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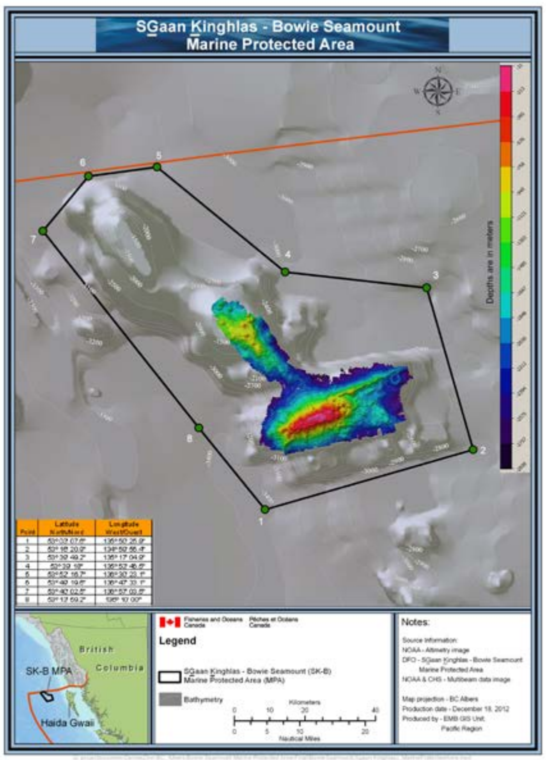
Science Advisory Report 2015/037

APPLICATION OF AN ECOLOGICAL RISK ASSESSMENT FRAMEWORK TO INFORM ECOSYSTEM-BASED MANAGEMENT FOR SGAAN KINGHLAS-BOWIE SEAMOUNT AND ENDEAVOUR HYDROTHERMAL VENTS MARINE PROTECTED AREAS



Bathymetric map of SGaan Kinghlas-Bowie Seamount Marine Protected Area. Map provided by G. Oldford, Oceans Management, Fisheries and Oceans Canada, Vancouver, BC.

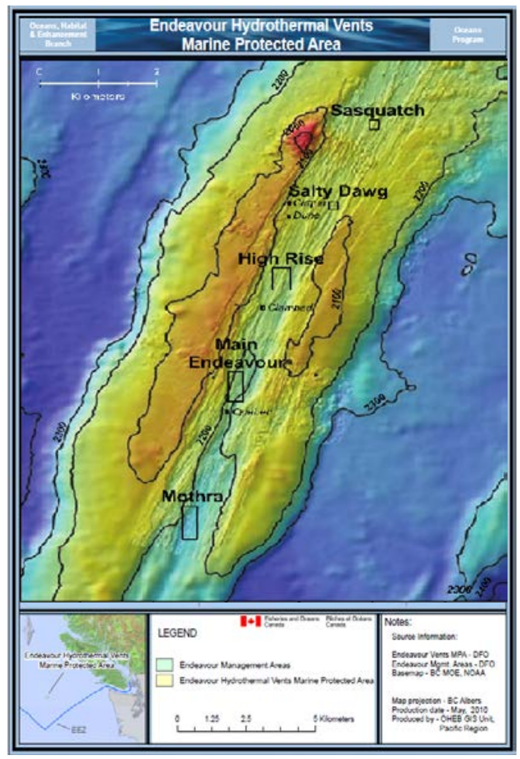


Figure 1. Bathymetric map of Endeavour Hydrothermal Vents Marine Protected Area.

Context

Canada's Oceans Act and Oceans Strategy commit Fisheries and Oceans Canada (DFO) to leading the development and implementation of a sustainable, precautionary and integrated ecosystem approach to oceans management. An Ecological Risk Assessment Framework (ERAF) was developed and reviewed at a Canadian Science Advisory Secretariat-Pacific (CSAP) Regional Peer Review (RPR) meeting in May 2012 (DFO 2012) and the results represent an important step toward meeting these commitments. This risk-based framework provides managers with a process and tools to inform the development of conservation objectives, management strategies, and action plans for the implementation of DFO's ecosystem-based integrated oceans management. A pilot application of the qualitative Level 1 risk assessment was completed in the Pacific North Coast Integrated Management Area (PNCIMA)

(DFO 2014). The present document describes two applications of the semi-quantitative Level 2 risk assessment in SGaan-Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas (MPAs). The results of both pilot applications are intended to further the development of the ERAF as a tool for identifying and assessing the risk of harm to significant ecological components (SECs) and to inform the development of indicators to monitor the impact of human activities on SECs and the achievement of conservation objectives.

