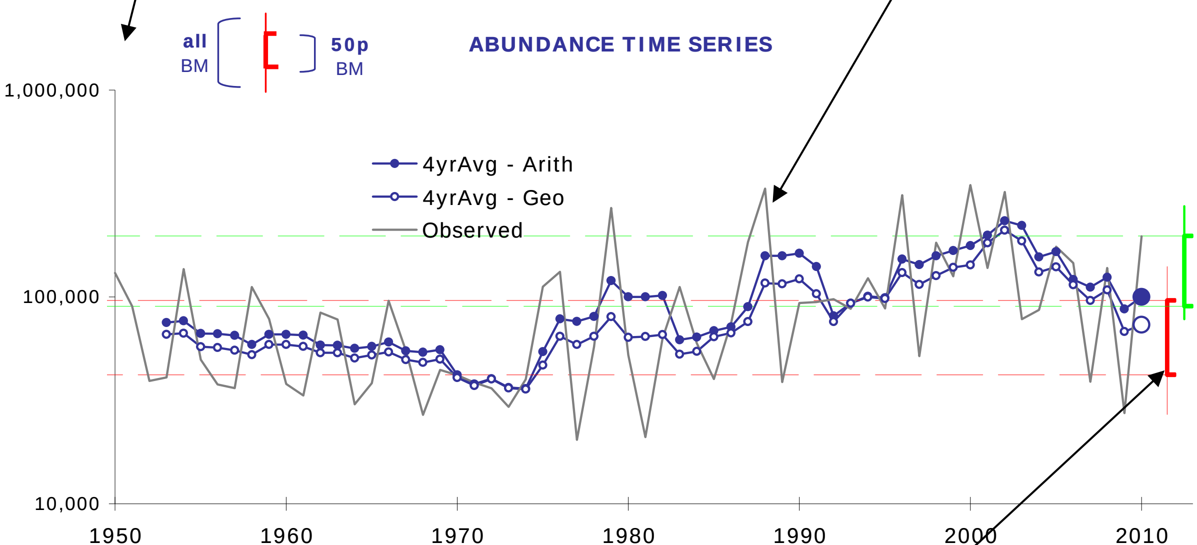
Section 5: Times Series of Abundance Compared to Benchmarks

Key Point: Show pattern in abundance over time compared to <u>current</u> estimates of abundance benchmarks.

Key Challenge: Considering uncertainty in BM estimates (i.e. across population models and probability levels). Another challenge is considering how BM estimates may change, especially with models that incorporate time-varying productivity.

Note the log scale.

The grey line shows observed abundance, and the blue lines with points show running 4yr averages (two different average calculations).

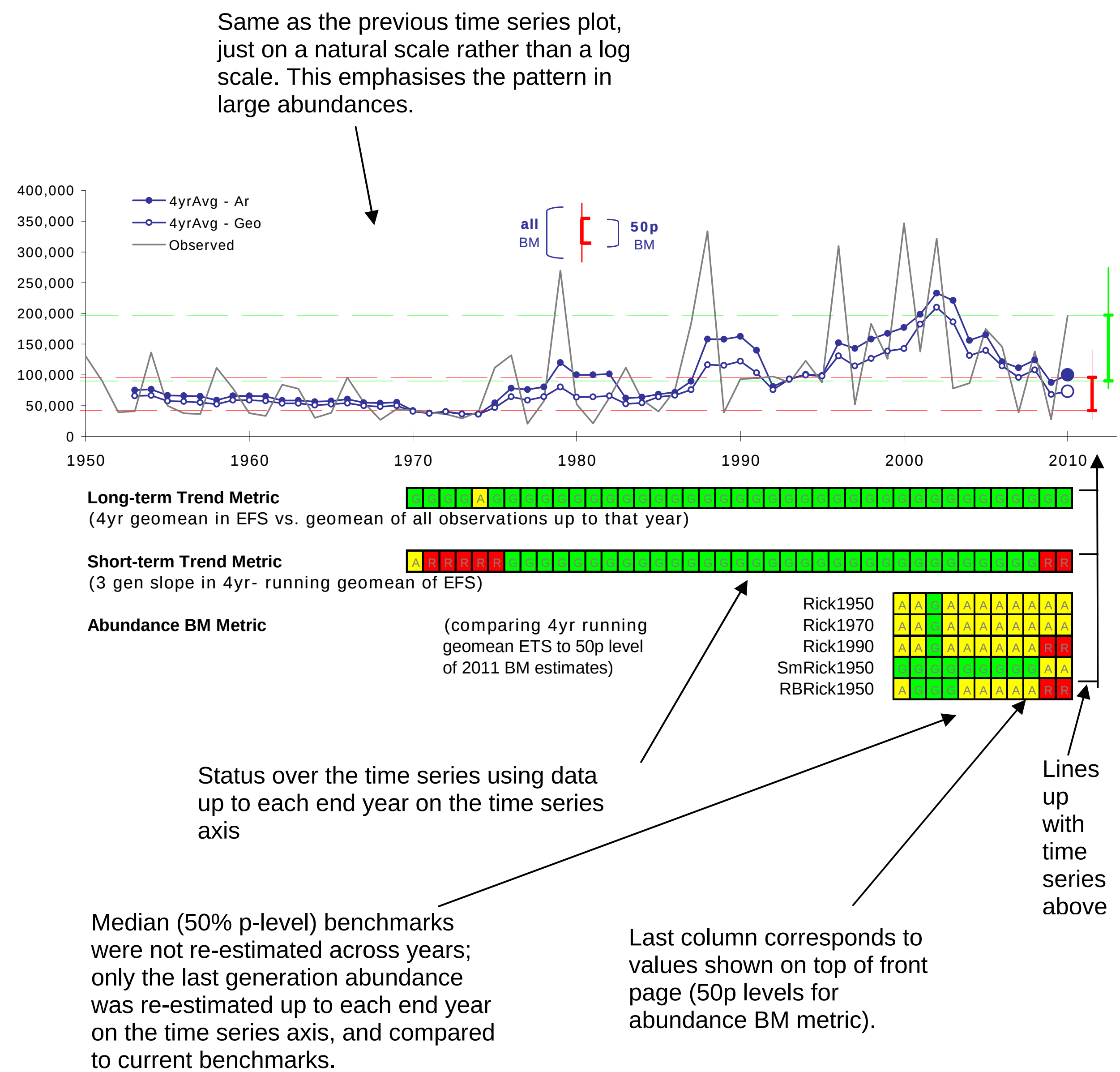


Vertical bars show the range of BM estimates. The thick part shows the range of best estimates across population models (i.e. 50p level, mid-point). The whiskers show full range of values across models and probability levels. A table in the back of the data sheet lists all of the estimates.

Section 6: Retrospective Pattern in Status Metrics

Key Point: All 3 metrics are designed to describe current status, but they differ in their sensitivity to changing observations through time.

Key Challenge: Considering current metric statuses in the context of past patterns.



Section 7: Summary Tables

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	346,744	346,744	196,091
Med	77,968	138,026	88,431
Min	20,348	27,431	27,431

Number of Observations in a range

5000	61	12	4
2500	0	0	0
1000	0	0	0
500	0	0	0
250	0	0	0
0	0	0	0

COSEWIC D Criteria (for reference):
<1,000 mature individuals: ‘threatened’
<250 mature individuals: ‘endangered’

Lower Benchmark Estimates (S-gen)	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	27,000	33,000	42,000	53,000	68,000
Rick(1970-2004)	28,000	34,000	43,000	59,000	76,000
Rick(1990-2004)	44,000	57,000	79,000	102,000	130,000
SmRicker(1950-2004)	49,000	58,000	67,000	79,000	90,000
RBRick(1950-2004)	65,000	79,000	96,000	117,000	140,000

Upper Benchmark Est. (80% S-msy)	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	151,000	168,000	195,000	225,000	264,000
Rick(1970-2004)	152,000	170,000	192,000	238,000	274,000
Rick(1990-2004)	155,000	172,000	197,000	219,000	246,000
SmRicker(1950-2004)	78,000	84,000	90,000	98,000	107,000
RBRick(1950-2004)	99,000	129,000	164,000	205,000	249,000

Benchmarks across model form (rows) and probability levels (columns)

APPENDIX 2: INTEGRATED STATUS COMMENTARIES AND DATA SUMMARIES

OVERVIEW

Status commentaries are presented in Appendix 2 (with the CU name identified) in the same order workshop participants viewed the case studies during the workshop (from 1 to 24).

Commentaries are compiled from information recorded during the final day's plenary sessions both electronically in Excel and PowerPoint files projected at the front of the room, and also from the workshop's transcript. The data summaries and notes from individual group's sheets were also used to expand on this information, where appropriate. Following the commentaries for each CU are the data summaries used by participants during the workshop to integrate CU status. These data summaries, therefore, provide the foundation for the commentaries provided in the current report.

CASE 1: FRANCOIS-FRASER-S (RED/AMBER)

(Management stock name: Stellako; Run-Timing Group: Summer)

Background: this CU rebuilt after both the 1913 Hells Gate landslide and a subsequent period (1964-1968) of log driving that impacted spawning habitat (see Grant et al. 2011 for details).

Integrated Status

R	A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	A	r	R	A	A

Status Commentary

- although most participants agreed on a provisional Amber integrated status designation for this CU, due to inconsistencies both within and amongst groups, this CU was designated a blended Red/Amber status; one group agreed on a provisional Red (indicated by the small ‘r’) for their group’s integrated status, although individual participant designations for this group included two Reds and four Ambers; integrated status evaluation for this CU was complicated by its conflicting statuses across metrics and information presented;

- factors that indicated an Amber integrated status designation included the relatively high recent absolute abundance (median effective total spawners was 88,000 in the last four years) and the Green long-term trend status (although some groups felt long-term trends should be given lower weight given the higher exploitation rates in earlier years); since abundances for this CU are returning to average, following a previous period of above-average abundance, the Red short-term trend metric for this CU was not weighted as highly;

- factors that indicated a Red integrated status designation included recent declines in CU productivity (with some years falling below replacement), and Red status for the relative-abundance metric for benchmarks at the 50% median probability level using the recursive-Bayesian model form, which was considered an important model form to use for CUs such as Francois-Fraser-S that have exhibited recent declines in productivity; note that for most other model forms, relative-abundance metric status was Amber at their 50% probability level benchmarks, therefore, model diagnostics might have influenced the factors pointing to Red integrated status; in addition, the short-term term trend metric was decreasing, although this metric was not given as much weight since this CU was returning from high abundances;

Points of Discussion

- debate regarding whether status evaluation should reflect only the current CU status, or anticipate future status based on short-term trends in abundance and productivity; although an Amber/Red integrated status was agreed to by participants, if the currently observed decreasing abundance (short-term trend) and productivity persist, this CU could fall solely into a Red zone shortly;

- debate over the weight of absolute abundance (which was high for this CU) versus the weight of status signals from other metrics and information (range: moderate to poor status);

- the contrast between this CU designated Red/Amber due to conflicting metric statuses and additional information, versus Cultus-L where all information points to a Red designation, highlights the range of CUs that could occupy a Red status zone and the importance of the status commentaries in subsequent WSP Strategic planning processes;

Francois-Fraser-S

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	A	A	A	

Time-varying Models

	25	50	75	p
Rick1970	A	A	A	
Rick1990	A	R	R	
SmRick1950	A	A	R	
RBRick1950	R	R	R	

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.15

Current gen. avg.
46,414

Historical Avg (61 Obs)
40,202

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-57%

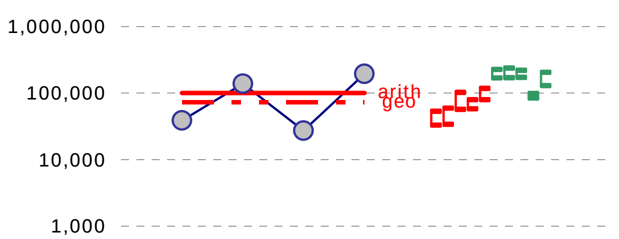
Prob. of 25% Decl.
over 3 Gen

98%

Data Quality
Excellent
Very Good
Good
Fair
Poor

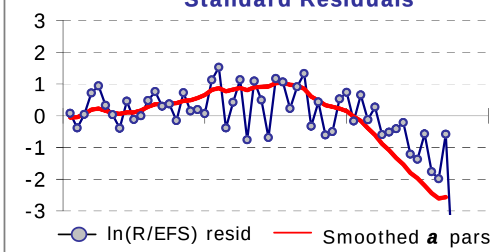
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1950	A	A	A	A	A		A	A	A	A	A
Rick1970	A	A	A	A	R		A	A	A	A	A
Rick1990	A	A	R	R	R		A	A	A	R	R
SmRick1950	A	A	A	R	R		G	G	G	G	A
RBRick1950	A	R	R	R	R		G	A	A	R	R

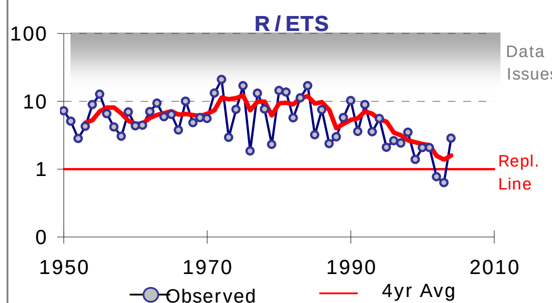
Effective Total Spawners (ETS)



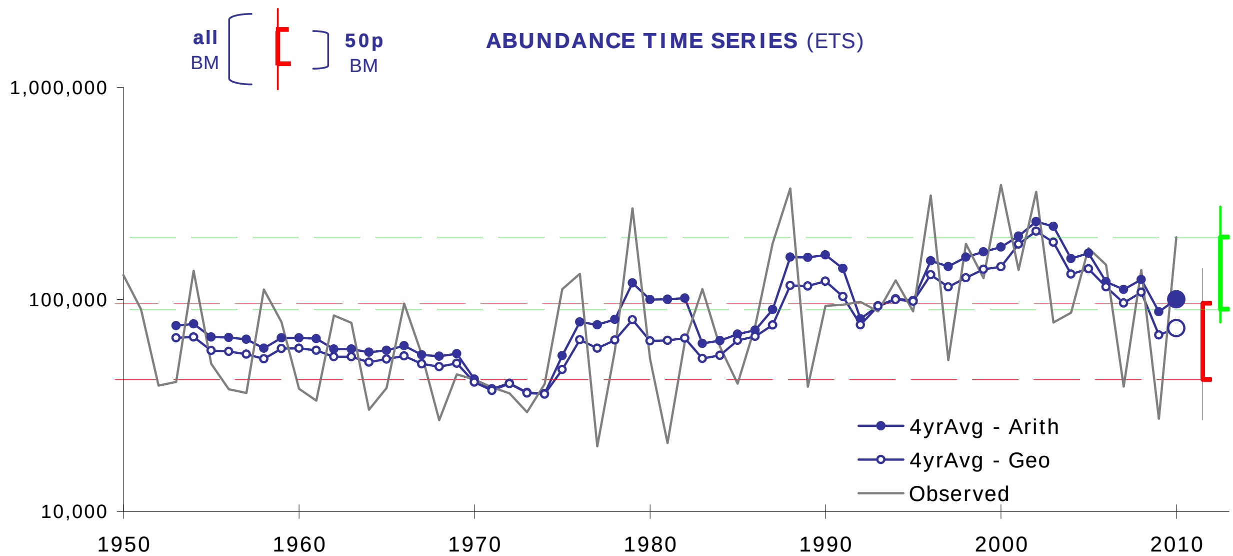
PRODUCTIVITY TIME SERIES

Standard Residuals



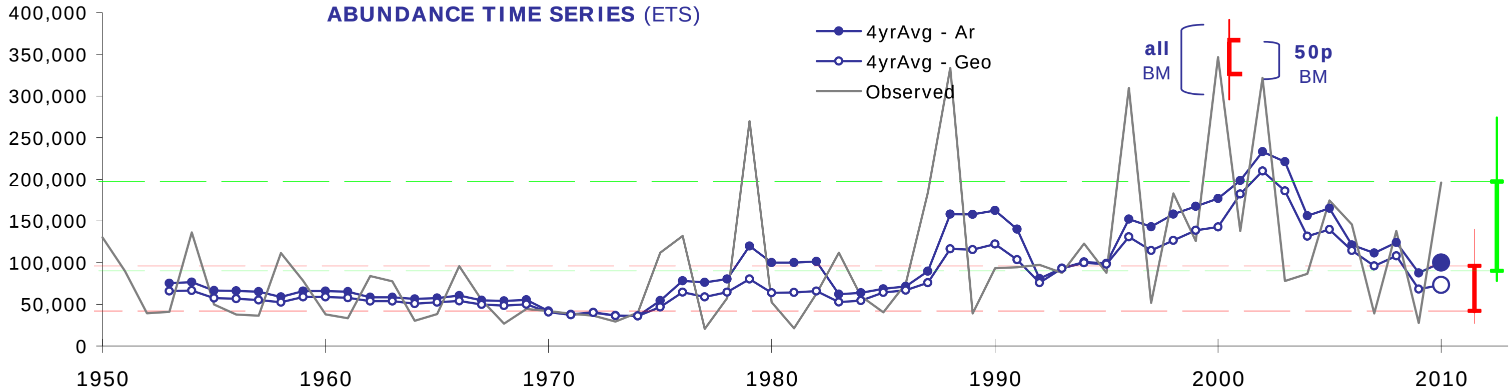


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Francois-Fraser-S



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G G G G A G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

A R R R R R G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G R R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	A	A	G	A	A	A	A	A	A	A	A
Rick1970	A	A	G	A	A	A	A	A	A	A	A
Rick1990	A	A	G	A	A	A	A	A	A	R	R
SmRick1950	G	G	G	G	G	G	G	G	G	A	A
RBRick1950	A	G	G	G	A	A	A	A	A	R	R

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	346,744	346,744	196,091
Med	77,968	138,026	88,431
Min	20,348	27,431	27,431

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	61	12	4
2500–5000	0	0	0
1000–2500	0	0	0
500–**1000**	0	0	0
250–500	0	0	0
0–**250**	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

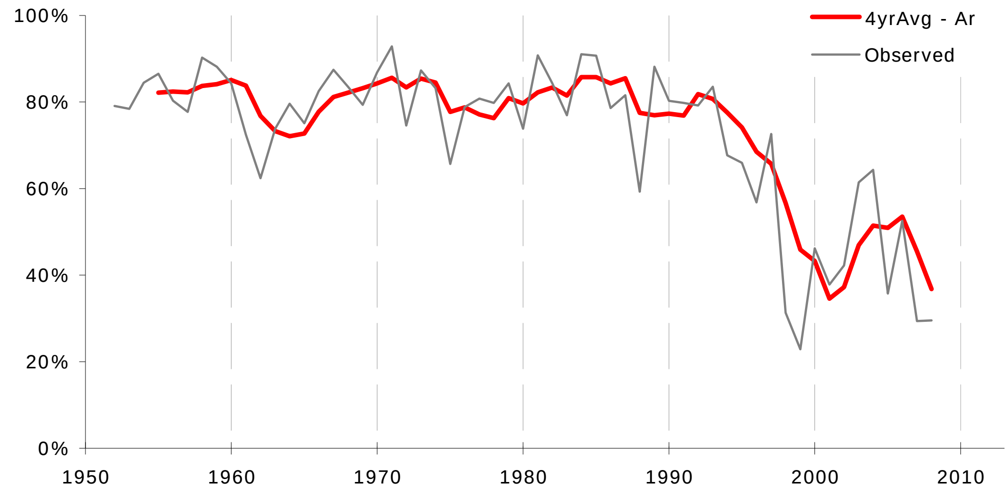
Lower Benchmark Estimates (S-gen)

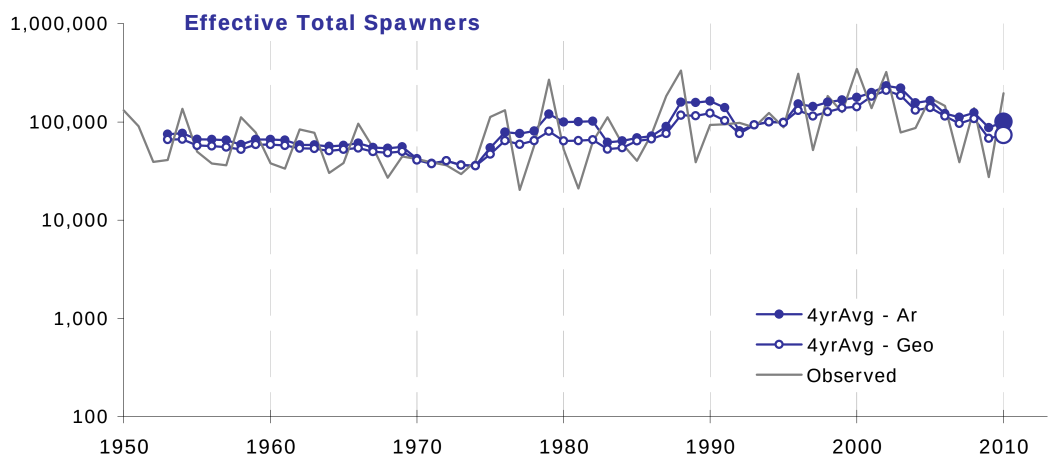
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	27,000	33,000	42,000	53,000	68,000
Rick(1970-2004)	28,000	34,000	43,000	59,000	76,000
Rick(1990-2004)	44,000	57,000	79,000	102,000	130,000
SmRick(1950-2004)	49,000	58,000	67,000	79,000	90,000
RBRick(1950-2004)	65,000	79,000	96,000	117,000	140,000

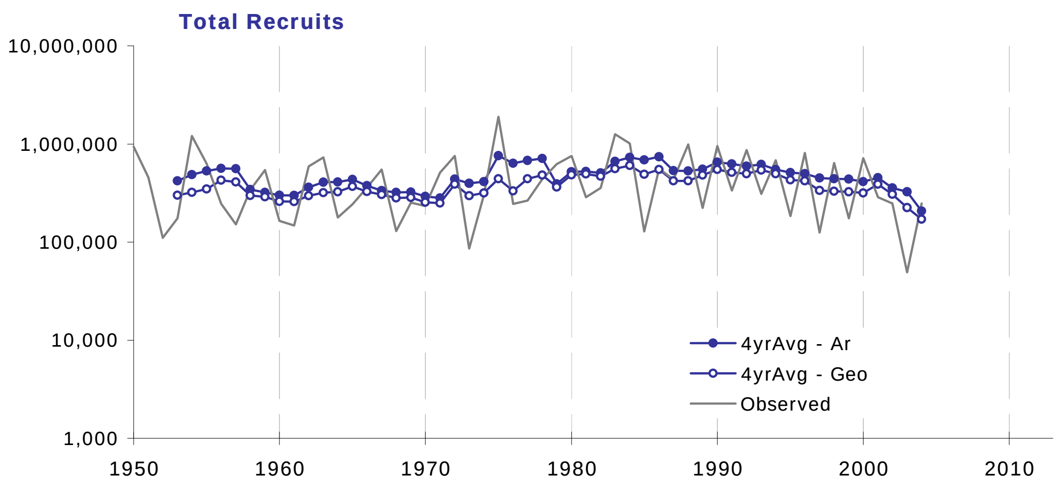
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	151,000	168,000	195,000	225,000	264,000
Rick(1970-2004)	152,000	170,000	192,000	238,000	274,000
Rick(1990-2004)	155,000	172,000	197,000	219,000	246,000
SmRick(1950-2004)	78,000	84,000	90,000	98,000	107,000
RBRick(1950-2004)	99,000	129,000	164,000	205,000	249,000

Francois-Fraser-S







CASE 2: NORTH BARRIERE-ES *DE NOVO* (AMBER)

(Management stock name: Fennell; Run-Timing Group: Early Summer)

Background: the original population was extirpated by the construction of a downstream dam; after dam removal and subsequent hatchery transplants, this population re-established as a new (de novo) hatchery-origin (see Grant et al. 2011 for further details); only data post 1970, after this CU started to re-build was used in status evaluations.

Integrated Status

A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	A	A	r	A	A

Status Commentary

- the Amber integrated status was driven by consistently Amber (or better) relative-abundance metric statuses across 29 of 30 paired upper and lower benchmark combinations (probability levels and model forms); however, the lower benchmarks were flagged as being low (ranging from 300 to 3,000, depending on model form and probability level) relative to the COSEWIC Criteria D1 values of 1,000 and 250 used to designate COSEWIC risk categories; very recent productivity appears to be stable or increasing; although this CU's short-term trends in abundance status is Red, this metric was given a low weight given this CU is coming off a period of higher abundances; Green long-term trend status (although some groups felt long-term trends should be given lower weight given the higher exploitation rates in earlier years); one group agreed on a provisional Red (indicated by the small 'r') for their group's integrated status, although individual participant designations for this group included a balance of Ambers and Reds;
- some concerns were flagged regarding the stock-recruitment data, given what was thought to be unrealistically high productivities early in the time series (prior to 1980); as a result, there was some concern regarding the use of this early data in relative-abundance benchmark estimation; this also resulted in a lower concern over the apparent decreasing productivity trend for this CU, since if the early suspect data were eliminated, the decreasing trend would not be nearly as pronounced;
- absolute spawner abundance was flagged as being relatively low and decreasing, with one year in the past four below COSEWIC Criteria D1, which led one group to a Red designation

Points of Discussion

- discussion about the appropriate weight for the long-term trend metric (which was Green for this CU), given this is a new hatchery-origin CU, so early abundances were negligible;
- data issues were flagged for data prior to 1980, where recruit to spawner ratios were greater than 20:1, which may account for part of the observed decreased trend in productivity; it was suspected that issues with the data were linked to recruitment estimates, which would be particularly uncertain during the early period of low abundances for this CU;
- discussion regarding relative importance of the WSP relative-abundance benchmark estimated for this specific CU compared to the COSEWIC criterion D1. Some participants leaned towards a Red designation for this CU, given this CUs absolute abundances were close to this criterion's benchmarks;

North Barriere-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1968	A	A	A	

Time-varying Models

Rick1990	A	A	A
RBRick1950?	A	A	A

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.27

Current gen. avg.

2,217

Historical Avg (44 Obs)

1,742

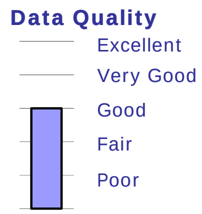
SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

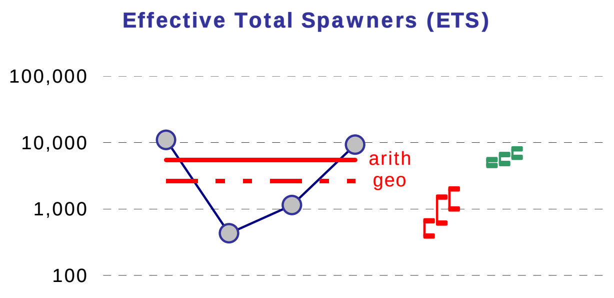
-68%

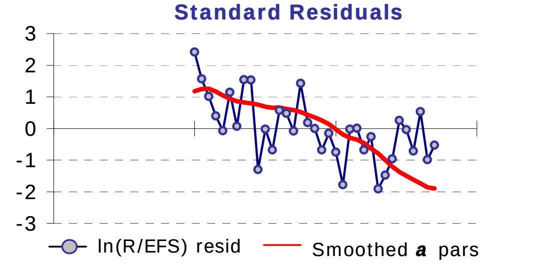
Prob. of 25% Decl. over 3 Gen

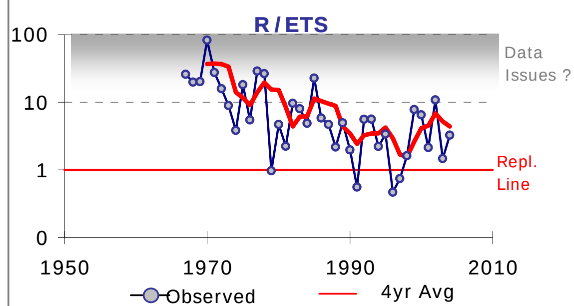
100%

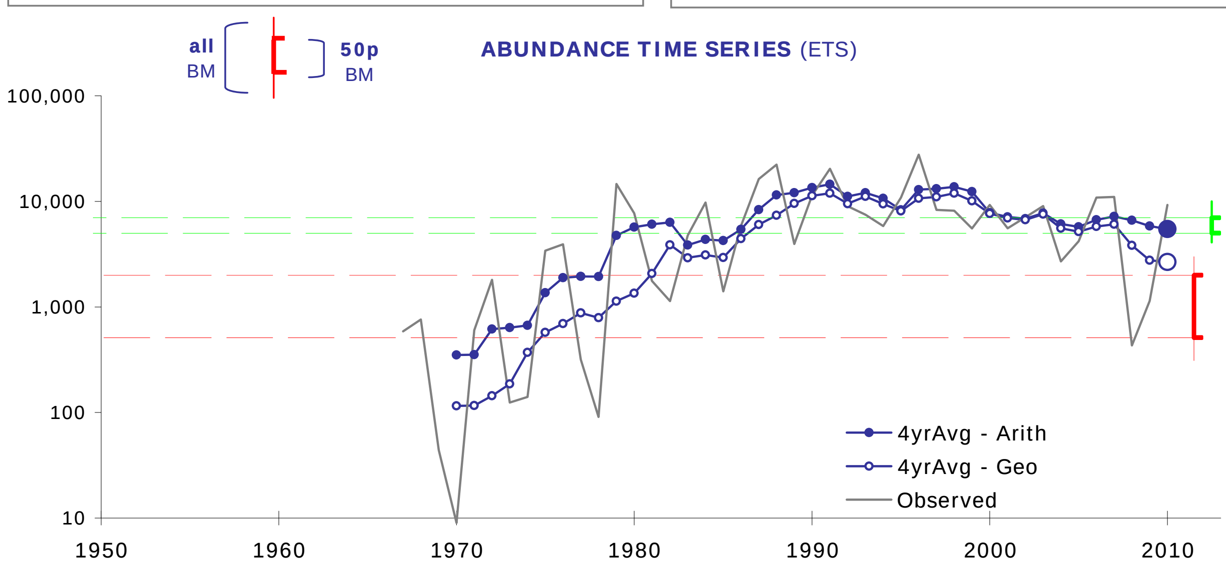


	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1968	A	A	A	A	A		G	G	G	G	A
Rick1990	A	A	A	A	A		G	G	A	A	A
RBRick1950?	A	A	A	A	R		G	A	A	A	A









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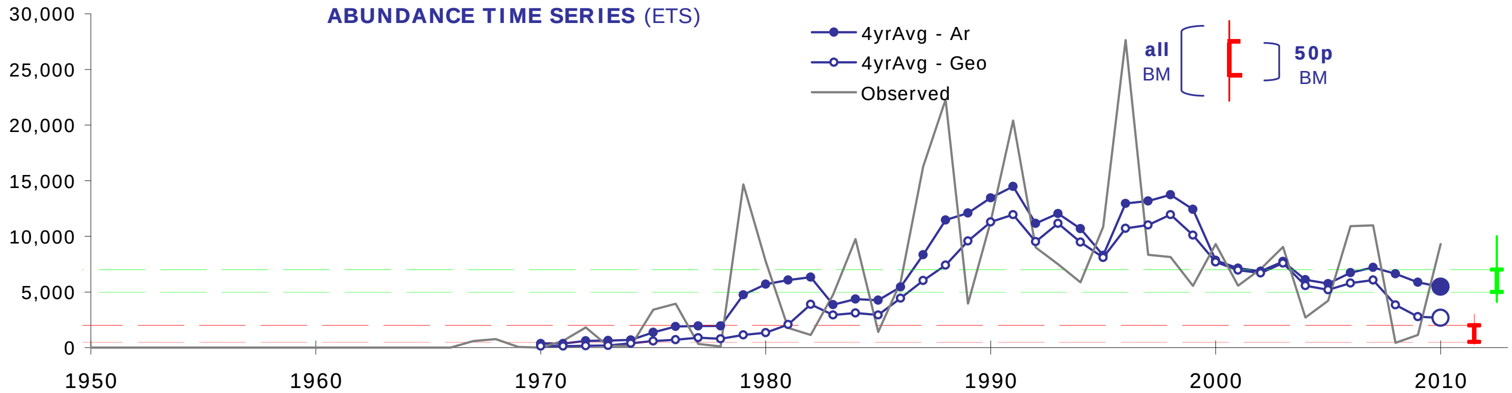
Retrospective Pattern in WSP Metrics

North Barriere-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	A	R	R	R	R	R	R	R	R	R	R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1968	G	G	G	G	G	G	G	G	A	A	A
Rick1990	G	G	G	G	A	A	G	G	A	A	A
RBRick1950?	G	A	A	G	A	A	A	A	A	A	A

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	27,628	10,991	10,991
Med	5,554	6,316	5,220
Min	9	431	431

Number of Observations in a range

	All Yrs	Last 12	Last 4
> 5000	23	8	2
2500–5000	6	2	0
1000–2500	5	1	1
500–**1000**	3	0	0
250–500	2	1	1
0–**250**	5	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

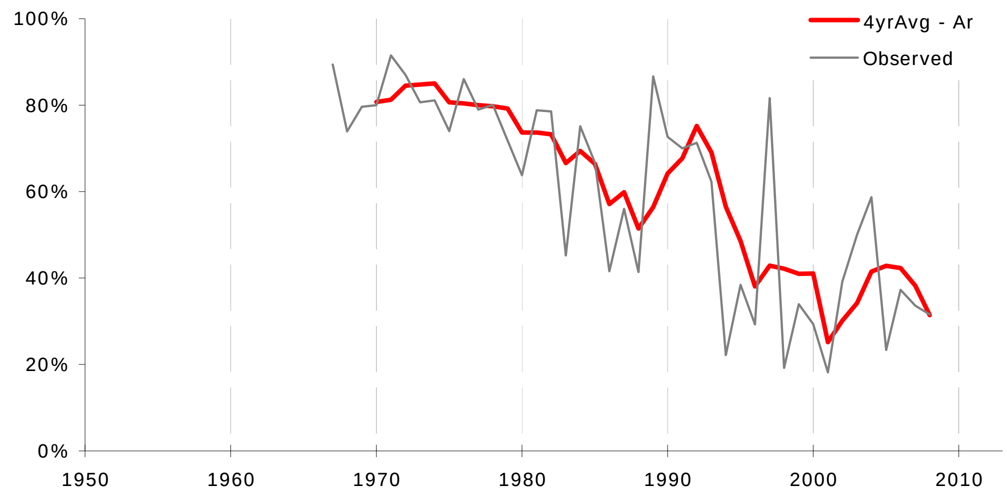
Lower Benchmark Estimates (S-gen)

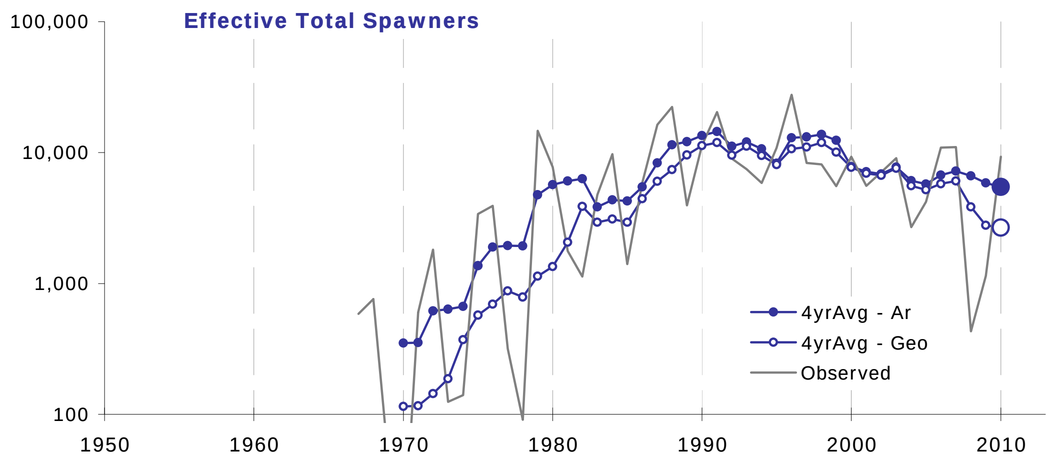
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1968-2004)	310	390	510	660	820
Rick(1990-2004)	440	610	940	1,500	2,200
RBRick(1950?-2004)	1,000	1,000	2,000	2,000	3,000
(-)					
(-)					

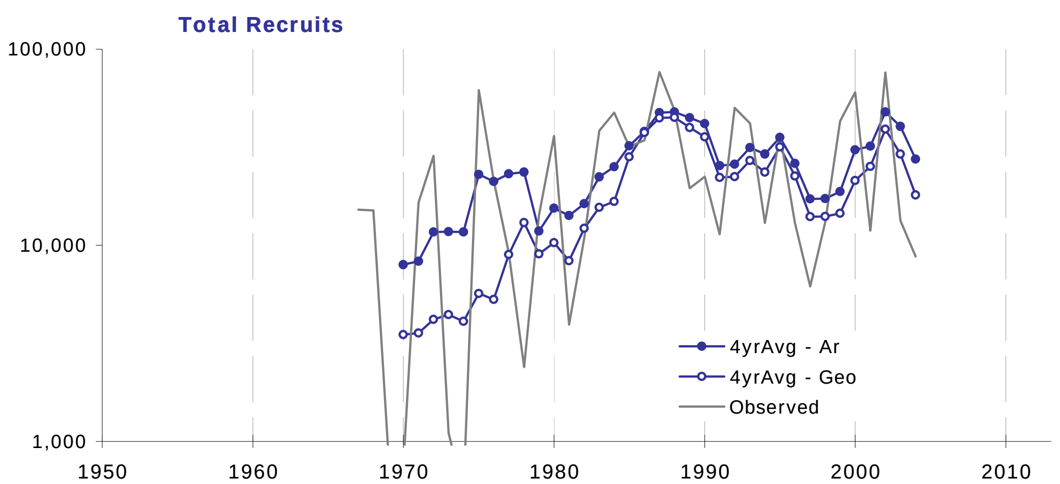
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1968-2004)	4,100	4,500	5,000	5,500	6,200
Rick(1990-2004)	4,300	4,800	5,600	6,600	8,000
RBRick(1950?-2004)	5,000	6,000	7,000	8,000	10,000
(-)					
(-)					

North Barriere-ES







CASE 3: CHILLIWAK-ES (RED/AMBER)

(Management stock name: Misc.-Chilliwack Lake & Dolly Varden Creek; Early Summer)

Background: this system is relatively isolated and was only consistently assessed starting in the 1970's, therefore the escapement time series for this CU is relatively short.

Integrated Status

R	A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	A	R	a	A	A

Status Commentary

- the differences in integrated status determination between groups, and therefore, to the final mixed Red/Amber designation, was due to different interpretations of the same limited information for this CU particularly related to whether or not this CU was cyclic;
- the factors that indicated an Amber integrated status designation was the Amber status for the abundance metric using the arithmetic average of recent abundances; in addition, this Amber integrated status was also designated due to the high abundance (~40,000 total spawners) years, as being well above the COSEWIC criterion D1 (assuming cyclic population dynamics)
- the factor that indicated a Red integrated status designation, was the Red status for the abundance metric using the geometric average of recent abundances; in addition, there are some recent years where abundances fall close to the COSEWIC criterion D1, when comparing all recent escapement data (assuming non-cyclic population dynamics)
- there were considerable gaps in the information available to assess this CU's integrated status; specifically, the short escapement time series precluded the estimation of trend metric statuses, and similarly, the absence of recruitment data precluded the estimation of abundance metric statuses uses the standard methods or to plot stock productivity trends; therefore, the only data which were available to evaluate this CUs status were very recent escapement data and benchmarks using the carrying capacity information for this CU's rearing lake;

Points of Discussion

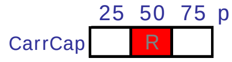
- given this CU has exhibited considerable inter-annual variation in abundance, there was considerable discussion on whether or not this CU is cyclic (which cannot be reconciled due to the short time series available); status designations between groups was influenced by each group's assumptions regarding this CU's population dynamics (cyclic versus non-cyclic); the cyclic versus non-cyclic debate also influenced group's interpretation of the very low (possibly weak) cycle years when high (possibly dominant) cycle years are so abundant;
- discussion regarding whether CUs, such as this one, with limited data should be automatically designated Red;
- since this CU is visually assessed, escapement estimates may be an underestimate;
- concerns were raised regarding the use of carrying capacity of the lake as a benchmark in abundance metrics, since this metric has not been evaluated rigorously in simulation models compared to the standard benchmarks used for CUs with recruitment data;

Chilliwack-ES

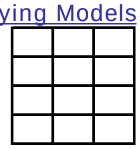
ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models



Time-varying Models



LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

#N/A

Current gen. avg.

