Fisheries and Oceans Canada | Pêches et Océans Canada
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Central and Arctic Region | Canadian Science Advisory Secretariat
Science Advisory Report 2019/045

REVIEW OF ALBERTA ENVIRONMENT AND PARKS CUMULATIVE EFFECTS ASSESSMENT JOE MODEL

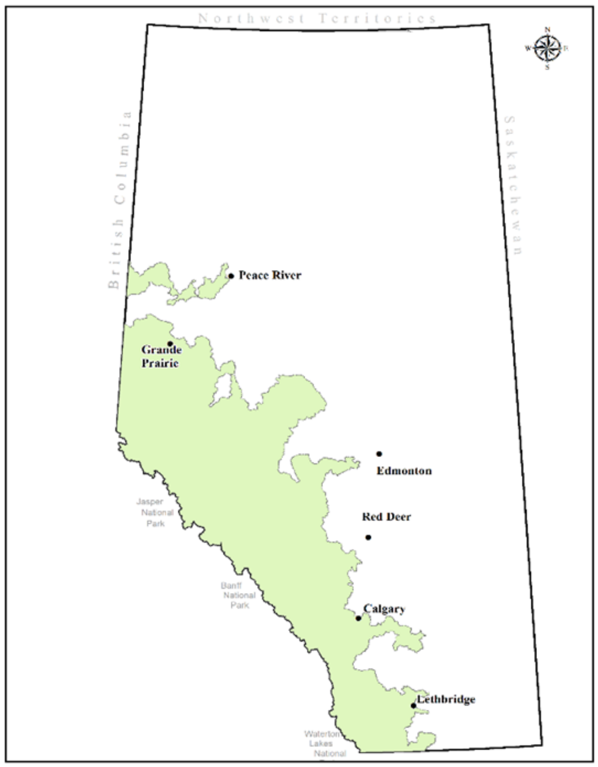

Figure 1. Alberta range (green) included in the Fisheries Sustainability Assessment (FSA) of imperiled Westslope Cutthroat Trout (Oncorhynchus clarkii), Athabasca Rainbow Trout (Oncorhynchus mykiss) and Bull Trout (Salvelinus confluentus).

Context:

The Province of Alberta (Ministry of Environment and Parks) has developed a new modelling approach for assessing threats to aquatic species at risk in Alberta. This approach, called the Joe Model, was developed for Bull Trout (Salvelinus confluentus) and is currently being applied to other Rocky Mountain East Slope salmonids at risk (Westslope Cutthroat Trout [Oncorhynchus clarkii lewisi] and Athabasca River Rainbow Trout [Oncorhynchus mykiss]) populations by the Alberta Ministry of Environment and Parks (AEP). This model is being used as a robust method for geographically prioritizing recovery, regulation, research, and management actions. The model will be formally introduced as a complementary approach to assessing threats for subsequent AEP recovery plans for Bull Trout, Westslope Cutthroat Trout, and Rainbow Trout. This could have significant ramifications for the DFO Species at Risk (SAR) Program, as adoption of Provincial Recovery Plans represents a best practice to ensure coordinated recovery and management of species at risk.

This Science Advisory Report is from the regional peer review of the Review of Alberta Environment and Parks Cumulative Effects Assessment Methodology held on September 18–20, 2018. The purpose of this meeting was to review the model developed by the Province of Alberta, assess the ability to incorporate quantitative and qualitative information and/or data into the model, and determine if components of the model would add additional value to the current DFO framework for assessing threats, ecological risk, and impact. Additional publications from this process will be posted on the [DFO Science Advisory Schedule](#) as they become available.