This Science Advisory Report is from the February 11-13, 2014 and March 13, 2015 Application of an Ecological Risk Assessment Framework to Inform Ecosystem-based Management for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Two applications of the scoping phase and the semi-quantitative Level 2 ecological risk assessment framework (ERAF) methodology (DFO 2012) were reviewed at a Regional Peer Review meeting in 11-13 February 2014 and 13 March 2015. Cumulative risk to significant ecosystem components (SECs) and the potency of stressors across SECs were estimated in the Endeavour Hydrothermal Vents (EHV) and SGaan Kinghlas-Bowie Seamount (SKB) Marine Protected Areas (MPAs) and were used to develop ranked lists of SECs and identify the activities/stressors driving those risks.
- Both applications of the Level 2 ERAF applied five important modifications that were addressed in the review:
  1. uncertainty associated with each term in the risk equation was incorporated into the score as recommended by DFO (2014);
  2. a bin for zero or negligible scores in resilience terms of the consequence factor and a very low bin in the scoring of exposure terms in ERAF risk equation were added;
  3. the intensity term in exposure was divided into amount and frequency components, and exposure was calculated as the product of the geometric mean of area, depth and temporal overlaps and the geometric mean of intensity;
  4. POTENCY of stressors was estimated as the sum of risk from a stressor across all SECs with which it interacts; and
  5. scoring decisions were reviewed by subject matter experts (SMEs) prior to the estimation of risk scores.
- Eleven SECs were identified in the EHV MPA (six species SECs, four habitat SECs, and one community SEC) during the scoping phase. Sixteen SECs were identified in the SKB MPA, but only fourteen (ten species and four habitat SECs) underwent a Level 2 Risk Assessment. The selection of SECs for both risk assessments was confined to components that could be managed at the MPA scale, which excluded species groups such as zooplankton and transient species, such as marine mammals and sea birds.
- Pathways of effects (POE) models were developed and used to identify stressors associated with human activities at a scale specific to each stressor. For example, substrate disturbance was divided into both crushing and resuspended sediment stressors. The extensive justifications of the POE models, combined with the strength-of-evidence interaction matrices used in the EHV and SKB MPA applications, are considered a suitable approach for proceeding in absence of CSAS peer-review of the POE models.

- Stressors from human activities in each MPA were categorized into potential and current snapshot based on frequency of occurrence and knowledge of exposure. Current snapshot stressors are from activities occurring predictably at frequencies of less than one year (e.g., daily, monthly, every few weeks), and for which there is some knowledge of exposure, whereas potential stressors are from activities that are unpredictable, but have intervals greater than one year, and were scored assuming a worst-case scenario for exposure and consequence.
- Three species SECs (*Ridgeia piscesae* – high flux and *R. piscesae* – low flux) and *Paralvinella sulfincola,* as well as the benthic clam bed community SEC, had the highest cumulative risk scores in the EHV MPA, while the four habitat SECs that were assessed (diffuse basalt flows, inactive chimneys, active venting chimneys, hydrothermal plume) had the lowest cumulative risk scores. The stressors with the highest *POTENCY* scores were debris, substrate disturbance (crushing) during sampling, substrate disturbance (crushing) during submersible operations, and aquatic invasive species from submersible operations.
- The highest cumulative risk scores in the SKB MPA were estimated for the Bamboo Coral *Isidella*, Alcyonacea coral habitat, and sponge habitat SECs. Rougheye Rockfish had the highest cumulative risk score of all fish SECs, but there was considerable overlap among fish SECs. The stressors with the highest potency were oil spills, seismic testing and aquatic invasive species (AIS). Each of these stressors was categorized as potential stressors.
- The highest SEC risk scores in both MPAs are driven by high levels of uncertainty in the exposure and/or consequence terms of the risk equation. Whether this uncertainty is related to a lack of data or lack of knowledge of SEC exposure or consequences was not assessed.
- All potential stressors (oil spills, AIS, debris, sound generation from seismic testing) had among the highest potency scores in each MPA. These scores tend to be driven by high uncertainty, particularly for *Exposure* terms in the risk equation, because they are scored on a worst-case scenario basis. Better monitoring will assist with quantification of exposure of SECs and improved understanding of the risks associated with these stressors within each MPA area.
- The SEC lists and analysis of stressors and drivers of that risk are suitable to inform the development of risk-based indicators in EHV and SKB MPAs.
- The review of scoring decisions by SMEs is a quality assurance procedure whose primary impact was a reduction in the uncertainty associated with some of the scoring decisions. Using SMEs to review scoring decisions prior to estimating risk scores is recommended for future applications of the ERAF.
- The modifications to the ERAF described in the EHV and SKP MPA Level 2 risk assessment applications improved contrast among SECs based on estimated cumulative risk scores and provide additional information on stressors (potential and current snapshot) and the drivers of risk to SECs. These operational modifications are recommended for future applications of the ERAF.
- Scoring the risk to ecosystem/community property SECs was challenging because the recovery factors described in DFO (2012) are relative and require baseline data, which is limited in both MPAs. Future Level 2 applications of the ERAF will benefit from baseline data collection through ongoing monitoring in each MPA.