2,398

Historical Avg (11 Obs)

3,191

SHORT-TERM TREND
(Eff. Female Spawners)

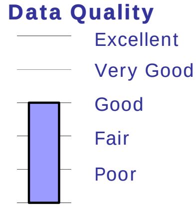
3 Gen Change
(in 4yr Avg)

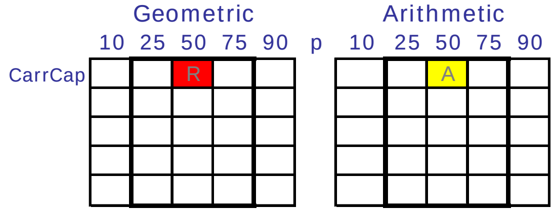
#N/A

Prob. of 25% Decl. over 3 Gen

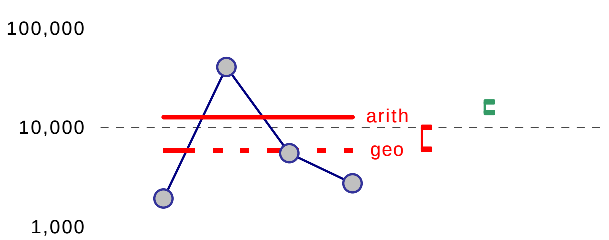
#N/A

Data Quality



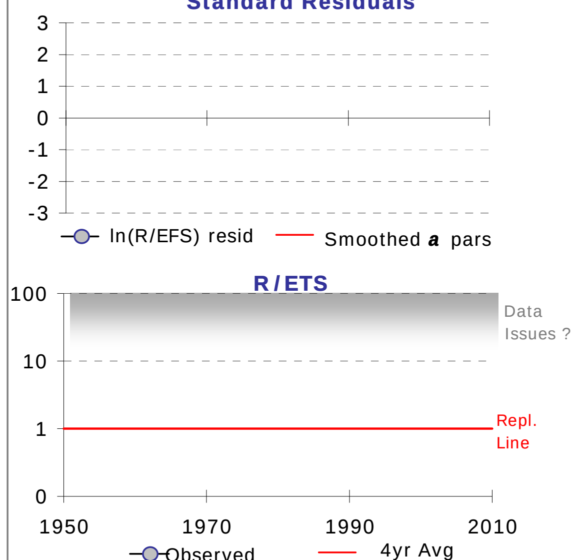


Effective Total Spawners (ETS)

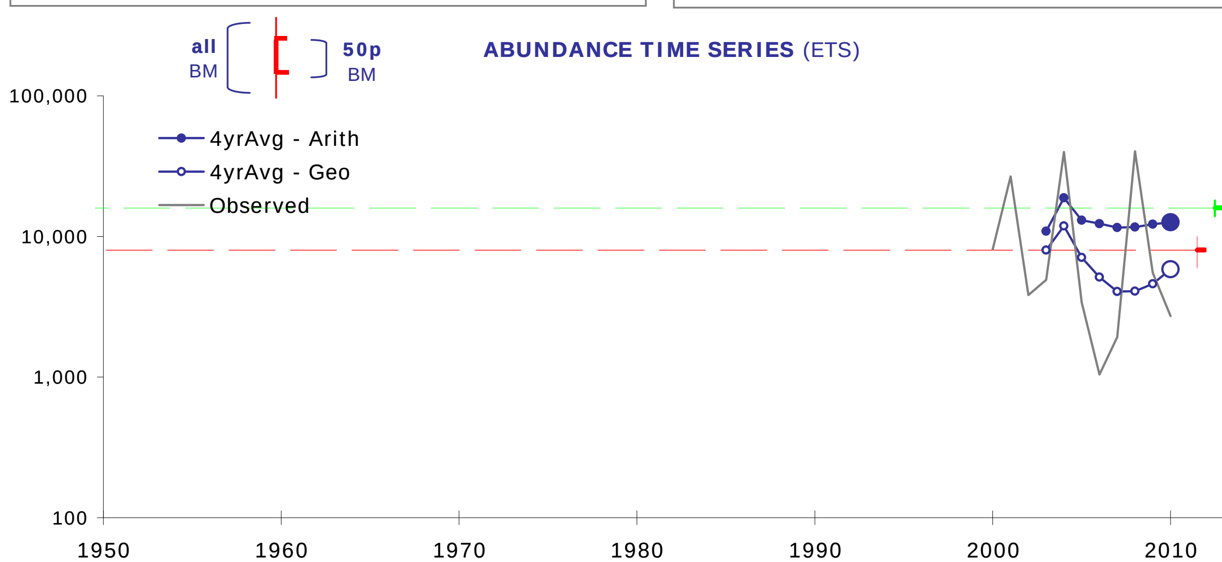


PRODUCTIVITY TIME SERIES

Standard Residuals

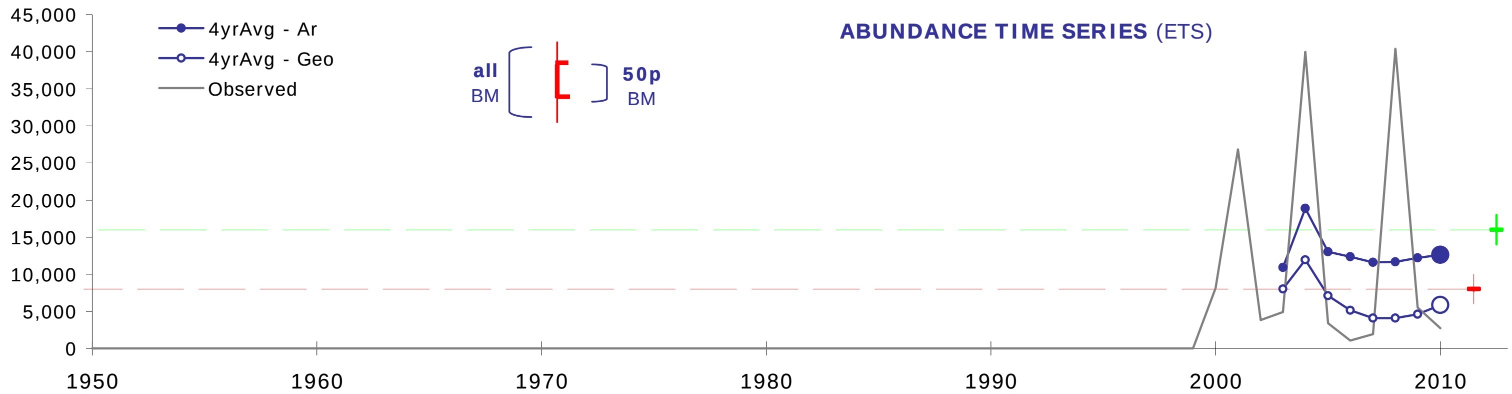


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Chilliwack-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

CarrCap				R	A	R	R	R	R	R	R

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	40,404	#N/A	40,404
Med	4,920	#N/A	4,110
Min	1,046	#N/A	1,923

Number of Observations in a range

	All Yrs	Last 12	Last 4
5000	5	5	2
2500	4	4	1
1000	2	2	1
500	0	0	0
250	0	0	0
0	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

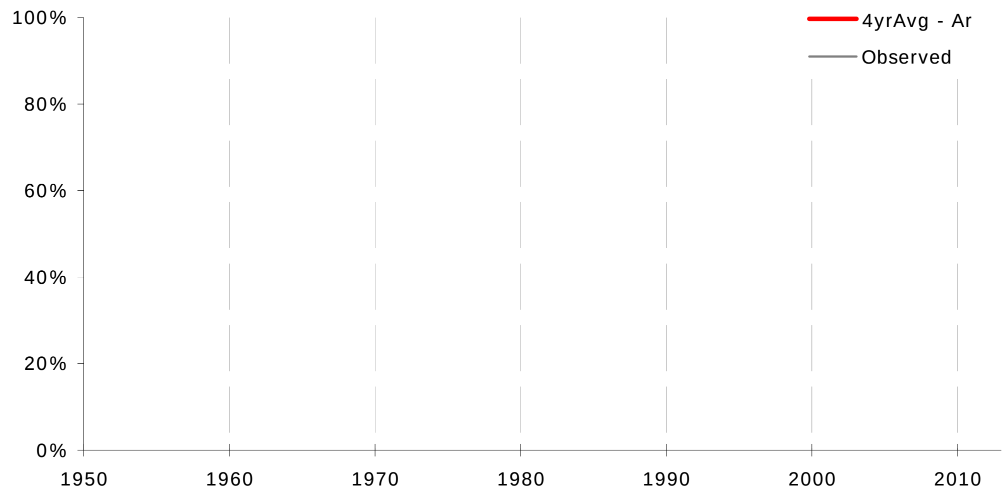
Lower Benchmark Estimates (S-gen)

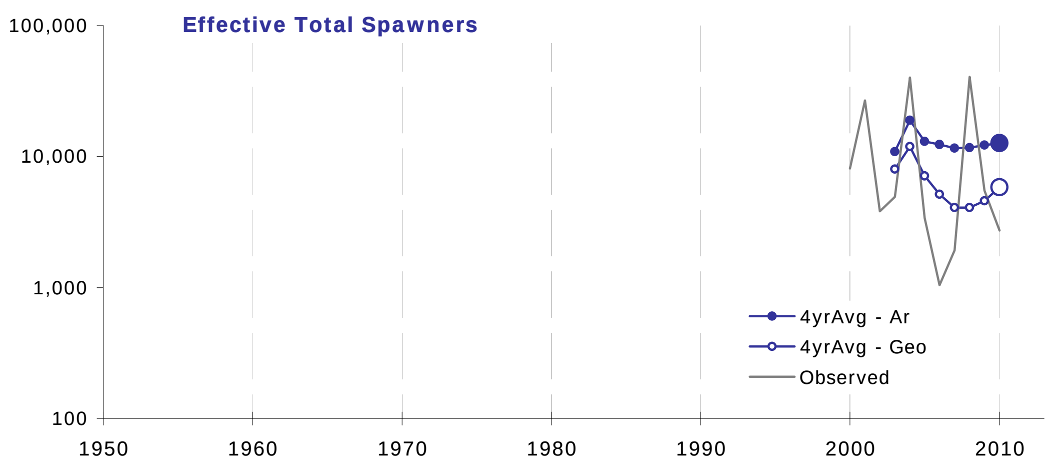
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
CarrCap(-)		6,000	8,000	10,000	
(-)					
(-)					
(-)					
(-)					

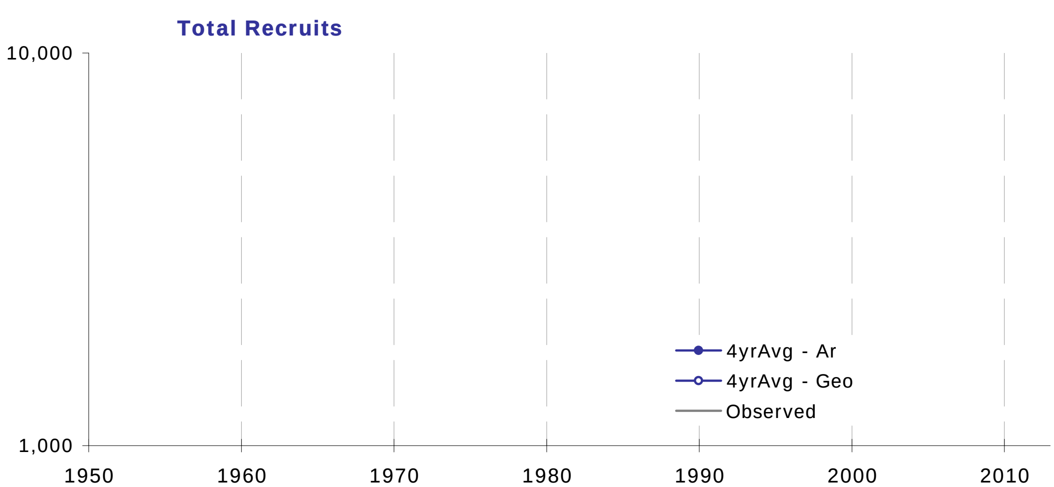
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
CarrCap(-)		14,000	16,000	18,000	
(-)					
(-)					
(-)					
(-)					

Chilliwack-ES







CASE 4: WIDGEON-RIVER TYPE (RED)

(Management stock name: Miscellaneous Non-Shuswap; Run-Timing Group: Late)

Background: this CU is a naturally small population, which occupies a small geographic area; this CU is a river-type CU (migrate to the ocean after gravel emergence) that is adapted to tidal conditions of Widgeon Slough; it is considered a very unique Fraser Sockeye population (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	R	R	R	R	R

Status Commentary

- The Red integrated status was driven by both this CU's low absolute abundance (falling below COSEWIC D1 for a number of recent years) and the Red status for the long-term trend metric; specifically, the current generational average abundance (89) is extremely small; this CU does not have recruitment data, therefore, there are no relative-abundance metric statuses available;
- the short-term trend metric, which indicates a Green status, and recent escapement trends, does provide some encouraging indications of improving trends, however, these trends were not sufficient to change this CU's integrated status designation from Red; although the short-term trends in abundance metric was Green in status, this metric was not given a high weight given this CU is re-building from a previous period of record-low abundances;

Points of Discussion

- discussion on whether COSEWIC criterion D1 automatically over-rides WSP metrics statuses; for CUs with no relative-abundance metric data, development of WSP-specific absolute abundance metrics was recommended;
- questions regarding whether the recent increase in abundance was caused by increased productivity for this CU or decreased exploitation rates, which would affect the interpretation of these increases; since recruitment and exploitation rate data are not available for this CU, this cannot currently be assessed;
- regardless of short-term trends, it was noted that this CU is triggering three COSEWIC criteria (small abundance, small geographic area, and limited number of populations); this CU is naturally quite small given its limited spawning habitat, therefore, it is likely that this CU will always trigger a poor status designation, which cannot be altered by human intervention;
- additional information was requested for this CU including the following: 1. difference between effective female spawners and viable female spawners; 2. exploitation rate pattern; 3. area of occupancy; and 4. number of populations.

Widgeon (River Type)

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.46

Current gen. avg.
89

Historical Avg (61 Obs)
193

SHORT-TERM TREND
(Eff. Female Spawners)

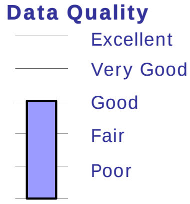
3 Gen Change
(in 4yr Avg)

736%

Prob. of 25% Decl.
over 3 Gen

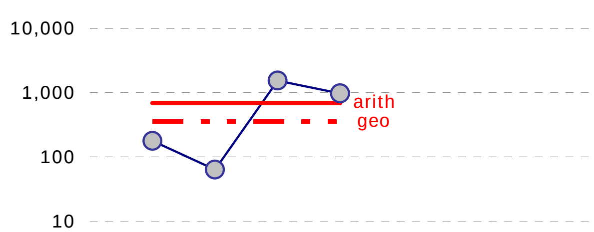
0%

Data Quality



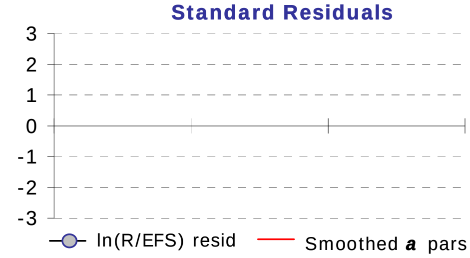
Geometric | Arithmetic
10 25 50 75 90 p 10 25 50 75 90

Effective Total Spawners (ETS)

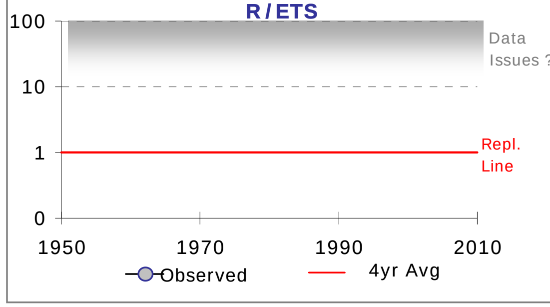


PRODUCTIVITY TIME SERIES

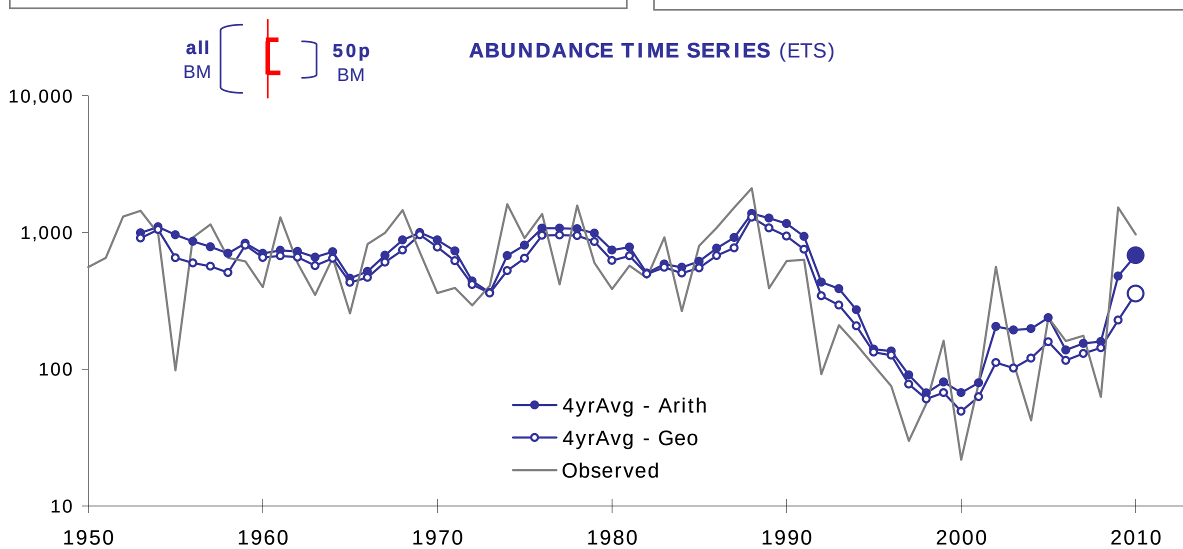
Standard Residuals



R/ETS

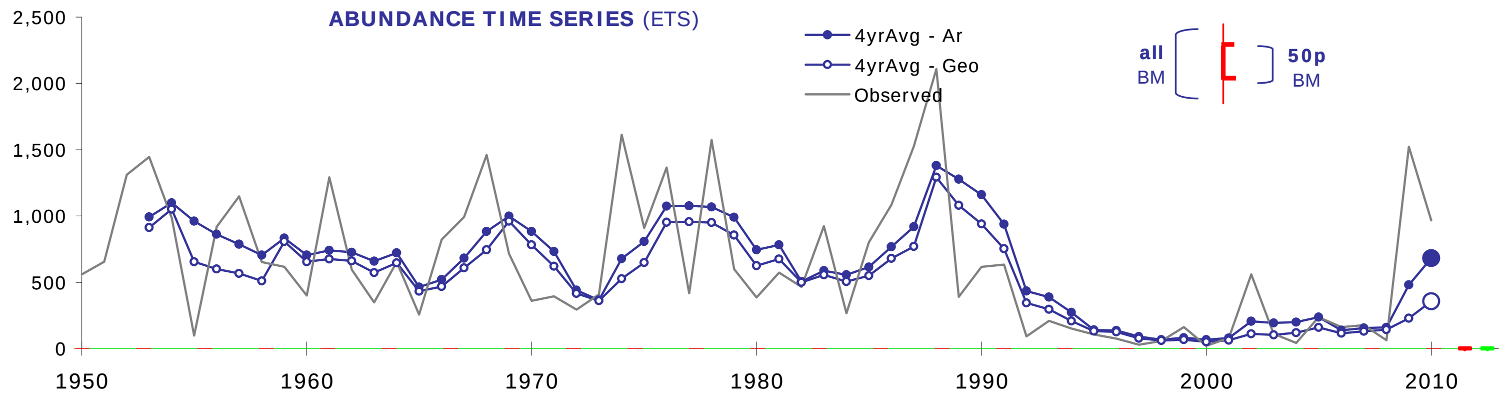


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Widgeon (River Type)



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G G G G G G G G G G G G G G G G G G G G G G G A A R R R R R R R R R R R R R R R R

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

G G G A G G G G G G G G G G G R R R A G G G G R R R R R R R R R R R R R G G G G G

Abundance BM Metric (comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	2,109	1,522	1,522
Med	560	161	571
Min	22	22	63

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
>5000	0	0	0
2500–5000	0	0	0
1000–2500	12	1	1
500–1000	20	2	1
250–500	12	0	0
0–250	17	9	2

Small Population Benchmarks (COSEWIC Criterion D1)

Lower Benchmark Estimates (S-gen)

	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
(-)					
(-)					
(-)					
(-)					
(-)					

Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
(-)					
(-)					
(-)					
(-)					
(-)					

CASE 5: CHILKO-S (GREEN)

(Management stock name: Chilko; Run-Timing Group: Summer)

Background: this CU is amongst the least impacted by the Hells Gate landslide of upper Fraser Sockeye populations; this lake was fertilized in 1988 and 1990-1993; although this CU is distinct from the Chilko-ES CU (different run timing and spawning locations in the Chilko watershed), the data for this CU currently has not been disaggregated from the smaller Chilko-ES CU; since the Chilko-ES abundance comprises less than 10% of the combined Chilko-S & Chilko-ES aggregate, status information for the aggregate is assumed to represent this larger Chilko-S CU (see Grant et al. 2011 for further details).

Integrated Status

G *(provisional status, given recent decreases in short-term trends in abundance and productivity)*

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
G	G	g	g	G	G

Status Commentary

- the Green integrated status was driven by consistently Green relative-abundance metric statuses across all benchmark probability levels and model forms; high data quality was noted for this CU;
- the short-term trend metric (Red status) did not weigh heavily in status determination, since current abundance indicated by both relative-abundance metric status and absolute abundance, was respectively, Green in status and high (no abundances on the time series below 5,000 spawners); further, this CU is returning to average, following a previous period of high abundance; in very recent years, both abundance and productivity have increased;
- this CU's integrated Green status was flagged as provisional, given the potential for this Green status to decreases to a poorer WSP status zone (Amber or Red) in the short-term, if these recent productivity (recruits/spawner) and abundance trends persist; a few recent years of below replacement productivity, although this could be linked to high spawner abundance (density-dependence);
- the Red short-term metric status does raise the importance of assessment frequency, since if this decreasing abundance trend persists, then status on other metrics could change (to Amber or Red WSP status zones);

Points of Discussion

- Workshop participants debated whether status evaluation should reflect only the current status, or anticipate future status based on current trends. Most participants agreed that this CU is currently in the green status zone, but short-term trend raises a flag to track it closely. Some participants argued for an amber designation to emphasize the worrisome trend.

Chilko-S & Chilko-ES aggregate

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	G	G	G	

Time-varying Models

	25	50	75
Rick1970	G	G	G
Rick1990	G	G	G
SmRick1950	G	G	G
RBRick1950	G	G	G

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.23

Current gen. avg.
163,789

Historical Avg (61 Obs)
132,857

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-74%

Prob. of 25% Decl. over 3 Gen

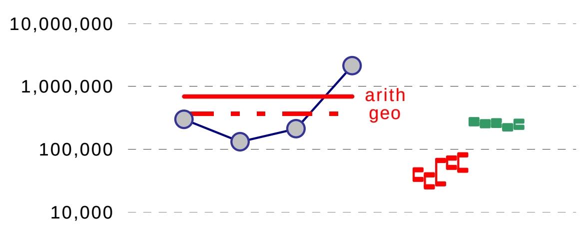
100%

Data Quality

Excellent
Very Good
Good
Fair
Poor

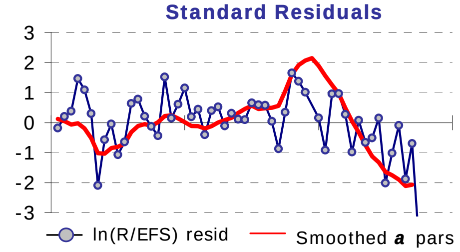
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1950	G	G	G	G	G		G	G	G	G	G
Rick1970	G	G	G	G	G		G	G	G	G	G
Rick1990	G	G	G	G	G		G	G	G	G	G
SmRick1950	G	G	G	G	G		G	G	G	G	G
RBRick1950	G	G	G	G	G		G	G	G	G	G

Effective Total Spawners (ETS)

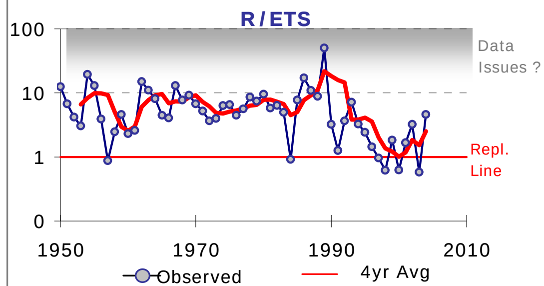


PRODUCTIVITY TIME SERIES

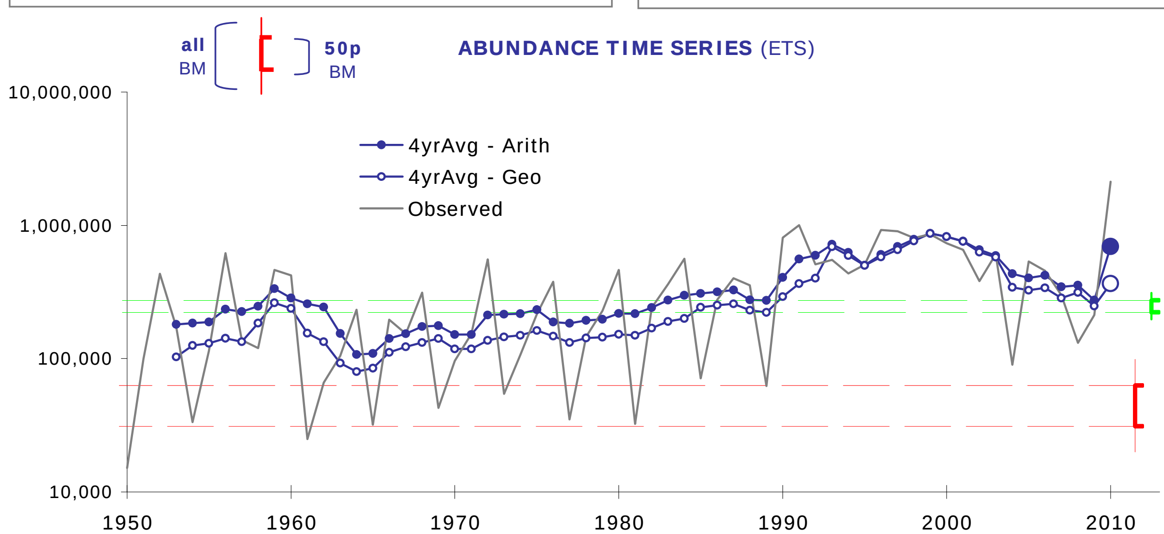
Standard Residuals



R/ETS

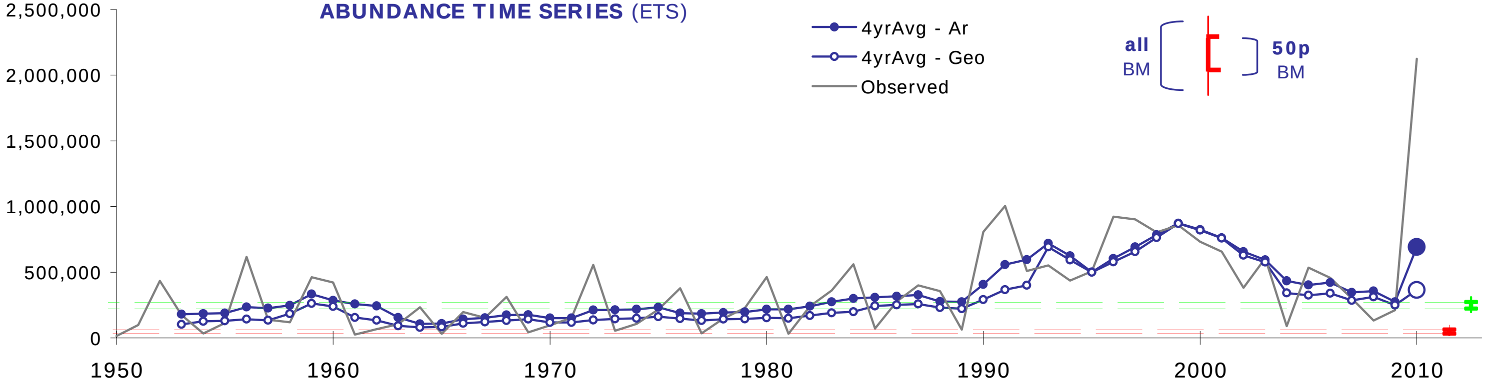


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Chilko-S & Chilko-ES aggregate



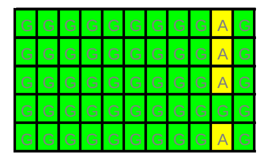
Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950
Rick1970
Rick1990
SmRick1950
RBRick1950



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	2,125,393	2,125,393	2,125,393
Med	276,194	496,146	255,898
Min	15,141	90,273	131,678

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
Total	61	12	4
5000–2500	0	0	0
2500–**1000**	0	0	0
1000–500	0	0	0
500–**250**	0	0	0
250–0	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

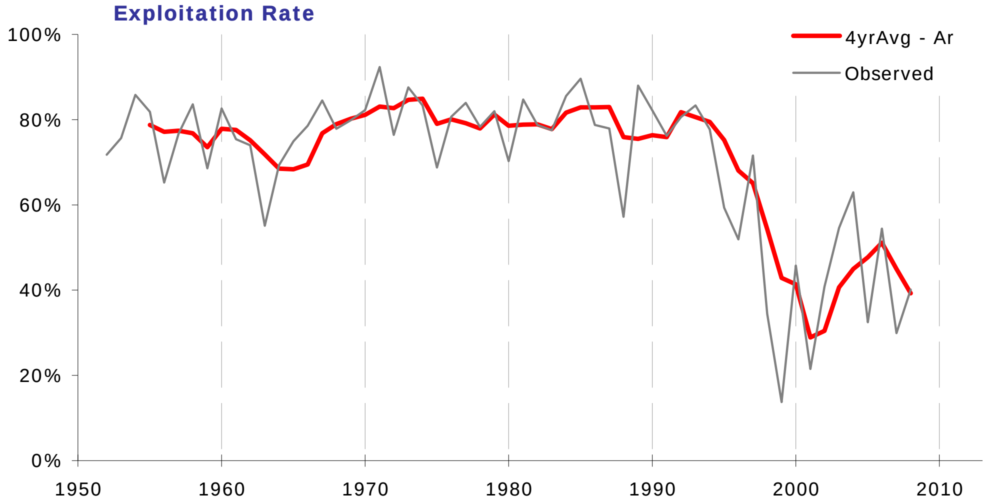
Lower Benchmark Estimates (S-gen)

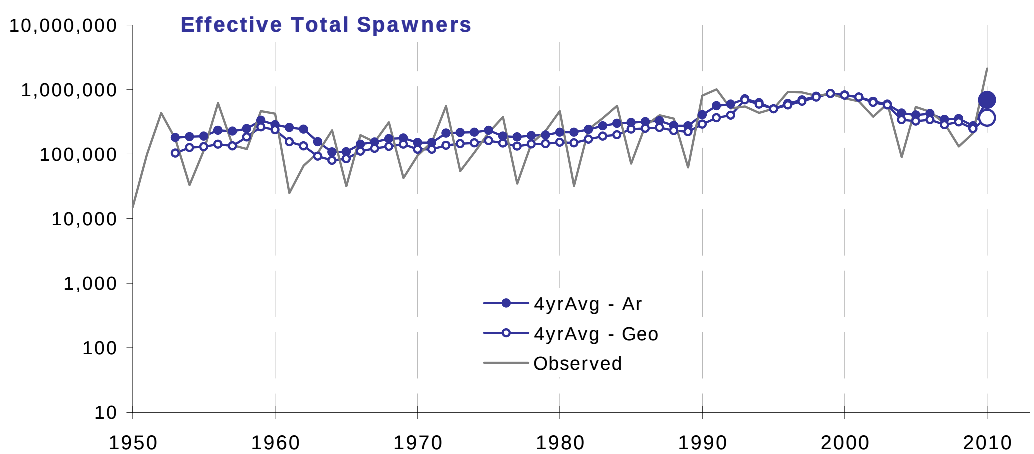
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	28,000	33,000	39,000	47,000	54,000
Rick(1970-2004)	20,000	25,000	31,000	39,000	50,000
Rick(1990-2004)	21,000	28,000	43,000	66,000	92,000
SmRick(1950-2004)	44,000	51,000	61,000	72,000	85,000
RBRick(1950-2004)	37,000	46,000	63,000	81,000	99,000

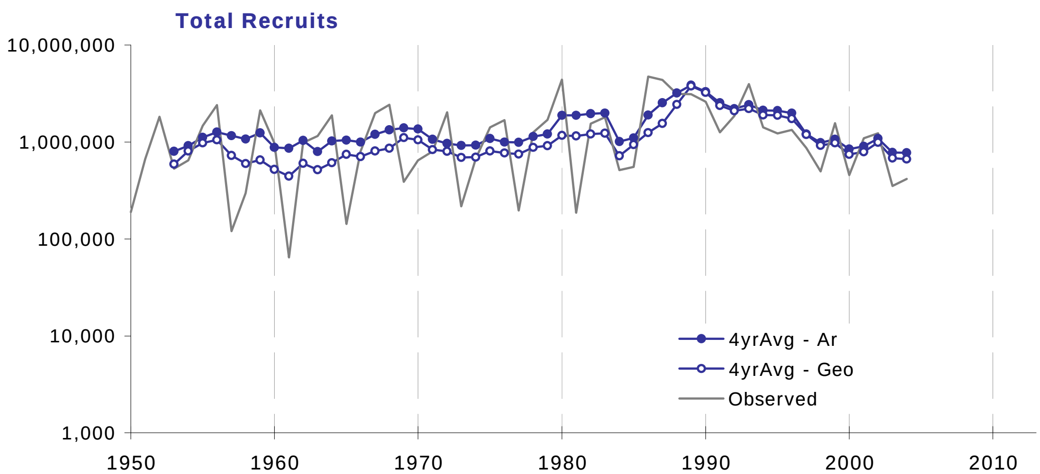
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	238,000	252,000	273,000	294,000	311,000
Rick(1970-2004)	215,000	235,000	252,000	274,000	304,000
Rick(1990-2004)	216,000	239,000	258,000	285,000	310,000
SmRick(1950-2004)	200,000	209,000	222,000	236,000	253,000
RBRick(1950-2004)	197,000	223,000	250,000	278,000	309,000

Chilko-S & Chilko-ES aggregate







CASE 6: CHILKO-ES (DATA DEFICIENT)

(Management stock name: Chilko; Run-Timing Group: Summer)

Background: although this CU is distinct from the Chilko-S CU (different run timing and spawning locations in the Chilko watershed), the data for this CU currently has not been disaggregated from the larger Chilko-S CU; the Chilko-ES abundance comprises less than 10% of the combined Chilko-S & Chilko-ES aggregate (see Grant et al. 2011 for further details).

Integrated Status

DD

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
DD	DD	DD	DD	DD	DD

Status Commentary

- integrated status could not be evaluated for this CU given there are no independent data available for this CU, separate from the Chilko-S/Chilko-ES aggregate which is comprised of ~90% of the Chilko-S CU (see Points of Discussion below);
- participants recommended that an escapement index and proxy exploitation rate for this Chilko-ES CU be developed to provide information for subsequent status evaluations;

Points of Discussion

- discussion about meaning of "data deficient" in this context, given that some survey data is available and a time series or index of abundance could be constructed; once data is extracted for this CU specifically, this CU may in fact have higher data quality than many other Pacific Salmon CUs;

CASE 7: HARRISON (U/S)-L

(Management stock name: Weaver; Run-Timing Group: Late)

Background: a channel started operations in 1965 to re-build production from the Weaver stock, and subsequently allow for increased harvest opportunities on the Late Run CUs; the channel was also constructed to protect this CU from periodic flooding events; Sockeye are preferentially diverted by channel operators into the channel rather than the creek in this system; channel freshwater production is higher than the adjacent creek (Weaver Creek) (see Grant et al. 2011 for further details).

Integrated Status

A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	A	A	A		a

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Amber integrated status was driven by the mostly Amber abundance metric status across the benchmark probability levels and model forms; although there are some Red statuses at 75% and 90% probability levels for certain models; the long-term trend metric was also Amber; one group agreed on a provisional Amber status (indicated by the small 'a') for their group's integrated status, although individual participant designations for this group included two Reds and four Ambers due to the Red statuses on the relative-abundance-metric benchmarks at higher probability levels for certain model forms and the decreasing abundance trends;
- frequent monitoring of the short-term trend (which is Red in status) was recommended, given it could produce changes in other metric statuses, and therefore, integrated status, if this trend persists; this metric was not weighted high given absolute abundance is currently high (generational average: 8,765 effective female spawners) with no years on the time series falling below COSEWIC Criteria D1 of 1,000.
- this CU has not exhibited systematic trends in CU productivity, although the productivity estimates may be biased high for certain years; biased high productivity may produce smaller lower benchmarks, therefore, the abundance metric status could be optimistic (this is an assumption that should be evaluated); in very recent years productivity has been low, but has remained above replacement;

Harrison (U/S)-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75
Rick1966	A	A	A

p

Time-varying Models

Rick1990	A	A	A
SmRick1966	A	A	R

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.65

Current gen. avg.