SUMMARY

- The DFO Science sector provides science advice to the Species at Risk Program for species that have been assessed by COSEWIC as Endangered or Threatened in the form of a Recovery Potential Assessment (RPA). One component of the RPA process is a threats assessment; to date threats assessments have been hampered by a lack of efficient tools. The Alberta Environment and Parks (AEP) Cumulative Effects Assessment Joe Model provides a novel approach by incorporating a standardized response (y-axis) that allows a prioritization of threats (doses/stressor). These stressor-response curves (i.e., dose-response curves) are the key functional component of the model.
- The model provides a framework for assessing threats (and possibly other effects) in an additive manner and generates hypotheses to inform and direct adaptive management actions. It also allows investigation of trade-offs under alternative scenarios of threats and/or recovery actions.
- It is a static model designed to assess system capacity (i.e., potential for the system to support adult individuals) as a function of the threats that have been assessed. The output from the model is expected to be testable.
- This is a semi-quantitative static modelling approach that can be used to prioritize among multiple threats at hierarchical levels and focus potential threat analyses and recovery actions. For example, it is scalable geographically from local to regional levels and taxonomically from the population level to larger designatable units. It is a structured and transferable approach that reduces subjectivity associated with the outputs.
- As a static model it is designed to assess threats affecting the population and does not directly or dynamically predict the population response. As an additive model (on a logarithmic scale) it does not incorporate interactions among threats.
- Quantitative and qualitative data, including monitoring data, traditional knowledge, local knowledge, and expert opinion, are appropriate to use in this approach, provided the uncertainty and underlying assumptions are clearly stated.
- The model represents an additional tool for managers to understand threats to system capacity and investigate scenarios intended to maintain or recover populations. As with any model, the output should be interpreted in the context of the underlying assumptions, limitations, and degrees of uncertainty.
- Users of the model should:
  - Explicitly state the uncertainty and underlying assumptions;
  - Undertake model validation, particularly adaptive management at appropriate scales and refinement of stressor-response curves, to further improve the model and its application over time; and
  - Conduct sensitivity analyses of stressors and stressor-response curves.

- The Joe model is complementary to the threat assessment matrix within RPAs and provides a more structured approach to assessing threats. Application of the model and its outputs should be further explored and its utility confirmed in future RPAs.
- This approach has the potential to inform Recovery Planning undertaken by the DFO Species at Risk Program by generating informed hypotheses and focusing management and research activities.
- There is potential for applicability and utility of the approach (i.e., threats assessment and prioritization) to the DFO Species at Risk Program and additional sectors (e.g., Fisheries and Aquaculture Management, Oceans Management, Fish and Fish Habitat Protection Program). The development of a focused research program within the Science sector to investigate model parameterization (e.g., develop and refine stressor-response curves) would be necessary for program delivery.

INTRODUCTION

Alberta has one of Canada's fastest growing human populations and economies, and consequently, faces rapidly changing issues of fisheries conservation. Fish and fish habitat are under significant pressure from development and resource use. The identification and prioritization of individual threats on a watershed by watershed basis is an important first step in developing potential mitigation measures and recovery actions to improve the status of fish populations under consideration for protection. The complex issue of considering multiple freshwater systems and species that are threatened by a variety of individual and/or cumulative effects (e.g., habitat loss/change, invasive species, recreational fishing) can be overwhelming. To address this issue, Alberta Environment and Parks (AEP) fisheries biologists have developed a systematic approach to assess cumulative effects of threats and to generate hypotheses that prioritize and focus mitigation and recovery efforts on a watershed by watershed basis (MacPherson et al. 2019 In Press).

As part of this approach, AEP first developed a Fisheries Sustainability Assessment (FSA) Rule Set to categorize the status of fish populations by watershed using a standardized, quantified scale. Each time the model is applied to a fish species, the historical status, current status (adult fish density), and Fisheries Management Objectives are defined using a FSA score. FSA scores range from 1 (highest risk populations) to 5 (lowest risk populations). Additionally, for each watershed the individual threats, including the frequency, intensity, and effect on fish populations are quantified. These may differ across the range of the species. Since resources are limited, recovery actions and mitigation measures need to be clearly identified and prioritized by watershed. The Alberta Environment and Parks (AEP) Cumulative Effects Assessment Joe Model (herein referred to as the Joe Model) was developed to assess multiple stressor impacts and prioritize hypotheses that identify the limiting stressors to the current status (i.e., FSA score) of a target species. The resulting hypotheses (i.e., scenarios) can then be tested using adaptive management actions to achieve Fisheries Management Objectives. Ultimately, the model is an additional tool that can be used to understand threats and identify where and what recovery actions and mitigation measures could be undertaken to achieve recovery and sustainability of target fish species.

