



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Ecosystems and
Oceans Science

Sciences des écosystèmes
et des océans

Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2019/011

Pacific Region

**Proceedings of the Pacific regional peer review of a reproducible data synopsis
for over 100 species of British Columbia groundfish**

Meeting dates: November 22–23, 2018

Location: Nanaimo, British Columbia

Chairperson: Mary Thiess

Editor: Kieran Forge

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Fisheries and Oceans Canada
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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

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csas-sccs@dfp-mpo.gc.ca](http://www.dfo-mpo.gc.ca/csas-sccs/csas-sccs@dfp-mpo.gc.ca)



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ISSN 1701-1280

Correct citation for this publication:

DFO. 2019. Proceedings of the Pacific regional peer review of a reproducible data synopsis for over 100 species of British Columbia groundfish; November 22-23, 2018. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2019/011.

Aussi disponible en français :

MPO. 2019. Compte rendu de l'examen, par les pairs de la région du Pacifique, d'une synthèse des données reproductible pour plus de 100 espèces de poisson de fond de la Colombie-Britannique. Secr. can. de consult. sci. du MPO, Compte rendu 2019/011

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting on November 22–23, 2018 at the Pacific Biological Station in Nanaimo, B.C. A working paper titled “A reproducible data synopsis for over 100 species of British Columbia groundfish” was presented for peer review.

In-person and web-based participation included current and retired DFO Science staff, Fisheries Management staff, and external participants from First Nations, non-governmental organizations, universities and commercial fishing groups.

The working paper introduced a reproducible report to give a snapshot of population and fishing trends, growth and maturity patterns, as well as data availability, for over one hundred groundfish species in British Columbia. Using cutting-edge analytic tools, the report is fully automated and reproducible, which is intended to facilitate data review and increase data transparency between Fisheries and Oceans Canada, the fishing industry, non-governmental organizations, and the public. The next phase of this project is expected to use the synoptic report to inform the development of operating models and in the selection of candidate management procedures, as part of a planned management procedure framework for data-limited groundfish stocks.

Meeting discussions covered data issues, analytic assumptions and structural components of the synoptic report, suitability of the report for a range of purposes, potential for future development of the report and next steps. Minor revisions to the report will include some editorial revisions, further discussion on choices of performance measures that might be included for the modelling components, and additional text documenting uncertainties, conclusions, and recommendations.

The working paper was accepted with minor revisions. Given that this was a request from Science for Science advice, a Science Advisory Report will not be developed for this process. The Research Document will be made publicly available on the [Canadian Science Advisory Secretariat](#) (CSAS) website.

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held November 22–23, 2018 at the Pacific Biological Station in Nanaimo to review a reproducible data synopsis for over 100 species of British Columbia groundfish.

The Terms of Reference (TOR; Appendix A) for the RPR were developed following the outcome of a previous regional peer review (DFO 2016). Notifications of this science review and conditions for participation were sent to representatives with relevant expertise from current and retired DFO Science staff, Fisheries Management staff and external participants from First Nations, non-governmental organizations, universities and commercial fishing groups.

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting (Abstract provided in Appendix B):

Anderson, S.C., Keppel, E.A., Edwards, A.M. A reproducible data synopsis for over 100 species of British Columbia groundfish. CSAP Working Paper 2014GRF07b.

The meeting Chair, Mary Thiess, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair discussed the role of participants and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, the background information, and supporting documents.

The Chair reviewed the Agenda (Appendix C) and objectives from the Terms of Reference (Appendix A) for the meeting. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting provided an opportunity for participants to provide feedback on the proposed synoptic report content and design. The rapporteur for the meeting was Kieran Forge.

Members were reminded that everyone at the meeting had equal standing as reviewers and they were expected to contribute to the review process if they had information or questions relevant to the materials being discussed. In total, 34 people participated in the RPR (participants list included in Appendix D).

REVIEW

Working Paper: A reproducible data synopsis for over 100 species of British Columbia groundfish

Rapporteur: Kieran Forge

Presenters: Sean Anderson, Elise Keppel, Andrew Edwards

PRESENTATION OF WORKING PAPER

The working paper introduced a reproducible report to give a snapshot of population and fishing trends, growth and maturity patterns, as well as data availability, for over one hundred groundfish species in British Columbia. Using cutting-edge analytic tools, the report is fully automated and reproducible, which is intended to facilitate data review and increase data transparency between Fisheries and Oceans Canada, the fishing industry, non-governmental

organizations, and the public. The next phase of this project is expected to use the synoptic report to develop operating models and select candidate management procedures as part of a planned management-procedure framework for data-limited groundfish stocks.

The co-authors provided an overview of the data presented, analytic methods used, and key features of the report's structure and content.

CLARIFICATION QUESTIONS FOLLOWING THE PRESENTATION

- A question was raised regarding the choice of time period to be included in the commercial catch per unit effort (CPUE) maps. The authors explained that trawl data were included from 2012 onwards to align with the introduction of the bottom trawl footprint, and hook and line data were included from 2008 onward to match the full implementation of 100% fishery monitoring programs. Historical data were limited in this way to ensure that the maps were more consistent with current fishing pressures and data availability. This question was tabled for further discussion later in the meeting.
- Related to the goal of accurately representing current fishing pressures, the authors were asked whether there was any intention to represent fishery closures due to Marine Protected Areas in future versions of the report. This question was also tabled for later discussion.
- In response to a request for clarification, the authors confirmed that the mean coefficient of variation printed on each of the survey biomass graphs is in reference to the design-based model, not the geostatistical model.
- The authors were asked whether trap data were included in any analysis. They confirmed that the report does not include the Sablefish trap survey index or age or length distributions derived from trap survey samples, but it does include commercial trap catches and the trap surveys are included in the counts of available fish lengths, ages, and maturities.

PRESENTATION OF WRITTEN REVIEWS

CHRIS ROOPER

Please refer to Appendix E.1 for a copy of the full written review.

Authors' response

- Information on model uncertainty was not presented in the report template because the goal was to make the generation of the entire report automated and reproducible across a large list of species, which limited the ability to present detailed model fit characteristics for every model. However the authors agreed to include supplementary tables describing basic model fit characteristics (parameter estimates) for the commercial CPUE and geostatistical survey models.
- The intention is to make the underlying data accessible where possible. Currently, the source data are available using the usual process for data requests through the regional data unit. The groundfish program has published catch, effort, and biological data from the bottom trawl survey to Open Data, and the intention is for other survey time series to be published in the same way, including the Hard Bottom Longline survey by next summer. The early years of the International Pacific Halibut Commission (IPHC) data are included with the publicly-available *gfp/ot* R package. Anyone with access to the Pacific Biological Station DFO network should be able to recreate the entire report in its entirety.