8,765

Historical Avg (61 Obs)

13,552

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-39%

Prob. of 25% Decl. over 3 Gen

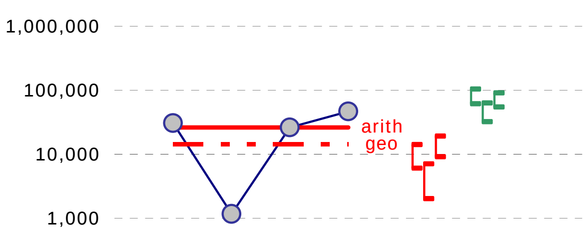
68%

Data Quality

- Excellent
- Very Good
- Good
- Fair
- Poor

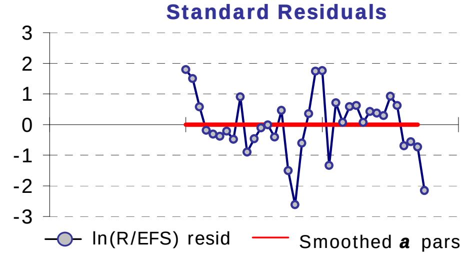
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1966	A	A	A	A	R		A	A	A	A	A
Rick1990	A	A	A	A	A		G	A	A	A	A
SmRick1966	A	A	A	R	R		A	A	A	A	R

Effective Total Spawners (ETS)

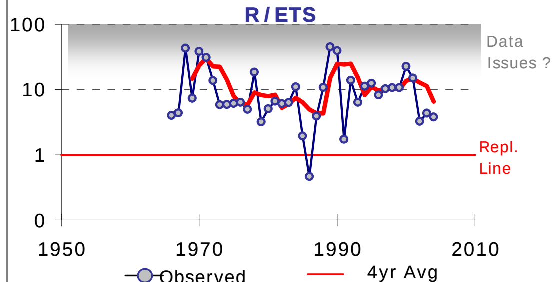


PRODUCTIVITY TIME SERIES

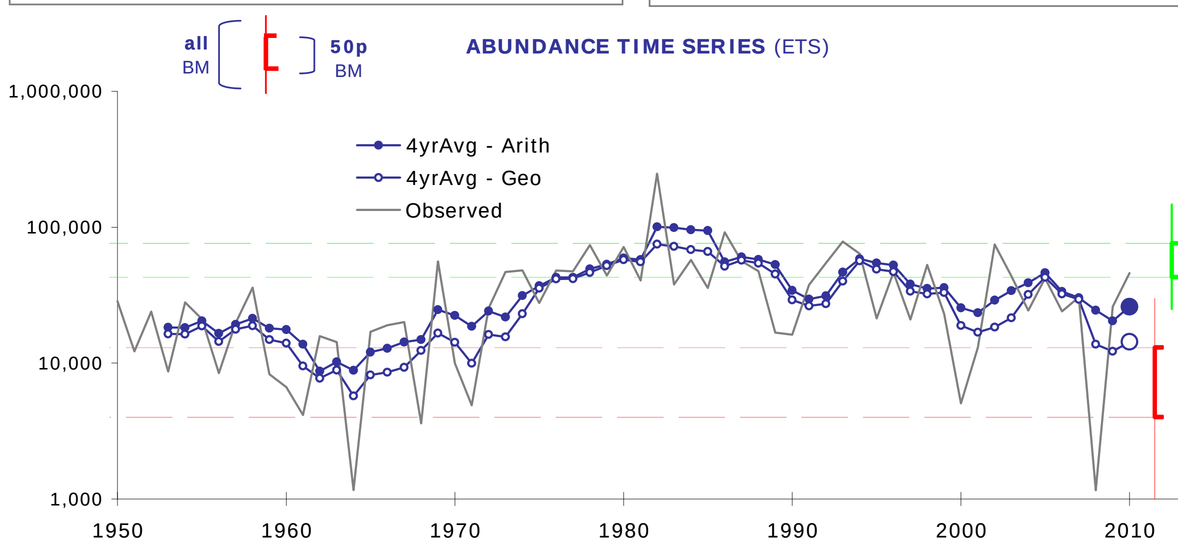
Standard Residuals



R/ETS

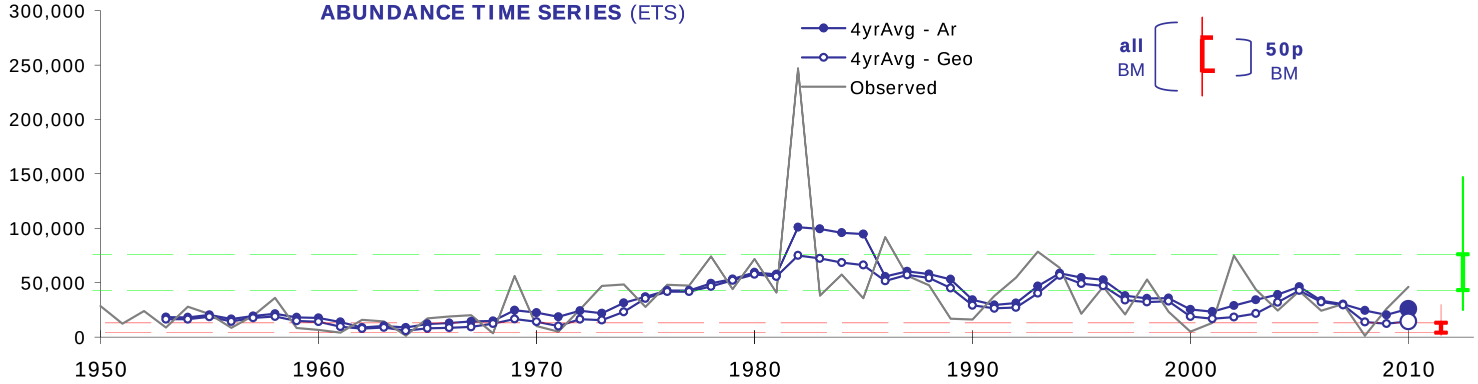


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Harrison (U/S)-L



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	A

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	R	R	R	R	R	R	R	R	R	G	A	R	R	R	R	R	A	G	A	R	R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Rick1966	A	A	A	A	A	A	A	A	A	A	A
Rick1990	A	A	A	A	A	A	A	A	A	A	A
SmRick1966	A	A	A	A	A	A	A	A	A	R	A

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	247,021	74,795	46,141
Med	27,769	25,202	28,277
Min	1,162	1,162	1,162

Number of Observations in a range

	All Yrs	Last 12	Last 4
(>5000)	56	11	3
5000–2500	3	0	0
2500–**1000**	2	1	1
1000–500	0	0	0
500–**250**	0	0	0
250–0	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

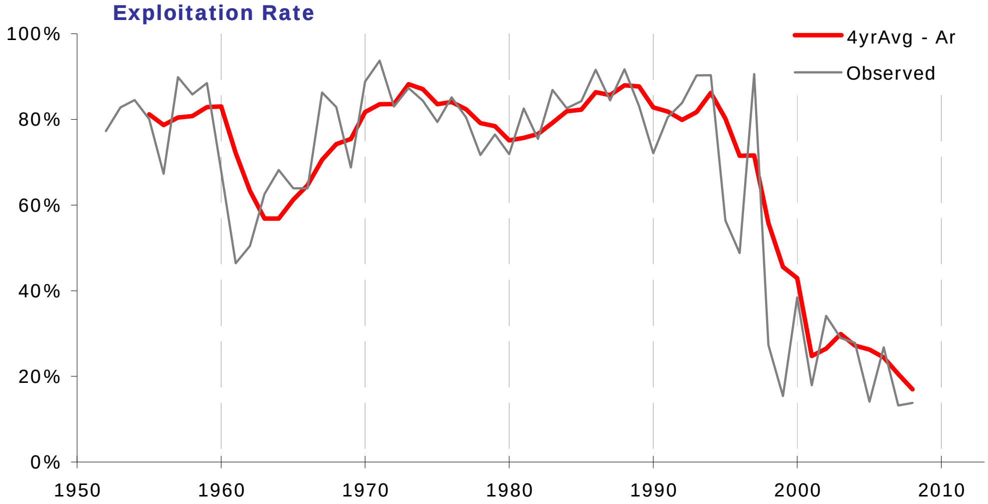
Lower Benchmark Estimates (S-gen)

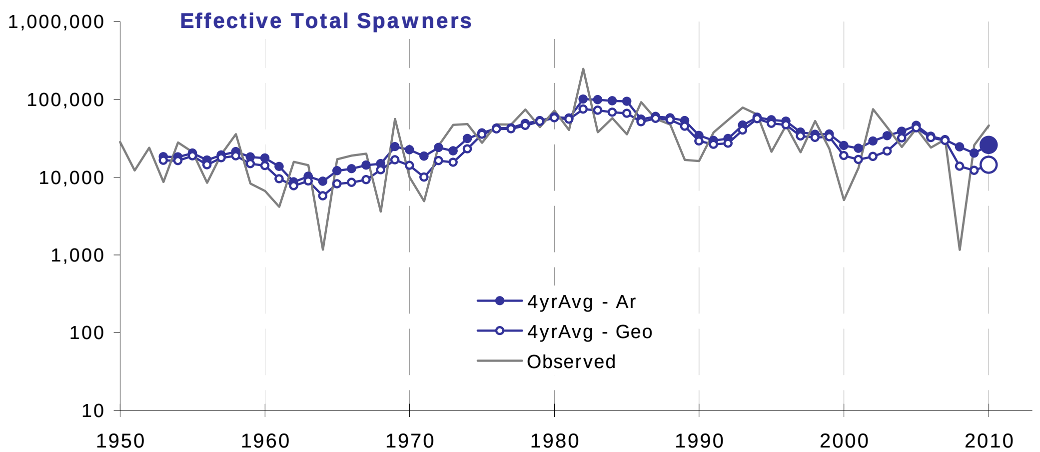
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1966-2004)	4,000	6,000	9,000	14,000	23,000
Rick(1990-2004)	1,000	2,000	4,000	7,000	13,000
SmRick(1966-2004)	7,000	9,000	13,000	19,000	30,000
(-)					
(-)					

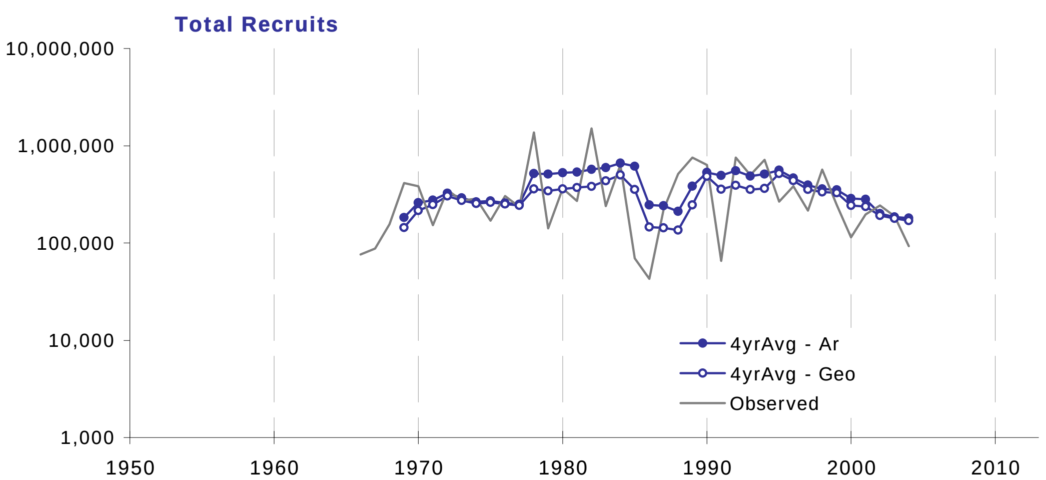
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1966-2004)	52,000	61,000	76,000	103,000	147,000
Rick(1990-2004)	25,000	32,000	43,000	63,000	99,000
SmRick(1966-2004)	45,000	54,000	67,000	90,000	133,000
(-)					
(-)					

Harrison (U/S)-L







CASE 8: NADINA-FRANCOIS-ES MIXED CU (RED)

(Management stock name: Nadina; Run-Timing Group: Early Summer)

Background: due to channel construction in 1973, two separate pre-channel runs (with different run timing and spawning locations) merged into this new mixed CU; abundance data used for metric status evaluation only included post-channel years (post-1973) (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
r	r	R	R		R

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Red integrated status was driven by consistently Red abundance metric status across 23 of 30 paired upper and lower benchmark combinations (probability levels and model forms); Red status for all probability levels at or above the median (50%) probability level; in addition, this CU has exhibited systematic decreases in productivity;
- although the short-term trend metric was also Red in status, this metric was not given a high weight in status evaluations given this CU is returning from a period of high abundance (particularly the year 2000); similarly the Green long-term trend metric was not given a high weight, given the changes in population structure from the early time series (spawning channel constructed in 1973);
- a few groups assigned this CU a provisional Red status (indicated by the small 'r') for their group's integrated status due to concerns regarding relative-abundance-metric benchmarks (see Points of Discussion below);

Points of Discussion

- participants wanted to see more detailed model diagnostics for the Spawner-Recruit models that underlie the estimates of abundance benchmarks, in order to determine which are most appropriate; concern that lower abundance metric benchmark estimates are driven down by the large escapements (and corresponding large productivity) particularly for the year 2000 (for this reason groups wanted additional confirmation that this data point is accurate);
- there is generally low contrast in escapements for this CU's time series and groups were interested in understanding why (was it due to exploitation rates or channel operations), since this may contribute to the high range of stochastic uncertainty in the abundance metric benchmarks (across probability levels);
- participants wanted more detail for prior assumptions about carrying capacity for this combination channel (enhanced) and natural spawning system; groups felt the carrying capacity of this system using photosynthetic rates (described in Grant et al. 2011) were a bit high and perhaps spawning capacity carrying capacities would be more appropriate to use;
- Despite discussions about uncertainty in abundance benchmarks, all groups consistently
- selected a Red status for this CU;

Nadina-Francois-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1973	R	R	R	

Time-varying Models

	25	50	75
Rick1990	R	R	R
SmRick1973	R	R	R

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.91

Current gen. avg.

4,539

Historical Avg (38 Obs)

5,011

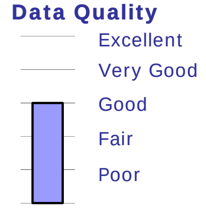
SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-44%

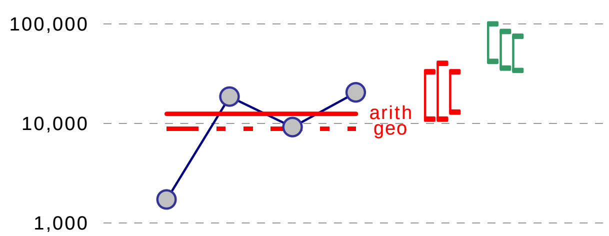
Prob. of 25% Decl. over 3 Gen

81%



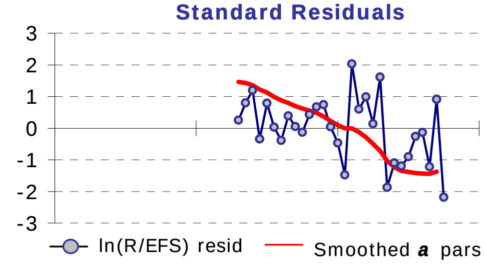
	Geometric					p	Arithmetic				
	10	25	50	75	90		10	25	50	75	90
Rick1973	A	R	R	R	R		A	A	R	R	R
Rick1990	A	R	R	R	R		A	A	R	R	R
SmRick1973	R	R	R	R	R		A	R	R	R	R

Effective Total Spawners (ETS)

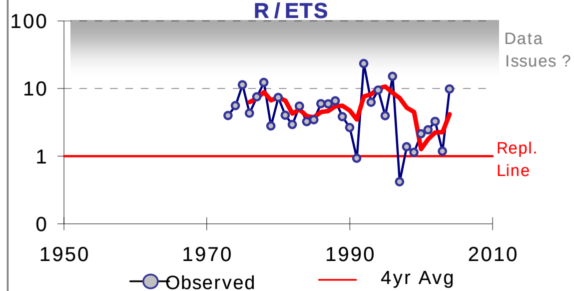


PRODUCTIVITY TIME SERIES

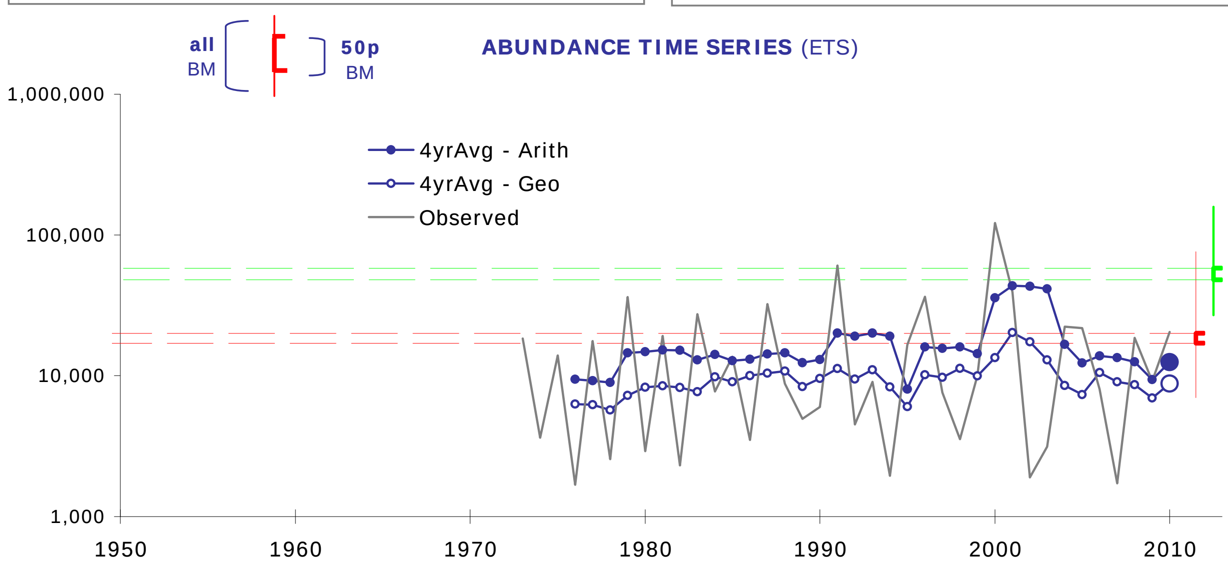
Standard Residuals



R / ETS

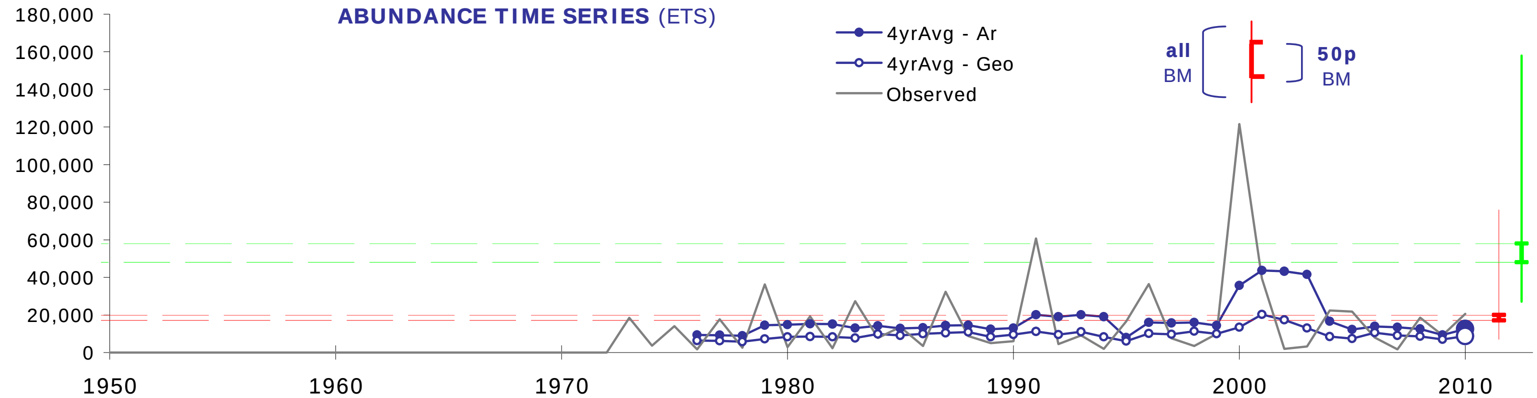


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Nadina-Francois-ES



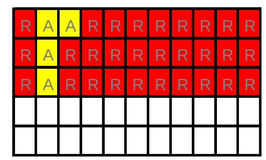
Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1973
Rick1990
SmRick1973



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	121,490	121,490	20,476
Med	9,118	14,295	13,876
Min	1,685	1,722	1,722

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	25	9	3
2500–5000	8	1	0
1000–2500	5	2	1
500–1000	0	0	0
250–500	0	0	0
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

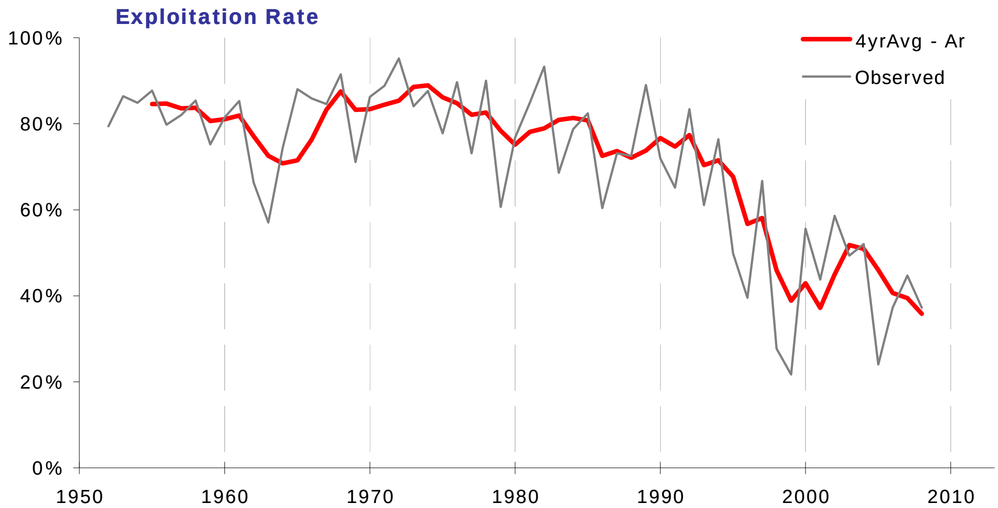
Lower Benchmark Estimates (S-gen)

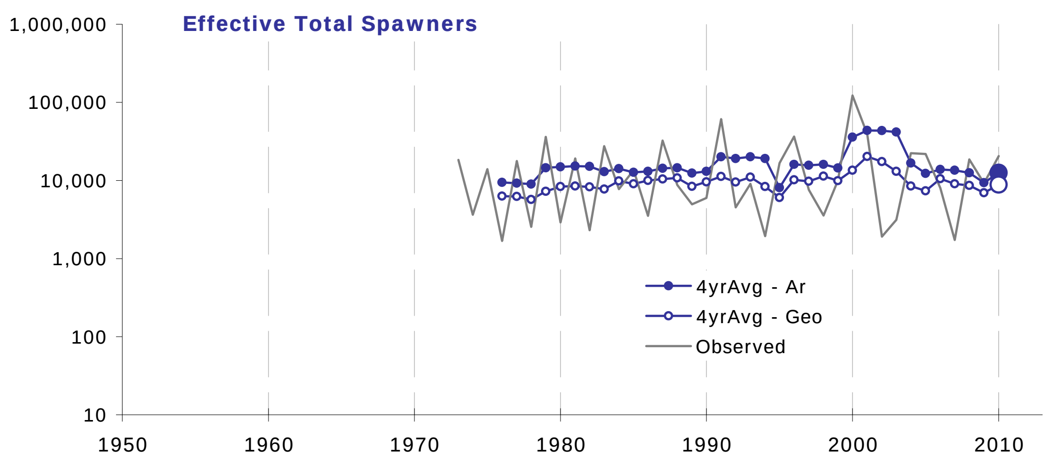
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1973-2004)	8,000	11,000	17,000	33,000	59,000
Rick(1990-2004)	7,000	11,000	18,000	40,000	76,000
SmRick(1973-2004)	10,000	13,000	20,000	33,000	61,000
(-)					
(-)					

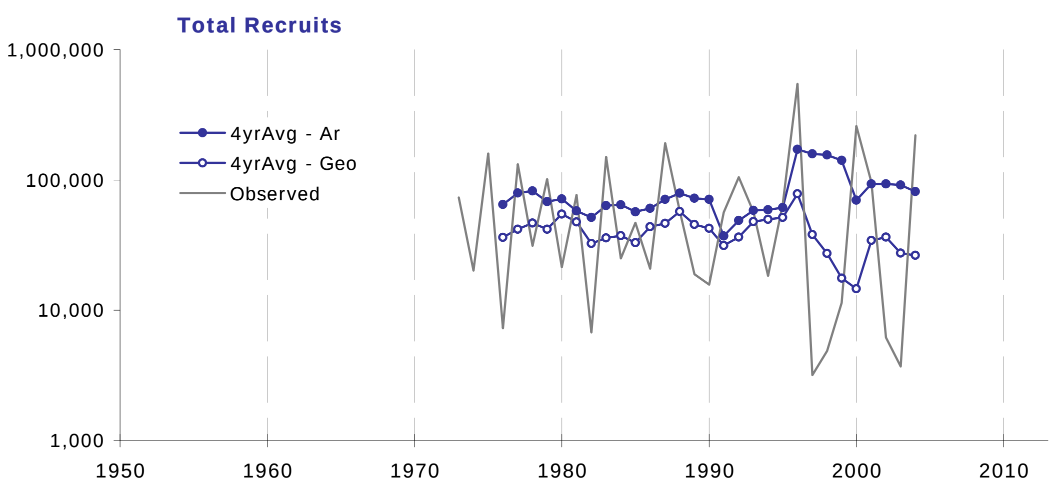
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1973-2004)	35,000	42,000	58,000	100,000	158,000
Rick(1990-2004)	29,000	36,000	48,000	84,000	121,000
SmRick(1973-2004)	27,000	34,000	48,000	75,000	132,000
(-)					
(-)					

Nadina-Francois-ES







CASE 9: HARRISON-RIVER TYPE (GREEN)

(Management stock name: Harrison; Run-Timing Group: Late)

Background: this is a river-type CU (migrates to the ocean shortly after gravel emergence); this CU has increased in abundance and productivity significantly in recent years (unlike most other CUs which have decreased in productivity); this CU also has a unique age structure to all other Fraser Sockeye CUs (Harrison-River Type are three and four year old Sockeye).

Integrated Status

G

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
G	G	G	G		G

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Green integrated status was driven by consistently Green status for all relative-abundance metric paired upper and lower benchmark combinations (probability levels and model forms) and across all trends in abundance metrics; in addition, status for all other WSP metrics was Green and productivity has been systematically increasing in recent years;
- since this CU has only recently dramatically increased in abundance, the stock-recruitment models used in abundance metrics likely have a spawner capacity estimate that is biased low due to the low number of high escapement data points in recent years; given some of the recent surveys during the high abundance period were estimated with low precision visual surveys, short-term trends likely underestimate the rate of increase;

Harrison River (River-Type)

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	G	G	G	

Time-varying Models

Rick1970	G	G	G
Rick1990	G	G	G
SmRick1950	G	G	G

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

8.85

Current gen. avg.

42,768

Historical Avg (61 Obs)

4,834

SHORT-TERM TREND
(Eff. Female Spawners)

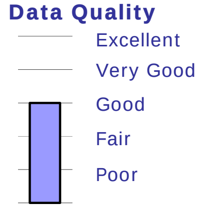
3 Gen Change
(in 4yr Avg)

3388%

Prob. of 25% Decl. over 3 Gen

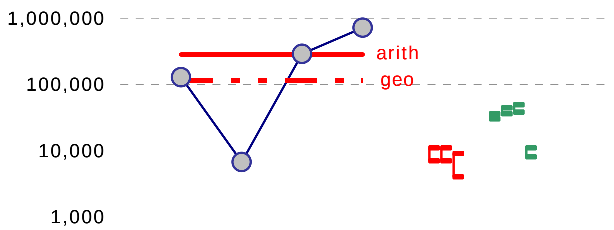
0%

Data Quality

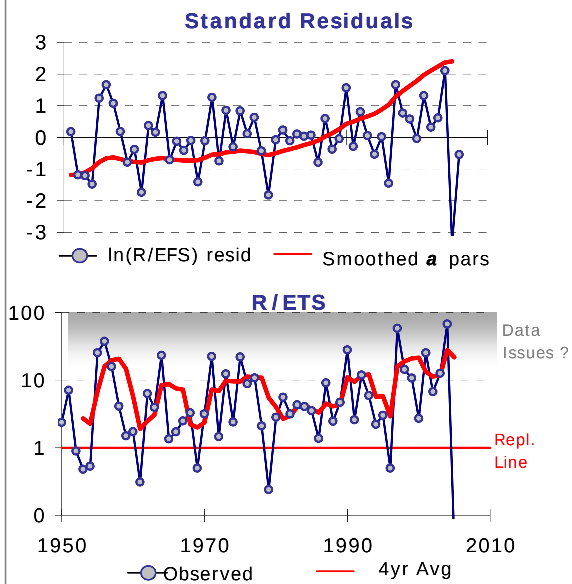


	Geometric						Arithmetic				
	10	25	50	75	90	p	10	25	50	75	90
Rick1950	G	G	G	G	G		G	G	G	G	G
Rick1970	G	G	G	G	G		G	G	G	G	G
Rick1990	G	G	G	G	G		G	G	G	G	G
SmRick1950	G	G	G	G	G		G	G	G	G	G

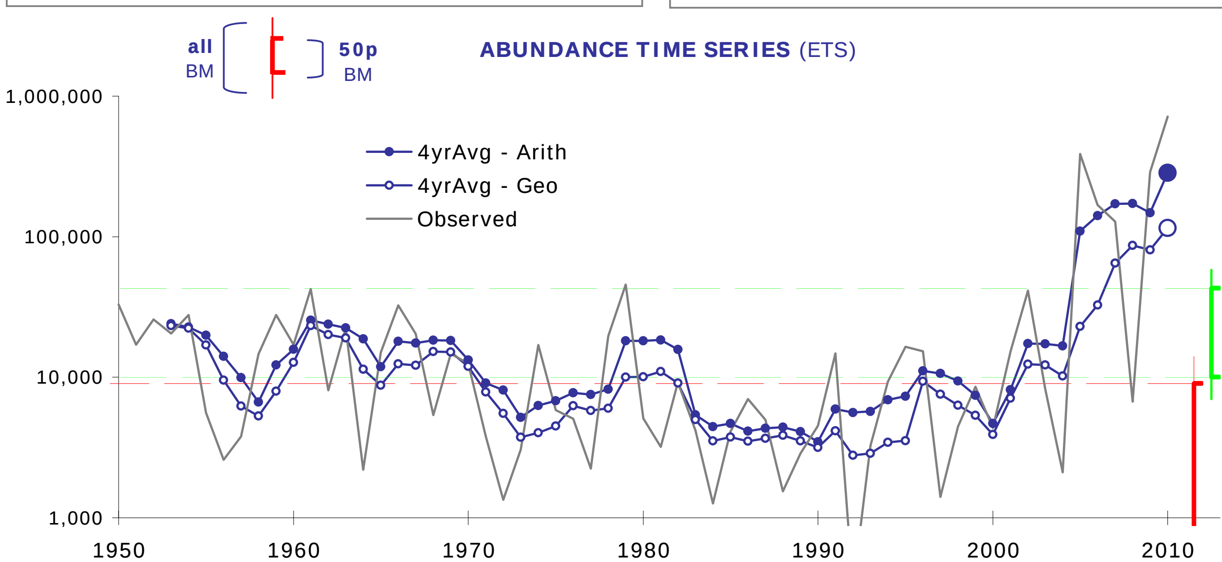
Effective Total Spawners (ETS)



PRODUCTIVITY TIME SERIES

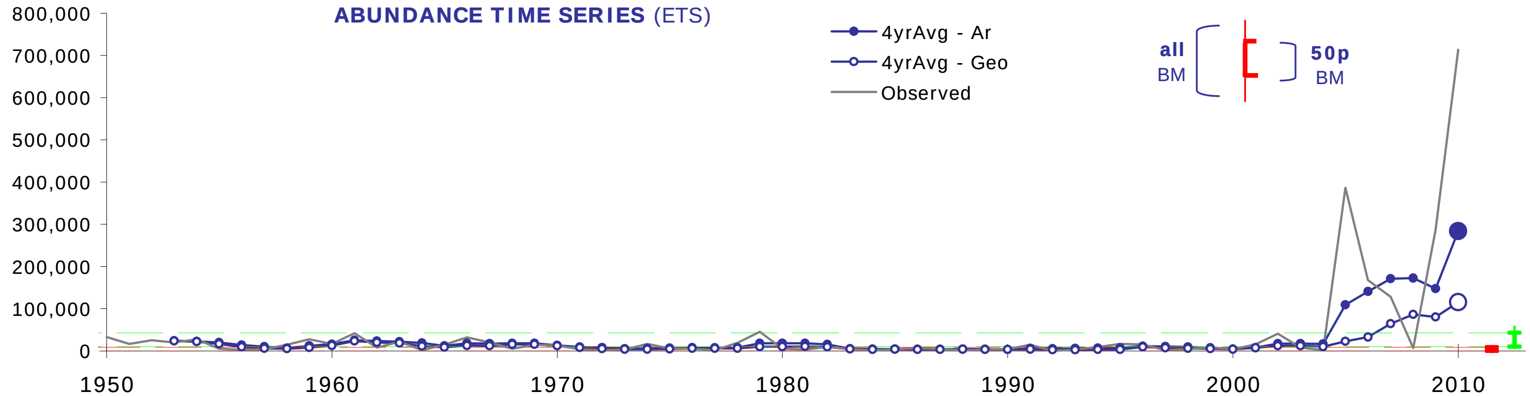


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Harrison River (River-Type)



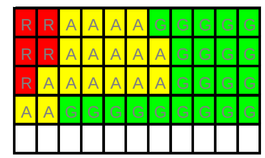
Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950
Rick1970
Rick1990
SmRick1950



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	713,683	713,683	713,683
Med	8,564	28,205	208,011
Min	313	2,106	6,709

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	40	10	4
2500–5000	13	1	0
1000–2500	7	1	0
500–1000	0	0	0
250–500	1	0	0
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

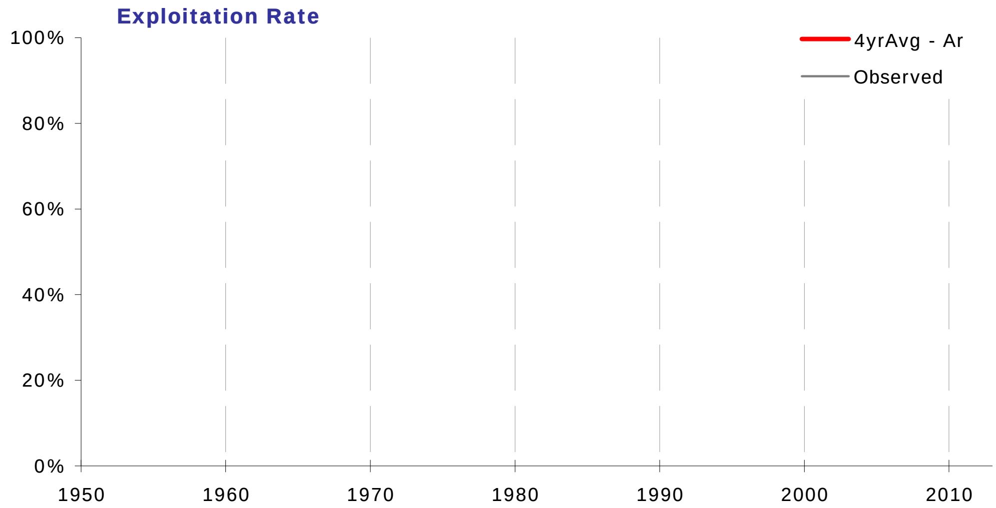
Lower Benchmark Estimates (S-gen)

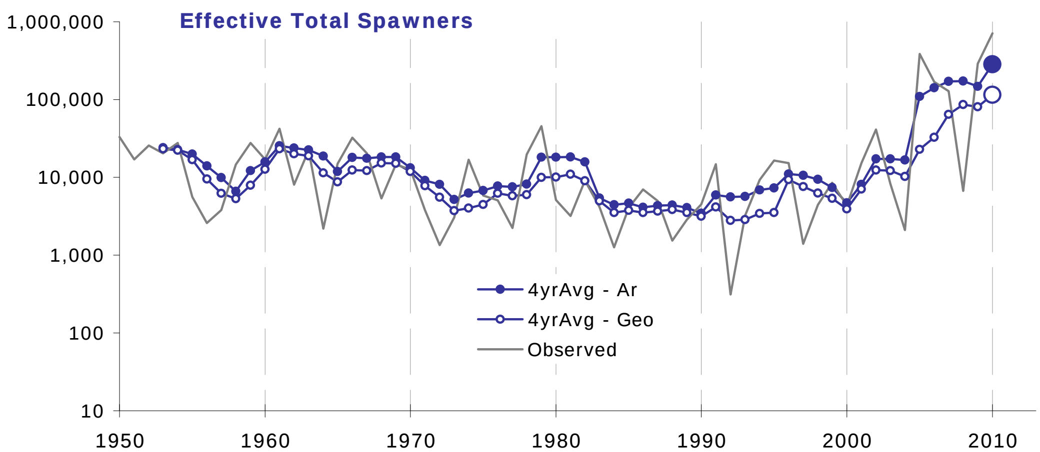
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	6,000	7,000	9,000	11,000	14,000
Rick(1970-2004)	6,000	7,000	9,000	11,000	14,000
Rick(1990-2004)	3,000	4,000	6,000	9,000	13,000
SmRick(1950-2004)	100	100	200	300	300
(-)					

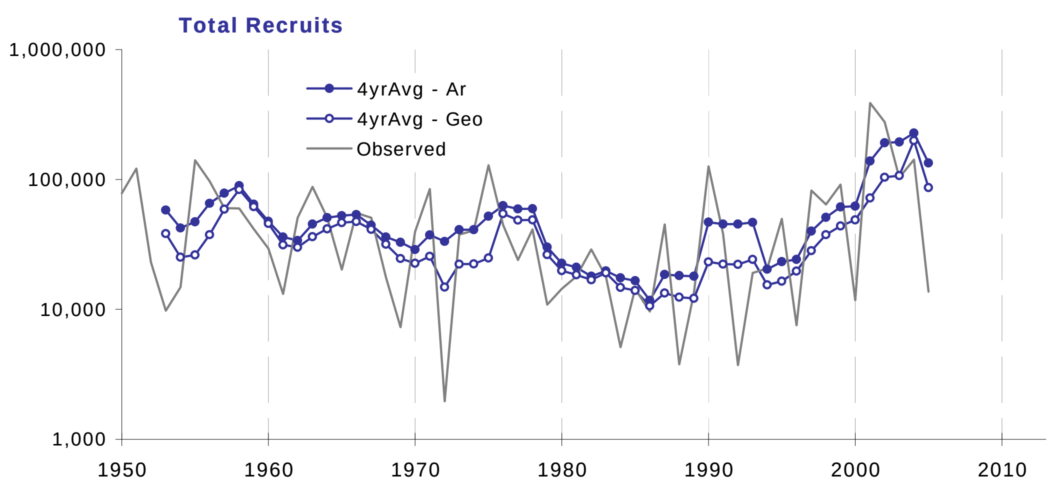
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	28,000	30,000	32,000	36,000	40,000
Rick(1970-2004)	33,000	36,000	39,000	44,000	48,000
Rick(1990-2004)	34,000	38,000	43,000	49,000	58,000
SmRick(1950-2004)	7,000	8,000	10,000	11,000	13,000
(-)					

Harrison River (River-Type)







CASE 10: TASEKO-ES (RED)

(Management stock name: Miscellaneous Early Summer; Run-Timing Group: Early Summer)

Background: this CU resides in a glacially influenced lake; escapement estimates are based on visual survey estimates of carcasses in a lake, expanded based on survey effort, and, therefore, are likely biased low and represent an index of spawning abundance only (see Grant et al. 2011 for further details).

Integrated Status

R *(provisional status, given data provide an index of escapement only)*

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	R	R	R		R

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Red integrated status was driven by consistently Red status for all trends in abundance metrics (short-term and long-term trends); this CU does not have recruitment data, therefore, relative-abundance metric statuses could not be estimated; since abundance data for this CU are an index only, recent absolute abundances could not be compared to COSEWIC Criteria D1.
- the integrated status for this CU was flagged as provisional, because data quality is rated fair; escapement data (which are an index of escapement only) require further evaluation;

Points of Discussion

- initially, due to an omission in the data summaries, it was not clear to participants that the Taseko-ES escapement time series represented indices only (as opposed to absolute abundance); as a result, early discussions centered on designating this CU Red in status given its absolute abundance triggers COSEWIC listing based on its criteria D1 on small populations; however, during plenary discussions when the escapement data for this CU were identified to participants as indices only, participants concluded that since absolute abundance data are not available for this CU, this CU could not be evaluated against COSEWIC criteria D1;
- the participating assessment biologist who manages the Taseko escapement program indicated that the short-term trend metric status is valid because escapement has been assessed using consistent methods over time, but that escapements represent indices of abundance only (rather than absolute abundance);
- given the escapement data are indices of abundance only, there was debate regarding whether the current data rating of 'fair' should be downgraded to 'poor';
- some participants argued that the escapement index time series should place this CU in a data deficient status category; others argued that the limited data available should still provide the ability to assess status;
- it was recommended that escapement data (which are an index of escapement only) require further evaluation to determine the reliability of the index, given lake visual surveys of carcasses are known to produce poor estimates of escapement;

Taseko-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.22

Current gen. avg.