The purpose of this regional peer-review meeting was to review the model developed by AEP, assess the ability to incorporate quantitative and qualitative information and/or data, and determine if components/outputs of the model would add additional value to the current DFO framework used in Recovery Potential Assessments (RPAs), for assessing threats, ecological risk, and impact (e.g., DFO 2014a).

This Science Advisory Report summarizes the conclusions and advice from the regional peer-review meeting, held in Canmore, AB on September 18–20, 2018. The research document, will provide the technical details of the model, using examples to support this advice (MacPherson et al. 2019 In Press). The meeting discussions are documented in the meeting proceedings (DFO 2019a In Press).

ASSESSMENT

The Joe Model is a two-part process (i.e., assess status, assess hypothesized threats), leading to adaptive management to test generated hypotheses (MacPherson et al. 2019 In Press). The first step requires the user to define the current status scaled to a provincial reference condition, and contrast this to desired status using the Fisheries Sustainability Assessment (FSA) Rule Set, and the second step assesses threats using stressor-response curves. The model generates hypotheses that identify the limiting stressors to the current status (i.e., FSA score) of a target species. From this process, effective mitigation actions can be designed, implemented, and tested.

Fisheries Sustainability Assessment (FSA) Rule Set

Alberta Environment and Parks (AEP) developed a Fisheries Sustainability Assessment (FSA) Rule Set by which the status of fish populations is categorized using a standardized scale (Table 1). The use of FSA scores provides consistency and allows for the comparison of stock status across the Province of Alberta. Each time the model is applied, the historical and current adult fish density, and the Fishery Management Objectives are defined using the FSA Rule Set.

It is important to define the objectives for a fishery (i.e., target FSA score) based on a reference population that is reasonable for the current landscape. For example, in the Alberta Oil Sands region it would be unreasonable to set the target FSA score relative to the historical population prior to development because the landscape has been manipulated to such an extent that it cannot be remediated to its historical state.

Table 1. Alberta Fisheries Sustainability Assessment (FSA) and Risk Assessment rankings for adult fish density. For each score, confidence in data is also assessed (e.g., see Appendix 1).

FSA Score	Risk Assessment Rank
0	Functionally Extirpated
1	Very High Risk
2	High Risk
3	Moderate Risk
4	Low Risk
5	Very Low Risk

Biologists should reassess the population's FSA score regularly as new data are collected on population status, as the severity of population impacts change, and as new impacts appear or management actions change. For any particular FSA, the most up-to-date data should be used to compare the fish population against the reference population described in the Fisheries Management Objectives. For high-profile fisheries, these data are collected using active monitoring protocols. These are generally index netting in lakes and electrofishing in streams and rivers. For lower-profile lentic fisheries (e.g., remote, undisturbed, or less-used by humans), monitoring is conducted following passive monitoring protocols. Passive monitoring for lakes relies on assessing information relating to five factors: similarity to nearby actively monitored lakes, surface area, road access, citizen science, and government staff reports. In instances where the data used may be imprecise or inaccurate, the quantity of data available is limited, or outdated data are used, this will be highlighted by low confidence scores (e.g., Appendix 1).

Assessing threats: integrating cumulative effects using Joe Modelling

Stressor-Response Curves

The Joe Model consists of a series of stressor-response curves where each impact is treated as independent, with the identified impact as the stressor and the system capacity of current adult density as the response (i.e., common y-axis). A common y-axis enables stressors to be combined into a cumulative effects model. System capacity is a continuous variable that is equal to the y-axis value from the stressor-response curve given a particular x-axis value (Table 2, Figure 2). The output from each curve is the current system capacity scaled to a maximum of 5 (i.e., potential for the system to support adult individuals; Figure 2). Using the results of each curve, system capacity can be displayed for each stressor in a visual comparison (Figure 3). This allows the user to identify the stressor(s) with the greatest hypothesized impact on the population.