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- The Generalized Linear Mixed Model (GLMM) estimates have larger coefficients of variation (CVs) than the stratified design-based estimates in some cases, generally where there are very few positive sets from which to extrapolate. Also, the GLMM estimates are parametric, whereas the uncertainty on the design-based estimates is derived from a bootstrap procedure, which may introduce other differences in the level of uncertainty.
 - The reviewer asked whether zero catches of bycatch species in the commercial fishery are really indicators of species absence, or if they are reflective of a lack of effort put towards sampling these species. The authors' understanding is that fisheries observers sample all species that are caught, and are generally good at accurately capturing species absence.
 - The reviewer asked whether the GLMM approach could also be used to standardize the Hard Bottom Longline survey data. The authors confirmed that this could be done and could be included in future versions of the report.
 - The commercial CPUE index time series includes only bottom trawl data, while the CPUE maps include both bottom and midwater trawl. The authors agreed that this choice warrants further discussion. A reviewer observed that the midwater trawl distributions are typically much more attenuated than the bottom trawl distributions and as such, should not be combined into a single plot (which would be misleading). If only one plot is possible, then it should be bottom trawl only.
 - In response to the suggestion of including auxiliary ecosystem data (such as temperature and salinity) in the report, the authors stated that they will likely not include it in the initial release of the report, but may be able to in future. In particular, any information to support the assessment of potential effects of climate change should be considered for inclusion.

DANIEL RICARD

Please refer to Appendix E.2 for a copy of the full written review.

Authors' response

- Currently, the grouping of species into two levels of importance (A and B) is based on the Groundfish Science Strategic Plan, an internal document produced by the groundfish program that is not publicly available. This classification was based on a combination of catch volume, conservation interest, and the researchers' personal knowledge of the species. This grouping is included because the authors originally intended to only report on A-level species.
- The introduction to the paper describes it as being intended to "facilitate regular review by groundfish scientists and managers of trends in survey indices and stock composition across all stocks to potentially flag stocks for prioritized assessment". The authors clarified that the report was not itself intended to prioritize stocks, as this is handled by Fisheries Management and, in consultation between DFO Fisheries Management and Science, based on a variety of factors. Instead, it is intended to facilitate these discussions and decisions. It is the reviewer's opinion that more explanation of this point is needed in the report, as the above sentence could be misinterpreted by readers.
- In response to this review, hake and halibut template pages were generated and will be included in the report. The most representative information for these species comes from surveys external to DFO, so caveats should be added to the report text stating that the data presented in the report are not the best available information for these species.

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- The reviewer had a question regarding how errors in the underlying data are handled, and how any new corrections will be included. Currently, the approach assumes that data quality control operations are executed when the data are initially brought into the source databases (GFFOS, GFBio, etc.), so the data being pulled from the sources into the report are assumed to be correct. A reviewer noted another issue where historical tows from newly-determined unfishable blocks are retrospectively removed from the synoptic surveys. This can potentially lead to detectable changes in the survey index if the removed block captured a significant amount of fish in a previous survey. For example, see most recent Redstripe Rockfish stock assessment.
 - The reviewer asked for clarification regarding the lack of any survey data in the Strait of Georgia, Strait of Juan de Fuca, Johnstone Strait, and Queen Charlotte Strait. There have only been two synoptic trawl surveys ever done in the Strait, due to logistical issues. The Hard-Bottom Longline Inside survey is available and is included in the survey biomass index trends, but has not been included in the maps. The authors noted that it could potentially be included in future years.

GENERAL DISCUSSION

DATA INCLUSION

- Electronic Monitoring (EM) was implemented for hook and line fisheries partway through 2006 (during the 2006/2007 fishing season), while 2008 was the first full calendar year with EM data for all commercial hook and line groundfish fisheries. As such, Hard Bottom Long Line data are only included in the CPUE maps from 2008 onward, to ensure the data are comparable across all years.
- The trawl fishery footprint was put in place in 2012, leading to a significant decrease in the area available for fishing. While there have been other management measures introduced since then, none have had as large an effect. This is a strong justification for only including data from 2012 onward.
- An argument could be made that data from previous years should be included in the CPUE maps, especially as the fleet has been shrinking in recent years and therefore likely does not cover the full extent of the stock (because it is constrained by the “trawl footprint”). However, as noted above, the data sources are not directly comparable, so this would have to be presented as a separate map. Currently there is not space in the report template to include historical maps.
- Conversely, data could be limited further to allow immediate comparison between maps. Either the longline data could be limited to 2012 onwards, making it equivalent to the trawl map (and limit the ability to objectively assess species distribution), or both could be limited to only the previous year, making it equivalent to the survey biomass maps. However, this would lead to further exclusion of data based on confidentiality rules due to the limited number of vessels fishing in recent years.
- Ultimately, the choice of how many years of data to include comes down to the underlying purpose of the report. Some possible uses of the report, such as spatial planning, absolutely would require historical context. The report is not intended to be used for these purposes. As a publically-available summary of DFO data, it is not possible to retain full control over how the report is used, other than to provide very clear disclaimers in the text.
- Text should be added to each map describing the years of data that are being shown.

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- The catch time series graphs currently only include catches which were reported and are available to DFO in logbook form. This is problematic for data prior to 1977, as there were many catches that were not reported to Canadian authorities. Efforts have been made to reconstruct these historical catches; in future, the reconstructed catches could be included in the time series (but may be more relevant to actual stock assessments than this synoptic report).
 - Halibut and Hake were previously excluded from analysis because DFO's data holdings represent only a small subset of the available data for these species. In particular, much of the age data comes from surveys done by other organizations and are not available for this report. These species are now included, but this caveat should be made clear on the report pages.
 - Data from the Hard Bottom Long Line (HBLL) Inside survey would be very valuable additions to the maps in future. At present, it has not been included because it is concentrated in such a small area, and there is not room on the page layout for a finer-resolution inset map. However, this level of detail is likely not required, so it could simply be added to the same map as the HBLL Outside survey.
 - A list or table of all surveys which exist but were not included in the analysis could be added to the report, recognizing that many of the earlier surveys were not part of a standardized survey design (i.e., "one-offs") and would not be comparable to those included in the report.
 - A paragraph should be added describing the custodianship and sources of the underlying data, and giving users the necessary information to request these data or to submit feedback. This should be updated regularly, as the way fisheries data are stored may change in the coming years. The Regional Data Unit's generic email address or website for data requests should be included in this paragraph. Some participants expressed concern with the fact that there is no way for users to directly give feedback and/or request the modelled data from the authors. However, the standard data inputs for *gplot* are well-documented, so it should be possible for users on the PBS network to recreate the underlying datasets themselves.