118

Historical Avg (37 Obs)

534

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-88%

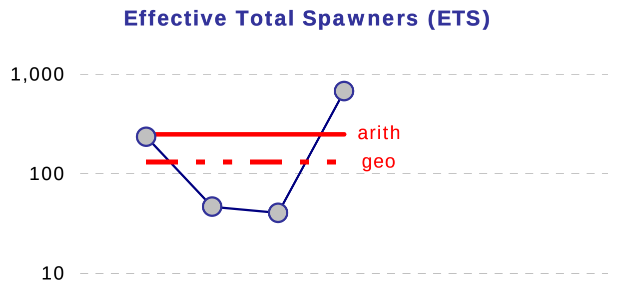
Prob. of 25% Decl.
over 3 Gen

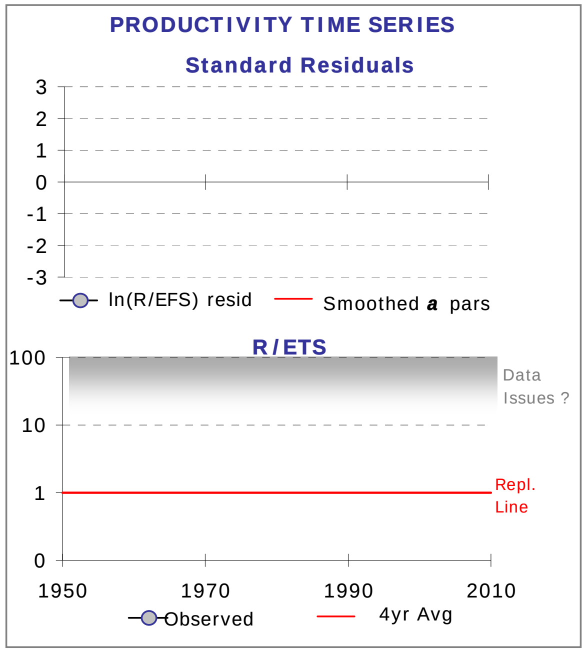
100%

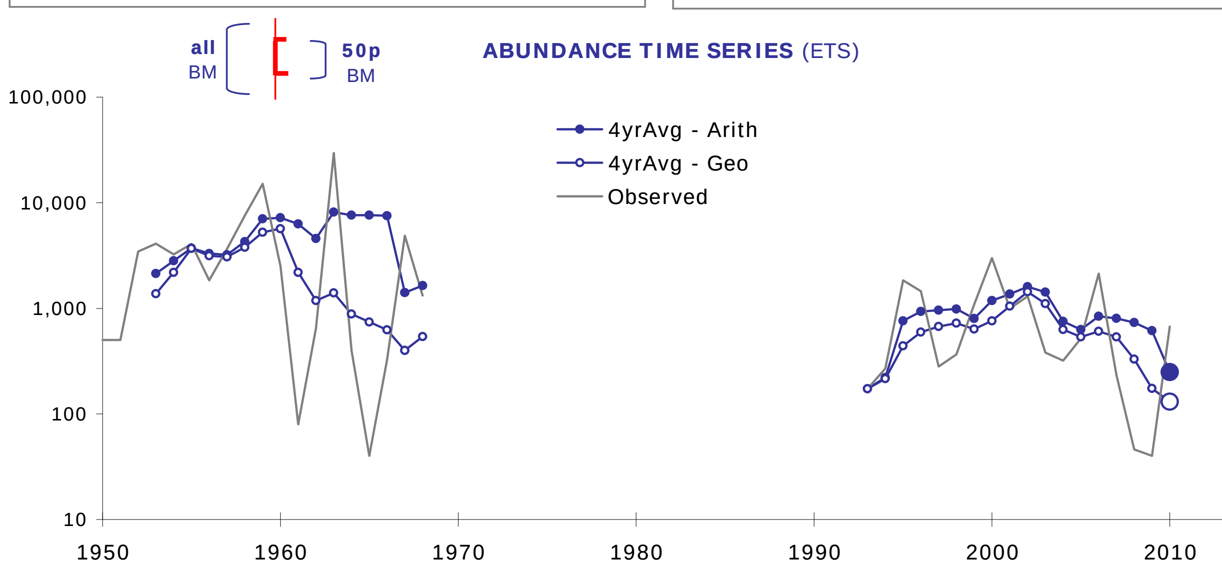
Data Quality

Excellent
Very Good
Good
Fair
Poor

Geometric: 10 25 50 75 90 p
Arithmetic: 10 25 50 75 90

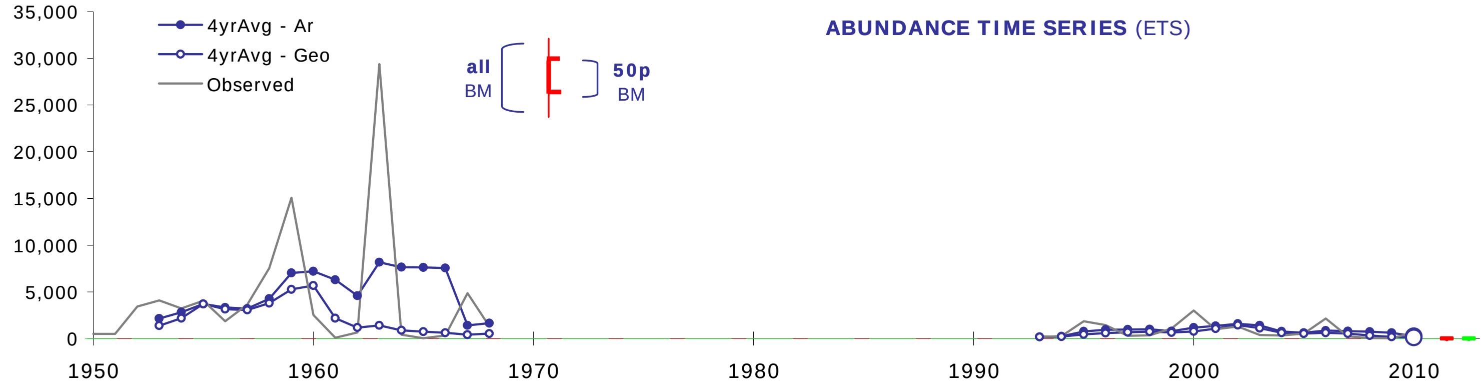






Retrospective Pattern in WSP Metrics

Taseko-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	29,388	3,000	673
Med	1,000	597	140
Min	40	40	40

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	3	0	0
2500–5000	8	1	0
1000–2500	7	3	0
500–1000	4	3	1
250–500	9	2	0
0–250	6	3	3

Small Population Benchmarks (COSEWIC Criterion D1)

Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

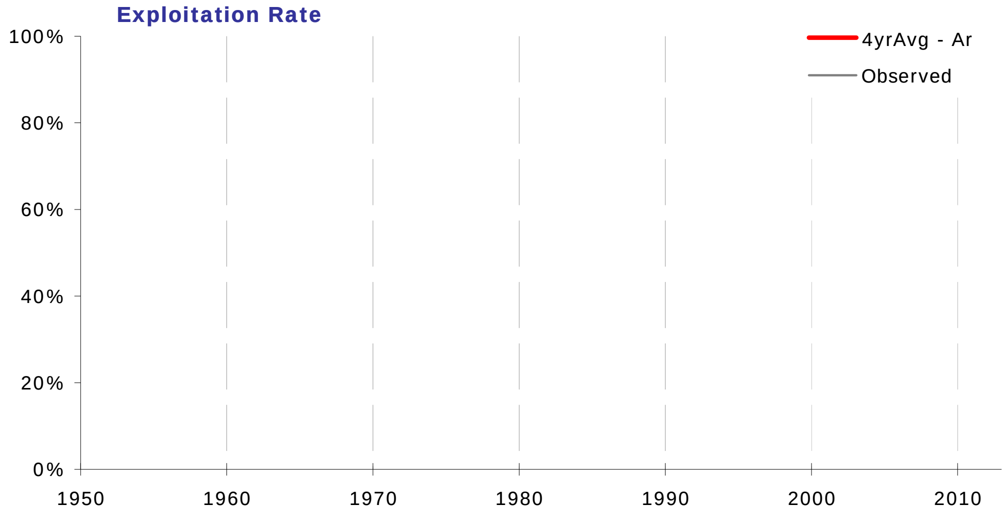
(-)
(-)
(-)
(-)
(-)

Upper Benchmark Est. (80% S-msy)

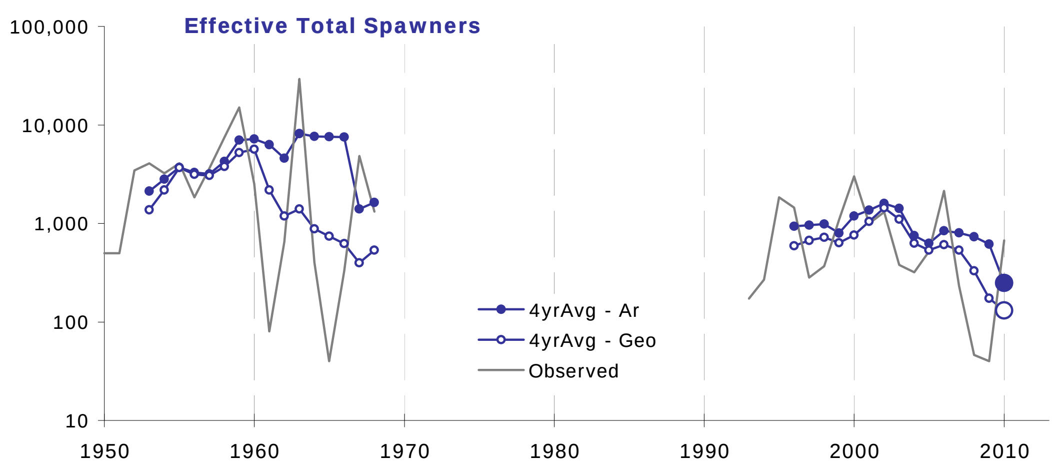
UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

(-)
(-)
(-)
(-)
(-)

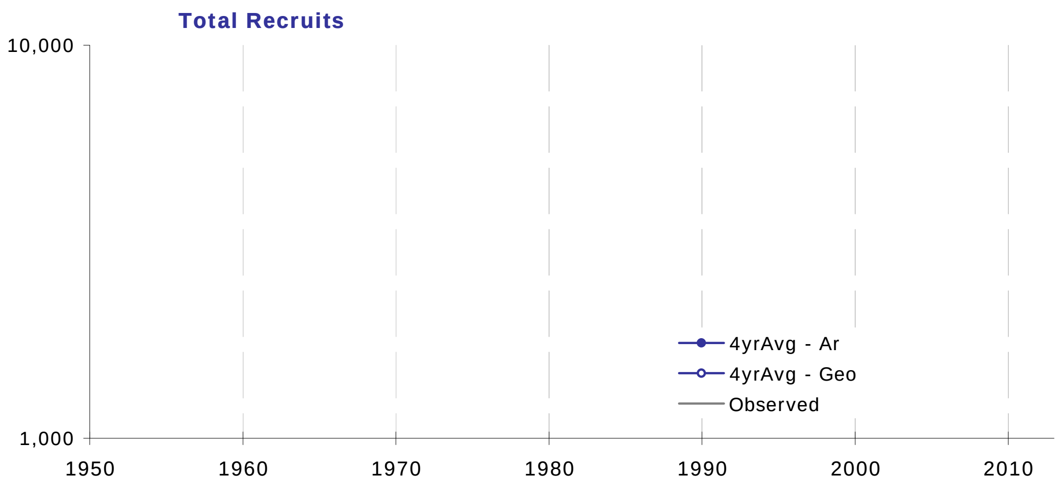
Taseko-ES



Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed



Effective Total Spawners
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed



Total Recruits
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CASE 11: HARRISON (D/S)-L (GREEN)

(Management stock name: Miscellaneous non-Shuswap; Run-Timing Group: Late)

Background: this CU is comprised of several separate stream populations that migrate downstream to rear in Harrison Lake during their freshwater fry stage; only a single population (Big Silver Creek) is used for status assessments given it has been consistently assessed and has a relatively long time series of escapement data (see Grant et al. 2011 for further details).

Integrated Status

G

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
G	G	G	G		G

Note: one out of the six groups did not complete a status evaluation for this CU; also one of the group's Green status was comprised of different status designations within this group (two Ambers and four Greens), however, this group agreed to a group integrated status of Green in the final plenary session;

Status Commentary

- the Green integrated status was driven by consistently Green status for all trends in abundance metrics (short-term and long-term); this CU does not have recruitment data, therefore, relative-abundance metric statuses could not be estimated;
- absolute abundance cannot be directly compared to COSEWIC Criteria for this CU since only one out of a number of creeks is being used as an indicator of this CU's status; however, for this single creek alone (Big Silver), it does not trigger COSEWIC's Criteria D1 in the last four years;
- although the short-term trends in abundance metric was Green in status, in very recent years there as been a decrease in abundance and it was recommended that this trend be monitored, since if it persists the status of this CU could change in the short-term (to Amber or Red);
- One group did not come to a consensus assessment, with two out of six group members leaning to Amber status given the absence of abundance and productivity data to inform the status evaluations and the very recent decreases in abundance which was assumed to coincide with decreasing exploitation rates (however, changing exploitation rates could not be confirmed at the meeting given this data does not exist for this CU); current escapement is also one third the peak abundance;

Points of Discussion

- Workshop participants debated whether status evaluation should reflect only the current status, or anticipate future status based on current abundance trends; although a Green integrated status was agreed to by participants, if the very recently observed decreasing abundance persists, this CU could fall into a lower status zone shortly; this issue is linked to the frequency of status evaluations assessments (if status is frequently assessed, then using the current status of the CU is appropriate, if status is infrequently assessed, then some indication of where the CU is headed in terms of status may be required);

Harrison (D/S)-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25 50 75 p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

6.56

Current gen. avg.

3,196

Historical Avg (61 Obs)

487

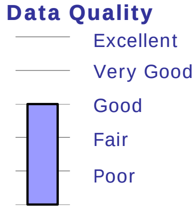
SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

103%

Prob. of 25% Decl. over 3 Gen

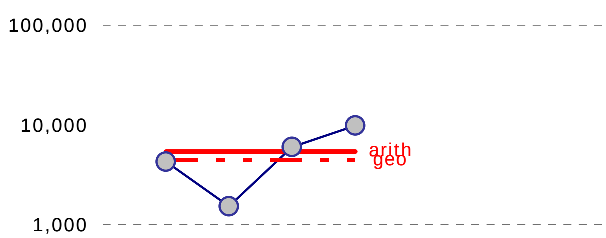
7%



Geometric | Arithmetic

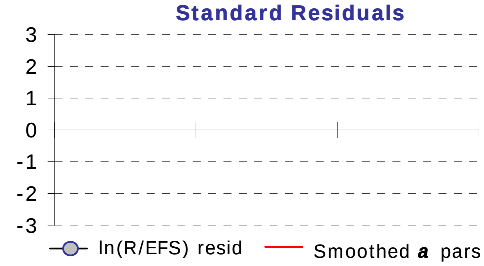
10 25 50 75 90 p 10 25 50 75 90

Effective Total Spawners (ETS)

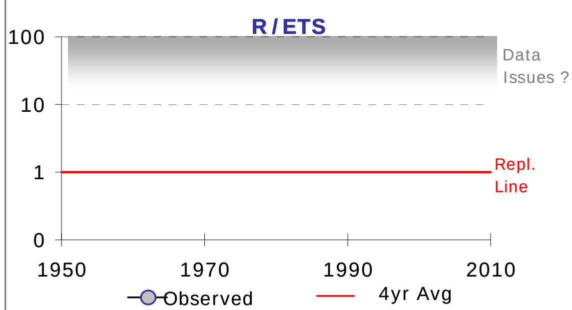


PRODUCTIVITY TIME SERIES

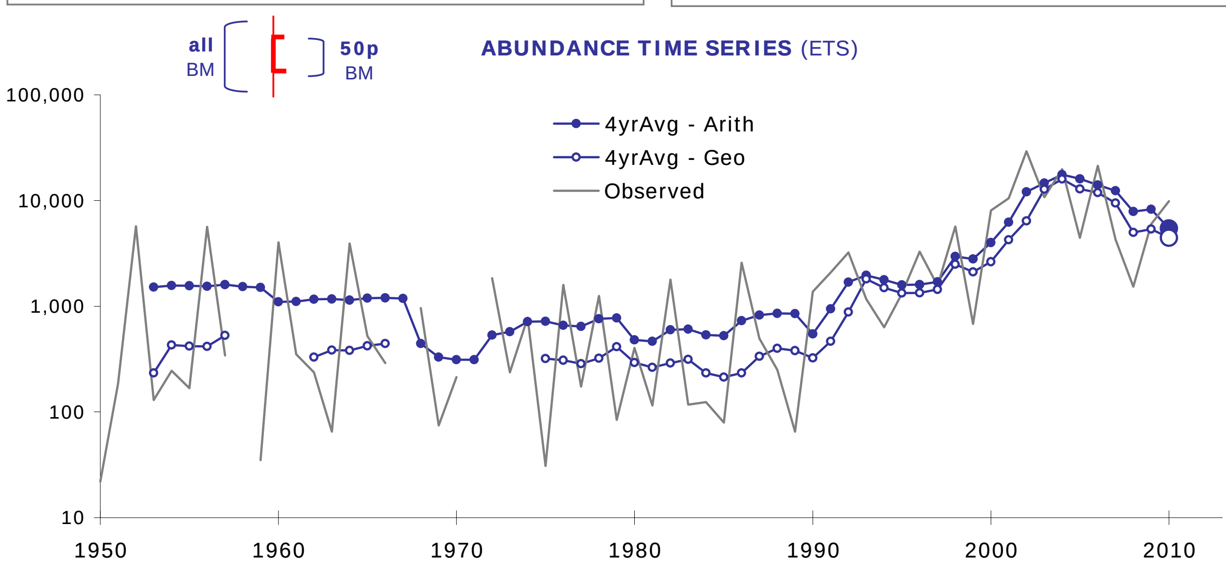
Standard Residuals



R/ETS

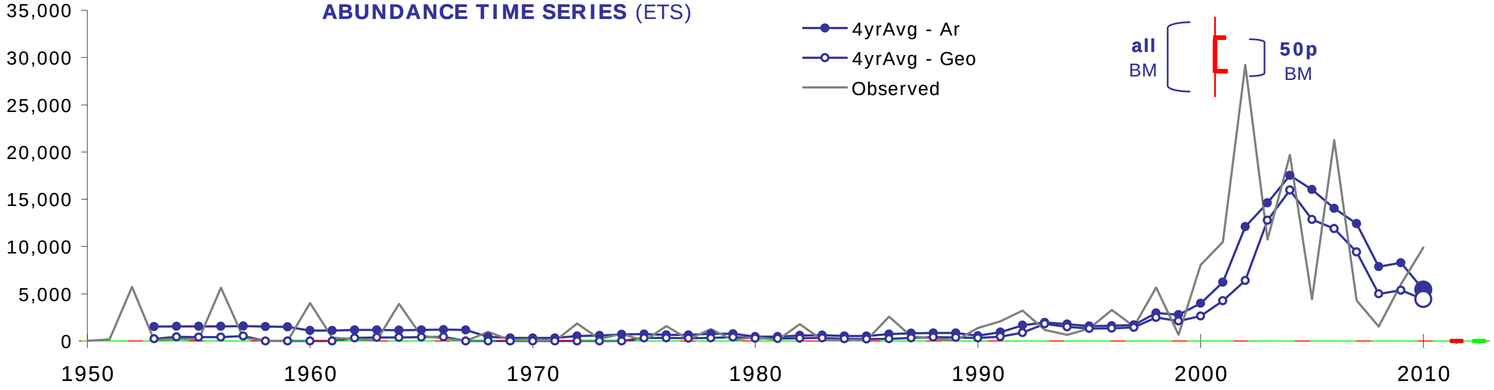


ABUNDANCE TIME SERIES (ETS)



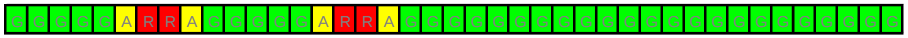
Retrospective Pattern in WSP Metrics

Harrison (D/S)-L



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)



Abundance BM Metric (comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	29,213	29,213	9,885
Med	682	8,964	5,143
Min	0	682	1,531

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
>5000	11	8	2
2500–5000	7	2	1
1000–2500	10	1	1
500–1000	5	1	0
250–500	5	0	0
0–250	20	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

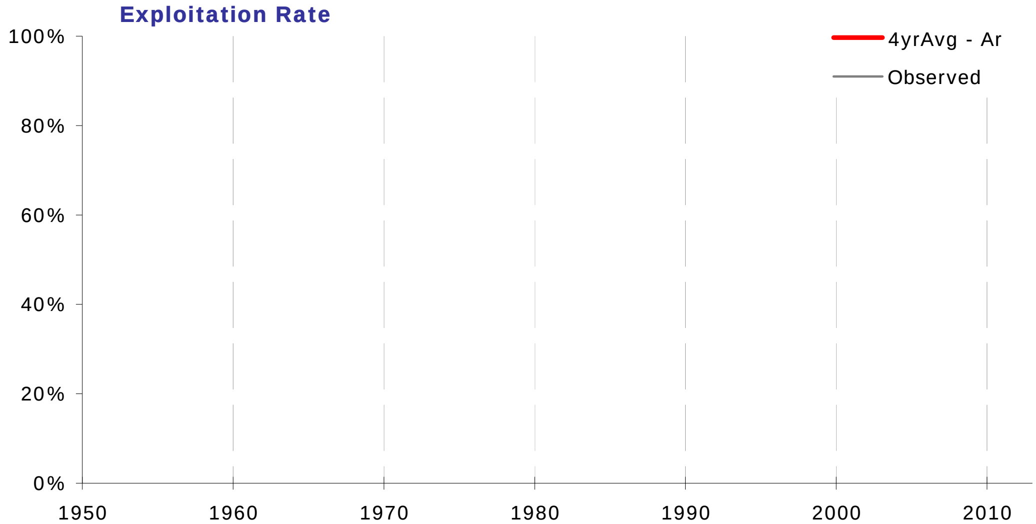
Lower Benchmark Estimates (S-gen)

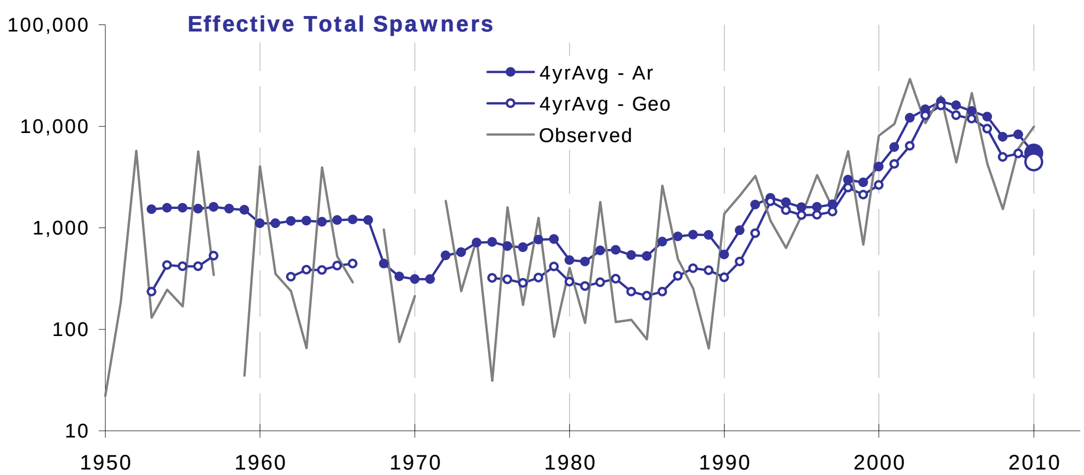
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
(-)					
(-)					
(-)					
(-)					
(-)					

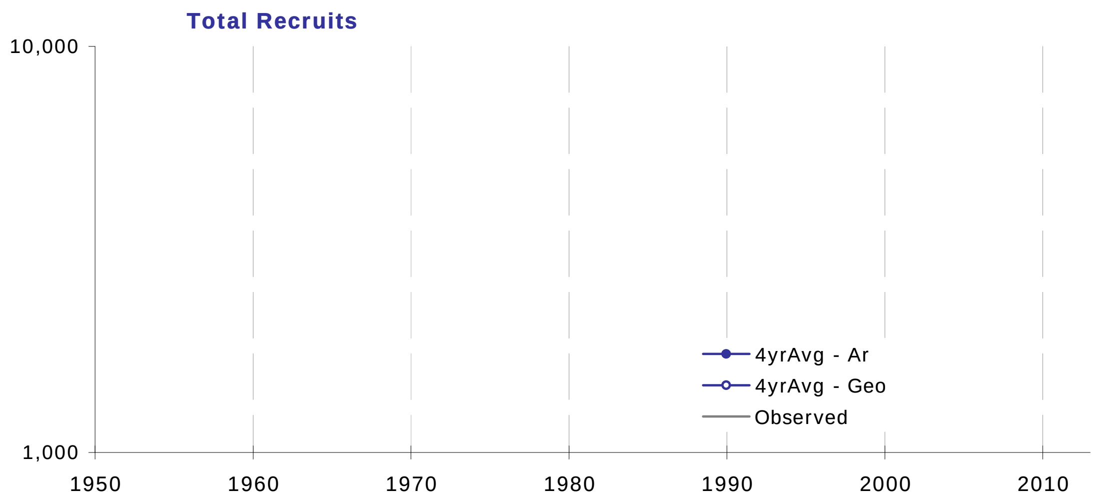
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
(-)					
(-)					
(-)					
(-)					
(-)					

Harrison (D/S)-L







CASE 12: NAHATLATCH-ES (RED)

(Management stock name: Miscellaneous Early Summer; Run-Timing Group: Early Summer)

Background: relatively remote system located in a protected BC park; no known transplants or major human activities (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	R	R		R	R

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Red integrated status was driven by consistently Red status for the short-term trends in abundance metric and some recent low years of abundance that fall below COSEWIC Criteria D1 on small populations; in addition, the long-term trend state (0.54), although Amber in status, is very close to the lower benchmarks (between the Amber and Red designation) for this metric (0.5);

Points of Discussion

- this CU has no recruitment data or carrying capacity data, therefore, relative-abundance-metric benchmarks for this CU could not be generated;

Nahatlatch-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.54

Current gen. avg.

849

Historical Avg (36 Obs)

1,581

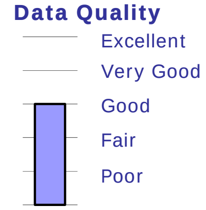
SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-82%

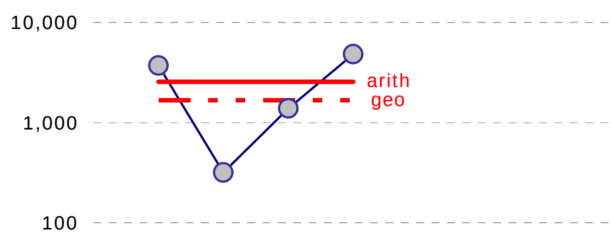
Prob. of 25% Decl. over 3 Gen

100%



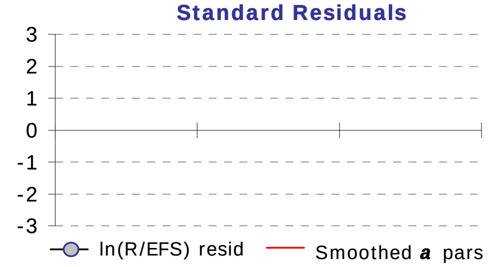
Geometric					p	Arithmetic				
10	25	50	75	90		10	25	50	75	90

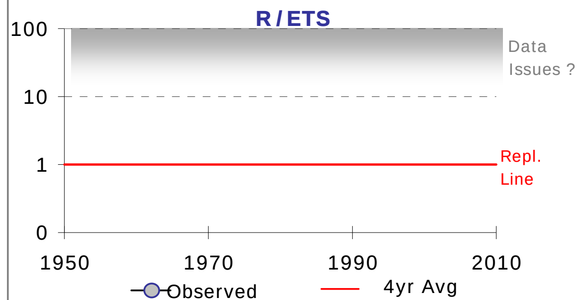
Effective Total Spawners (ETS)



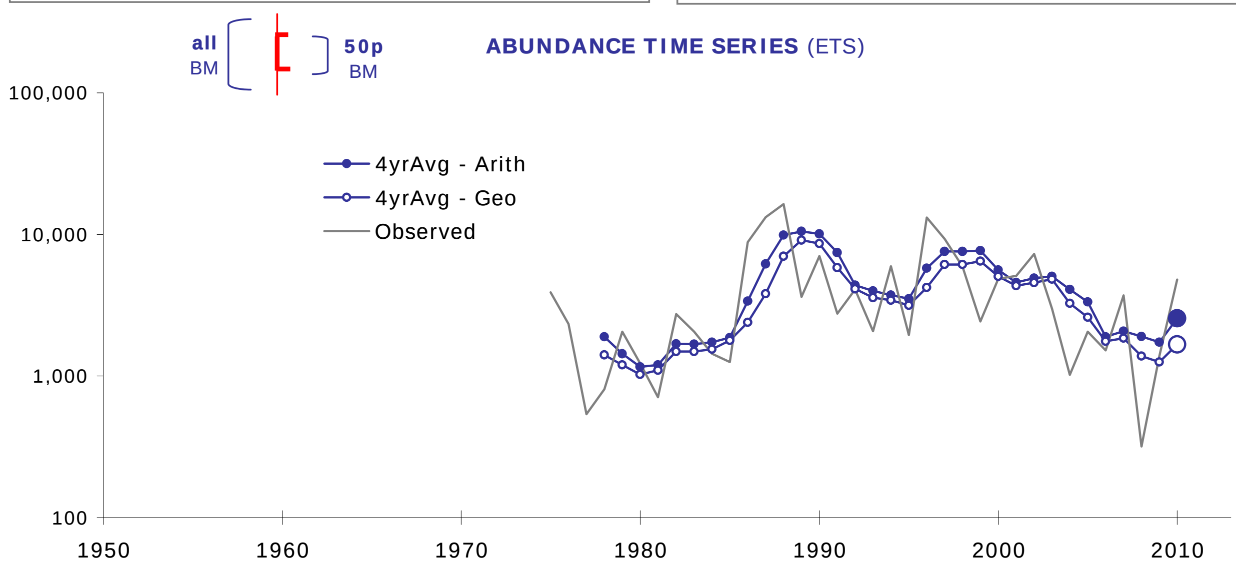
PRODUCTIVITY TIME SERIES

Standard Residuals



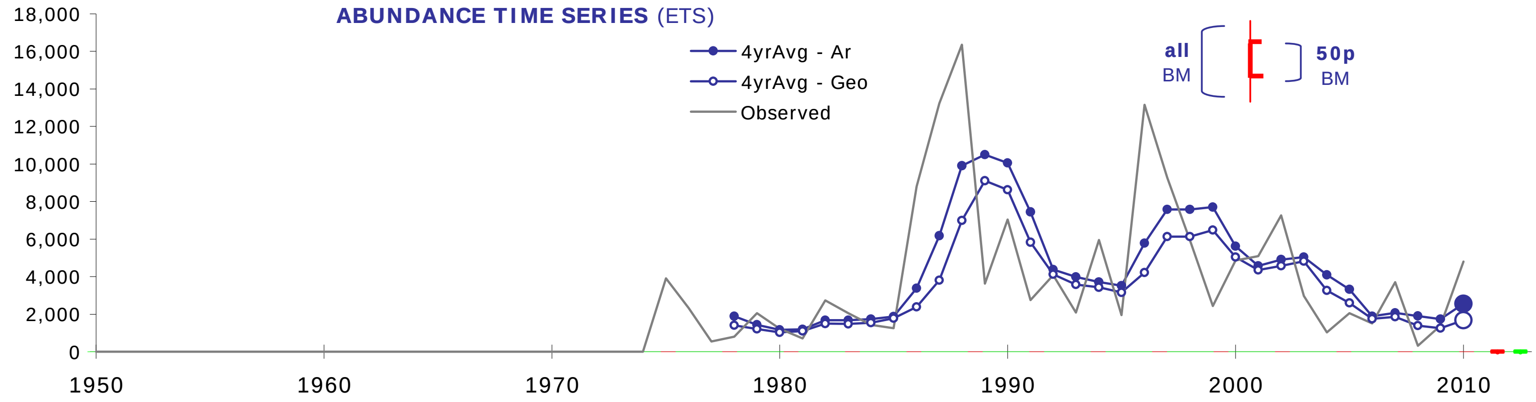


ABUNDANCE TIME SERIES (ETS)

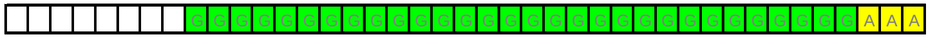


Retrospective Pattern in WSP Metrics

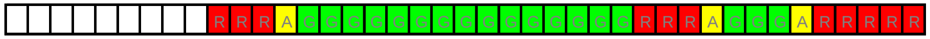
Nahatlatch-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

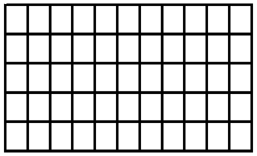


Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)



Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	16,349	7,263	4,805
Med	2,745	2,702	2,546
Min	318	318	318

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
> 5000	10	2	0
2500–5000	9	4	2
1000–2500	13	5	1
500–1000	3	0	0
250–500	1	1	1
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

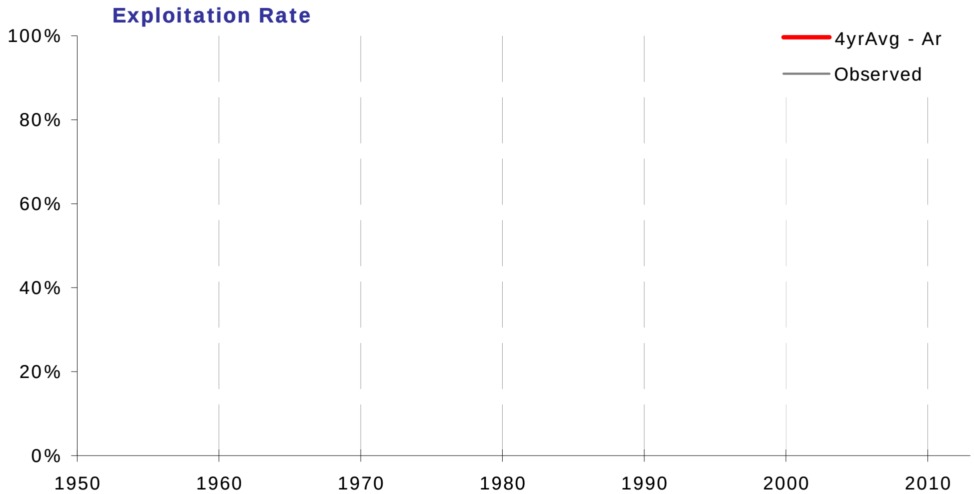
(-)
(-)
(-)
(-)
(-)

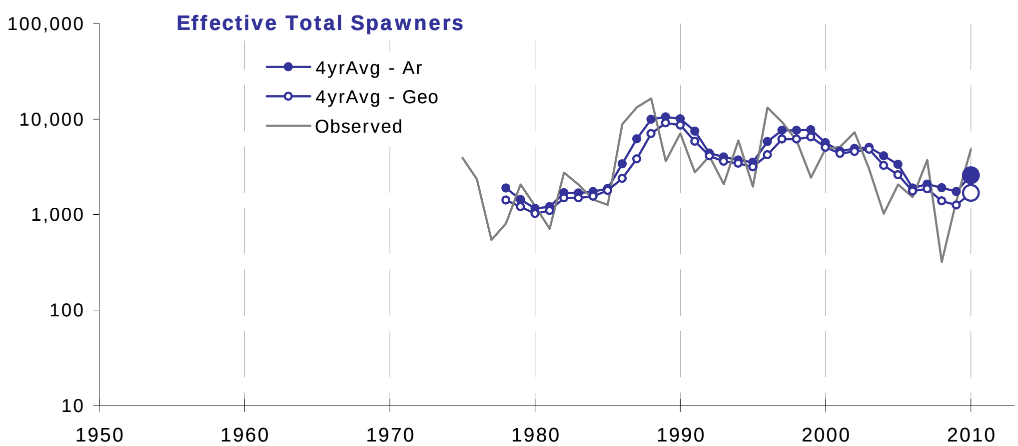
Upper Benchmark Est. (80% S-msy)

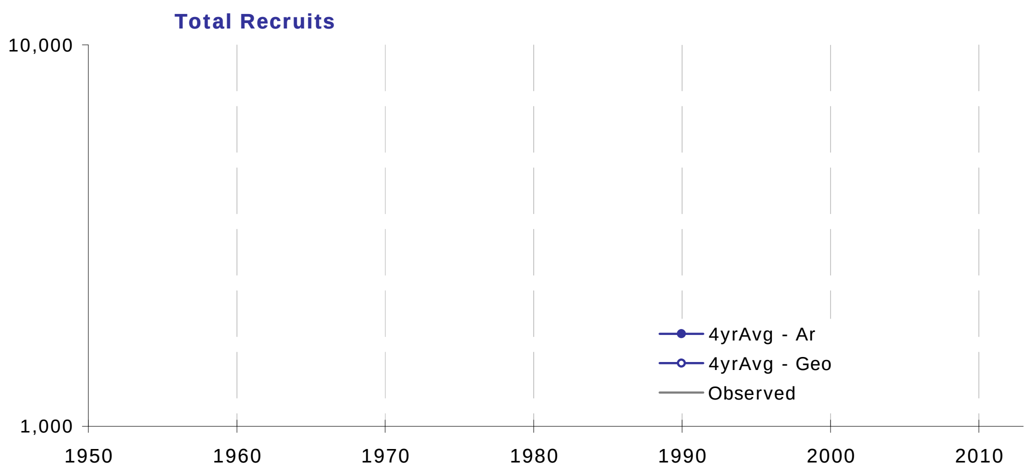
UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

(-)
(-)
(-)
(-)
(-)

Nahatlatch-ES







CASE 13: KAMLOOPS-ES (AMBER)

(Management stock name: Raft & miscellaneous North Thompson; Run-Timing Group: Early Summer)

Background: Raft was the only population in this CU consistently assessed, therefore, Sockeye in this river alone was used to assess status for this CU (see Grant et al. 2011 for further details).