Table 2. System capacity and percent of reference population categories as they relate to current adult density.

System Capacity	Percent of Reference Population (%)	Current Adult Density
0	0	No adults observed
<0.9	<20	Very Low Density (e.g., lowest possible without extirpation, adults barely detectable)
1.0-2.4	20-49.9	Low density, recruitment overfishing[1]
2.5-3.4	50-69.9	Moderate density, growth overfishing[2] below Maximum Sustainable Yield (MSY)
3.5-4.99	70-99.9	High density, population at or above MSY with mild growth overfishing
5	100	Highest possible, adult population at reference carrying capacity

[1] A population state similar to that caused by recruitment overfishing, which is the rate of fishing above which the recruitment to the exploitable stock becomes significantly reduced. It does not imply the state is caused by fishing.
[2] A population state similar to that caused by growth overfishing, which occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. It does not imply the state is caused by fishing.

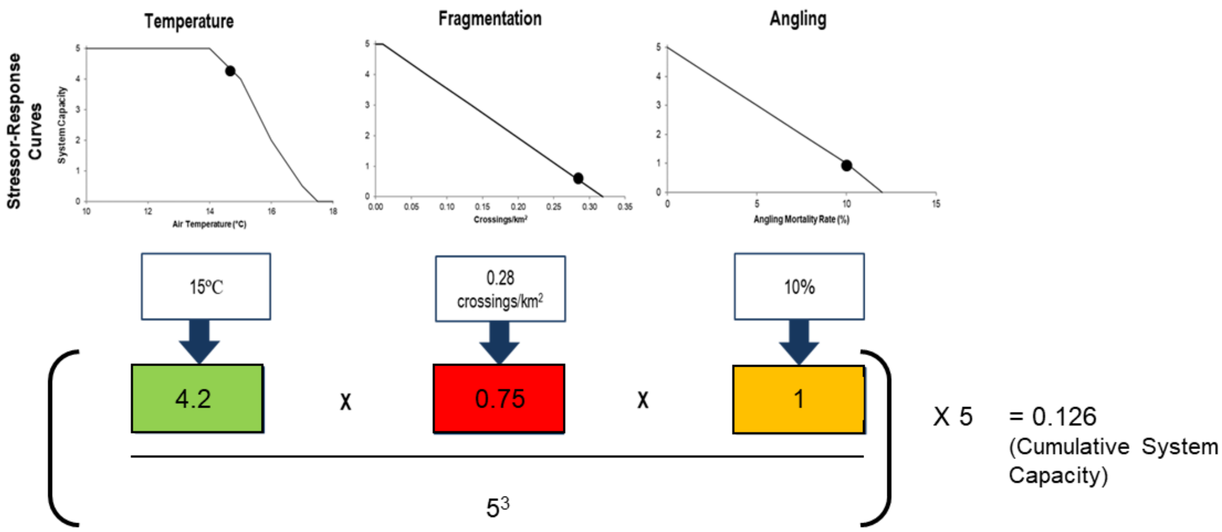

Figure 2. Illustration of the multiplicative effect of three hypothetical stressor-response curves on predicted total system capacity. 0.126 means a Very Low current adult density (see Table 2). Figure adapted from Reilly and Johnson (pers. comm.).