ANALYTIC METHODS

- The geostatistical methods used in the report are relatively new to fisheries science (i.e., having appeared in the past decade), and especially to the Pacific Region DFO, and therefore the assumptions and parameter choices that are associated with them could use more detailed explanation. More attention could be paid to the potential downsides of these methods. For example, in some cases spatial random effects will attempt to account for variation that might make more biological sense if it were associated with another covariate.
- In order to be fully automated, the report uses a common modelling approach across all species. However, there are some species for which this approach may be less suitable. While it would require more work on the part of the researchers, future iterations of the report should include some indication of model performance to help readers interpret the results. The authors may be able to include supplementary tables of model parameter estimates for all of the commercial CPUE and geostatistical survey models in their revisions.
- Many of the surveys are conducted biennially. The spatiotemporal GLMM model could be adjusted to give an annual index, filling in years and areas for which we do not have survey data and creating a continuous time series. This is not straightforward and is an active area of research for the authors.

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- In the future, a standardized CPUE time series could be created for longline data in the same way that is currently done for the trawl time series, although there remain considerable challenges with accurately quantifying effort in some years as well as understanding the interaction between CPUE and hook occupancy.
 - Currently, the unstandardized CPUE time series is provided as an arithmetic mean. It is possible that a geometric mean shown in log space would be a better comparison to the standardized series, particularly for the positive catches. The authors will investigate this further, and if it turns out to be the case, they will change the graph accordingly. Alternatively, the graph could show the mean of the Tweedie distribution without standardization. Currently, this is not done because the Tweedie distribution is slow to fit and there is a benefit to showing the simplest method (that is comparable to methods used in previous Research Documents).
 - Lengths and ages could be weighted if necessary and weighting is implemented in the *gfplot* package. However, not doing so makes the presentation simpler.

REPORT STRUCTURE

- The 2-page template format was praised for its succinctness and clarity; however, its restrictiveness was a recurring issue. In addition to limiting the addition of any new figures or text to the page, it also leads to problems over the longer term as more years of data are added to the figures. One way to deal with this would be to change the time window from year to year. If this is the case, it should be noted in the paper. Alternatively, the report could be moved into a more flexible HTML format such as one created using the *shiny* package developed by RStudio.
- The authors should reconsider how species pages are ordered. Currently, they are first grouped into A- and B-level species based on the Groundfish Science Strategic Plan, then ordered by the Hart codes commonly used at DFO. It may make more sense to remove the Strategic Plan categorization entirely and order entirely by species code, as classifying the species in the current way conflicts with the idea that the report should not include any prioritization, and additionally does not necessarily reflect current priorities. The species codes are intended to largely reflect taxonomic groupings, but more recently added species do not necessarily follow this pattern. Possible alternatives discussed include alphabetical order or phylogenetic branching order. If taxonomic groupings are used, divider pages could be added between major groups, or information on taxonomic group could be added to the header or footer.
- A map could be added to the beginning of the document showing the extent of the area in which fishing has historically been allowed, and how this extent has changed over time. This would also allow for the inclusion of further management measures such as MPA designations planned for the coming years. Alternatively, the authors could include the historical fishing area for each species shaded in grey in the background of the commercial CPUE maps.
- The colour scales used in the maps are normalized such that colours are relative to each species' maximum biomass density, rather than to a constant absolute value across maps. There is not room for a full legend on each map showing how the colours relate to the actual values. Some more limited numeric indicator of scale could be added, such as median density per grid cell.
- Biomass/Depth distributions such as those provided for trawl survey data in Appendix B should be generated for longline survey data as well.

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- More information could be added to the header for each species. This might include the predominant gear types used to catch the species, important times of year for the species, environmental data, and a WoRMS ID for easier linkage to the species' full taxonomy. These data would need to be provided by other groundfish researchers.
 - Wherever a method has not been used in Pacific Region groundfish stock assessments before, this should be pointed out in the text.
 - A few minor changes to figure text were identified. In a couple of the maps, Queen Charlotte Sound was mislabeled as Queen Charlotte Strait. "Commercial catch" as the title of the plots should be changed to "Canadian commercial catch". "Tons" should be changed to "tonnes" or "t" to be clear that it refers to metric tonnes.
 - A vertical line could be added on the time series graphs to show the extent of the data presented in the maps.
 - The total number of sets excluded due to confidentiality rules should be noted on each of the commercial CPUE maps.
 - In addition to the number of biological specimens available, the report could also show the number of samples. This may run into space limitations.
 - There was discussion on whether outputs from previous stock assessments (such as total biomass estimates) should be included in report for comparison. However, this may be difficult as often stock assessments do not have a single output value. In addition, there was concern that this may be going too far in the direction of stock assessment, when that is explicitly not the purpose of the report.
 - Similarly, there was discussion on the possibility of including some measure of a stock's relative value, such as the previous year's total landed value. These data could potentially be requested from Policy Branch, Economic Analysis Division, but this might lead to problems with reproducibility due to changing data formats. This idea was eventually rejected, as it ventures too far into the realm of economics and fisheries management than is appropriate given the scope of the report.

UNCERTAINTIES

- It is difficult to determine at this time how the report might be used outside of its original intended purpose. For example, as one of the few comprehensive DFO data releases, it may be tempting to use some of the maps in spatial planning processes. More strongly worded caveats should be added to clarify that this report is intended to be a snapshot of the available data, and to warn of the potential consequences of using it in ways for which it was not intended. In general, the full utility of the report will only become clear over time as it is actively used by researchers and managers.
- The report will need to be periodically updated; however, it is not clear what the best avenue for this would be. Currently, the plan is to release it yearly as a CSAS Science Response; as Science is the requestor, only an internal review process would be necessary. This is consistent with the use of Science Responses for recurring data products in other parts of the country. Alternatively, it could be published as a DFO Technical Report, accessible from the DFO Library. Each new release of the report should contain an update notes section detailing what has changed from the previous version.
- Regardless of the publication avenue, it is intended that the report will be published annually, with the potential of moving to biennial updates over the longer term. Any more

frequent updates would not be handled by the authors, and it would be up to users at PBS to access the available tools. Data for each fishing season likely would only be ready for publication in the report by summer or fall of the following year; this one-year time lag should be documented in the report.