Integrated Status

A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	A	a		A	a

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Amber integrated status was driven by the Amber status for relative-abundance metric paired upper and lower benchmark combinations at the median probability levels (50%) for all models but the recursive Bayesian Ricker model; however, since this CU does not exhibit any systematic productivity trends, models that consider recent productivity (such as the recursive-Bayesian Ricker model) were not given high weight in relative-abundance metric status evaluations;
- long-term trend metric Green status provides extra weight to the relative-abundance metric status which were mostly Amber, with some Reds at higher probability levels;
- although short-term trend metric is Red in status, this metric was given a lower weight in status integration evaluations given this CU is returning from a period of high abundance and also this CU does not exhibit any systematic trends in productivity (unlike most CUs which have decreased in productivity in recent years);
- diagnostics for recursive-Bayesian Ricker model were requested, given it results in a Red status for the relative-abundance metric using this model at the 50% probability level, despite this CU having not exhibited systematic declines in productivity;

Points of Discussion

- debate over stationary versus non-stationary stock-recruitment models used to estimate relative-abundance-metric benchmarks; groups were confused by the different benchmarks and status results between stationary and non-stationary model forms, as they thought these benchmarks should in fact be similar, given this CU has not exhibited systematic decreases in productivity; diagnostics for all models were requested for future status integration processes;
- the standardized residual trend removes the effect of spawner abundances, and therefore, this time series was used by most groups to focus on stationary model forms given no systematic productivity trends have been observed for this CU; however, other groups focused on the R/ETS recent declining trends and focused on the non-stationary models;

Kamloops-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75
Rick1950	A	A	R

Time-varying Models

	25	50	75
Rick1970	A	A	R
Rick1990	A	A	A
RBRick1950	A	R	R

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

2.23

Current gen. avg.
5,466

Historical Avg (61 Obs)
2,453

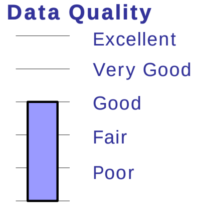
SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

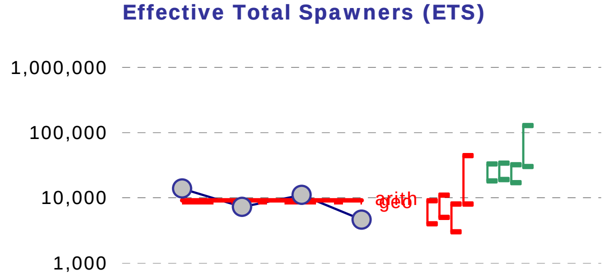
-31%

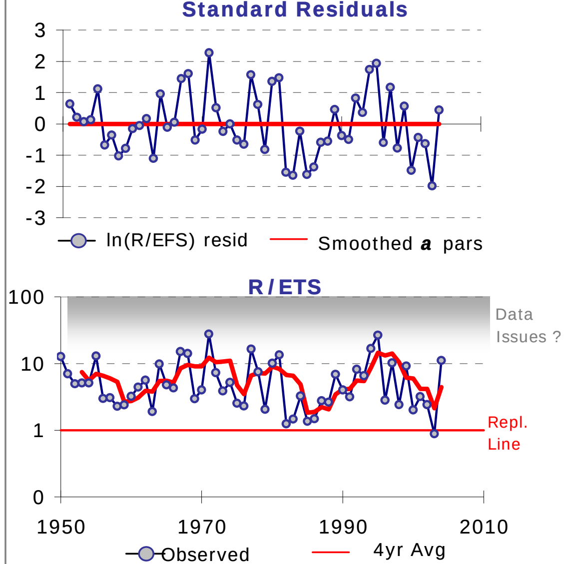
Prob. of 25% Decl. over 3 Gen

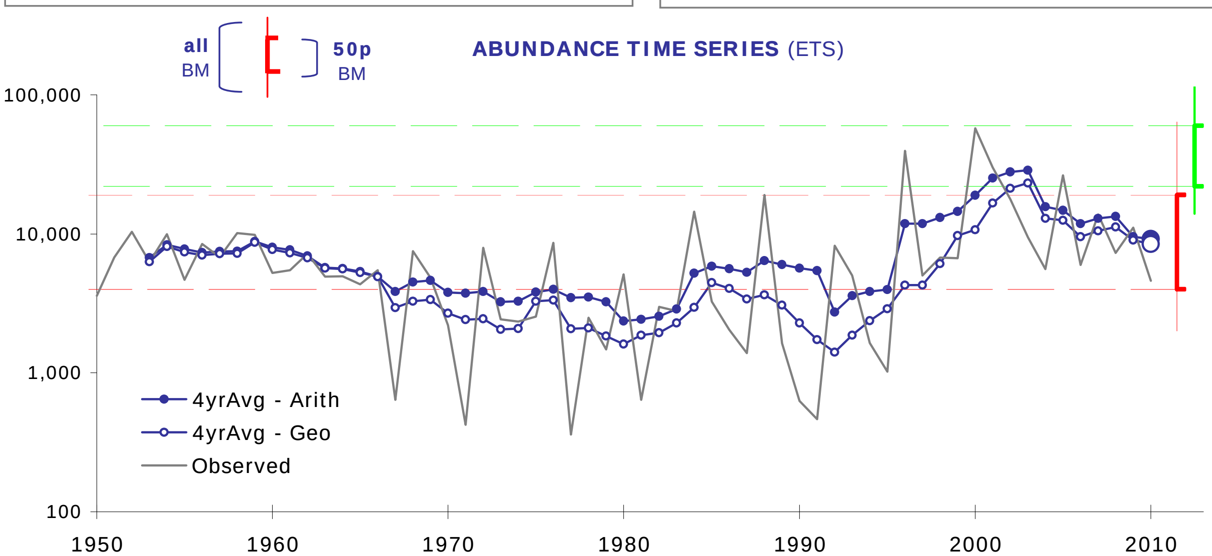
59%



	Geometric 10	25	50	75	90	Arithmetic 10	25	50	75	90
Rick1950	A	A	A	R	R	A	A	A	A	R
Rick1970	A	A	A	R	R	A	A	A	R	R
Rick1990	A	A	A	A	R	A	A	A	A	R
RBRick1950	A	A	R	R	R	A	A	R	R	R

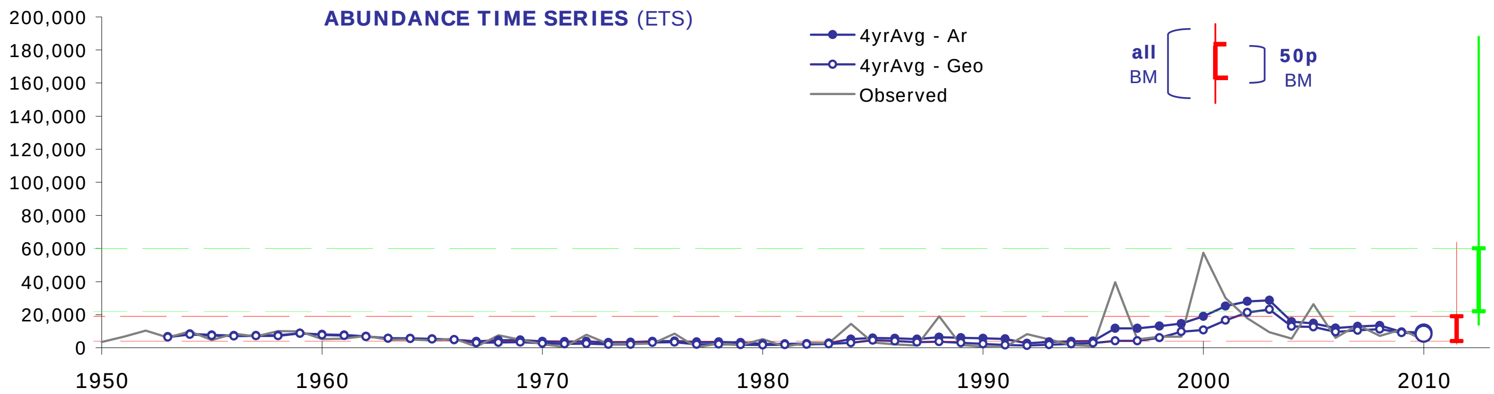






Retrospective Pattern in WSP Metrics

Kamloops-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

A A A R R A A A A A R R R R A A G G G G G A A A A A G G G G G G G G G G G G G G G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

R R R R R R R R A R R R R R A G G G G G G G G R R R R G G G G G G G G G G G G G R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	A	A	A	G	A	A	A	A	A	A	A
Rick1970	A	A	A	A	A	A	A	A	A	A	A
Rick1990	A	A	A	G	A	A	A	A	A	A	A
RBRick1950	R	R	A	A	R	R	R	R	R	R	R

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	57,396	57,396	13,813
Med	5,243	10,278	9,191
Min	360	4,607	4,607

Number of Observations in a range

	All Yrs	Last 12	Last 4
> 5000	34	11	3
2500–5000	11	1	1
1000–2500	10	0	0
500–1000	3	0	0
250–500	3	0	0
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

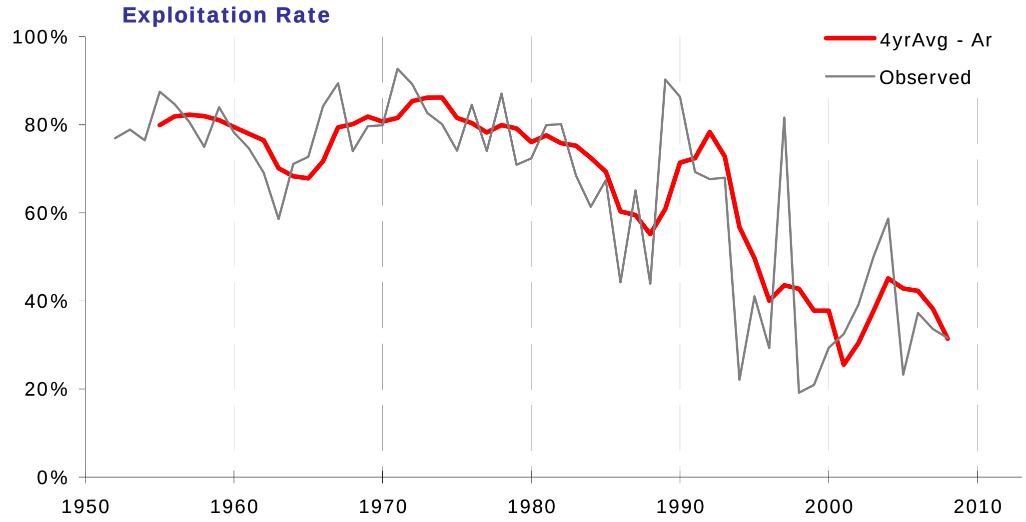
Lower Benchmark Estimates (S-gen)

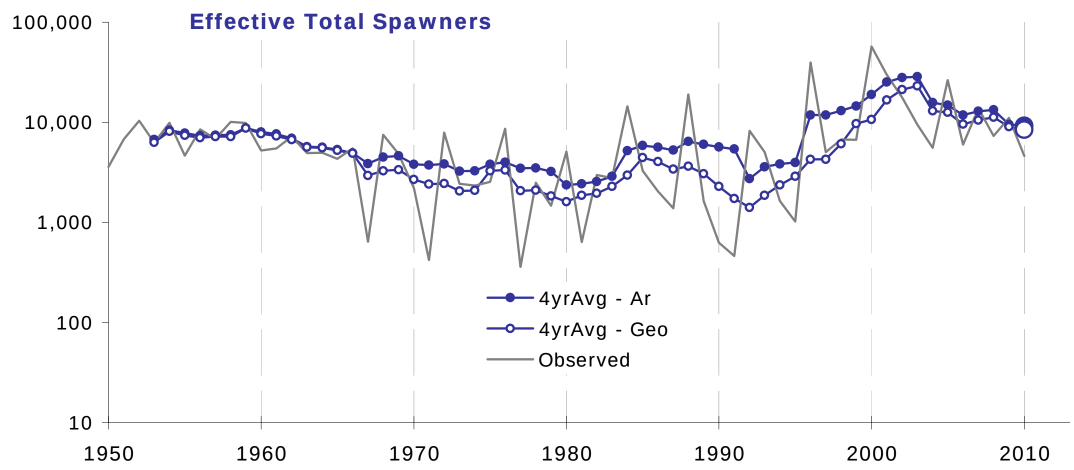
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	3,000	4,000	6,000	9,000	15,000
Rick(1970-2004)	3,000	5,000	7,000	11,000	18,000
Rick(1990-2004)	2,000	3,000	4,000	8,000	14,000
RBRick(1950-2004)	5,000	8,000	19,000	44,000	64,000
(-)					

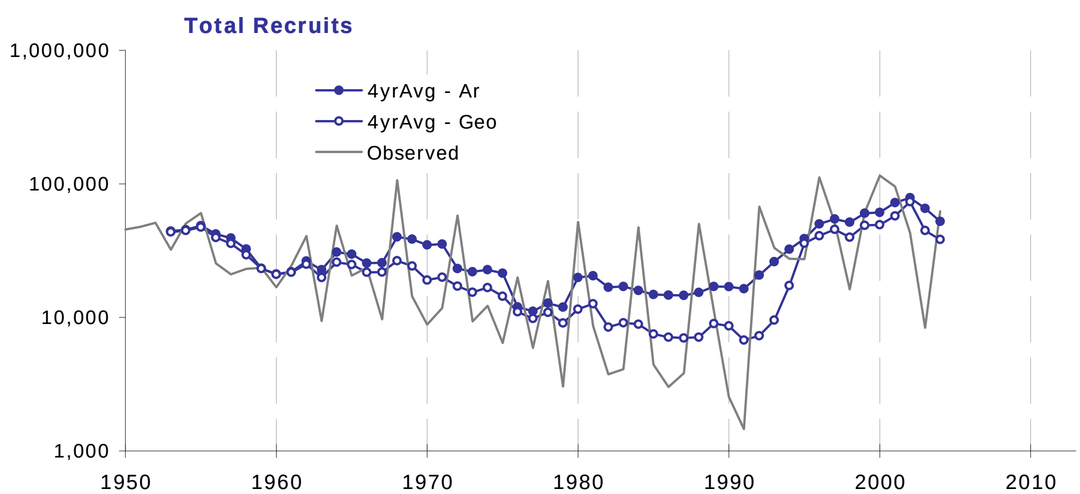
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	15,000	18,000	23,000	33,000	50,000
Rick(1970-2004)	15,000	19,000	25,000	34,000	53,000
Rick(1990-2004)	14,000	17,000	22,000	32,000	48,000
RBRick(1950-2004)	20,000	30,000	60,000	128,000	188,000
(-)					

Kamloops-ES


Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed


Effective Total Spawners
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed


Total Recruits
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CASE 14: CULTUS-L (RED)

(Management stock name: Cultus; Run-Timing Group: Late)

Background: this CU has been listed as 'endangered' by COSEWIC, and it has been hatchery enhanced starting in the year 2000 as a conservation measure; the influence of the hatchery enhanced fish has been removed from this status evaluation (stock-recruitment data for relative-abundance metric benchmark estimates only includes data prior to 2000 and trends in abundance data does not include hatchery marked Sockeye) (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	R	R		R	R

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Red integrated status was driven by consistently Red status for all relative-abundance metric paired upper and lower benchmark combinations (probability levels and model forms) and across all trends in abundance metrics (short-term and long-term trends); in addition, recent abundance falls below COSEWIC Criteria D1 for small populations;
- productivity trends have also decreased for this CU in recent years;

Points of Discussion

- discussion about the sensitivity of the short-term trend metric to annual variability in abundance; in the retrospective plot this CUs short-term status switched to Green twice despite the long-term persistent decline in abundance; the recommendation was that short-term metrics need to be interpreted cautiously when used for all CUs;
- debate over relative importance of WSP metrics and COSEWIC criteria; COSWIC Criteria D1 for small populations was the main driver for one of the groups to designate this CU Red; alternatively, other groups did not see the value in looking at COSEWIC criteria, given all WSP metrics clearly indicated a consistent Red status for this CU;

Cultus-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	R	R	R	

Time-varying Models

	25	50	75	p
Rick1970	R	R	R	
Rick1990	R	R	R	
SmRick1950	R	R	R	
RBRick1950	R	R	R	

LONG-TERM TREND
(Eff. **Total** Spawners)

Ratio
(geometric means)

0.09

Current gen. avg.
296

Historical Avg (61 Obs)
3,263

SHORT-TERM TREND
(Eff. **Total** Spawners)

3 Gen Change
(in 4yr Avg)

-69%

Prob. of 25% Decl. over 3 Gen

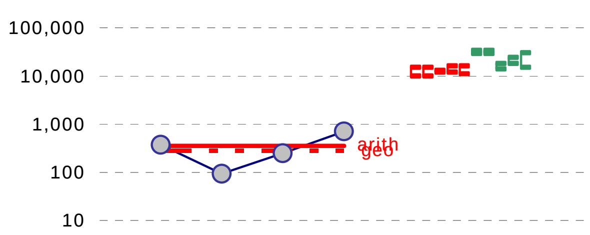
99%

Data Quality

Excellent
Very Good
Good
Fair
Poor

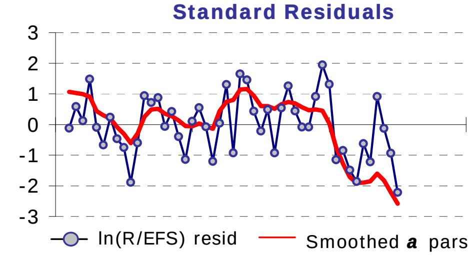
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1950	R	R	R	R	R		R	R	R	R	R
Rick1970	R	R	R	R	R		R	R	R	R	R
Rick1990	R	R	R	R	R		R	R	R	R	R
SmRick1950	R	R	R	R	R		R	R	R	R	R
RBRick1950	R	R	R	R	R		R	R	R	R	R

Effective Total Spawners (ETS)

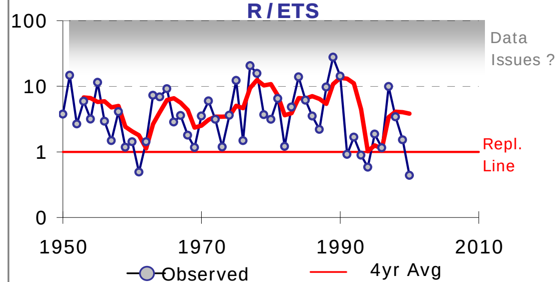


PRODUCTIVITY TIME SERIES

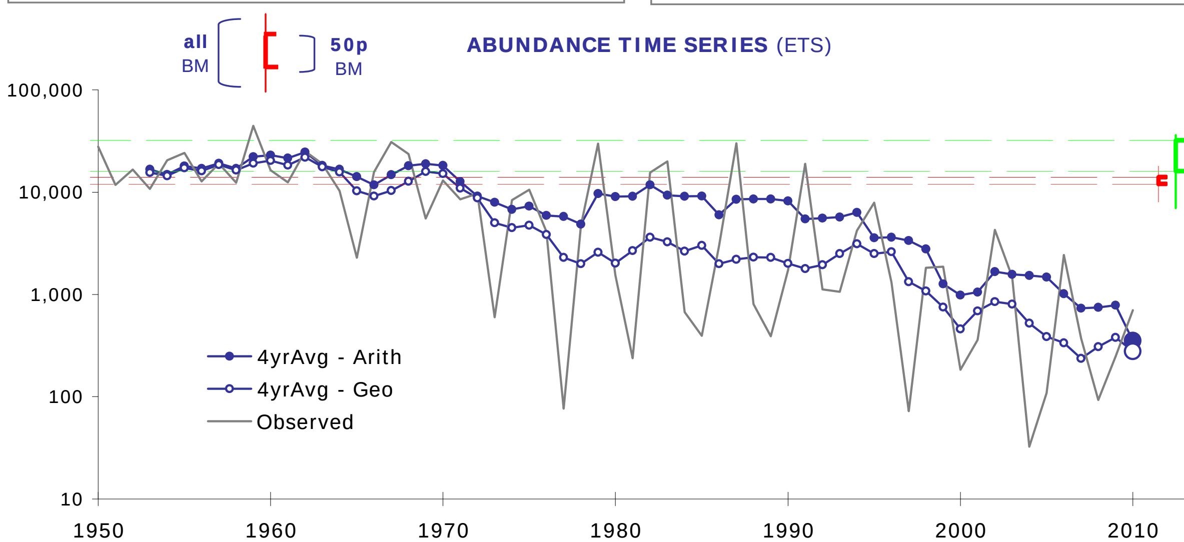
Standard Residuals



R / ETS

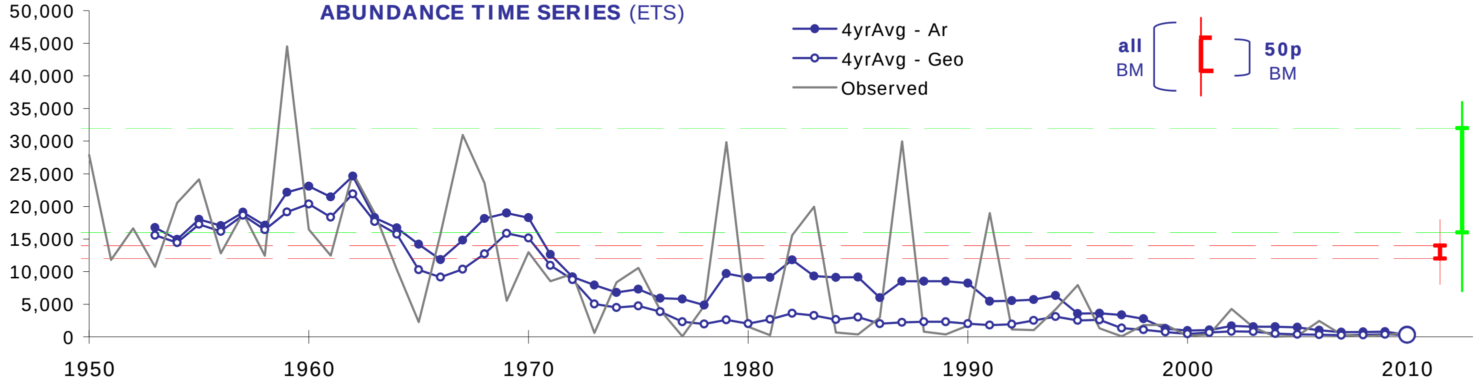


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Cultus-L



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G G G A A R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

R R R R R R R R R R R R R R R R R G G G A R R R A G G G R R R R R R R R R R R R R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	R R R R R R R R R R R
Rick1970	R R R R R R R R R R R
Rick1990	R R R R R R R R R R R
SmRick1950	R R R R R R R R R R R
RBRick1950	R R R R R R R R R R R

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	44,526	4,268	702
Med	4,730	365	309
Min	33	33	93

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	30	0	0
2500–5000	5	1	0
1000–2500	10	3	0
500–1000	4	1	1
250–500	4	2	1
0–250	8	5	2

Small Population Benchmarks (COSEWIC Criterion D1)

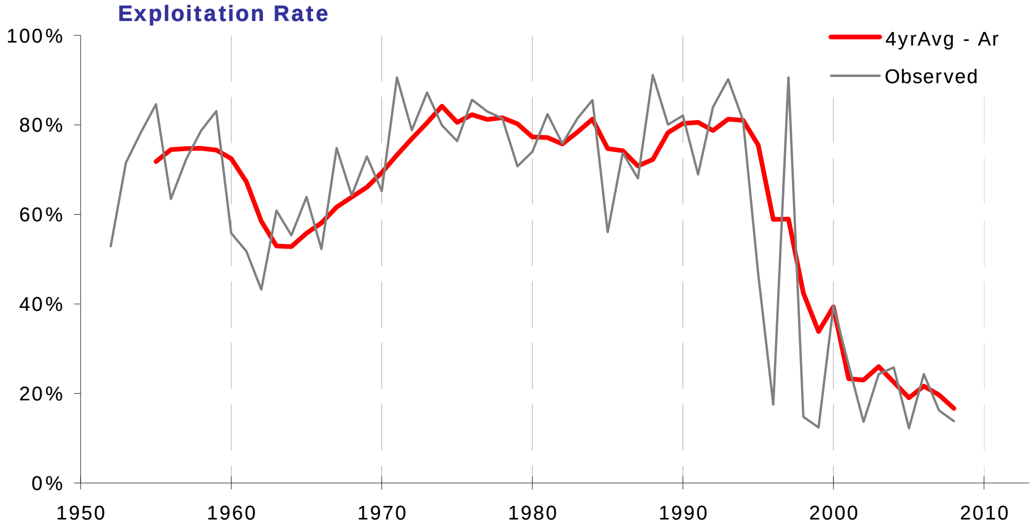
Lower Benchmark Estimates (S-gen)

	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	9,000	10,000	12,000	15,000	17,000
Rick(1970-2004)	8,000	10,000	12,000	15,000	18,000
Rick(1990-2004)	11,000	12,000	13,000	13,000	8,000
SmRick(1950-2004)	11,000	12,000	14,000	16,000	18,000
RBRick(1950-2004)	8,000	11,000	13,000	16,000	18,000

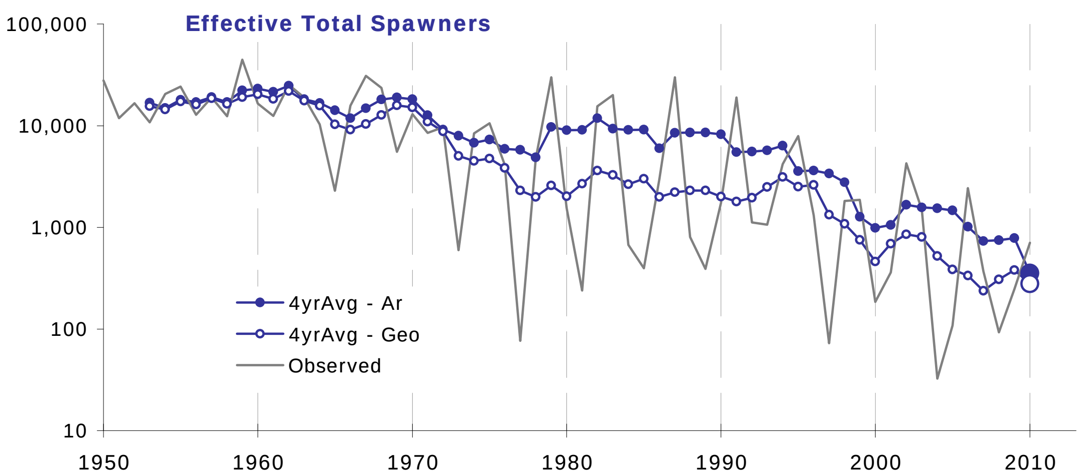
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	28,000	29,000	32,000	34,000	36,000
Rick(1970-2004)	27,000	29,000	32,000	34,000	36,000
Rick(1990-2004)	19,000	18,000	16,000	14,000	7,000
SmRick(1950-2004)	16,000	18,000	21,000	24,000	26,000
RBRick(1950-2004)	7,000	15,000	22,000	30,000	36,000

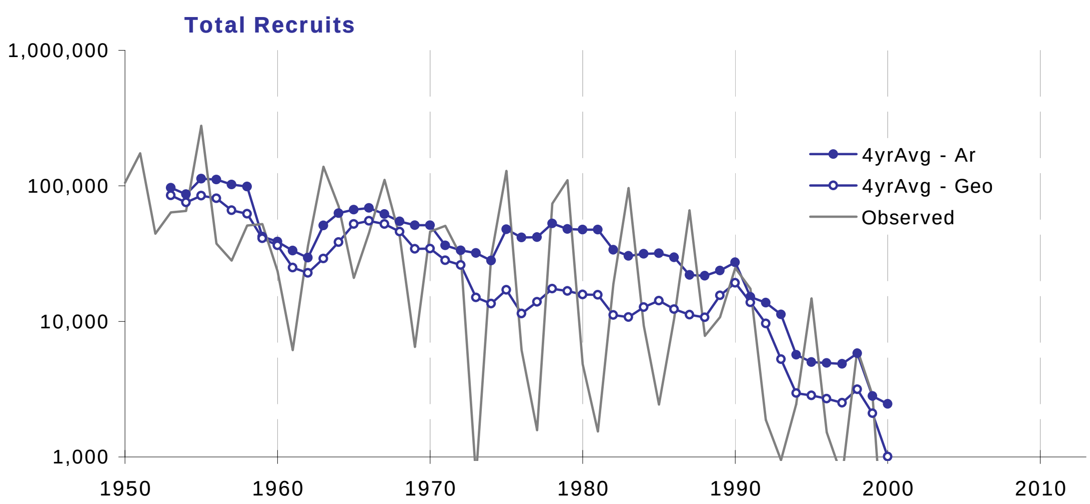
Cultus-L



Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed



Effective Total Spawners
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed



Total Recruits
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CASE 15: LILLOOET-HARRISON-L (GREEN)

(Management stock name: Birkenhead; Run-Timing Group: Late)

Background: only the Birkenhead River are included in abundance time series, since it has been consistently assessed and has a relatively long and complete time series (see Grant et al. 2011 for further details).

Integrated Status

G	*(provisional status, given productivity for this CU is decreasing)*

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
G	G	g		G	

Note: two out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Green integrated status was driven by the absolute abundance for this CU, which was well above COSEWIC Criteria D1 on small populations for the entire time series (of further note: not all populations are included in the absolute abundance estimates for this CU, which include Birkenhead River only, so absolute abundance for the CU is, in fact, higher than indicated by the data summary results); in addition, short-term abundance trends are Green in status (and trend is increasing) and long-term abundance trends are also Green in status;
- relative-abundance metric paired upper and lower benchmark combinations (probability levels and model forms) have only in recent years changed to Amber status based on the retrospective status time series for some model forms; current relative-abundance metric status ranges from Amber to Green, depending on the model form used; participants expressed concerns regarding the benchmarks estimated for this CU and requested further diagnostics to consider in their status evaluations; therefore the Amber statuses for the relative-abundance metric at particular probability levels and models, did not weigh as heavily in the integrated status determination;
- this CU was designated a provisional Green integrated status, given the declining productivity trends observed for this CU, which should be tracked; in addition, further relative-abundance metric diagnostics required for more thorough integrated status evaluations;

Points of Discussion

- debate over trend metrics vs. trends visible in time series plot; trends in abundance metrics were all Green, however, very recent trends on the time series are decreasing;
- Workshop participants debated whether status evaluation should reflect only the current status, or anticipate future status based on current abundance and productivity trends. Although a provisional Green integrated status was agreed to participants, if the currently observed decreasing productivity persist, this CU could fall into the Amber zone shortly;
- considerable discussion regarding the need for Ricker parameter values and further diagnostics to cross-check the benchmarks for this CU; some concerns with high productivity years and whether or not these values are correct, which may affect benchmark estimates;

Lillooet-Harrison-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75 p
Rick1950	A	A	A

Time-varying Models

	25	50	75 p
Rick1970	A	A	A
Rick1990	A	A	A
SmRick1950	G	G	G
RBRick1950	G	A	A

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.27

Current gen. avg.
35,808

Historical Avg (61 Obs)
28,240

SHORT-TERM TREND
(Eff. Female Spawners)

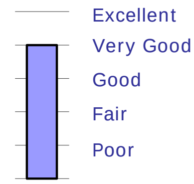
3 Gen Change
(in 4yr Avg)

3%

Prob. of 25% Decl. over 3 Gen

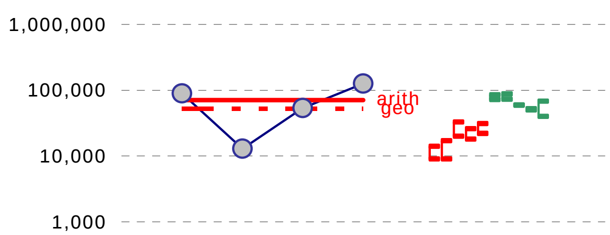
11%

Data Quality

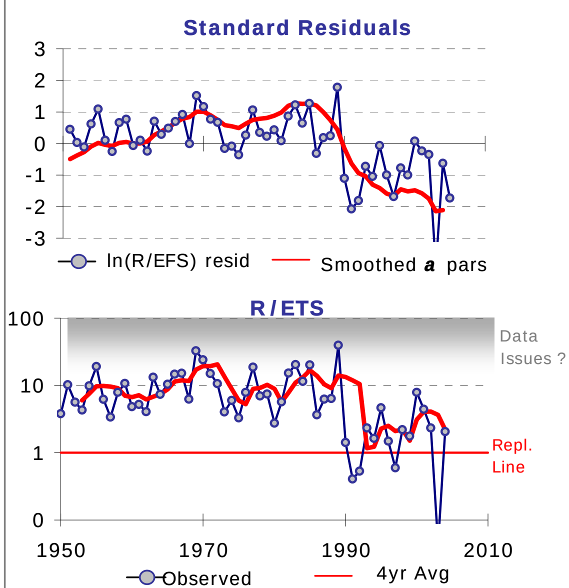


	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1950	A	A	A	A	A		G	A	A	A	A
Rick1970	A	A	A	A	A		G	A	A	A	A
Rick1990	G	A	A	A	A		G	G	G	G	G
SmRick1950	G	G	G	G	A		G	G	G	G	G
RBRick1950	G	G	A	A	A		G	G	G	G	A

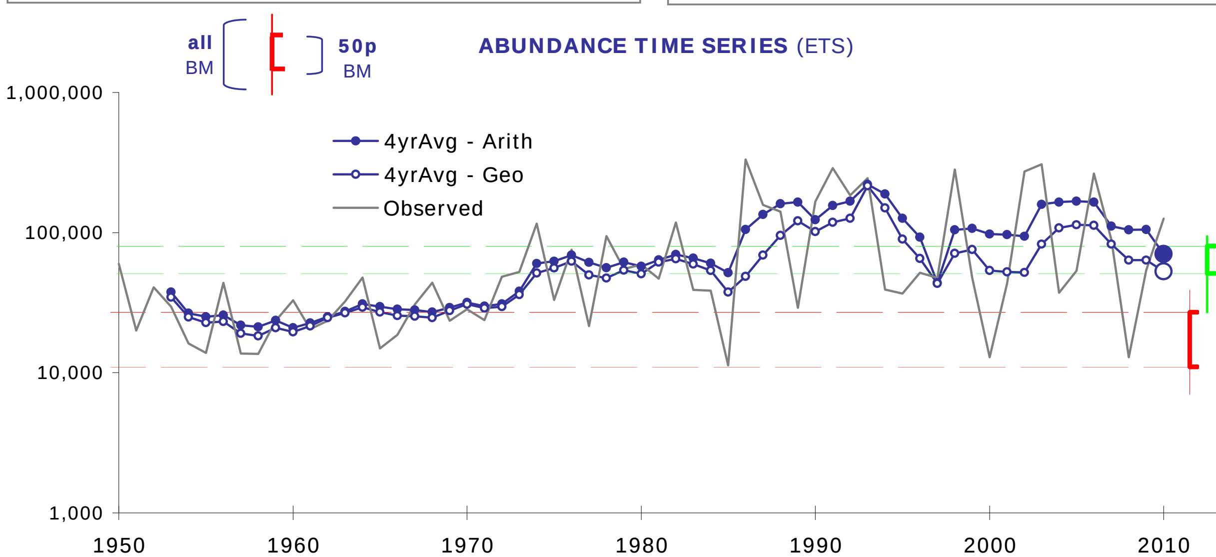
Effective Total Spawners (ETS)



PRODUCTIVITY TIME SERIES



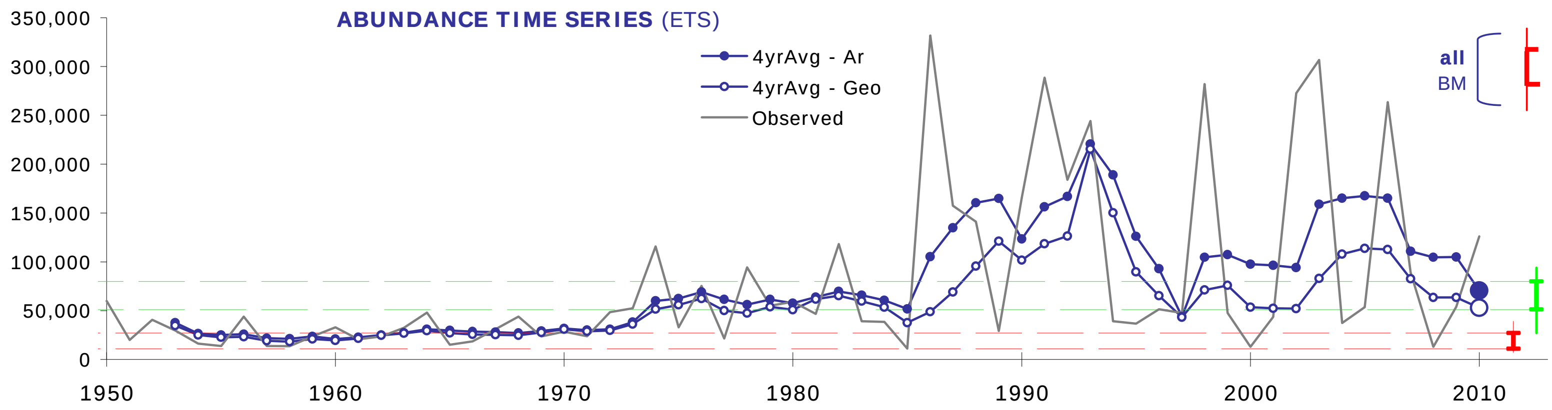
ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Lillooet-Harrison-L

ABUNDANCE TIME SERIES (ETS)



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	A	A	G	G	G	G	G	G	G	G	G	G	G	R	R	R	R	R	R	R	G	G	G	G	G	G

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	A	A	A	G	G	G	G	G	A	A	A
Rick1970	A	A	A	G	G	G	G	G	A	A	A
Rick1990	A	A	A	G	G	G	G	G	G	G	A
SmRick1950	G	G	G	G	G	G	G	G	G	G	G
RBRick1950	A	A	A	G	G	G	G	G	G	G	A

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	331,737	306,748	125,976
Med	43,689	53,646	71,542
Min	11,311	12,923	12,929

Number of Observations in a range

	All Yrs	Last 12	Last 4
	61	12	4
5000	0	0	0
2500	0	0	0
1000	0	0	0
500	0	0	0
250	0	0	0
0			

Small Population Benchmarks (COSEWIC Criterion D1)

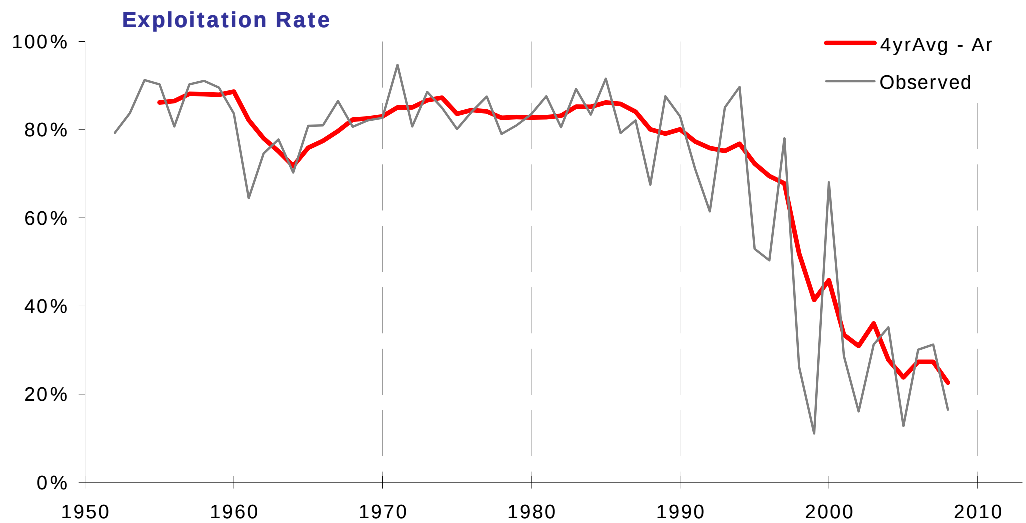
Lower Benchmark Estimates (S-gen)

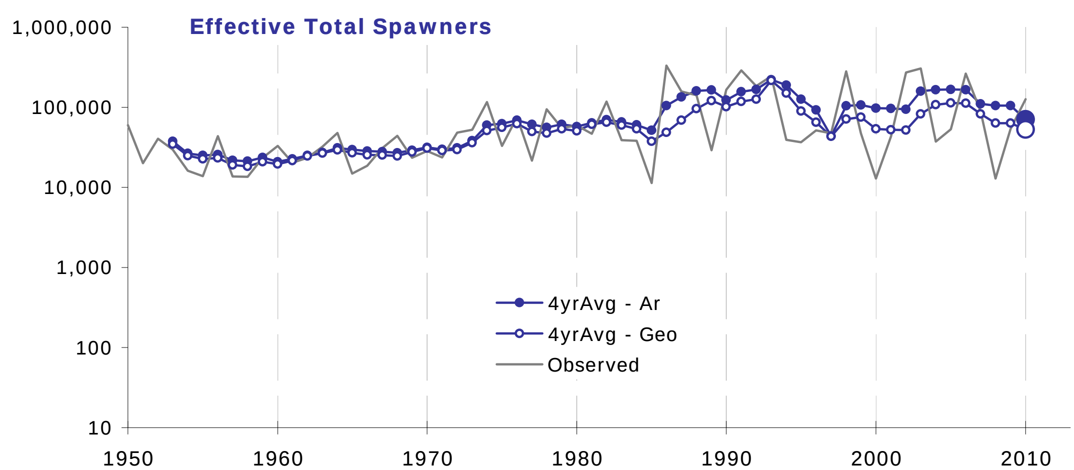
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	8,000	9,000	11,000	14,000	17,000
Rick(1970-2004)	7,000	9,000	13,000	17,000	21,000
Rick(1990-2004)	15,000	20,000	26,000	33,000	39,000
SmRick(1950-2004)	15,000	18,000	22,000	26,000	30,000
RBRick(1950-2004)	17,000	22,000	27,000	31,000	36,000

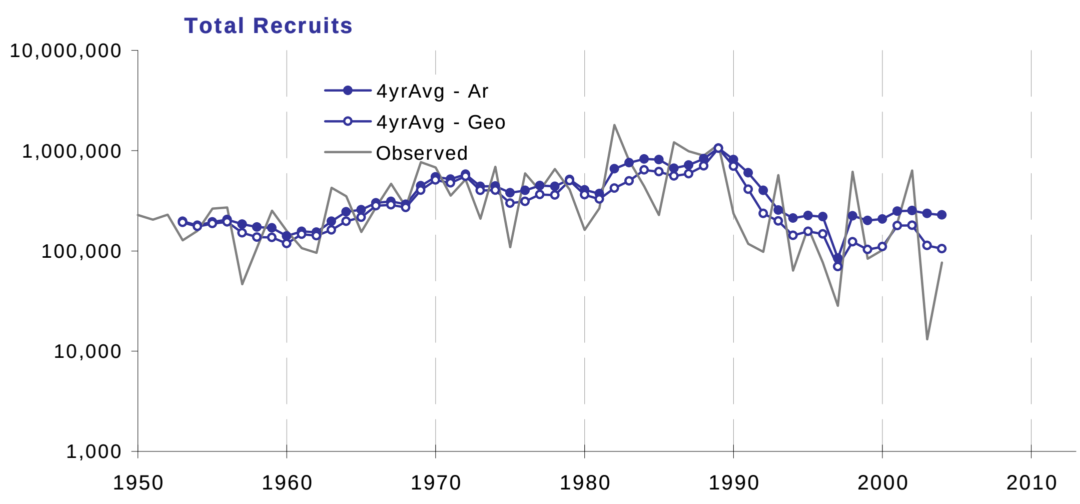
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	67,000	72,000	77,000	85,000	93,000
Rick(1970-2004)	67,000	73,000	80,000	88,000	94,000
Rick(1990-2004)	27,000	59,000	61,000	59,000	55,000
SmRick(1950-2004)	48,000	50,000	51,000	52,000	54,000
RBRick(1950-2004)	28,000	40,000	55,000	68,000	79,000

Lillooet-Harrison-L







Background: population expansion after Hells Gate landslide attributed to remnant Bowron Sockeye (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
R	R	R		R	

Note: two out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Red integrated status was driven by consistently Red status for all relative-abundance metric paired upper and lower benchmark combinations (probability levels and model forms) and across all trends in abundance metrics; in addition, this CU has exhibited very low recent absolute abundance, with three of the four years below 2,500 effective total spawners and one year below 1,000, which are the COSEWIC Criteria D1 for small populations;
- productivity trends have also been systematically decreasing for this CU;

Points of Discussion

- no discussion or debate on this CU's Red integrated status, given the consistency in status across all metrics and benchmarks;

Bowron-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	R	R	R	

Time-varying Models

	25	50	75	p
Rick1970	R	R	R	
Rick1990	R	R	R	
SmRick1950	R	R	R	

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.28

Current gen. avg.