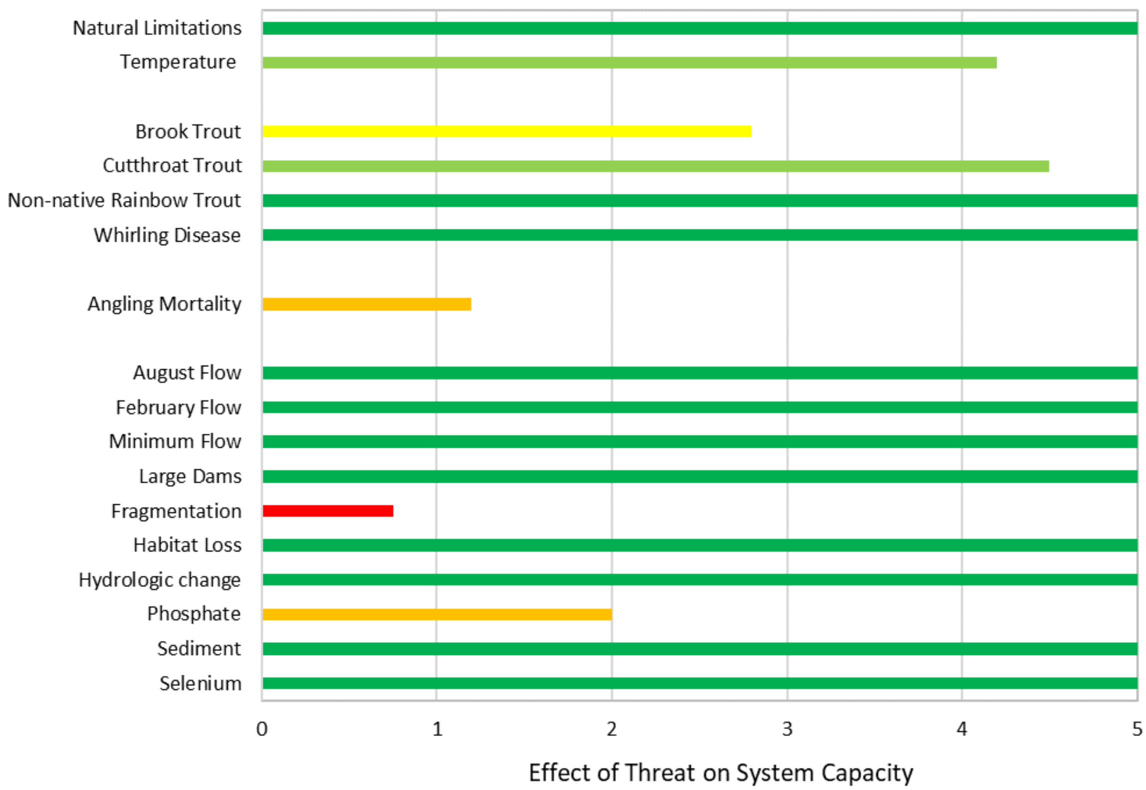

Figure 3. Predicted impacts on system capacity for stressors used for an example of the Joe Model. System capacity of 5 suggests little to no effect on adult fish densities (dark green), whereas low system capacities, close to 0, would suggest the strongest negative effect (red).

The biology of the species and the stressors impacting the species should be considered when determining the scale at which the model is applied. Consequently, a detailed biological summary of the target species is required.

Stressor-response curves are developed using the best-available information, including analysis of spatial data, fishery data available in the Province of Alberta's Fisheries and Wildlife Information Management System database, consensus of professional opinion in workshops, and stakeholder and local knowledge. For stressor-response curves that are not quantified or substantively researched, there is high subjectivity in developing the shape of the curve. Continued efforts to validate and/or estimate the curve shape and characteristics from empirical data will improve the confidence in the overall model. Development of defined confidence categories and descriptions for each stressor-response curve is recommended (e.g., Appendix 1). For each curve, a ranking of the confidence in both the input data and the hypothesized stressor-response relationship should be stated.

It is important to note that this is an additive model (on a proportional (logarithmic) scale) and it does not consider synergistic and/or antagonistic relationships (i.e., greater or less than additive cumulative effects among the stressors). It also does not incorporate density-dependent aspects of stressors (e.g., competition, predation, disease). Moreover, spatial and temporal cumulative effects may be quite different in terms of scale of applicability and relevance to a particular stressor. It is unclear whether this approach effectively brings these both together, an aspect worthy of further investigation.

The Joe Model is best suited for chronic threats (e.g., angling mortality, habitat fragmentation) and it does not address pulsed and/or unforeseen catastrophic events (e.g., large-scale accidental spills) that may occur occasionally. A dynamic version of the Joe Model would be needed for the incorporation of these events.