- The long-term viability of Github as a hosting service and version control system for government code is unclear. The authors intend to archive the source code elsewhere, both internally at DFO and using an archival hosting service such as Zenodo.
- *gfplot* depends on several 3rd-party R packages, and any changes to these packages could make it unusable. Updating package dependencies is planned as part of annual updates to the report; if this does not continue to be viable, users may need to use a service such as the R package *packrat* or the software Docker to maintain a complete reproducible computing environment.

MISCELLANEOUS COMMENTS

- Many attendees stressed the importance and value of the report's reproducibility and transparency, and expressed hope that this will be an example guiding future research at DFO.
- The (manual) process of finding the most recent COSEWIC and CSAS documents for each species was both tedious and difficult. If possible, it would be ideal to design some sort of automated scraping process that can pull the most recent documents from the respective websites. In general, wherever the gathering of metadata can be automated, it should be. This was flagged for further development going forward.
- Interim versions of the report, such as those generated between the official annual releases, should be clearly noted. This is one of the strengths of a version control system such as Git.
- One suggestion for a future project is to collaborate with NOAA on a Northeast Pacific data synopsis report, combining Canadian and US data.

CONCLUSIONS

The WP was accepted with minor revisions at the conclusion of the RPR. The list of required WP revisions was reviewed at the RPR and is provided in Appendix F. A list of future work to guide further development of the synoptic report is also provided at the end of Appendix F.

RECOMMENDATIONS AND ADVICE

With respect to the RPR Objectives stated in the Terms of Reference (Appendix A):

Objective 1. Participants agreed with the approaches used by the authors to extract, filter, and summarize data, and to fit statistical models to fisheries dependent and independent data used in the report. Minor revisions for clarity, completeness and/or accuracy were agreed to by the authors for inclusion in the research document. These are listed in Appendix F.

Objective 2. Without exception, participants appreciated the succinct, standardized layout of the report, along with the associated analytic tools that ensure its high degree of automation and reproducibility. It was identified that the utility of the report to inform Science on the development of operating models and select candidate management procedures will not be known until it gets used for this purpose and will likely need to evolve over time to best address this purpose. At this time, there were no immediate concerns with using the report to proceed to that next phase of the project. Participants were very supportive of the report's utility for facilitating

discussions between Science, resource managers, rightsholders and stakeholders on stock composition and stock assessment prioritization.

Objective 3. Discussions during the RPR highlighted the need to be clear about the report's limitations. It provides a preliminary view of available data that might inform the feasibility for undertaking further stock assessment analyses or decision frameworks. Due to the high-level and general nature of the information presented, it should be viewed for what it is: a summary of available information in DFO databases. It cannot be treated as a stock assessment. As a further example, the maps generated in this report are not at a resolution that could be used for marine spatial planning purposes, nor can they be considered "complete", given the restriction to present only recent data.

Objective 4. A list of recommendations for future development of the report is included in Appendix F. As noted in Objective 2, the full utility of the report will only be realized with its use and development over time.

ACKNOWLEDGEMENTS

The Chair thanks the authors (Sean Anderson, Elise Keppel and Andrew Edwards) for delivering the working paper and revisions in a timely manner; Daniel Ricard and Chris Rooper for providing very thorough and thoughtful reviews; Kieran Forge for his support as rapporteur, both during the RPR and during the development of the proceedings; all of the participants for the time they contributed to the RPR process; and finally, the CSAS office (Lesley MacDougall, Lisa Christensen, Ann Mariscak, and John Candy) for their assistance in preparation for the meeting and in the production of the final documents.

REFERENCES CITED

DFO. 2016. Proceedings of the Pacific regional peer review on A Review of International Best Practices to Assigning Species to Tiers for the Purposes of Stock Assessment Based on Data Availability and Richness; May 30-31, 2016. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2016/051.

APPENDIX A: TERMS OF REFERENCE

Data Synopsis Report for British Columbia Groundfish

Regional Peer Review – Pacific Region

November 22-23, 2018

Nanaimo, British Columbia

Chairperson: Mary Thiess

Context

The Canadian Sustainable Fisheries Framework (DFO 2009) lays the foundation for an ecosystem-based and precautionary approach to fisheries management in Canada to ensure continued health and productivity of Canada's fisheries and healthy fish stocks. The application of the sustainable use policies is implemented through the Fisheries and Oceans Canada (DFO) Integrated Fisheries Management Plan (IFMP), which requires knowledge of the status of fish stocks affected by a given fishery.

DFO groundfish stock assessments have focussed on single-species assessments, resulting in a subset of stocks with full stock assessments, while many stocks with minimal informative data remain unassessed. For example, the Pacific Region IFMP includes over 200 groundfish species (DFO 2017) of which approximately 100 are regularly caught by the British Columbia (BC) fisheries. Multi-species Individual Transferable Quotas are used to manage the BC groundfish fishery, and quotas assigned to rarely assessed or unassessed stocks can restrict harvesters' opportunities to catch target species and can limit their ability to meet marine stewardship certification criteria. Consequently, DFO manages groundfish fishery and fishery-independent data; however, data availability, quality, and capacity challenges can preclude the development of annual stock assessments for all groundfish species currently targeted in active groundfish fisheries.

In 2016, DFO Science Branch initiated a 'tiered approach' to assign assessment tiers by species, based on data availability and quality (DFO 2016). Recent progress in computing and data-limited approaches has shifted the direction of the original tiered approach, resulting in DFO Science developing a data synopsis report as the first of a two-phase approach to explore assessment methodologies for groundfish stocks that can be robust to a range of data quality, information, and uncertainty. The first phase, the data synopsis, will provide a visual snapshot or 'report card' of long-term and recent population trends, fishing trends, and data availability for candidate BC groundfish stocks.

The second phase will be to develop a management procedure framework (initially begun as a 'tiered approach'); that outlines a process by which DFO Science Branch can provide advice to the DFO Fisheries Management on the status of data-limited and data-moderate groundfish stocks in the Pacific Region that lack sufficient data for a full age-structured stock assessment, or lack existing assessment models.