- The ERAF is an iterative process that can be updated as new information becomes available through monitoring or research or as a result of new activity proposals. It is recommended that work be conducted to identify triggers for updates to the ERAF assessments of an area.
- It is recommended that additional considerations be added to the SEC selection process into order to overcome the challenge of capturing the extreme species endemism in the EHV MPA.
- It is recommended that SEC exposure to potential stressors (noise from vessels, sound generation from air guns used for seismic testing), and fishing be quantified at each MPA, so that the risks from each of these stressors can be better understood.

INTRODUCTION

Canada's Oceans Act and Oceans Strategy commit Fisheries and Oceans Canada (DFO) to the development and implementation of a sustainable, precautionary and integrated ecosystem approach to oceans management. The development of a risk-based framework to identify and prioritize management issues for Large Ocean Management Areas (LOMAs) and Marine Protected Areas (MPAs) represents an important step toward meeting these commitments.

An Ecological Risk Assessment Framework (ERAF) was developed by a team of DFO Oceans and Science staff in Pacific Region (O et al. 2015) and reviewed at a Canadian Science Advisory Secretariat-Pacific (CSAP) Regional Peer Review (RPR) meeting in May 2012 (DFO 2012). The ERAF is a framework for assessing single and cumulative risks to significant ecosystem components (SECs), and for ranking the significance of activities and stressors based on the relative risks to SECs. The aim of developing this risk-based framework is to provide managers with a process and tools to inform the development of conservation objectives, the selection of risk-based monitoring indicators, management strategies, and action plans for the implementation of DFO's ecosystem-based integrated oceans management in large ocean management areas (LOMAs) such as the Pacific North Coast Integrated Management Area (PNCIMA) and Pacific Region Marine Protected Areas (MPAs).

The May 2012 RPR meeting reviewed the ERAF methodology (O et al. 2015) and recommended pilot projects to operationally test and review the performance of the ERAF (DFO 2012). The qualitative Level 1 risk assessment methodology was applied to a subset of SECs and stressors in the PNCIMA and was found to perform well in that it can distinguish SECs with high and low relative risk profiles, and it provides considerable information on the drivers of risk (DFO 2014). The present report summarizes discussion and guidance from DFO Pacific Region Science on key modifications to the ERAF prototype methodology that were made for two applications of semi-quantitative Level 2 risk assessment in the Endeavour Hydrothermal Vents (EHV) and SGaan Kinghlas-Bowie Seamount (SKB) Marine Protected Areas (MPAs) and the performance of the ERAF with respect to ranking SECs with respect to cumulative risk and the drivers (activities and stressors, uncertainty) of risk in these areas. The results of these applications are intended to further the development of the ERAF as a tool for identifying and assessing the relative risk of harm to SECs from human activities and their associated stressors and to inform the development of risk-based monitoring indicators in both the EHV and SKB MPAs.

ANALYSIS

Methods

The ERAF has two phases: Scoping and Risk Assessment. Scoping and the Level 2 Risk Assessment were completed for the current test applications in EHV and SKB MPAs. The methods described by O et al. (2015) along with modifications to the scoping phase recommended by DFO (2014) based on the PNCIMA pilot test were used in the EHV and SKB MPA applications of the ERAF. Operational modifications for a Level 2 risk assessment are described here.

The selection of SECs for both risk assessments was confined to components that could be managed at the MPA scale, which excluded transient species such as marine mammals and sea birds, as potential SECs. It should be noted that this selection approach, while potentially justifiable at the MPA level, may have important consequences on the outputs from an ERAF application. For this exercise, the selection rational has been documented to ensure transparency and repeatability in SEC selection.

Oceans Management provided a list of anthropogenic activities known to be legally occurring in or around the EHV and SKB MPAs and manageable at the MPA scale, including vessel traffic, seismic surveys, fishing, and scientific research. POE models of each activity/sub-activity were developed and used to identify associated stressors with the potential to interact with the SECs. While the POE models were reviewed and accepted by a small group of experts, they have not been subjected to a CSAS peer review at present. Activities were categorized as 'current snap-shot' activities and 'potential' activities for the risk assessments. A current snapshot represents activities that are known to occur annually at the EHV and SKB MPAs and for which data are available for scoring the terms of the risk equation. Potential activities include those that occur infrequently and/or unpredictably at intervals greater than one year and include oil spills, discharge, and seismic testing/air guns and are scored on a worst-case scenario for the risk calculation.