Model Outputs

The output of the Joe Model is the predicted total system capacity for the target species from which the predicted percent reference population can be determined (Table 2). The model summarizes the stressors, which if desired, can be grouped into major threat categories (e.g., habitat (loss and degradation), hybrids (non-native and exotic species), harvest (sources of direct mortality)). The output is used to identify the potential stressors with the greatest adverse effect on the population of the target species (e.g., fragmentation; Figure 3) and test possible management strategies to identify the mitigation with the greatest positive overall effect (i.e., increase in system capacity) (Table 3).

The Joe Model output is a total system capacity. Using the example shown in Figure 3 (i.e., 17 stressors), the equation for calculating system capacity would be (Equation 1):

(Equation1) $$\left(\frac{4.2\times0.75\times1.2\times5^{11}\times2.8\times4.5\times2}{5^{17}}\right)\times 5 = 0.03\ (Total\ System\ Capacity)$$

Predicted percent reference population can be calculated by dividing the total system capacity by 5 and then multiplying by 100 (Equation 2).

(Equation 2) $$\left(\frac{0.03}{5}\right)\times 100 = 0.61\%$$

Table 3. Example of the current predicted total system capacity for adult Bull Trout in sub-basins (HUC10 watersheds) of the larger Clearwater River watershed (HUC8) and the predicted change to the total system capacity from the implementation of recovery actions. Regs = regulations; WQ = water quality.

HUC8[3]	HUC10	HUC10 Name	Predicted System Capacity	Recovery Action(s)						
				Fishing Regs	Road Crossing Remediation	Improve WQ	Fishing Regs & Road Crossing Remediation	Fishing Regs & Improve WQ	Road Crossing Remediation & Improve WQ	Fishing Regs & Road Crossing Remediation & Improve WQ
				Predicted Change to System Capacity						
11010301	1101030101	Clearwater River – Banff National Park	3.2	1.5	0.0	0.0	1.5	1.5	0.0	1.5
11010301	1101030102	Clearwater River above Elk Creek	3.1	1.5	0.0	0.0	1.5	1.5	0.0	1.5
11010301	1101030103	Forbidden Creek	3.2	1.5	0.0	0.0	1.5	1.5	0.0	1.5
11010301	1101030104	Timber Creek	3.2	1.5	0.0	0.0	1.5	1.5	0.0	1.5
11010301	1101030105	Washout Creek	3.2	1.5	0.0	0.0	1.5	1.5	0.0	1.5
11010301	1101030106	Elk Creek	1.8	0.8	0.0	1.3	0.8	2.8	1.3	2.8
11010301	1101030107	Middle Clearwater River	1.6	0.7	0.1	0.9	0.9	2.1	1.1	2.4
11010301	1101030108	Limestone Creek	1.9	0.9	0.4	0.3	1.5	1.3	0.8	2.1
11010301	1101030109	Seven Mile Creek	0.6	0.3	0.1	1.6	0.5	2.6	2.1	3.3
11010301	1101030110	Tay River	0.7	0.3	0.3	1.2	0.8	2.1	2.0	3.3
11010301	1101030111	Lower Clearwater River	0.2	0.1	0.2	0.9	0.3	1.4	1.9	2.9

[3] In 2013, the Fisheries Management Branch in collaboration with Alberta Environment and Parks Data Management and Water Management, created a provincially comprehensive and aggregated collection of standard hydrologic units based on United States Geological Survey (USGS) standards and procedures. The Hierarchical Unit Code (HUC) watersheds establish a standardized baseline that covers all areas, and where successively smaller hydrologic units are nested within larger hydrologic units, creating a hierarchal watershed boundary dataset. Currently, four levels of nested watersheds have been delineated, 2, 4, 6 and 8-digit HUCs. 10-digit HUCs are delineated for Alberta's East Slopes. The 2-digit HUCs are the largest watersheds and 10-digit HUCs are the smallest, finer scale watersheds (MacPherson et al. 2019 In Press).