The assessment and advice arising from this Canadian Science Advisory Secretariat (CSAS) regional peer review (RPR) is intended to support the management procedure framework by facilitating discussions about stock prioritization for the framework, the selection of candidate management procedures, and the development of tools to generate standardized data products and assessment models.

Objectives

The following working paper will be reviewed and provide the basis for discussion and advice on the specific objectives outlined below.

Anderson, Sean C., Keppel, Elise A., and Edwards, Andrew M. A Data Synopsis Report for British Columbia Groundfish. CSAP Working Paper 2014GRF07b

The specific objectives of this review are to:

1. Review and assess the appropriateness of the approaches to extract, filter, and summarize data, and fit statistical models to fisheries dependent and independent data used in the report.
2. Assess the suitability of the structure and content (standardized datasets, biological model fits, and data visualizations) of the report examined in Objective #1 and comment on the report's ability to achieve the following goals:
 - a. inform Science on the development of operating models and select candidate management procedures, and;
 - b. generate a reproducible report with consistent data visualizations across all major stocks to facilitate discussions between Science and resource managers on stock composition and stock assessment prioritization
3. Examine and identify uncertainties and caveats regarding the data and methods in the report.
4. Make recommendations for future uses and application of the report.

Expected Publications

- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (Science Branch, Fisheries Management)
- Academia
- Other Government Agencies (NOAA)
- Non-government organizations
- Aboriginal communities/organizations
- Commercial and recreational fishing industry

References

DFO 2009. [Sustainable Fisheries Framework](#).

DFO 2016. Proceedings of the Pacific regional peer review on A Review of International Best Practices to Assigning Species to Tiers for the Purposes of Stock Assessment Based on Data Availability and Richness; May 30-31, 2016. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2016/051.

DFO 2017. [Groundfish, Pacific Region 2017 Integrated Fisheries Management Plan Summary](#).

APPENDIX B: WORKING PAPER ABSTRACT

The combination of fishery-dependent data, such as catch and effort, and fishery-independent survey data, such as biomass indices and age compositions, forms the backbone of most fisheries stock assessments. For British Columbia groundfish, vast quantities of such data are collected annually, with 100% at-sea observer coverage, 100% dockside monitoring of landings, and deployment of multiple trawl, trap, and hook-and-line surveys. However, there is not the capacity to conduct formal annual stock assessments for most stocks, and therefore much of these data are not regularly published or readily accessible. Here, we introduce a reproducible report to give a snapshot of population and fishing trends, growth and maturity patterns, as well as data availability, for 110 groundfish species in British Columbia. The report generation is fully automated – pulling data from databases, fitting models, generating visualizations, and stitching the document together to facilitate annual publication, reproducibility, and transparency. Our goals are (1) to facilitate regular review by groundfish scientists and managers of trends in survey indices and stock composition to potentially flag stocks for prioritized assessment; (2) to generate standardized datasets and visualizations that will help assessment scientists develop operating models and select candidate management procedures as part of a planned management-procedure framework for data-limited groundfish stocks; and (3) to increase data transparency between Fisheries and Oceans Canada, the fishing industry, non-governmental organizations, and the public.

APPENDIX C: AGENDA

Regional Peer Review Meeting (RPR)

Canadian Science Advisory Secretariat
Centre for Science Advice Pacific

Data Synopsis Report for British Columbia Groundfish

November 22-23, 2018

Nanaimo, BC

Chair: Mary Thiess

DAY 1- Thursday, November 22

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Mary Thiess
0915	Review Terms of Reference	Mary Thiess
0930	Presentation of Working Paper	Sean Anderson & team
1030	Break	-
1050	Continue Working Paper presentation	Sean Anderson & team
1200	Lunch	-
1300	Presentation of Written Reviews	Dan Ricard Chris Rooper
1400	General Discussion <ul style="list-style-type: none">Data Issues (data treatment, models, approach)Report Issues (structure, content, visualizations)	RPR Participants
1445	Break	-
1500	General Discussion: <ul style="list-style-type: none">Goals of the Report: achieved?Uncertainties & Caveats	RPR Participants
1645	Develop Plan for Day 2	Mary Thiess
1700	Adjourn for the Day	-

DAY 2- Friday, November 23

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping	Mary Thiess
0915	Review the Results of Day 1 Discussions	RPR Participants
0930	General Discussion Results & Conclusions Relative to ToR Objectives	RPR Participants
1030	<i>Break</i>	-
1045	Recommendations for future uses and application of the report	RPR Participants
1115	Check-in: Consensus on Paper Acceptability & Review of Agreed-upon Revisions	RPR Participants
1130	Next Steps & Concluding Remarks: <ul style="list-style-type: none">- Timelines for research document & proceedings- Other follow-up or commitments required- Summarize any other business arising from the review	Mary Thiess Sean Anderson RPR Participants
1200	<i>Adjourn meeting</i>	-

Agenda time blocks subject to revision during the meeting. In particular, discussions could continue into the afternoon on November 23, if needed.

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Anderson	Sean	DFO Science
Archibald	Devan	Oceana Canada
Benson	Ashleen	Landmark Fisheries
Carruthers	Tom	University of BC
Christensen	Lisa	DFO Science, Centre for Science Advice Pacific
Edwards	Andrew	DFO Science
English	Philina	DFO Post Doctorate
Forge	Kieran	DFO Science
Forrest	Robyn	DFO Science
Grandin	Chris	DFO Science
Haggarty	Dana	DFO Science
Haigh	Rowan	DFO Science
Keizer	Adam	DFO Resource Management
Keppel	Elise	DFO Science
King	Jackie	DFO Science
Kronlund	Rob	DFO Science
Lane	Jim	Nuu-chah-nulth Tribal Council
McGreer	Madeleine	Central Coast Indigenous Resource Alliance (CCIRA)
Mose	Brian	Groundfish Trawl Advisory Committee
Obradovich	Shannon	DFO Science, Stock Assessment
Olmstead	Melissa	DFO Science
Olsen	Norm	DFO Science, Groundfish Section
Ricard	Daniel	DFO Science, Gulf Region
Rooper	Chris	DFO Science
Rutherford	Kate	DFO retired
Schweigert	Jake	DFO emeritus
Sporer	Chris	Pacific Halibut Management Association
Starr	Paul	Canadian Groundfish Conservation Society
Surry	Maria	DFO Science
Tadey	Rob	DFO Resource Management, Groundfish
Thiess	Mary	DFO Science, Salmon Assessment
Turris	Bruce	BC Groundfish Conservation Society
Wallace	Scott	David Suzuki Foundation
Workman	Greg	DFO Science, Groundfish