754

Historical Avg (61 Obs)

2,656

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-88%

Prob. of 25% Decl. over 3 Gen

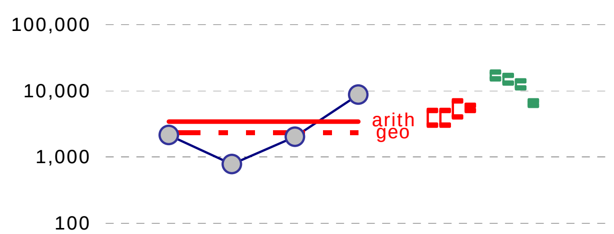
99%

Data Quality

- Excellent
- Very Good
- Good
- Fair
- Poor

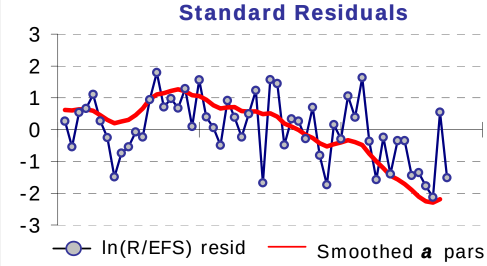
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90
Rick1950	R	R	R	R	R		A	A	R	R	R
Rick1970	R	R	R	R	R		A	A	R	R	R
Rick1990	R	R	R	R	R		A	R	R	R	R
SmRick1950	R	R	R	R	R		R	R	R	R	R

Effective Total Spawners (ETS)

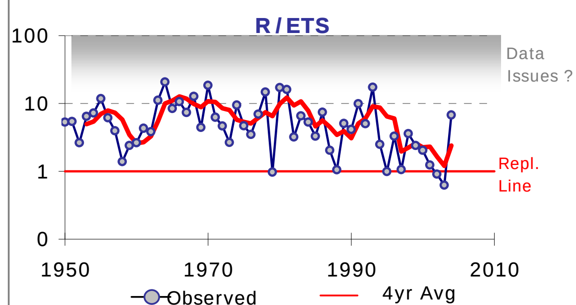


PRODUCTIVITY TIME SERIES

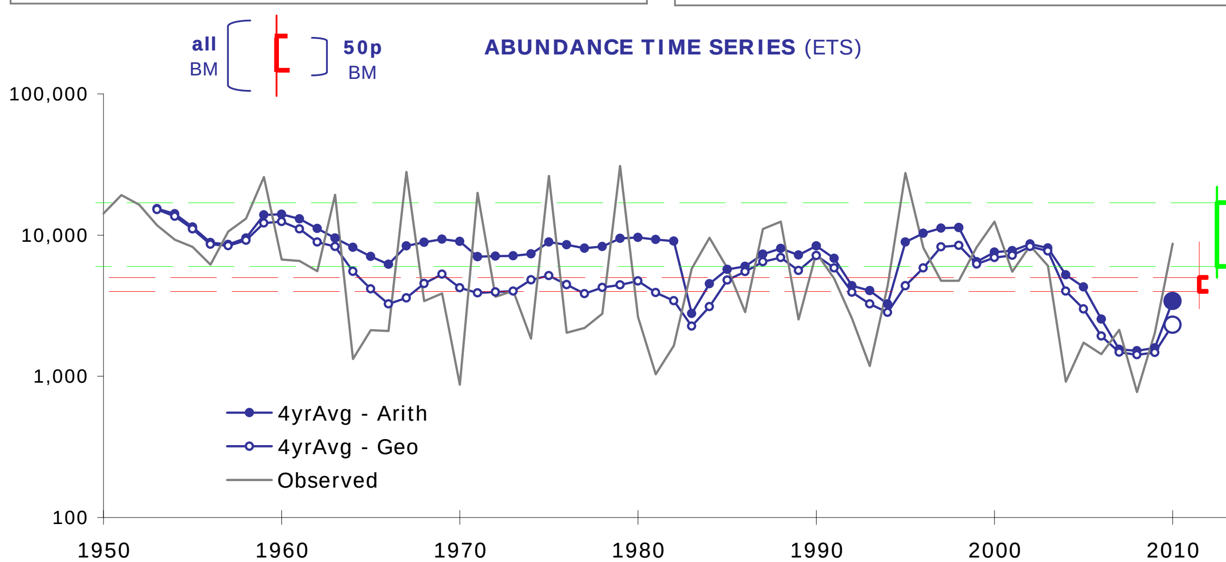
Standard Residuals



R / ETS

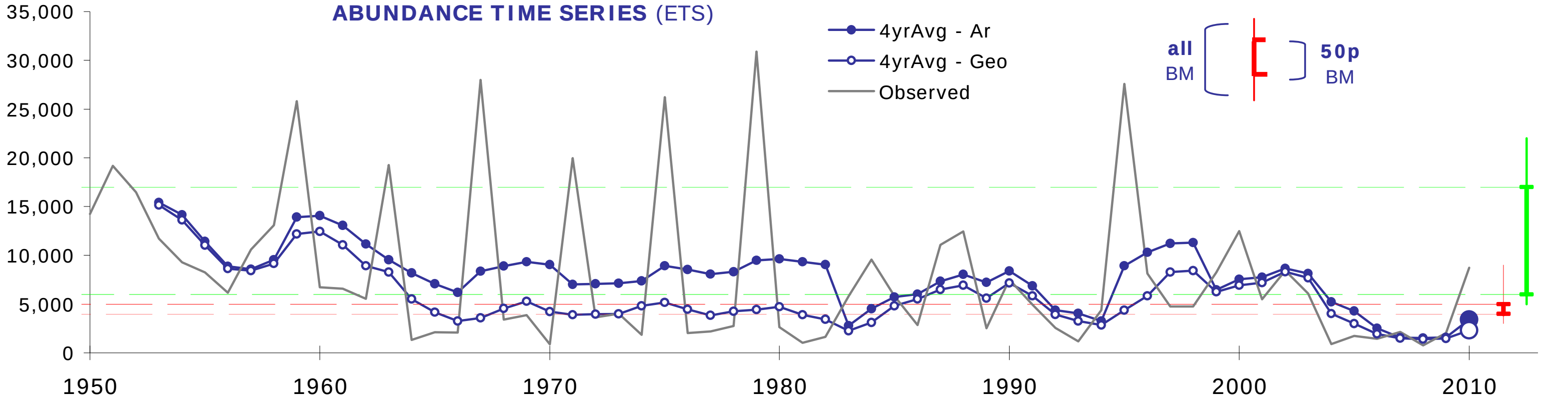


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Bowron-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	G	G	G	G	G	G	G	A	A	A	G	G	G	G	G	G	G	G	G	A	R	R	R	R

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

R	R	R	R	R	G	G	G	G	G	G	G	G	R	R	R	A	G	G	G	G	G	G	G	G	R	R	R	A	G	G	G	G	G	G	G	R	R	R	R	R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	A	A	A	A	A	R	R	R	R	R	R
Rick1970	A	A	A	A	A	R	R	R	R	R	R
Rick1990	A	A	A	A	R	R	R	R	R	R	R
SmRick1950	G	G	G	G	R	R	R	R	R	R	R

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	30,898	12,480	8,714
Med	5,549	3,819	2,075
Min	774	774	774

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	32	6	1
2500–5000	13	0	0
1000–2500	13	4	2
500–**1000**	3	2	1
250–500	0	0	0
0–**250**	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

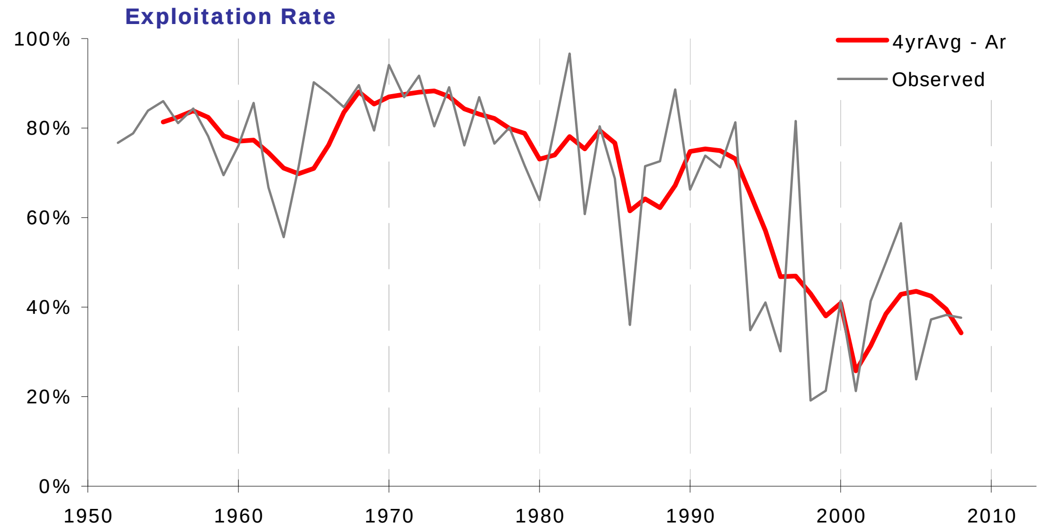
Lower Benchmark Estimates (S-gen)

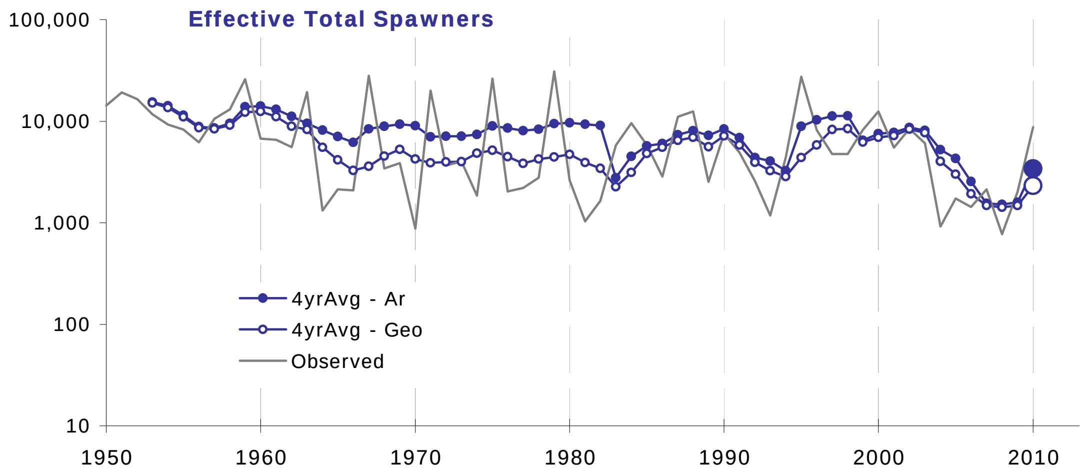
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	3,000	3,000	4,000	5,000	6,000
Rick(1970-2004)	3,000	3,000	4,000	5,000	7,000
Rick(1990-2004)	3,000	4,000	5,000	7,000	9,000
SmRick(1950-2004)	4,000	5,000	5,000	6,000	7,000
(-)					

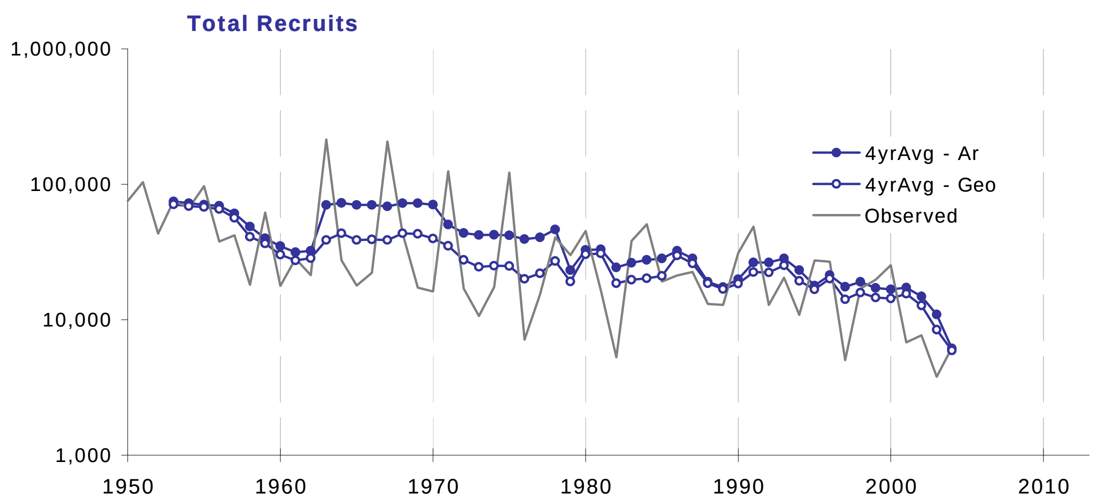
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	13,000	15,000	17,000	19,000	22,000
Rick(1970-2004)	11,000	13,000	14,000	17,000	18,000
Rick(1990-2004)	10,000	11,000	12,000	14,000	15,000
SmRick(1950-2004)	5,000	6,000	6,000	7,000	8,000
(-)					

Bowron-ES


Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed


Effective Total Spawners
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed


Total Recruits
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CASE 17: PITT-ES (AMBER/GREEN)

(Management stock name: Pitt; Run-Timing Group: Early Summer)

Background: this CU is supplemented with hatchery produced fry releases (Pitt Sockeye origin); given these hatchery-origin Sockeye are not marked, it is unclear how this supplementation influences the stock-recruitment time series, which affects both the relative-abundance metric benchmark estimates and productivity time series (see Grant et al. 2011 for further details).

Integrated Status

A	G

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	G	A		G	

Note: two out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- the Amber/Green integrated status was linked to the mixed signals amongst metrics and status information presented in the data summaries, and the different interpretations of these mixed status signals between groups;
- the Amber integrated status designation was driven by the relative-abundance metric statuses, which although Green at the 50% probability (median) benchmark for most models, are Amber at the adjacent higher probability level (75%); in addition, this CU has exhibited systematic decreases in productivity with some recent years of productivity falling below replacement; further the hatchery influence could be confounding the productivity time series, making productivity appear better than it actual is;
- The factors that indicated a Green integrated status were the relative-abundance metric and long-term trend metric, which were generally Green in status at the 50% median probability level (for some the consideration of adjacent probability level Amber statuses were not weighted as high); although the recursive-Bayesian model did have an Amber status at the 50% probability level and this should be evaluated in more detail (diagnostics and parameter values required); the short-term trend was not given a high weight because this CU is returning to average abundances after a previous period of high abundances (so assumed recent decreases in abundance were linked to density-dependent factors); high absolute abundance (no years below 2,500 on the time series) with current average effective female spawners of 15,877;

Points of Discussion

- debate regarding interpretation of short-term trend metric status, when CU is coming off a period of high production (returning to average) and the recent trend metric is Red in status; debate regarding whether or not the short-term trend metric should be given low weight in integrated status determinations in these cases; there appears to be a trend in integrated status determination to consider the consistency of the statuses amongst metrics, for CUs where most metric statuses are Green, but productivity is decreasing, productivity alone does not change the status; however, in cases of mixed status signals amongst metrics, productivity trends weigh more heavily into the status integration designations;
- status category discussion: Amber designation used to monitor a CU if there are concerns regarding where the CU is headed; versus flagging a Green CU in regards to concerning productivity trends; will both have the same affect in regards to monitoring the CU?

Pitt-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

	25	50	75	p
Rick1950	G	G	A	

Time-varying Models

	25	50	75	p
Rick1970	G	G	A	
Rick1990	G	G	A	
SmRick1950	G	G	G	
RBRick1950	A	A	A	

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.68

Current gen. avg.

15,877

Historical Avg (61 Obs)

9,463

SHORT-TERM TREND
(Eff. Female Spawners)

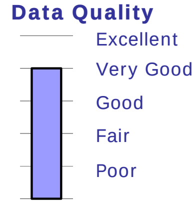
3 Gen Change
(in 4yr Avg)

-54%

Prob. of 25% Decl. over 3 Gen

88%

Data Quality



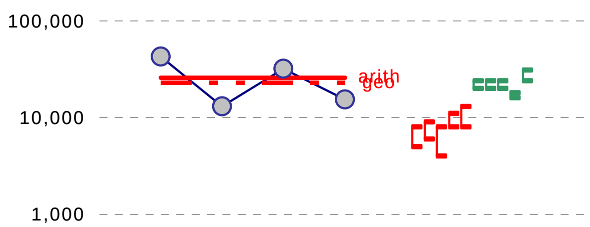
Geometric

	10	25	50	75	90	p
Rick1950	G	G	G	A	A	
Rick1970	G	G	G	A	A	
Rick1990	G	G	G	A	A	
SmRick1950	G	G	G	G	G	
RBRick1950	G	A	A	A	A	

Arithmetic

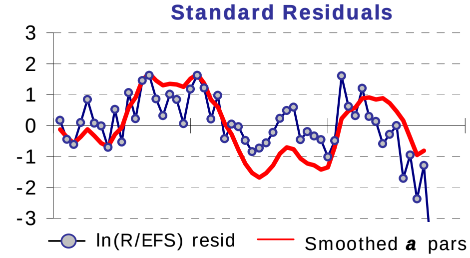
	10	25	50	75	90
Rick1950	G	G	G	G	A
Rick1970	G	G	G	G	A
Rick1990	G	G	G	G	A
SmRick1950	G	G	G	G	G
RBRick1950	G	G	A	A	A

Effective Total Spawners (ETS)

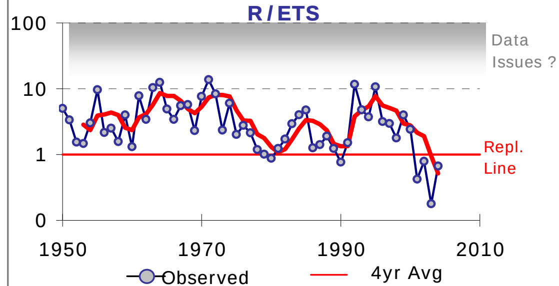


PRODUCTIVITY TIME SERIES

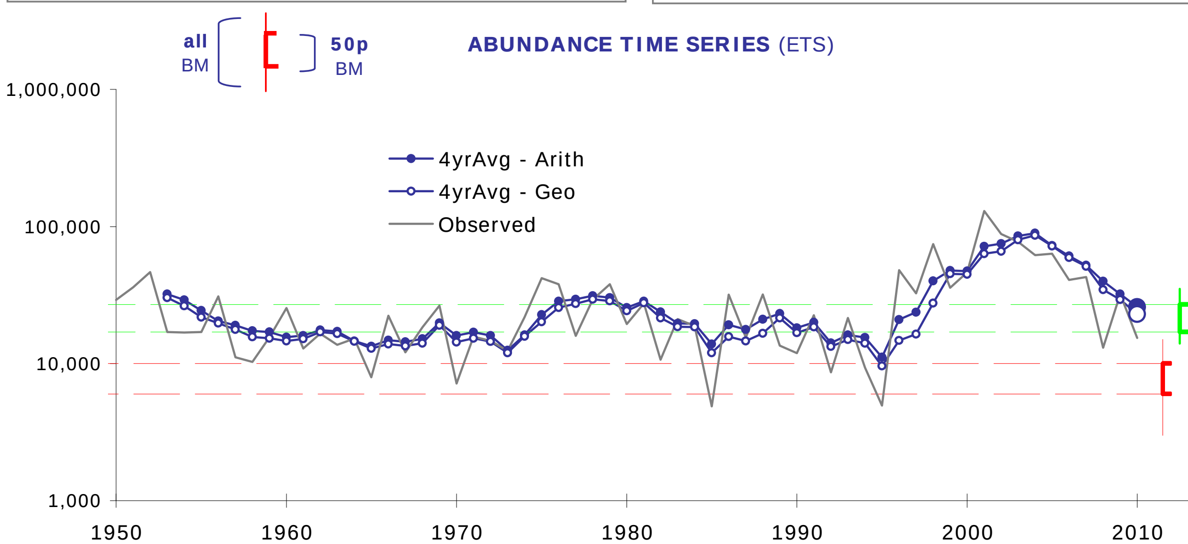
Standard Residuals



R/ETS

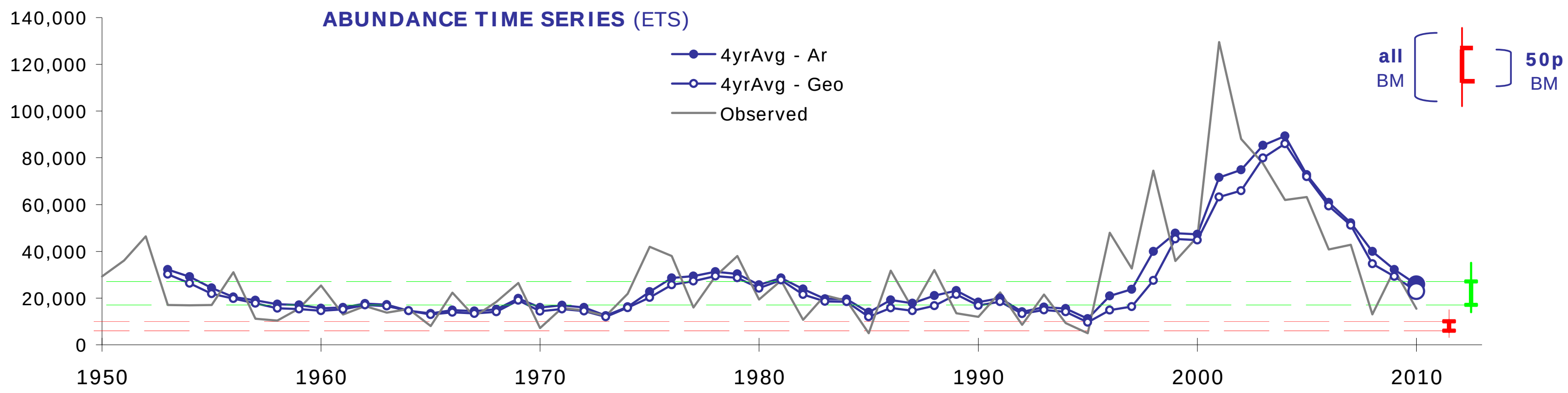


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Pitt-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

A G G A G G G G G G G G G G G G G G G G G G G G G A G G G G G G G G G G G G G G G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

R R A A G G G G G G G G G G G A R R R R R R R G G A G G G G G G G G G G G G G G R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Rick1950	G G G G G G G G G G G
Rick1970	G G G G G G G G G G G
Rick1990	G G G G G G G G G G G
SmRick1950	G G G G G G G G G G G
RBRick1950	G G G G G G G G G G A

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	129,561	129,561	42,827
Med	21,109	44,541	23,741
Min	4,882	13,077	13,077

Number of Observations in a range

	59	12	4
5000	2	0	0
2500	0	0	0
1000	0	0	0
500	0	0	0
250	0	0	0
0			

Small Population Benchmarks (COSEWIC Criterion D1)

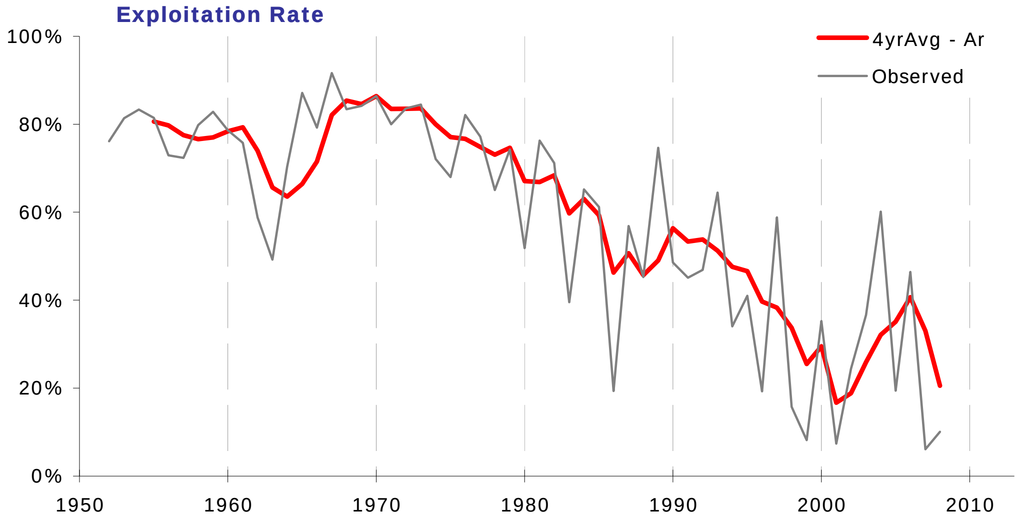
Lower Benchmark Estimates (S-gen)

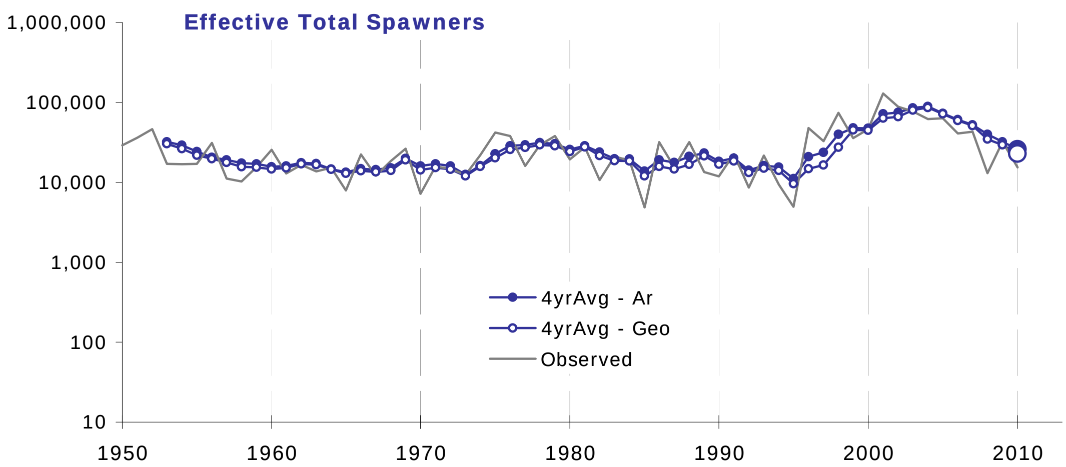
	LB_10p	LB_25p	LB_50p	LB_75p	LB_90p
Rick(1950-2004)	4,000	5,000	6,000	8,000	9,000
Rick(1970-2004)	5,000	6,000	7,000	9,000	12,000
Rick(1990-2004)	3,000	4,000	6,000	8,000	12,000
SmRick(1950-2004)	6,000	8,000	9,000	11,000	11,000
RBRick(1950-2004)	5,000	8,000	10,000	13,000	15,000

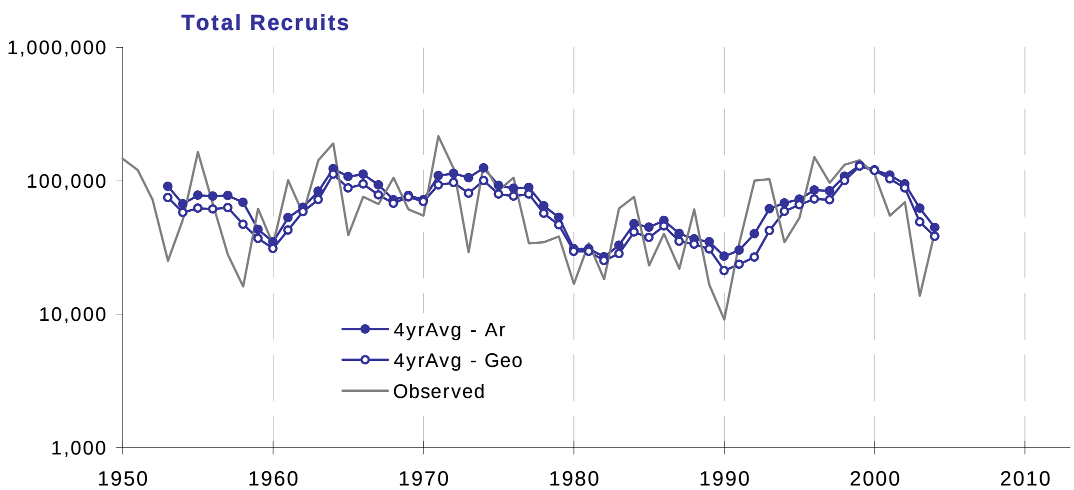
Upper Benchmark Est. (80% S-msy)

	UB_10p	UB_25p	UB_50p	UB_75p	UB_90p
Rick(1950-2004)	18,000	20,000	22,000	24,000	26,000
Rick(1970-2004)	19,000	20,000	22,000	24,000	27,000
Rick(1990-2004)	19,000	20,000	22,000	24,000	27,000
SmRick(1950-2004)	14,000	16,000	17,000	18,000	18,000
RBRick(1950-2004)	20,000	24,000	27,000	31,000	35,000

Pitt-ES


Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed


Effective Total Spawners
1,000,000
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed


Total Recruits
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CYCLIC CU-CASE 18: SETON-L *DE NOVO* (UNDETERMINED)

(Management stock name: Portage; Run-Timing Group: Late)

Background: the original population was extirpated by poor hatchery husbandry techniques and the Hells Gate landslide; subsequently hatchery transplants were used to re-build this population; this population re-established and labelled a de novo CU due to its hatchery origins (see Grant et al. 2011 for further details).

Integrated Status

UD

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
a	R		R	G	G

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- cyclic CU's: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, relative-abundance metrics were not considered in final status evaluations;
- no integrated status designation could be agreed upon by workshop participants; the integrated status designated by groups included all three WSP status zones (Red, Amber, and Green); even within groups, there was inconsistency in status determinations amongst individuals;
- two groups designated this CU Red based on the steep decline in abundance (-67%) and the Red status for the short-term trends in abundance metric, and the decreasing productivity (one year below replacement in recent years); in addition, one year (single sub-dominant cycle year) was below the COSEWIC Criteria D1 for small populations abundance of 250;
- two groups designated this CU Green, emphasizing that the dominant cycle did not exhibit any decreasing trend in abundance and has been quite stable since the 1980's (after a period of rebuilding in the previous decade after the original CU was extirpated); these groups discounted the short-term and long-term trend metric in their status evaluations since they felt these metrics were strongly influenced by a single low observation on a single subdominant cycle year;
- one group designated this CU Amber, as a middle ground to balance all the considerations presented by the Red and Green designations described in previous bullets; although the group agreed to an Amber integrated status, interpretations varied amongst individuals in this group;

Points of Discussion

- discussions on how to treat subdominant or weak cycles versus subdominant cycles in status evaluations; if trends in abundance are stable for the dominant cycle that drives abundance for a particular CU versus decreasing for weak (small) cycles, how do you evaluate these differences during integrated status determinations; if a dominant cycle has large abundances, then genetic exchange and spill over of other age classes from the dominant cycle occurs between cycle lines;

Seton-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25 50 75 p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.67

Current gen. avg.