Applicability to DFO RPA Threat Assessments

The Joe Model is complementary to the threat assessment matrix within RPAs for species at risk and provides a more structured approach to assessing threats by recognizing the cumulative effects of stressors. However, it should not be considered a replacement of the current DFO threats assessment process. The development of a Joe Model is labour intensive, requiring historical data that for many species are not available or in some cases discoverable, and regular monitoring and engagement with knowledge holders (e.g., scientists, local fishermen) for development and refinement of the stressor-response curves. To further understand its use within DFO, application of the model and its outputs should be further explored in future Alberta salmonid RPAs. This would also allow a more in-depth review of the model outputs in the context of a RPA threat assessment (i.e., case study) and a comparison of the outcomes of the DFO RPA Threat Assessment versus those of the Joe Model.

There may be potential for applicability and utility of the approach (i.e., threats assessment and prioritization) to the DFO Species at Risk Program and additional sectors (e.g., Fisheries and Aquaculture Management, Oceans Management, Fish and Fish Habitat Protection Program). The development of a focused research program within DFO's Science sector to investigate model parameterization (e.g., develop and refine stressor-response curves) would be necessary for program delivery.

Sources of Uncertainty

It is unclear if the Joe Model effectively brings the spatial and temporal cumulative effects together. As an additive model it does not currently incorporate synergistic or antagonistic interactions among stressors.

Compounded variances or uncertainties may be an inherent issue within the model; the applications of the approach thus need to be critically evaluated before accepting the conclusions and the approach itself. Explicit reporting of variances and sources of uncertainty is required and should be done at each relevant stage of the modelling process and also overall at the final outputs.

There is some element of subjectivity in the heuristic development of each stressor-response curve for stressors that are not quantified and those that have not been substantially researched. Additionally, for each stressor-response curve, there is a risk of not knowing the shape of the response curve, and where the inflection point(s) (i.e., threshold) occurs.

For each stressor-response curve, a formal sensitivity analysis of both the input data and the hypothesized stressor-response relationship should be conducted. This is important to determine which parameters cause the most sensitive changes to the model output. It will also be important for identifying buffers (i.e., error bars) around the thresholds for each stressor. This is particularly important for those stressor-response curves that have low confidence in the data used to develop the curve. This further emphasizes the need to conduct field studies to substantiate the shapes of the stressor-response curves.

CONCLUSIONS AND ADVICE

The Joe Model provides a novel approach by incorporating a standardized response (y-axis) that allows for a prioritization of threats. Stressor-response curves are the key functional component of the model. It is a semi-quantitative static model designed to assess system capacity (e.g., potential to support adult individuals) as a function of the threats that have been assessed. The output from the model can be used to prioritize among multiple threats at hierarchical levels and is expected to be testable via adaptive management experiments. The model is designed to assess threats affecting the population and does not directly or dynamically predict the population response. It is also not currently designed to incorporate interactions (e.g., antagonistic, synergistic) among threats.

Several suggestions were provided to AEP to improve model refinement. As with any model, the output should be interpreted in the context of the underlying assumptions, limitations, and degree of uncertainty. Specifically, users of the model should explicitly state the uncertainties and underlying assumptions, report variances, conduct sensitivity analyses, and undertake model validation (e.g., refinement of stressor-response curves) to further improve the model and its application. Compounded variance and/or uncertainties may be an inherent issue, subsequently, the application of the approach needs to be critically evaluated before accepting the conclusions.

Ultimately, the model allows for a structured and transparent method for management decision-making by contrasting current to desired status and prioritizing potential management actions necessary to achieve Fisheries Management Objectives and, thus, identify actions for adaptive management. The model is complementary to the threat assessment matrix within RPAs and provides a more structured approach to assessing threats. Application of the Joe Model and its outputs should be further explored in future RPAs. This approach has the potential to inform Recovery Planning undertaken by the Species at Risk Program by generating informed hypotheses and focusing management and research activities.

OTHER CONSIDERATIONS

The Joe model is a useful qualitative tool for use in engagement and the collection of local and traditional knowledge and expert opinion. The model as a tool has also been shown to provide stakeholders the opportunity to understand cause and effect of known or predicted stressors. This is a useful application for public engagement and provides a transparent approach for demonstrating the basis of management decisions. Additionally, the model has the ability to incorporate traditional and local ecological knowledge (TEK/LEK), however, in all cases the uncertainty and underlying assumptions need to be clearly stated.