APPENDIX E: WORKING PAPER REVIEWS

E.1. CHRIS ROOPER

Fisheries and Oceans Canada

Canadian Science Advisory Secretariat (CSAS)

Regional Peer Review Process - Pacific

Written Review

Date: 11/14/2018

Reviewer: Chris Rooper, DFO

CSAS Working Paper: 2014GRF07b

Working Paper Title: A reproducible data synopsis for over 100 species of British Columbia groundfish

Authors: Anderson, Keppel & Edwards

General comment:

The CSAS working paper presenting the data synopsis for BC groundfish is an excellent example of the power of linking multiple data sources to a reporting template that can show trends in multiple aspects of BC fish populations (e.g. trends in abundance, trends in length and on). The report represents a tremendous amount of work and coding in R, SQL and knitr/markdown. The authors should be commended for this effort and for producing a document that can be readily updated every year when new data becomes available. I particularly liked the 2-page limit per species.

One question that immediately came to mind is regarding the distribution of the underlying data. There will undoubtedly be requests for data when this information is put out, is there a plan for these to be easily managed or served somewhere?

A second general comment is that it might be useful for those species where a stock assessment exists to have the stock assessment fits to landings and survey biomass (where these are used). It would be a useful comparison and since one of the goals is to make the data readily available to stakeholders, this might be a good place to put some of the relevant stock assessment outputs. I was thinking about say a third line on each of the figures of landings and survey biomass that would show the assessment fit. If this is not possible, that is OK, but it seems like a good context to show these things.

Overall, fantastic job of summarizing the data and modeling into a digestible format. This is a very useful effort that should be replicated across other surveys/species where the data can be centralized and accessed.

Is the purpose of the working paper clearly stated?

Yes, the purpose of the working paper is to provide an overview of the data available for each of 110 species of groundfishes in BC with the goals of having the data report be consistent in the information it presents across species and reproducible on an annual basis by drawing directly from the relevant databases and knitting the document using specialized R packages and code. This is clearly stated throughout.

Are the data and methods adequate to support the conclusions?

As a data report, there are limited conclusions. However, the methods and data seem appropriately presented within the document. Some decisions were made about data standardization (for example scaling of time series) and choices of data (for example the years of commercial catch included). These decisions seemed well supported and thought out, and the reasons for the decisions were documented. In particular the appendices are very useful at documenting the steps taken in data extraction and compilation of time series.

Are the data and methods explained in sufficient detail to properly evaluate the conclusions?

The data and methods are explained in exquisite detail.

If the document presents advice to decision-makers, are the recommendations provided in a useable form, and does the advice reflect the uncertainty in the data, analysis or process?

The document does not present advice per se to decision makers. The data itself is presented in a useable form and for the most part uncertainty in the data, models and figures are presented. I would note that a single example of the geostatistical methods is worked through in the appendices (for cod) where uncertainty and details are presented, although I understand the reason for presenting a single example, I'm sure that the other species have pluses and minuses associated with their model choice.

From TOR Document

Review and assess the appropriateness of the approaches to extract, filter, and summarize data, and fit statistical models to fisheries dependent and independent data used in the report.

The methods used to extract, filter, summarize and fit the data seemed very appropriate for the data. Standard and relatively cutting edge methodologies were used throughout, although some of the specifics (in particular the use of the tweedie distribution) were fairly unique. There did not seem to be any particular issues with the methodology, and it was all very well documented in the appendices.

Assess the suitability of the structure and content (standardized datasets, biological model fits, and data visualizations) of the report examined in Objective #1 and comment on the report's ability to achieve the following goals:

- a. inform Science on the development of operating models and select candidate management procedures, and;***
- b. generate a reproducible report with consistent data visualizations across all major stocks to facilitate discussions between Science and resource managers on stock composition and stock assessment prioritization***

The structure of the data report and the content were all very useful in meeting the objective of informing science about data availability and trends in key components of data for each species. As mentioned previously, the reproducibility and linkages of the document to the databases is an excellent step forward and I'm not sure that I have seen this done so nicely anywhere else.

The report as a reference document with annual updates of the data streams is an excellent resources for managers and scientists alike. It seems certain that the information provided here can be relatively easily used to prioritize stock assessments. The criteria for prioritization is not necessarily laid out in this document, but it appears to me that the data identified and presented in this report will be useful for any criteria that are generated.

Examine and identify uncertainties and caveats regarding the data and methods in the report.

In general, the uncertainties and caveats regarding the data and methods were very well explained in the report. There are some specific comments in the pdf, but the authors did a very nice job on this aspect. In particular the detail on some of the data caveats in the appendices (for example on the IPHC survey data) of the report was more than adequate.

Exploring different spatial modelling approaches was probably done at some point in the initial data examination, but these species have a lot of different life history characteristics which make them more or less inclined to have some geospatial correlation that can be captured and used. In looking at some of the confidence bounds I'm wondering what the model fits were like for some of these species and whether using a spatial model is an advantage, or if a simpler approach might work just as well. Also, would it be possible in an appendix to provide a few of the results/uncertainty from the landings and the survey modelling? This may be a bit much to ask, but something akin to the depth-relationships shown in Appendix B, but tables of standard model results/fits? Or at minimum a RMSE or something on the figure?

Make recommendations for future uses and application of the report.

The current document is limited to presenting information on groundfishes. It would be useful to think about including other species, such as forage fish, invertebrates, salmon possibly in another format. For many species, the trawl and longline surveys might be one of the only sources of information out there. Yet many of these species, such as jellyfish, are often thought of as indicators of ecosystem status. Under DFO's mandate to conduct ecosystem management, the same types of information could be presented for non-target species other than groundfish as a supplemental reference material for stock assessments.

I would also recommend thinking in the longer term about presenting some of the auxiliary data that is collected on these surveys in this type of format, such as temperature and salinity data that is routinely collected on many of these surveys.