1,369

Historical Avg (46 Obs)

2,058

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-67%

Prob. of 25% Decl. over 3 Gen

96%

Data Quality

Excellent

Very Good

Good

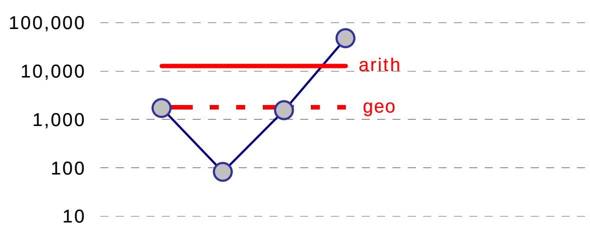
Fair

Poor

Geometric: 10 25 50 75 90 p

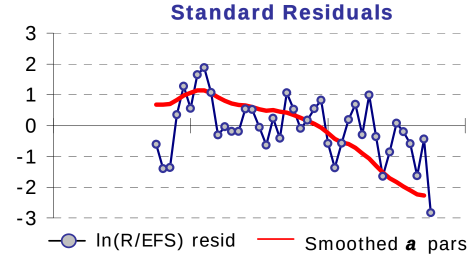
Arithmetic: 10 25 50 75 90

Effective Total Spawners (ETS)

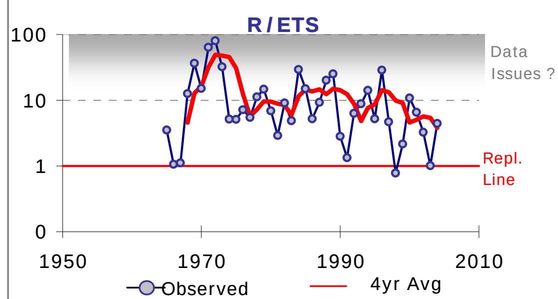


PRODUCTIVITY TIME SERIES

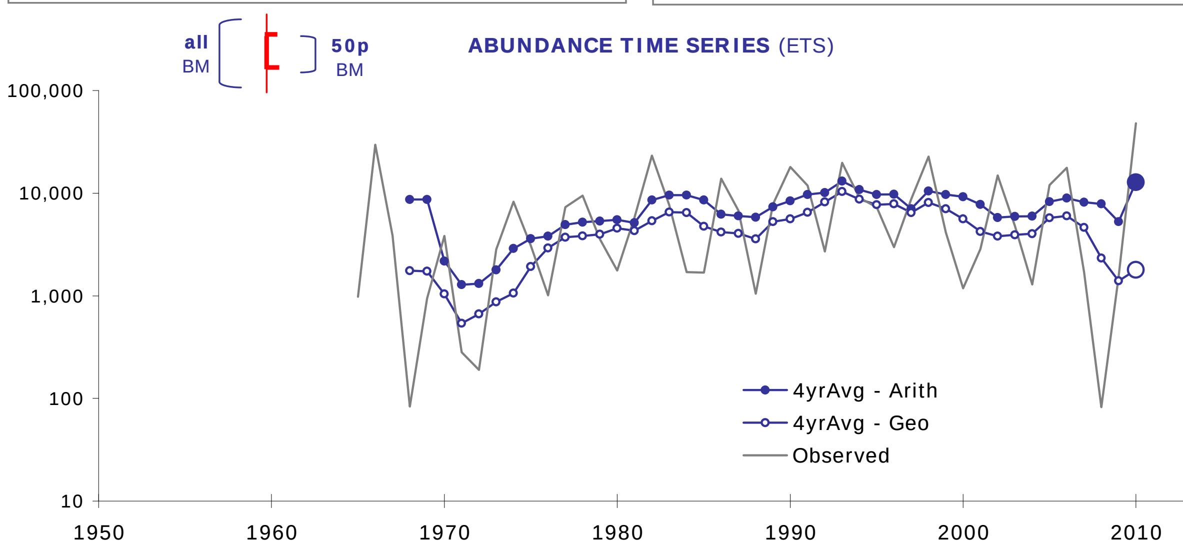
Standard Residuals



R/ETS

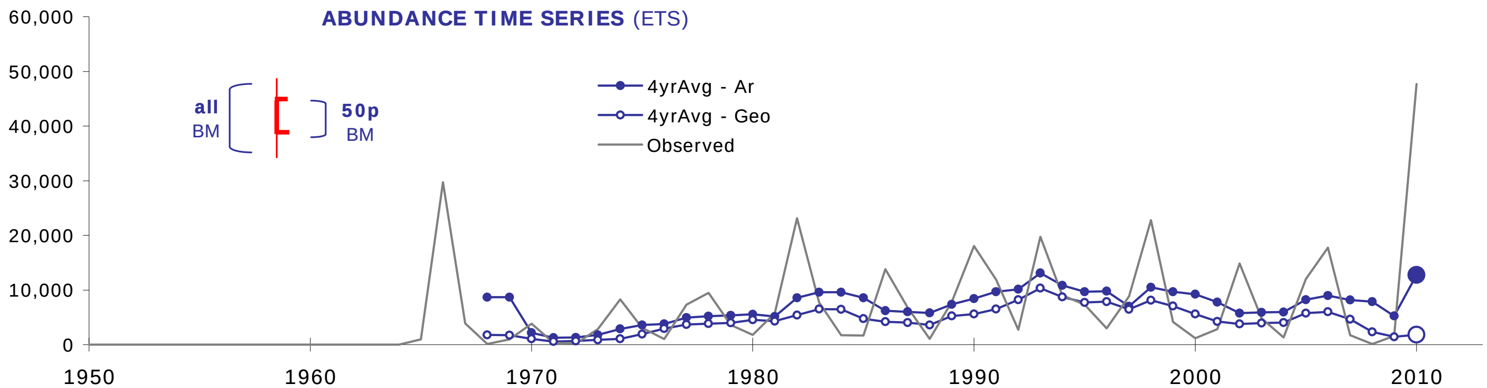


ABUNDANCE TIME SERIES (ETS)



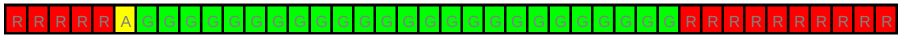
Retrospective Pattern in WSP Metrics

Seton-L



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)



Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	47,722	47,722	47,722
Med	4,004	3,498	1,622
Min	82	82	82

Number of Observations in a range

	All Yrs	Last 12	Last 4
above 5000	21	4	1
2500–5000	10	3	0
1000–2500	9	4	2
500–**1000**	2	0	0
250–500	1	0	0
0–**250**	3	1	1

Small Population Benchmarks (COSEWIC Criterion D1)

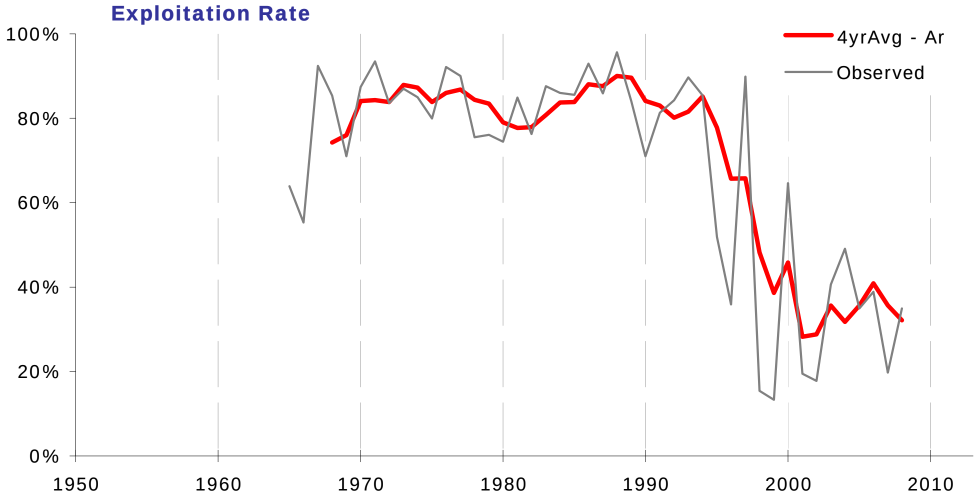
Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

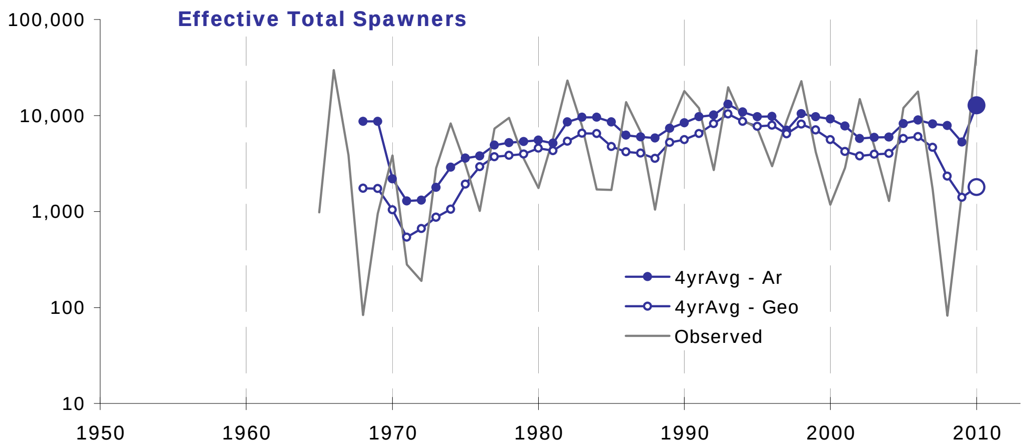
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

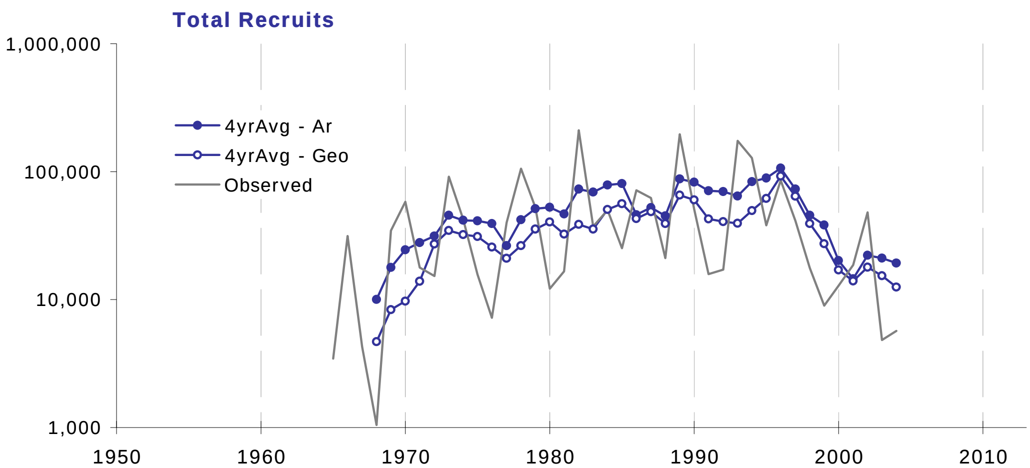
Seton-L



Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed



Effective Total Spawners
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed



Total Recruits
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CYCLIC CU-CASE 19: ANDERSON-SETON-ES (AMBER)

(Management stock name: Gates; Run-Timing Group: Early Summer)

Background: forest harvesting and other human activities were believed to have deteriorated habitat quality prior to the 1960's, as a result, a channel was constructed between 1967-1968 compensate for this loss to production; the channel accounts for a high proportion of this CU's production; both the Gates creek and channel are included in the escapement time series for status evaluations (see Grant et al. 2011 for further details).

Integrated Status

A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
A	A	A	R	A	A

Status Commentary

- cyclic CUs: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the Amber integrated status was driven by the overall population increase since the 1960s and 1970s (Green status for the long-term trend metric) and the stable abundance in recent years; combined with the recent declining trend (Red status for the short-term trend metric) and relatively low abundance weak cycle years; however, no recent years fall below the COSEWIC D1 Criteria;
- One group designated this CU Red in status; this determination was driven by the observed recent decrease in abundance and productivity (one recent year exhibited below replacement productivity) and the Red short-term trend metric status; also comments regarding concerns for the loss of the dominant cycle year in recent cycles;

Points of Discussion

- No specific discussions on this CU;

Anderson-Seton-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.75

Current gen. avg.
2,441

Historical Avg (57 Obs)
1,391

SHORT-TERM TREND
(Eff. Female Spawners)

3 Gen Change
(in 4yr Avg)

-39%

Prob. of 25% Decl. over 3 Gen

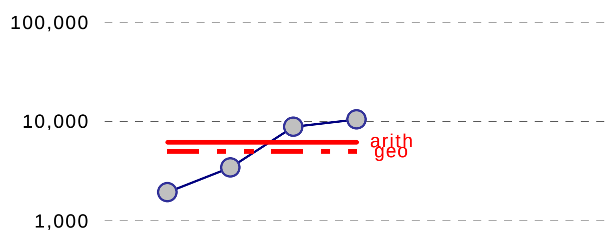
77%

Data Quality

Excellent
Very Good
Good
Fair
Poor

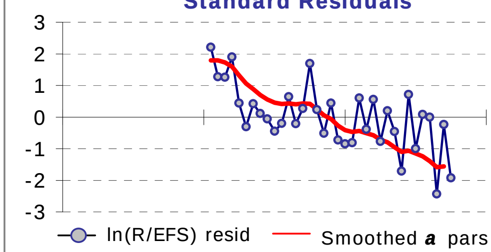
Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90

Effective Total Spawners (ETS)

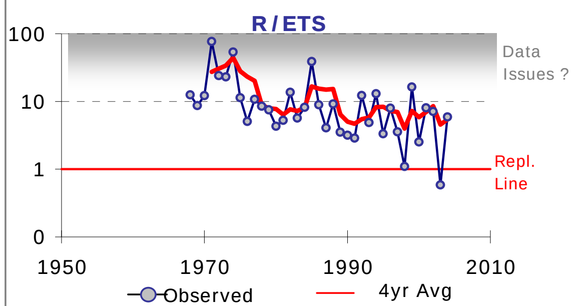


PRODUCTIVITY TIME SERIES

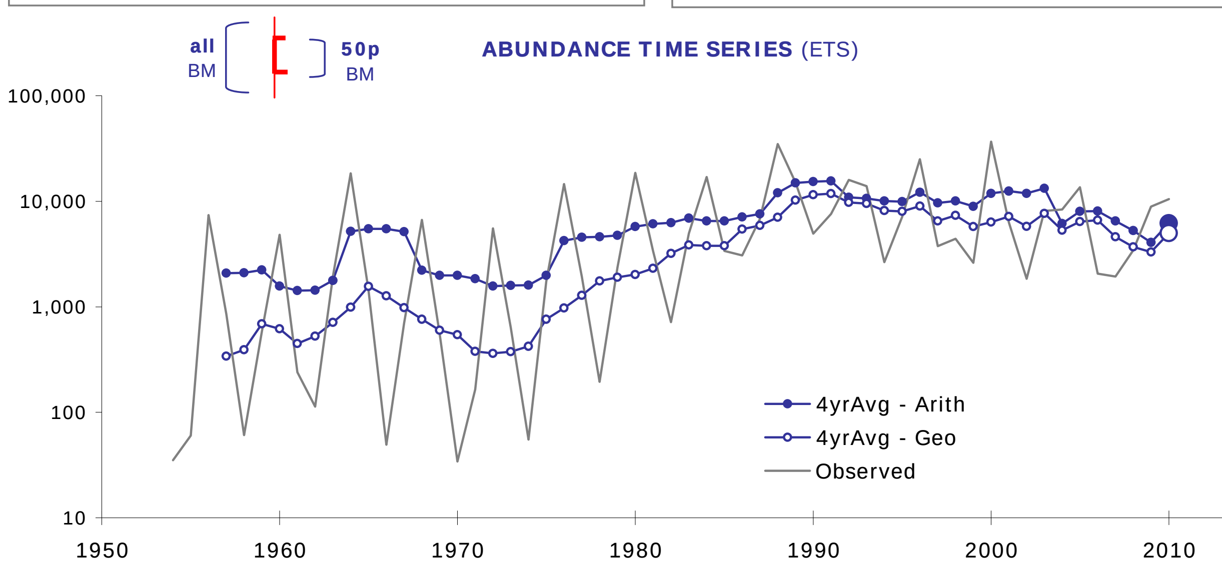
Standard Residuals



R/ETS

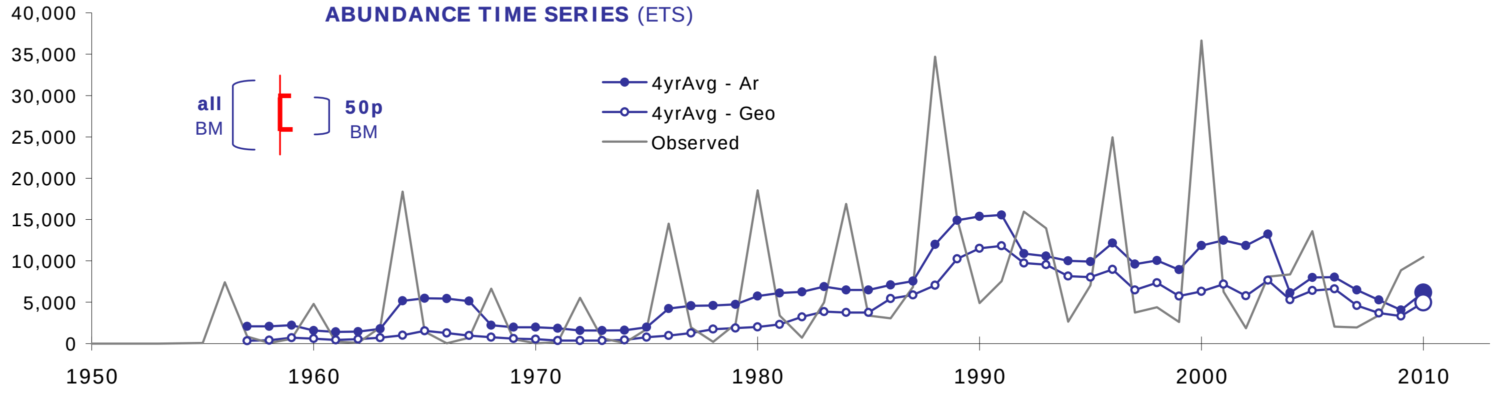


ABUNDANCE TIME SERIES (ETS)



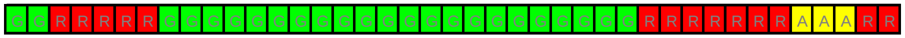
Retrospective Pattern in WSP Metrics

Anderson-Seton-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)



Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	36,653	36,653	10,488
Med	3,396	7,202	6,141
Min	34	1,838	1,932

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
> 5000	22	7	2
2500–5000	11	2	1
1000–2500	8	3	1
500–1000	6	0	0
250–500	0	0	0
0–250	10	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

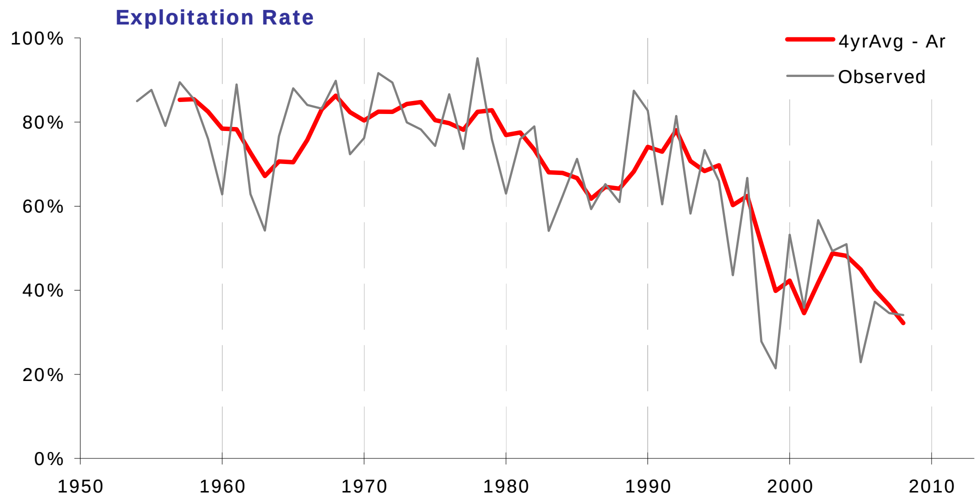
Lower Benchmark Estimates (S-gen)

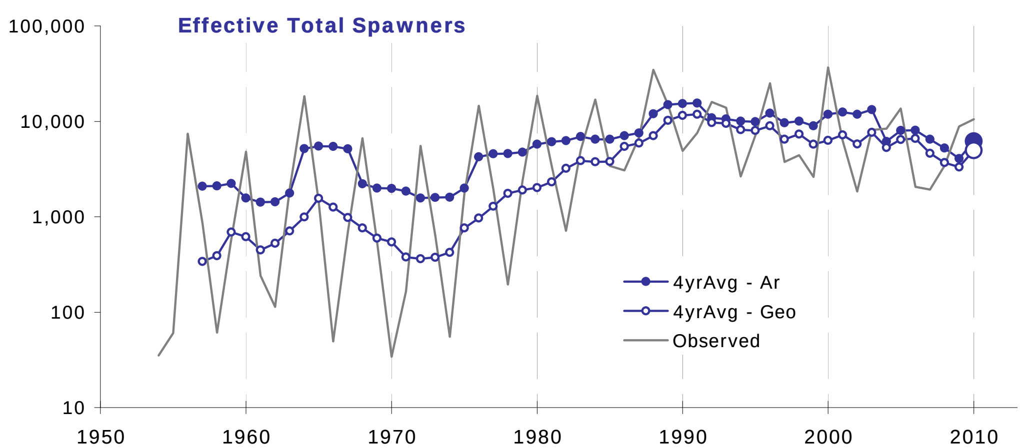
LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

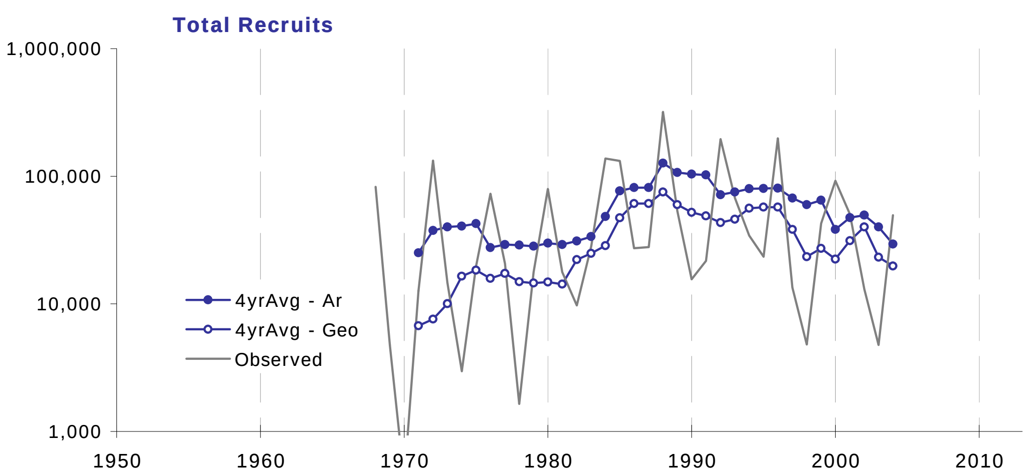
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

Anderson-Seton-ES







CYCLIC CU-CASE 20: TAKLA-TREMBLEUR-ESTU (RED)

(Management stock name: Early Stuart; Run-Timing Group: Early Stuart)

Background: historical evidence suggests this CU has never been large; abundance was particularly low from 1962-1968, peaked in the 1990s and has subsequently decreased; decreases in abundance are largely attributed to this CU's long migration route (greatest upstream migration of all Fraser Sockeye CUs), their spring upstream migration timing, and the increased water temperatures in the Fraser during their upstream migration (see Grant et al. 2011 for further details).

Integrated Status

R

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
r	R	R	R	R	R

Status Commentary

- cyclic CU's: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the Red integrated status was driven by the short-term trend in abundance metric which was Red in status and steep (58% decrease); declines have occurred in both dominant and weak cycles years; abundance trends are supported by declining trends in productivity, which dropped below replacement in a number of years after 1990; however, participants noted that spawner abundance did not fall below the COSEWIC Criteria D1 in the last four to 12 years;
- CU increased in abundance from lows in the 1960's, peaked in the 1990's, and has subsequently decreased in recent years; although long-term trends were Amber, they fell close to the lower benchmark so did not alter the Red status designation;

Points of Discussion

- debate regarding the interpretation of the two alternative productivity time series (Ricker residuals versus R/ETS);

Takla-Trembleur-EStu

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25 50 75 p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.59

Current gen. avg.

11,195

Historical Avg (61 Obs)

19,116

SHORT-TERM TREND
(Eff. Female Spawners)

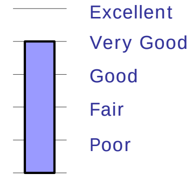
3 Gen Change
(in 4yr Avg)

-58%

Prob. of 25% Decl.
over 3 Gen

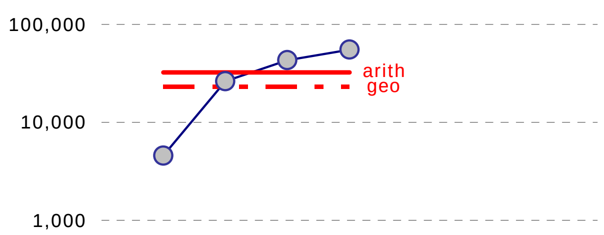
99%

Data Quality



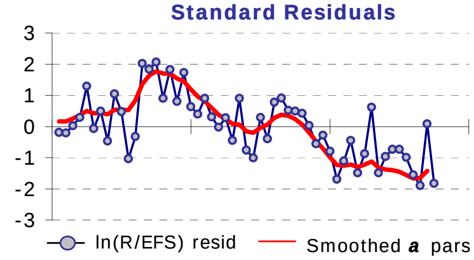
Geometric | Arithmetic
10 25 50 75 90 p 10 25 50 75 90

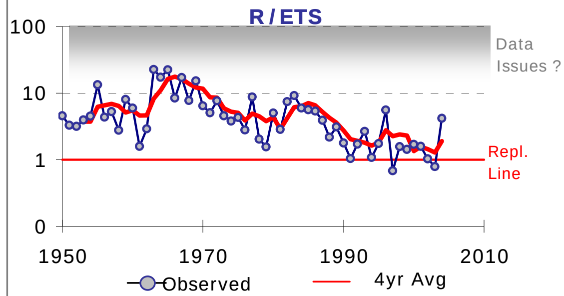
Effective Total Spawners (ETS)



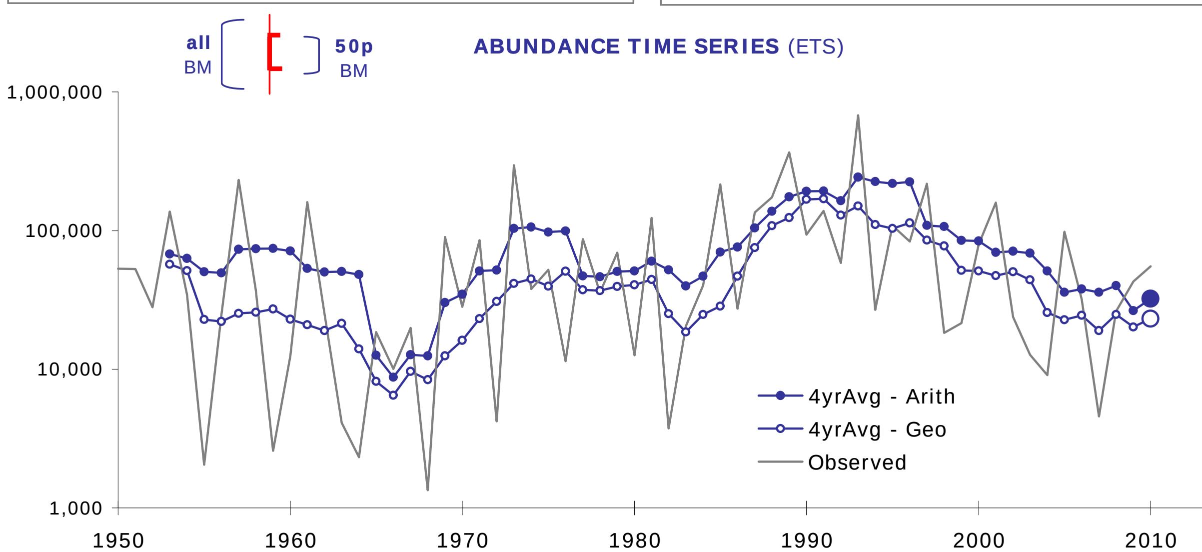
PRODUCTIVITY TIME SERIES

Standard Residuals



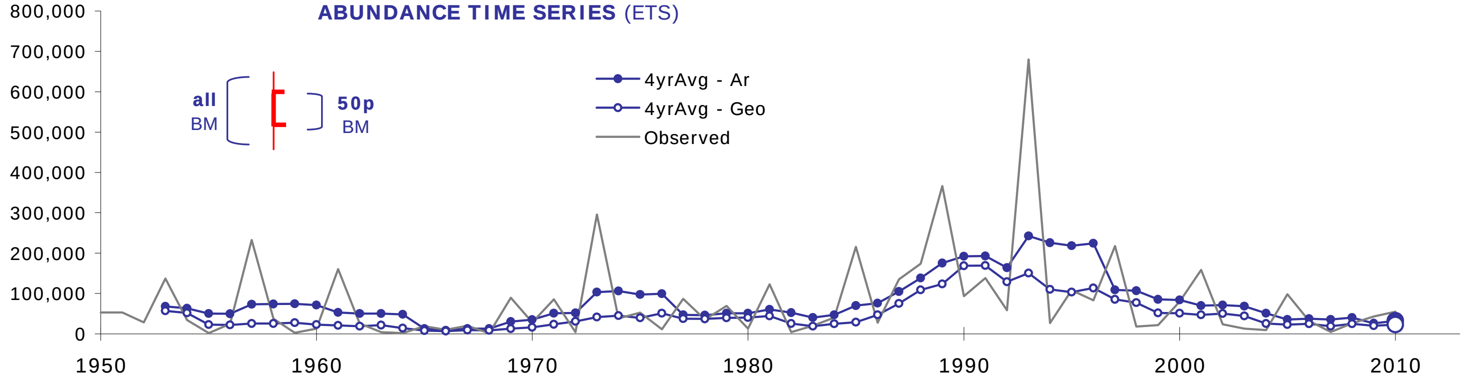


ABUNDANCE TIME SERIES (ETS)

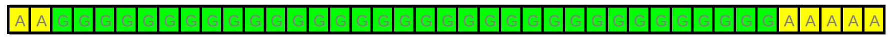


Retrospective Pattern in WSP Metrics

Takla-Trembleur-EStu



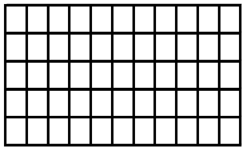
Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)



Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	679,755	158,704	55,362
Med	37,300	29,140	34,628
Min	1,346	4,584	4,584

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	53	11	3
2500–5000	5	1	1
1000–2500	3	0	0
500–1000	0	0	0
250–500	0	0	0
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

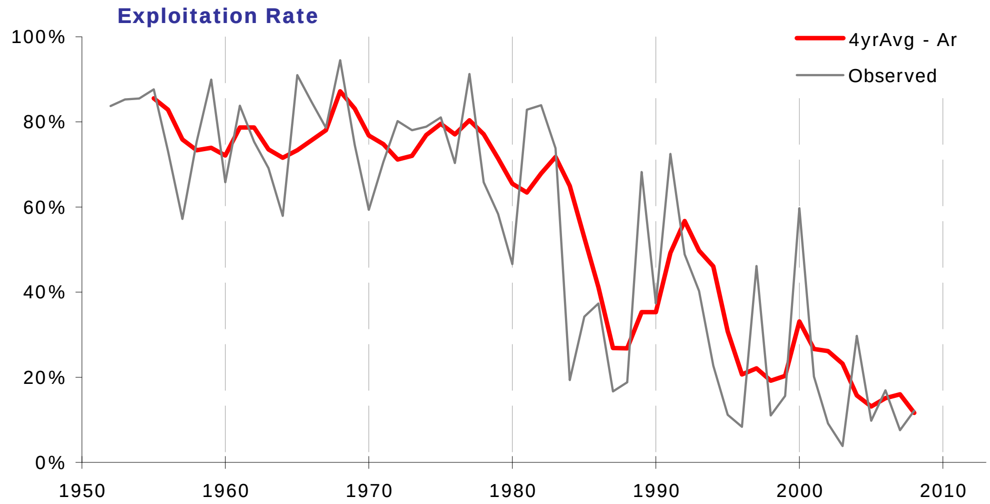
Lower Benchmark Estimates (S-gen)

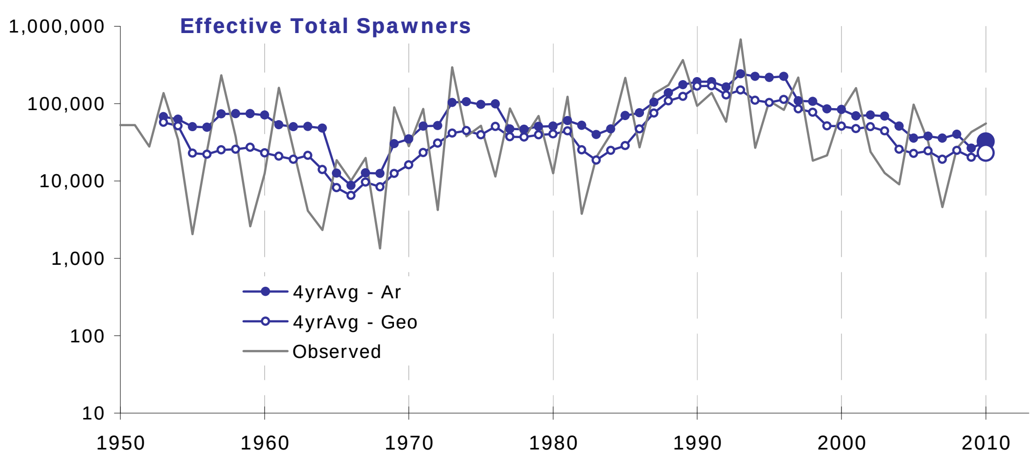
LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

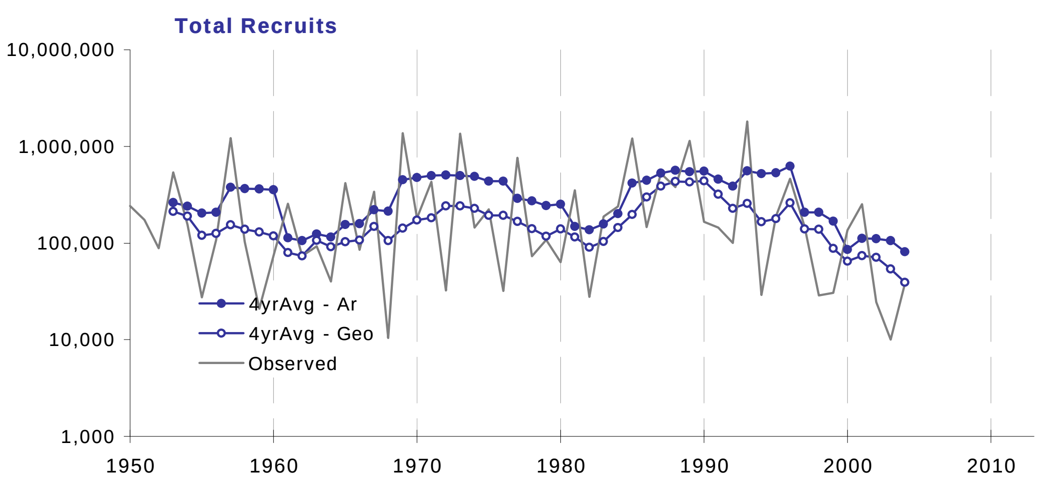
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

Takla-Trembleur-EStu







CYCLIC CU-CASE 21: QUESNEL-S (RED)

(Management stock name: Quesnel; Run-Timing Group: Summer)

Background: this CU was likely the largest of all Summer Run timed populations prior to the late-1880's; subsequently, this CU declined due to dam construction at the outlet of Quesnel Lake, placer mining impacts on spawning habitat, and the Hells Gate landslide; after barriers to fish migration were eliminated, this CU started to re-build notably in the 1980's (see Grant et al. 2011 for further details).

Integrated Status

R	A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
r	R	r	R	A	R

Status Commentary

- cyclic CUs: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the Red integrated status was driven by productivity, which decreased strongly with a number of years falling below replacement; the short-term trend metric was Red and indicated a steep decline (-92%) also influenced status, however, it was also noted that this CU was returning to average abundances after a period of high abundance (*however, see Points of Discussion on productivity trends);
- one group designated this CU Amber due to the large absolute abundance (current average effective female spawners: 39,952) and concerns regarding the productivity trends estimated using Ricker model residuals, which may not be capturing the effects of delay density on the productivity trends (Larkin model may be more appropriate); therefore, if using a more appropriate model for cyclic CUs, this CU may not exhibit systematic decreases in productivity (see Peterman & Dorner 2012);
- long-term trend metric (Green status) was not weighted in the status evaluations, given this CU's early time series was low after a period of human activities that significantly reduced this population's size; therefore, the long-term time series does not provide appropriate comparison for the long-term trend metric;

Points of Discussion

- lots of discussion on this CU, particularly after this CU was revealed to be Quesnel-S CU; lots of concern interpreting productivity trends for this CU using Ricker residuals given this is a cyclic CU with delay-density interactions, therefore, a Larkin model may more appropriately reflect trends in productivity and, if the Larkin model were used, the productivity trend may not be decreasing for this CU and this was one of the key drivers of the Red status designation;
- some participants felt more information on the effects of the high abundance years on population dynamics is required to evaluate the status of this CU effectively; as abundance started to increase on the subdominant cycles, in addition to the dominant cycles, had an effect on productivity and subsequent abundances; some participants indicated that this increase in abundance on dominant and subdominant cycles in the 1990s was caused by decreased exploitation;

Quesnel-S

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

5.74

Current gen. avg.
39,952

Historical Avg (61 Obs)
6,962

SHORT-TERM TREND
(Eff. Female Spawners)

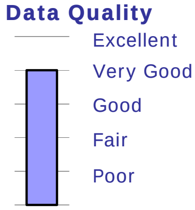
3 Gen Change
(in 4yr Avg)

-92%

Prob. of 25% Decl. over 3 Gen

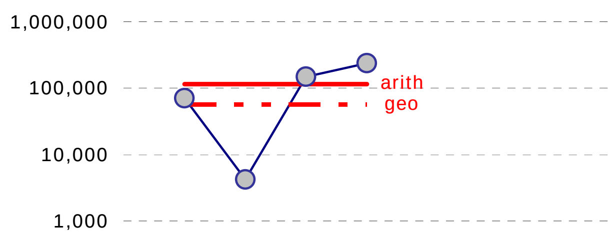
100%

Data Quality



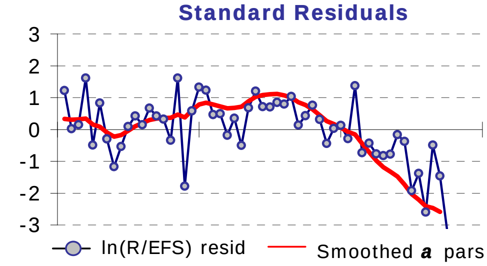
	Geometric 10	25	50	75	90	p	Arithmetic 10	25	50	75	90

Effective Total Spawners (ETS)

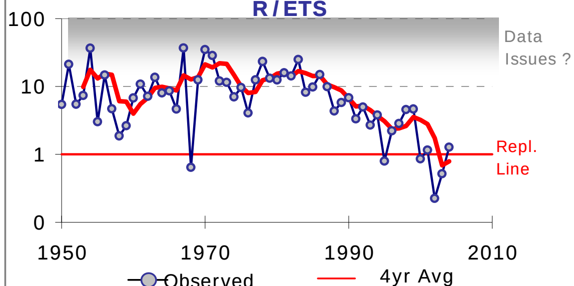


PRODUCTIVITY TIME SERIES

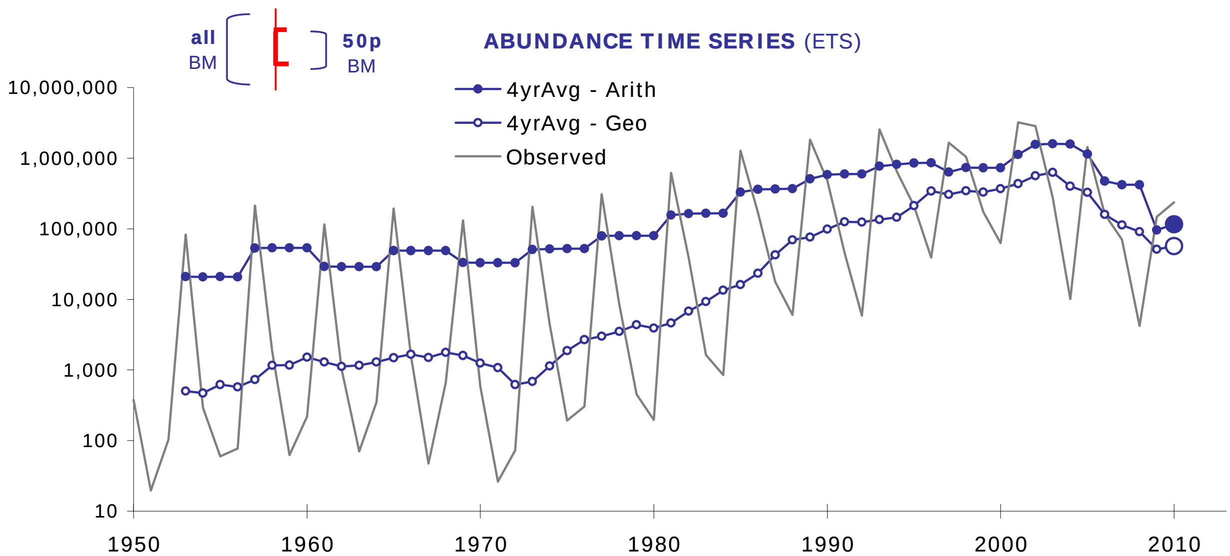
Standard Residuals



R/ETS

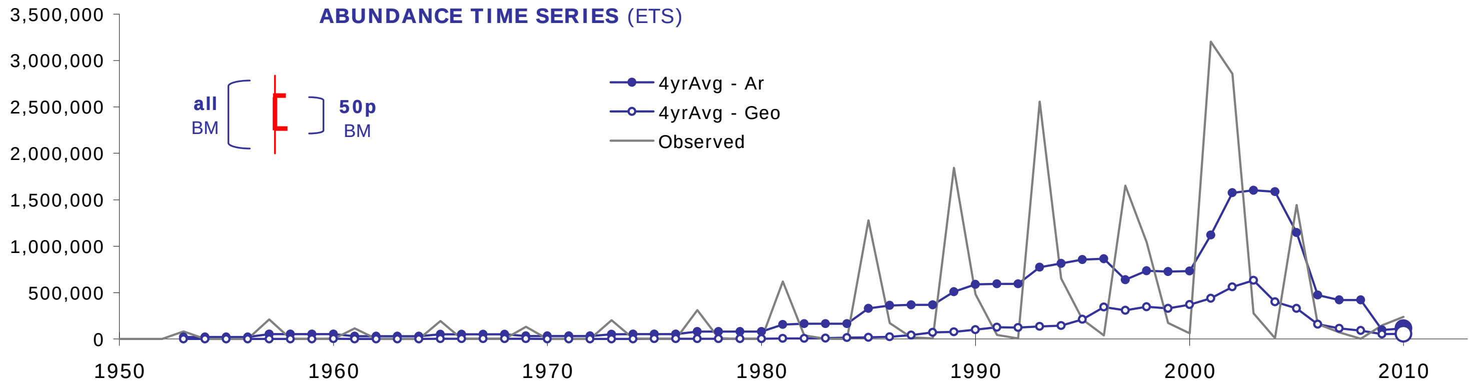


ABUNDANCE TIME SERIES (ETS)

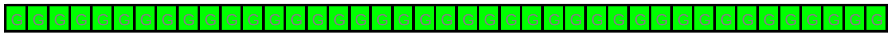


Retrospective Pattern in WSP Metrics

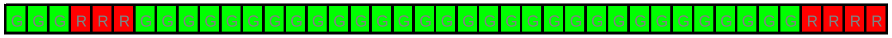
Quesnel-S



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)



Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)



Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	3,204,417	3,204,417	237,677
Med	17,754	167,378	109,224
Min	20	4,212	4,212

Number of Observations in a range

Range	All Yrs	Last 12	Last 4
> 5000	35	11	3
2500–5000	2	1	1
1000–2500	4	0	0
500–**1000**	3	0	0
250–500	5	0	0
0–**250**	12	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

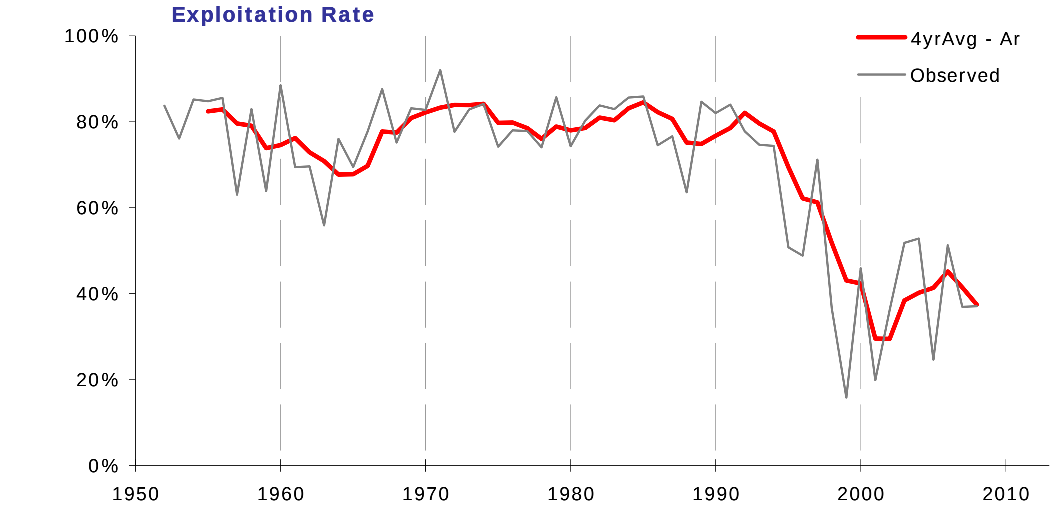
Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

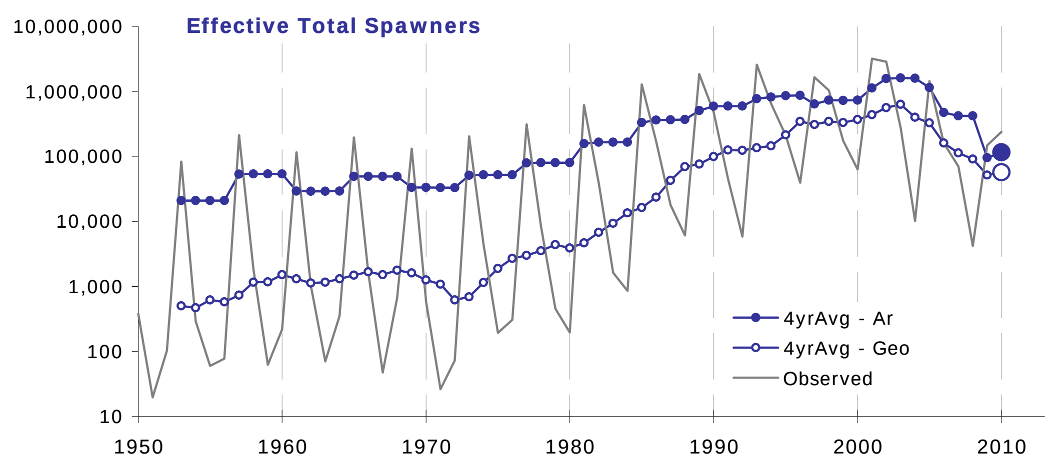
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

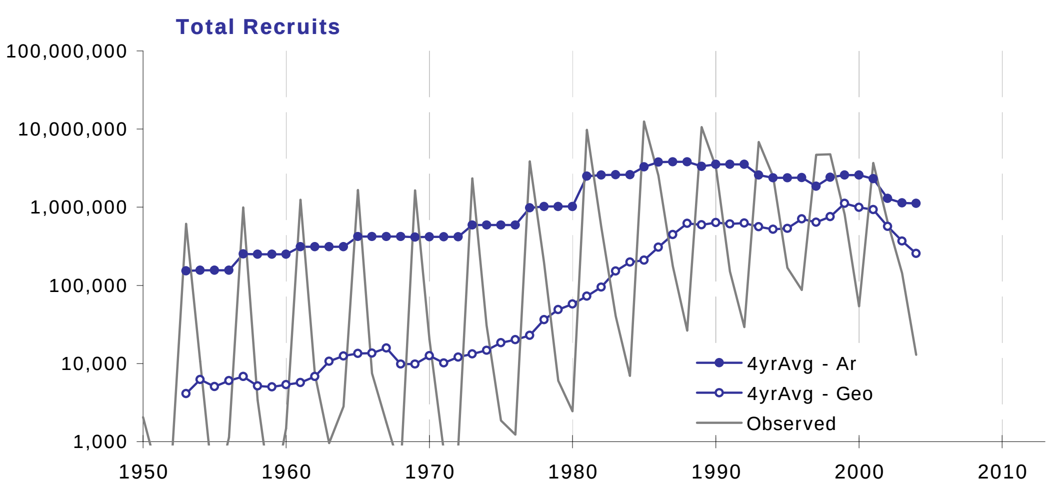
Quesnel-S



Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed



Effective Total Spawners
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed



Total Recruits
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CYCLIC CU-CASE 22: SHUSWAP-COMPLEX-L (GREEN)

(Management stock name: Late Shuswap; Run-Timing Group: Late)

Background: This CU comprises a large proportion of total Fraser Sockeye return abundances when this CU is on its dominant cycle; in contrast the subdominant and weak cycles of this CU have relatively small abundances (see Grant et al. 2011 for further details).