There is potential for applicability and utility of the approach (i.e., threats assessment and prioritization) to the DFO Species at Risk Program and additional sectors (e.g., Fisheries and Aquaculture Management, Oceans Management, Fish and Fish Habitat Protection Program). The development of a focused research program within the Science sector to investigate refinement/testing of the model and parameterization (e.g., consistency of results) and the extent to which the model and the parameters reflect the ‘real world’ would be necessary for program delivery. Further application of the model over time should be considered as a heuristic process from which additional model improvements and applications may result.

The development of the tool was intended for species at risk, but it also has the potential to be applied proactively to prevent species from becoming at risk. In other words, stressor-response curves followed by management scenarios could be developed for species that are not yet Threatened or Endangered with subsequent evaluation of the efficacy of the actions.

The model is designed to deal with current stressors or predicted stressors that impact adult fish density and to focus on those threats that have the greatest negative impact. However, “killer variables” or accidents (e.g., catastrophic oil spill, chlorine spill) are only introduced to the model if the event occurs because it would be an overwhelming stressor. The model may be used to demonstrate changes in adult fish density resulting from the implementation of mitigation measures. This would also be an opportunity to collect relevant data to improve current stressor-response curves for these events (e.g., thresholds for decline, how long a system takes to naturally recover).

Future work to include uncertainty within the Joe Model could be considered (e.g., DFO 2014b). Additionally, a y-axis scale of 0–100 rather than 0–5 would eliminate the use of system capacity, which is a redundant step and remains a holdover from early formulations of the process. This could also reduce confusion between the FSA scoring system and the system capacity scoring system, which are both on a scale of 0–5. The output of the Joe Model using the 0–100 approach would be a simple to understand predicted percent of the reference population (Table 2).

LIST OF MEETING PARTICIPANTS

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SOURCES OF INFORMATION

This Science Advisory Report is from the September 18–20, 2018 Review of the Alberta Environment and Parks Cumulative Effects Assessment Methodology. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2014a. Guidance on Assessing Threats, Ecological Risk and Ecological Impacts for Species at Risk. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/013. (Erratum: June 2016).

DFO. 2014b. Pilot application of an ecological risk assessment framework to inform ecosystem based management in the Pacific North Coast Integrated Management Area. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/026.

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DFO. 2019b. Identification of Ecologically Significant Species, Functional Groups and Community Properties in the Western Arctic Biogeographic Region. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/019.

MacPherson, L., Sullivan, M., Reilly, J., and Paul, A. 2019. Alberta's Fisheries Sustainability Assessment: A Guide to Assessing Population Status, and Quantifying Cumulative Effects using the Joe Modelling Technique. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/058. vi + 45 p. In Press.

APPENDIX 1: CERTAINTY CATEGORIES AND DESCRIPTIONS

Table A1. Certainty categories and descriptions used in the assessment of ecologically significant species, functional groups, and community properties (DFO 2019b).

Category	Description
Very High Certainty (VH)	Extensive peer-reviewed scientific information or data specific to the area including long-term relevant datasets.
High Certainty (H)	Substantial scientific information or recent data specific to the area. This includes both peer-reviewed and non-peer-reviewed sources.
Moderate Certainty (M)	Moderate amount of scientific information mainly from non-peer reviewed sources and first hand, unsystematic or opportunistic observations. This includes both scientific information and expert opinion. This may include older data from the area and may also include information not specific to the area.
Low Certainty (L)	Little scientific information but expert opinion relevant to the topic and area.
Very Low Certainty (VL)	Little or no scientific information. Expert opinion based on general knowledge.
Unknown (U)	No information.

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ISSN 1919-5087
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Correct Citation for this Publication:

DFO. 2019. Review of Alberta Environment and Parks Cumulative Effects Assessment Joe Model. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/045.

Aussi disponible en français :

MPO. 2019. Examen du modèle de Joe d'évaluation des effets cumulatifs du ministère de l'environnement et des Parcs de L'Alberta. Secr. can. de consult. sci. du MPO, Avis sci. 2019/045.