More specific comments:

1. The GLMM estimates tended to have larger CVs than the stratified estimates and reproduced the same trends? What gives?
2. It might be better or more useful to present the latest year of commercial catch in the spatial figures. This could be used to relate more to the survey time series (or is there some reason you chose to do it the current way?).
3. D. 2. Instead of dealing with nonlinear relationships by binning, why not move to a non-linear method (like GAM) which can also be used with the Tweedie distribution?
4. Why standardize the landings data? It seems like you are modelling to try to compute an index of relative abundance, I'm not totally certain why this was done, wouldn't the landings be a relatively known data stream? Maybe just a couple sentences on why this was done would be good.
5. I wonder if a simple statement of the total landings and/or ex-vessel value from the preceding year could be put in the header information. This might provide a representation of the relative importance of the species.
6. For length frequency plots I would suggest having males and females on negative and positive axes. Like example below. For example, see Figure 3 in [Data Report: 2017 Gulf of Alaska Bottom Trawl Survey](#).
7. Additional comments can be found in the pdf document.

E.2. DANIEL RICARD

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat (CSAS)
Regional Peer Review Process - Pacific
Written Review

Date: November 17 2018

Reviewer: Daniel Ricard, DFO Science Gulf Region

CSAS Working Paper: 2014GRF07b

Working Paper Title: A reproducible data synopsis for over 100 species of British Columbia groundfish

Authors: Anderson, Keppel & Edwards

Is the purpose of the working paper clearly stated?

The purpose of the paper is clearly stated and the document is clear and honest about its objectives and the important caveats it entails

Are the data and methods adequate to support the conclusions?

The document is about data and details the methods used in analysing a variety of data sources. Moreover, the reproducible nature of the analytical framework developed makes the document uniquely transparent.

Are the data and methods explained in sufficient detail to properly evaluate the conclusions?

The appendices provide a clear and exhaustive description of the different analytical steps undertaken. These descriptions are sufficient in details and adequately support the body of the document.

If the document presents advice to decision-makers, are the recommendations provided in a useable form, and does the advice reflect the uncertainty in the data, analysis or process?

This document is not a usual provision of advice to manager but rather a source of information to guide and support further research. The analyses adequately convey the existing uncertainty in the underlying data and methods used.

Can you suggest additional areas of research that are needed to improve our assessment abilities?

I provide a more detailed review of the document below, including suggestions about additional areas of analyses.

The title, abstract and caveats section of the working document are honest about the goals of this work as the resulting paper is an exhaustive presentation of available information without a specific research goal. But it is also much more than that since the reproducible analytical framework presented therein will, in addition to fulfilling its stated goals, likely enable considerable novel analyses of marine ecosystems in West Coast waters. I do have a number of suggestions for potentially improving the document and some comment about the contents of the document and their accessibility.

Sections 1 and 2 are just two tables showing the species names. I think that this would be better handled as tables in the Introduction section of the document. Additionally, instead of presenting the scientific and common names in separate tables, consider having a single table containing both, and order that single table using a taxonomic hierarchy based on the phylogenetic branching of the species in the document. This table would also indirectly provide an overview of the taxonomic diversity of the information presented and would show if some information is available at taxonomic groupings other than the species level (if the report is ever extended beyond groundfish species). In addition to providing links to FishBase, I would suggest an additional link to the World Registry of Marine Species as well. Including an Index at the end of the document could provide links to the different species presented in the report, both for common and scientific names, and could provide links to the different species in a higher taxonomic grouping such as taxonomic family.

A-level and B-level species are used to distinguish between primary commercial or conservation interest, and B-level species is all the rest. But how do we decide if something becomes of conservation interest? The commercial species are readily identifiable but there are likely some B-level species that will be of conservation interest in the future, or whose conservation status will improve hence removing them from the A-level list. I would suggest describing in more details how the assignment to A-level and B-level lists is done.

The exclusion of Pacific Halibut and Pacific Hake is justified through a citation to other documents that I did not consult. But is it coincidental that these two species also happen to be commercially exploited rather successfully? It seems that whatever reasons that were used to justify the exclusion of these two species could also be used for other species once we learn more about the intricacies of their ecological dynamics. As such, I question the exclusion of these species from the current document. The document is very clear about its limitations and I felt that these important caveats would alleviate concerns about presenting information on Pacific halibut and Pacific Hake.

A question that comes to mind for the remaining 80 B-level species is whether those are also the species for which we have a more limited amount of information, or are there species in that group for which we have reliable ecological understanding.

Section 3.1: "colour scales are consistent": what does that mean? Also, are the colour schemes used appropriate for colour-blind readers?

When survey information is presented as temporal indices, high CVs trigger a gray background. Why is that? To indicate that it is to be trusted less because of the large amount of year-to-year variability? The reason why a gray background appears is not explicitly stated. A small number of samples with the species present also trigger a gray background, again suggesting that the information is to be trusted less. However, elusive records of species, if they are consistently recorded in a similar fashion, can probably be trusted to provide relative indices of biomass and abundance.

Figure 4 shows a scale for each survey map but the same scale does not appear in the remainder of similar figures in the document. Are all the maps using the same scale or are the scales omitted from the 2-page summary for each species?

Maturity ogives: while the model presented here examines maturity as a binomial variable, the maturity staging recorded in the surveys is likely to be more detailed. Can this information be presented too?

Appendix C: is there available metadata for the different databases presented?

Appendix D appears exactly as it does in the Research Document of the Pacific cod assessment. I am not sure how to deal with this duplication.

Is the sampling design included in the fitting of the models presented in Appendix H? For example, when fitting a growth model, the lack of independence of paired length and age observations must be accounted for in the model fitting.

Would it be useful if each species presented had a “total score” about its available information? If such a species-level criterion could be established, sorting species over this criterion may add further information about the dataset as a whole as it would rank the level of information available for different stocks and would guide the analytical treatment they can potentially receive.

All the information that is presented in the report is likely to be of interest to a community larger than scientists at DFO. So the publication of this report will probably elicit requests for data products generated using the same sources as those presented in the report. The accessibility level of these data should be stated in the document so as to guide readers towards the appropriate channels to access the information. Is the custodianship of the data presented solely with the authors of the report?

The figures presented in the report rely on the computation of a number of indices and exactly how the underlying numbers were obtained should be accessible to practitioners. The methods are currently described in the appendices but their actual software implementation should also be available. For example, some of the SQL presented seems to access bootstrap estimates and seems one step removed from the data itself.

How are the underlying data sources likely to change in the future (both in term of custodianship and correction of errors), and how could this affect the trends presented? I am thinking for example about misreporting of commercial catches that were discussed at the Pacific cod stock assessment review.