Integrated Status

G

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
G		G	R	G	G

Note: one out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- cyclic CUs: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the Green integrated status was driven by the recent increasing trend in abundance (Green status and 46% increase); the absence of systematic trends in productivity (stable productivity); and a large number of spawners on the dominant cycle year for this CU (the dominant cycle abundance in the last generation was 5.5 million);
- Red status designation by one group was attributed to a few years of below replacement productivity in recent years and a recent decrease in productivity on the R/ETS time series; in addition, one weak cycle year was particularly low in 2009 (164 effective total spawners), falling below the COSEWIC Criteria D1 of 250;

Points of Discussion

- debate regarding the implications of highly cyclic abundance patterns for risk of extirpation; if there is one high-abundance dominant cycle that is consistently stable in terms of productivity and trends and three very small cycles, does this uneven distribution of generational abundance, with most of the genetic information and biomass concentrated in a single dominant year (out of four) increase the CU’s risk of extirpation?

Shuswap Complex-L

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25 50 75 p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.76

Current gen. avg.

19,711

Historical Avg (61 Obs)

25,851

SHORT-TERM TREND
(Eff. Female Spawners)

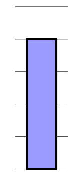
3 Gen Change
(in 4yr Avg)

46%

Prob. of 25% Decl. over 3 Gen

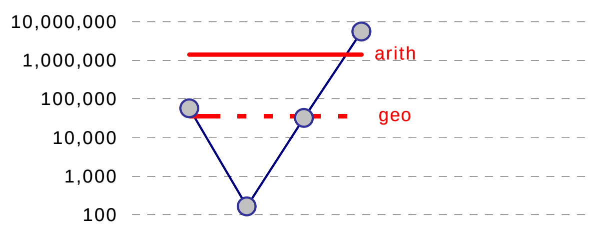
12%

Data Quality



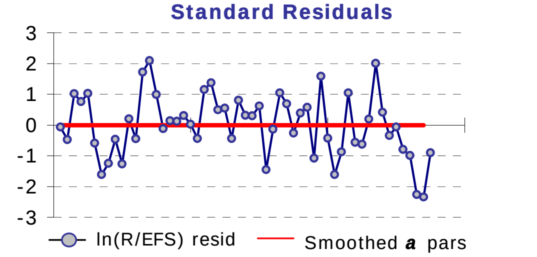
Geometric: 10 25 50 75 90 p — Arithmetic: 10 25 50 75 90

Effective Total Spawners (ETS)

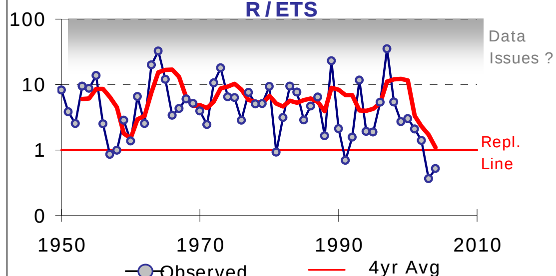


PRODUCTIVITY TIME SERIES

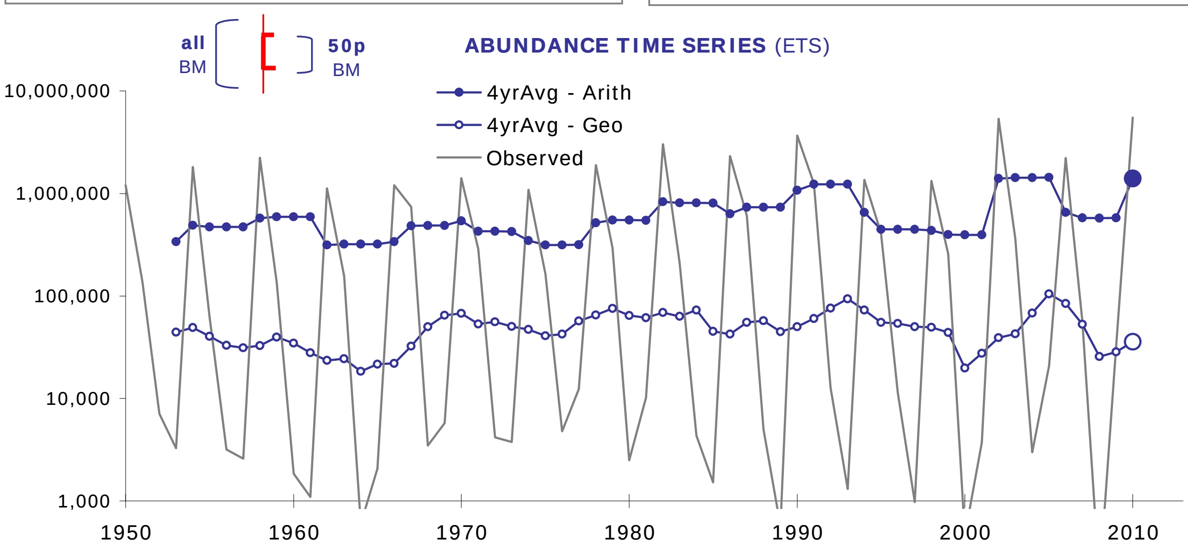
Standard Residuals



R / ETS

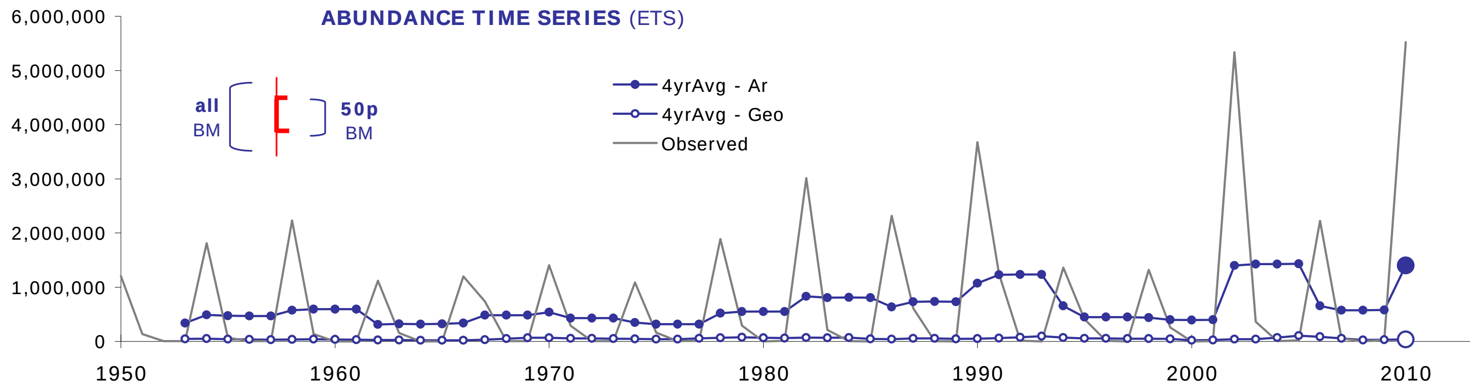


ABUNDANCE TIME SERIES (ETS)

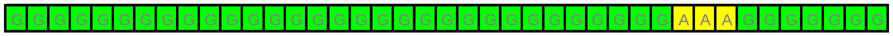


Retrospective Pattern in WSP Metrics

Shuswap Complex-L



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)



Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric (comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	5,522,291	5,522,291	5,522,291
Med	56,905	44,401	44,401
Min	164	164	164

Number of Observations in a range

	All Yrs	Last 12	Last 4
>5000	40	8	3
2500–5000	10	2	0
1000–2500	6	0	0
500–1000	3	0	0
250–500	1	1	0
0–250	1	1	1

Small Population Benchmarks (COSEWIC Criterion D1)

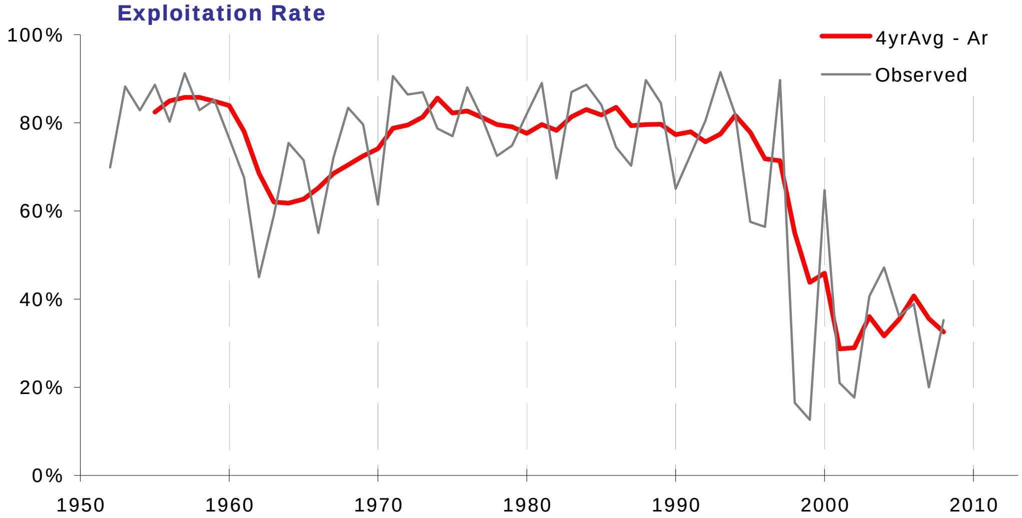
Lower Benchmark Estimates (S-gen)

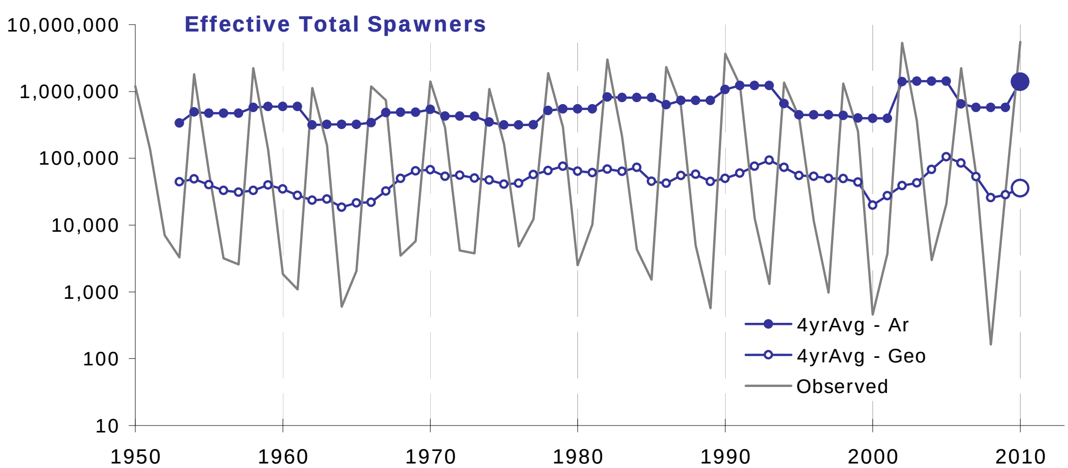
LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

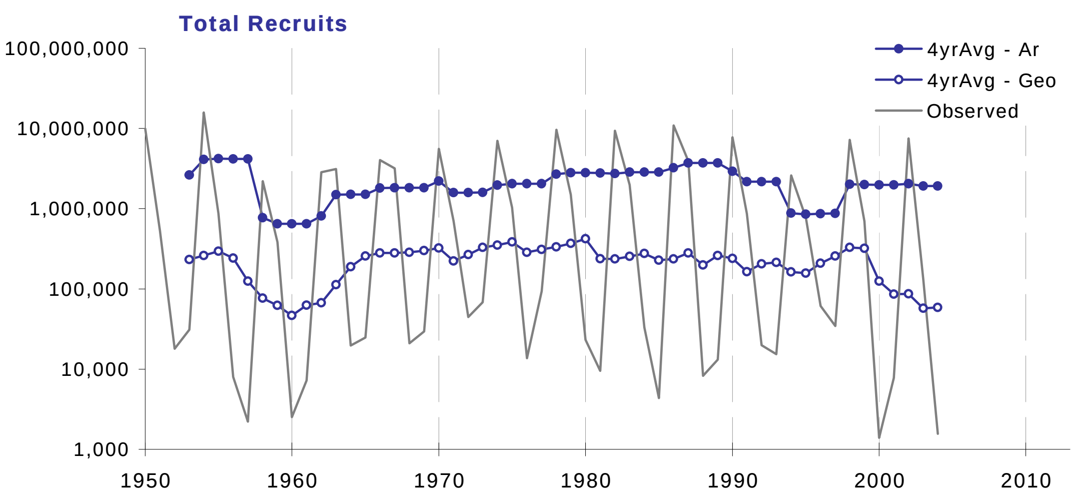
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

Shuswap Complex-L







CYCLIC CU-CASE 23: SHUSWAP-ES (AMBER/GREEN)

(Management stock name: Scotch & Seymour; Run-Timing Group: Early Summer)

Background: the Scotch Creek time series was enhanced on the cycle line coinciding with the Adams River dominant cycle, using Seymour Creek as a donor stock; as a result the Scotch Creek population started to build in the 1980's; Seymour is frequently used a hatchery donor population (see Grant et al. 2011 for further details).

Integrated Status

A	G

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
			A	G	G

Note: three out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- cyclic CUs: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the Green integrated status was driven by the large and building abundances on the dominant cycle (Green long-term trends metric) and increasing productivity in recent years;
- the Amber integrated status included the Green integrated status considerations described in the previous bullet, but also included concerns over short-term trend in abundance metric (Red and 34% decrease), one very recent observation of low abundance on a weak cycle that falls below the COSEWIC Criteria D1 of 1,000, and recent decreases in abundance in the off-cycle years; however, most of this decreasing trend was attributed to a single weak cycle year in 2009, therefore, this decreasing trend along was not sufficient to place this CU in a Red status zone;

Points of Discussion

- discussion regarding how to interpret trends on the dominant versus subdominant cycle; one participant suggested that the dominant cycle's trends is key, given it contributes most to a cyclic CUs abundance and that instead of tracking subdominant cycle trends, a lower threshold of abundance was recommended (such as no single cycle year falling below 1,000?); another participant suggested that abundance trends on the weak cycle years should not be ignored;

Shuswap-ES

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models
25 50 75 p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

0.89

Current gen. avg.
8,868

Historical Avg (61 Obs)
9,949

SHORT-TERM TREND
(Eff. Female Spawners)

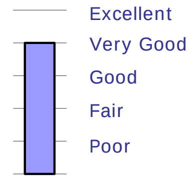
3 Gen Change
(in 4yr Avg)

-34%

Prob. of 25% Decl. over 3 Gen

65%

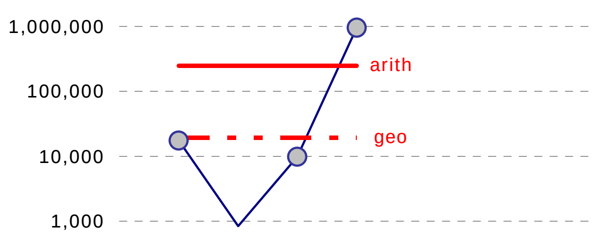
Data Quality



Geometric
10 25 50 75 90 p

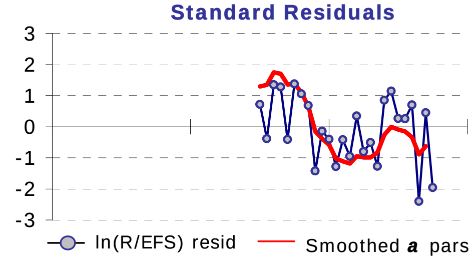
Arithmetic
10 25 50 75 90

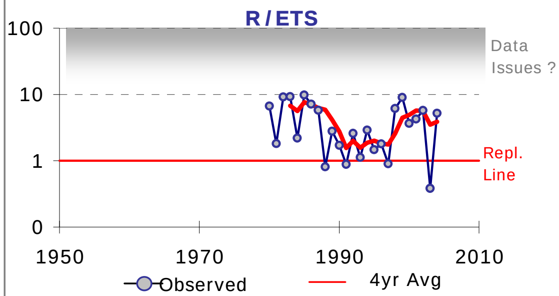
Effective Total Spawners (ETS)



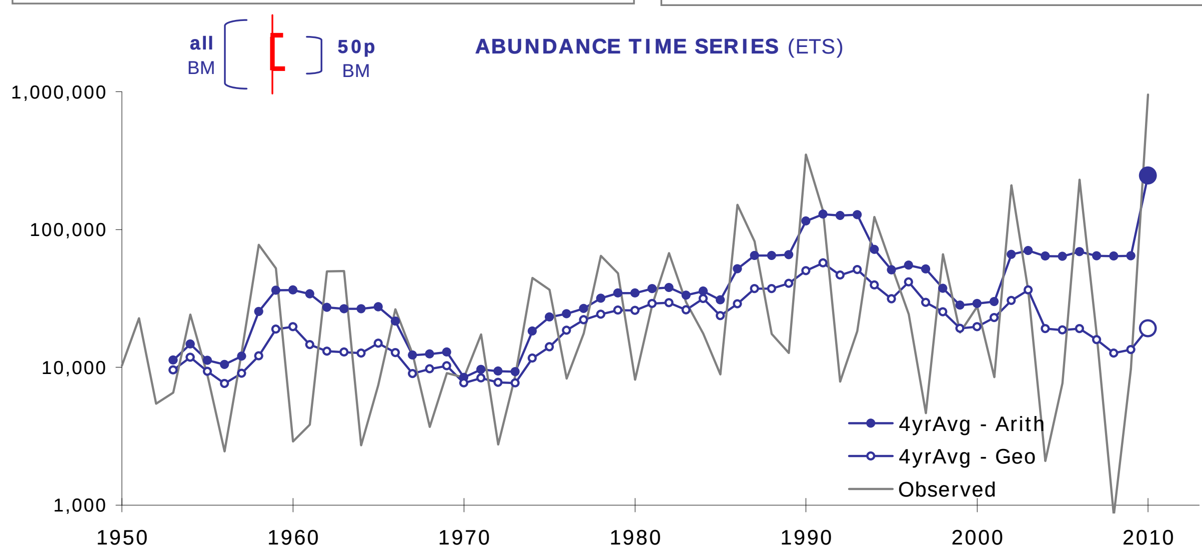
PRODUCTIVITY TIME SERIES

Standard Residuals



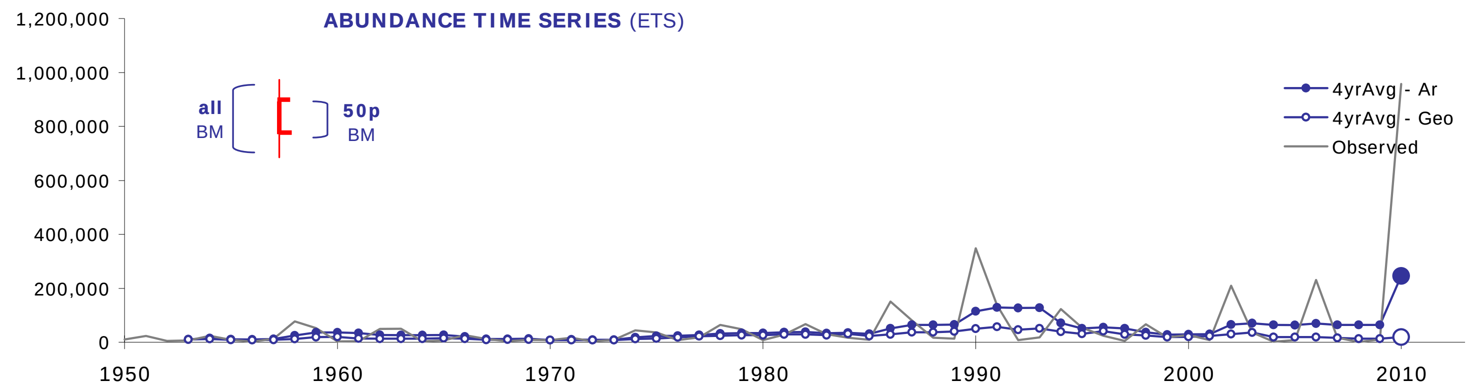


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Shuswap-ES



Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

G G A A G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G G

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

R R R R R A G G G G G G G G G G G G G G G G G G G G G G R R R R R R R R A R R R R

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)

Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	956,688	956,688	956,688
Med	17,570	17,640	13,554
Min	842	842	842

Number of Observations in a range

	All Yrs	Last 12	Last 4
	52	10	3
5000	6	0	0
2500	2	1	0
1000	1	1	1
500	0	0	0
250	0	0	0
0			

Small Population Benchmarks (COSEWIC Criterion D1)

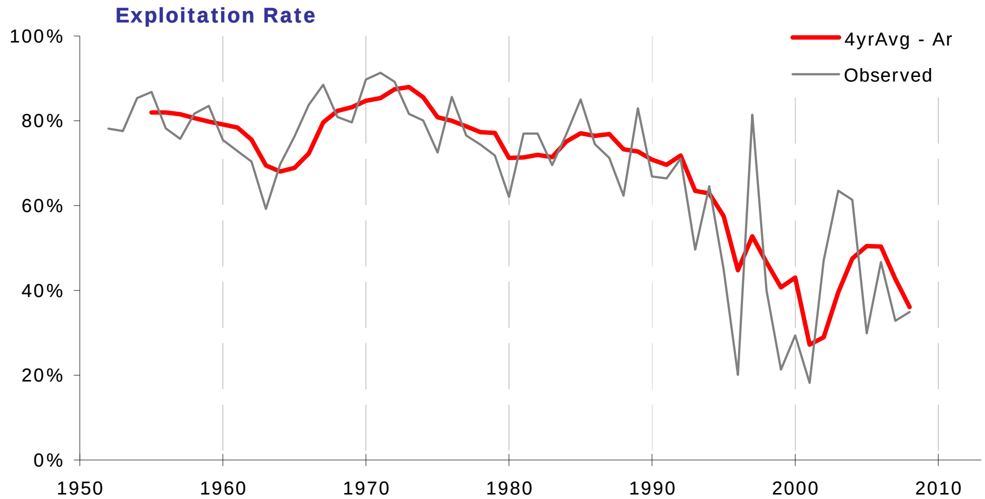
Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

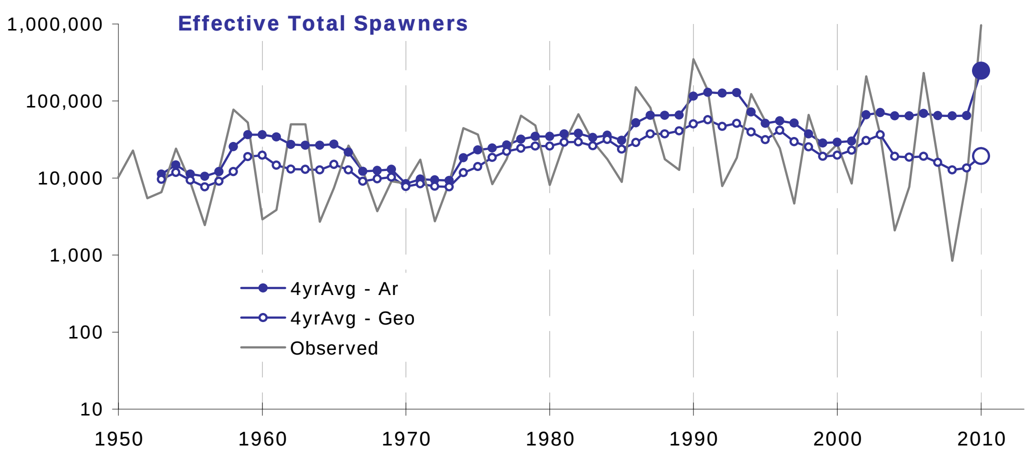
Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

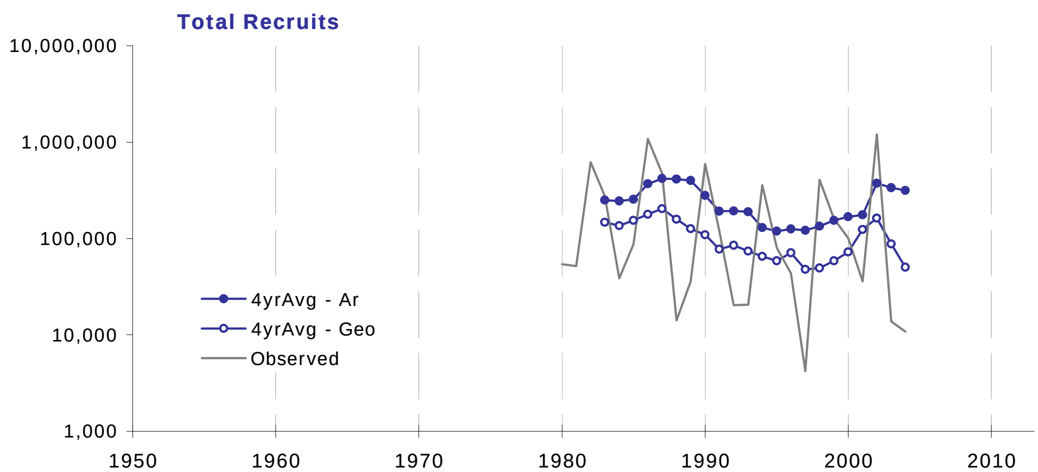
Shuswap-ES



Exploitation Rate
100%
80%
60%
40%
20%
0%
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
Observed



Effective Total Spawners
1,000,000
100,000
10,000
1,000
100
10
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed



Total Recruits
10,000,000
1,000,000
100,000
10,000
1,000
1950
1960
1970
1980
1990
2000
2010
4yrAvg - Ar
4yrAvg - Geo
Observed

CYCLIC CU-CASE 24: TAKLA-TREMBLEUR-STUART-S (RED/AMBER)

(Management stock name: Late Stuart; Run-Timing Group: Summer)

Background: historically human activities impacted spawning habitat, which has subsequently improved in Middle River; Tachie had log driving activity historically, although the impact of this on spawning habitat is unknown (see Grant et al. 2011 for further details).

Integrated Status

R	A

Group-Specific Integrated Status Results

Groups					
1	2	3	4	5	6
		R	R	A	A

Note: two out of the six groups did not complete a status evaluation for this CU;

Status Commentary

- cyclic CUs: due to concerns regarding the appropriate estimation of relative-abundance metric benchmarks for these CUs, these metrics were not considered in final status evaluations;
- the integrated Amber status was selected due to the combination of large absolute abundance (no recent abundances near the COSEWIC Criteria D1 for small populations), and the Green long-term trend metric and red short-term trend metric (however, this CU is returning to average following a period of high abundance);
- the integrated Red status was driven by the decreasing productivity (including a few recent years of below replacement productivity); also influenced by declining trends in abundance (which were large at -85%), although it was noted that this CU is coming off a period of high abundance, the steepness of the recent decrease in abundance is a concern;

Takla-Trembleur-Stuart-S

ABUNDANCE
(Effective Total Spawners)

Current vs. benchmark
(geometric means)

Stationary SR Models

25	50	75	p

Time-varying Models

LONG-TERM TREND
(Eff. Female Spawners)

Ratio
(geometric means)

1.54

Current gen. avg.

21,960

Historical Avg (58 Obs)

14,227

SHORT-TERM TREND
(Eff. Female Spawners)

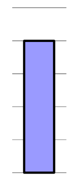
3 Gen Change
(in 4yr Avg)

-85%

Prob. of 25% Decl.
over 3 Gen

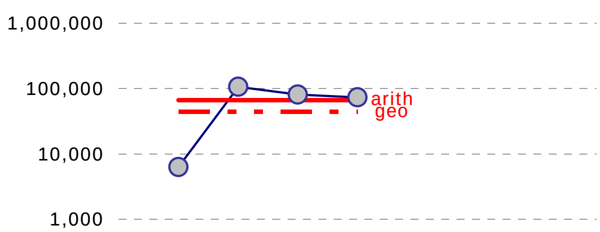
100%

Data Quality



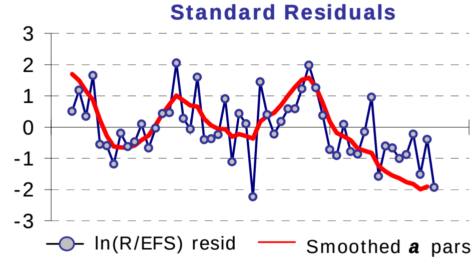
	Geometric						Arithmetic				
	10	25	50	75	90	p	10	25	50	75	90

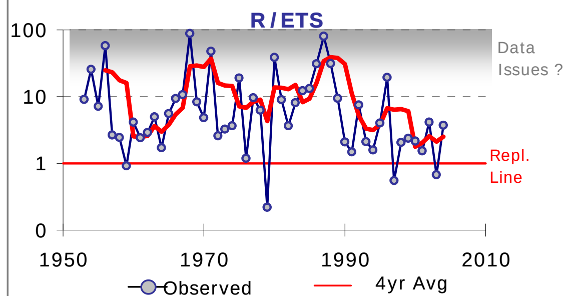
Effective Total Spawners (ETS)



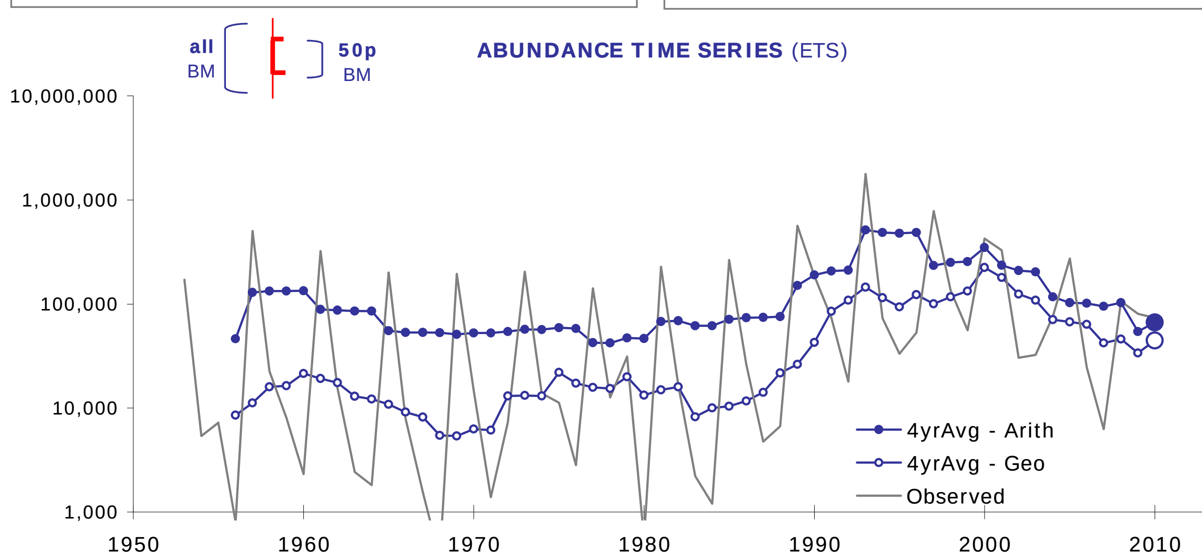
PRODUCTIVITY TIME SERIES

Standard Residuals



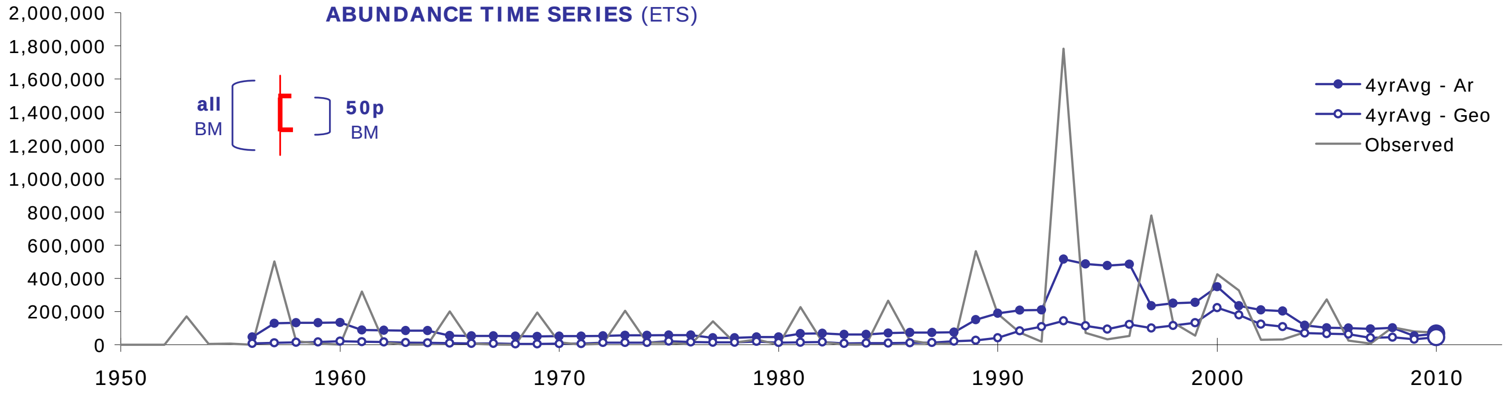


ABUNDANCE TIME SERIES (ETS)



Retrospective Pattern in WSP Metrics

Takla-Trembleur-Stuart-S

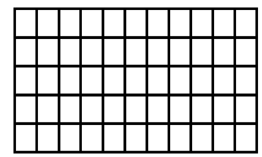


Long-term Trend Metric
(4yr geomean in EFS vs. geomean of all observations up to that year)

Short-term Trend Metric
(3 gen slope in 4yr- running geomean of EFS)

Abundance BM Metric

(comparing 4yr running geomean ETS to 50p level of 2011 BM estimates)



Summary of Observations and Estimates

Effective Total Spawners

	All Yrs	Last 12	Last 4
Max	1,783,353	424,380	106,224
Med	28,428	74,723	76,956
Min	355	6,271	6,271

Number of Observations in a range

	All Yrs	Last 12	Last 4
Total	46	12	4
5000 and above	2	0	0
2500–5000	7	0	0
1000–2500	2	0	0
500–1000	1	0	0
250–500	0	0	0
0–250	0	0	0

Small Population Benchmarks (COSEWIC Criterion D1)

Lower Benchmark Estimates (S-gen)

LB_10p	LB_25p	LB_50p	LB_75p	LB_90p

Upper Benchmark Est. (80% S-msy)

UB_10p	UB_25p	UB_50p	UB_75p	UB_90p

Takla-Trembleur-Stuart-S