How could this report be used for its stated “planned management procedure framework for data-limited and data-moderate groundfish stocks”? Under what criteria would stocks be prioritised for inclusion into this planned framework? It seems that the information necessary to identifying these stocks (scale of commercial catches, conservation concerns, ...) is already present in the document and could be used to make a list of candidate stocks for this purpose.

The proposed update schedule must be put in the context of the incoming inflow of information on a yearly basis. What additional information will appear from year to year? While I understand that the amount of work required to update and reproduce the report will be elegantly cut down because of the reproducible framework used, it is worth asking what is the additional value of the yearly information? Does a Science Response under CSAS require a face-to-face meeting of contributors? What “larger changes to the structure, methods or content” do the authors expect?

I feel that the amount of information presented far exceeds what is normally shared as a result of a CSAS process. Each Appendix represents a document in itself, and will likely spawn publications in the primary scientific literature. So is the scale of the current endeavour too large? On the other hand, the document may also represent a long overdue summary of all available information about groundfish stocks on the west coast of Canada. As a reviewer, I feel overwhelmed at the amount of information presented in the report and can’t scrutinise all the components of the analytical framework presented in a thorough level of detail. The report does make clear that all its components have matured from a number of previous science processes that have stood the test of peer review.

A minor edit to do in the references, Chamberlain & Szocs (2013): complete first names appear instead of initials. For references to CSAS documents, consider adding a URL to the splash page associated with the publication on the CSAS website.

Some points of discussion for the meeting:

- The report states that it may help guide the prioritisation of data-deficient species, so what are examples of such species that can be identified from the report?
- How was the order of the appendices decided?
- What are the long-term prospects of putting things on github? By government standards, this is a novel technology and I wonder whether this platform will remain an option for the medium to long-term.
- What are the accessibility realities of the data presented in the report? Are there issues of privacy and confidentiality that can limit the sharing of the information presented in the report?

The authors have clearly put considerable effort and thought into developing the framework necessary for the production of this document. The resulting document is laudable and will undoubtedly catalyse a number of analytical initiatives that will further our understanding of marine ecosystems in the Pacific Northwest. I think that all DFO regions can learn something from this effort and can use the synoptic report to guide the development of better data access and data analysis tools to support their own work.

Thank you for the opportunity to review this work. Sorry for the delay in submitting this review. Looking forward to the meeting.

APPENDIX F. RESEARCH DOCUMENT REVISIONS

The authors agreed to make the following revisions prior to publication of the research document:

- halibut and hake to be included (and re-work text to emphasize that other agency data exists that is not included as part of this report)
- include some additional text to strengthen the rationale for using longer commercial CPUE time series maps (there should not be a problem to extend back to 1996)
- a passage in the introduction (“facilitate regular review by groundfish scientists and managers of trends in survey indices and stock composition across all stocks to potentially flag stocks for prioritized assessment”) could be misinterpreted by readers and invite questions about the report’s intended use in prioritization exercises. If this can be reworded to be absolutely clear about this caveat, it might be worth doing so.
- remove references to specific CSAS processes, in case a different avenue is chosen for annual updates (e.g., DFO Technical Report)
- add WoRMs link to species header text
- change “tons” to “tonnes” or just “t”
- include year ranges on the maps to show what years are included in the data illustrated
- include a fishery exclusion map at the beginning of the report (similar to map shown in the Yelloweye Rockfish pre-COSEWIC document)
- instead of “commercial catch”, use "Canadian commercial catch" for the title above the catch plots
- remove type A/B species lists as well as references to the groundfish strategic plan; list all 112 species in Hart Code order (which is taxonomic); authors to figure out if further group footer/header info needed
- Appendix F and Fig 1: change “Queen Charlotte Strait” to “Queen Charlotte Sound”
- include an appendix summarizing how well models fit for each species (for both commercial CPUE and geostatistical survey indexes)
- Expand section 3.3 to include other aspects of data custodianship/stewardship ("extra" slide info; the added paragraph will note that the synoptic survey data is already available to the public through the [Open Government Data Portal](#). Hook and line survey data are currently being prepared for upload to the Open Data Portal. Commercial data will be uploaded in a rolled-up format in compliance with the Federal Privacy Act. Requests for data held by DFO Pacific Region can be made through [Pacific Fisheries Catch Statistics](#)).
- Add number of ageing structures available.
- Add sample size information
- Include a table of other surveys that are not included as part of this report
- Generate Appendix B for hook and line data as well.
- Include summary of % data excluded due to confidentiality (i.e, for commercial trawl and hook and line CPUE maps)
- text: add explanation where models are being used for first time—e.g., geostatistical model
- Add "Release Notes" section to future iterations to highlight changes/updates over previous versions; git tag/date to help with version control (to be included in R code).
- If space on the standardized layout permits (and time to implement allows):

-
- Length composition figures—modify as per C. Rooper’s review suggestion to separate male/female lengths.
 - Suggest using geometric rather than arithmetic mean (in log space for just positive events) will be much closer to the standardized series. Authors will include this if it is more similar to the standardized index, noting that it only works for non-zero (positive) events (i.e. fishing events where a species is caught). The arithmetic mean provides a simpler, easy-to-understand metric that applies to all events (i.e., zero and non-zero catches).
 - Include number of samples along with biological data specimen counts.
 - Include a shaded outline of the entire historic fishery extent (similar to Extent of Occurrence figure in pre-COSEWIC reports).
 - Add wording to metadata section (e.g., important time of year, important years in text field for each species)

RECOMMENDATIONS FOR FUTURE WORK

- Investigate the use of a GLMM approach to standardize IPHC data, although not recommended to generate competing index series.
- Add reconstructed catches
- Continue research of hook competition with respect to long line surveys
- Include HBLL Inside data on current HBLL Outside map
- May be able to use geostatistical model to fill in areas/years without surveys (create annual index in areas that were not surveyed in a given year)
- Expand to broader ecosystem reports (covering all intercepted species, oceanographic data, climate change, etc.)
- Expanded landings summaries (e.g., by gear type, month, ...?)
- Manual updates (of metadata) to be automated when possible
- Assess whether it is feasible to include stock assessment outputs (e.g., stock assessment fits to survey biomass) when available on future iterations
- Could propose to use this work as the basis for developing a “Northeast Pacific” data synopsis at the Technical Subcommittee of the Canada-U.S. Groundfish Committee