Risk to SECs was estimated using the uncertainty incorporation method recommended by DFO (2014). The grid used to score the terms of exposure and consequence was modified with the inclusion of a category for low or negligible. Once the scoring of SEC-stressor interactions, including uncertainty scoring, was completed, subject matter experts (SMEs) reviewed these decisions and provided feedback in a workshop-style session where suggested changes and/or discrepancies were discussed and resolved to develop consensus-based scores. These scores for each variable in the risk equation were assigned as the mean of the normal distribution and the level of uncertainty was used to define the standard deviation of that distribution. The normal distribution was bounded by the minimum and maximum possible scores for each variable and the score of each variable was randomly sampled 10,000 times from this distribution to compile a distribution of scores. The final score for each SEC-stressor relationship was the product of the Exposures and Consequences variable arrays, where the first score generated from each variable array is multiplied across all risk variables, followed by the second, and for all 10,000 replicates, resulting in a final risk array of 10,000 scores. Estimated risk is reported as the median value and the 10th and 90th percentiles of 10,000 bootstrapped replicates of each scoring decision.

Cumulative risk from multiple stressors is estimated by summing the median risk values for each SEC across all stressors. In addition, the Potency of each stressor was calculated by summing the risk scores of that stressor across all SECs for which there are interactions. Potency is a measure of the extent of the risk imparted by a stressor across SECs and is especially useful when interpreting risks related to potential and current snapshot stressors. However, improved delineation of current (snapshot) and potential human activities might be required to properly assess the impacts of stressors since legal and known activities as used in the EHV and SKB applications might not fully represent the overall risk to an MPA from human activities.

Results

Identification of Activity/Stressors and SECs

Eleven SECs were identified in the EHV MPA (Table 1) and were evaluated for negative interactions, with 20 stressors associated with vessels, research, and seismic surveys. The hydrothermal plume (a habitat SEC) did not have any direct negative interaction with any stressors and was removed from the risk analysis. Stressors related to fishing in EHV MPA were not evaluated because commercial fishing is rare in the MPA. When fishing for Albacore Tuna and other pelagic species takes place, it occurs in surface waters and is not believed to significantly affect the benthic ecosystem more than 2,000 m below the surface.

Sixteen SECs were identified in the SKB MPA (Table 1), but only fourteen (ten species SECs and four habitat SECs) underwent a Level 2 Risk Assessment. Two community property SECs were initially identified, but the available baseline information was not sufficient to support the application of a Level 2 assessment to these SECs. Thirty-two stressors associated with vessels, research, seismic surveys and fishing were evaluated for negative impacts on SECs in the SKB MPA.

Table 1. Species, habitat, and community SECs identified in the EHV and SKB MPAs using the selection criteria described by O et al. (2015) and expert advice during the Scoping Phase of the ERAF application.

SEC Type	Endeavour Hydrothermal Vents	SGaan Kinghlas-Bowie Seamount
Species	*Ridgeia piscesae* (high flux -Tubeworm)	*Zaprora silenus* (Prowfish)
	Ridgeia piscesae (low flux - Tubeworm)	*Anoplopoma fimbria* (Sablefish)
	Lepetodrilus fucensis (Limpet)	*Hippoglossus stenolepis* (Pacific Halibut)
	Macroregonia macrochira (Spider crab)	*Sebastes paucispinis* (Bocaccio Rockfish)
	Paralvinella palmiformis (Palm worm)	Sebastes ruberrimus (Yelloweye Rockfish)
	Paralvinella sulfincola (Sulfide worm)	*S. aleutianus/S. melanostictus* (Rougheye/Blackspotted Rockfish complex)
		Sebastes entomelas (Widow Rockfish)
		Munida quadrispina (Squat Lobster)
		Isidella (Bamboo Coral)
		Primnoa (Coral)

SEC Type	Endeavour Hydrothermal Vents	SGaan Kinghlas-Bowie Seamount
Habitat	Active venting hydrothermal mineral chimneys	Sponges (Demosponges)
	Inactive hydrothermal chimneys	Deep water Alcyonacean Corals
	Hydrothermal plume	Macroalgae
	Diffuse venting basalt flows	Coralline Algae
Community	Benthic clam bed community	Benthic Invertebrate Assemblage
		Rockfish Species Assemblage

The high level of species endemism and sensitive species/habitats within EHV MPA, and the lack of baseline information and understanding of oceanographic processes at SKB MPA, were challenges when using the selection criteria described by O et al. (2015) to identify species, habitat, and community SECs. Although zooplankton and microbial communities fulfilled several of the selection criteria, they were not selected as a SEC for either MPA because their diversity, density, and distribution are independent of anthropogenic activities that occur within the MPA boundaries and, therefore, they are not manageable at the MPA scale.

Criteria that were particularly relevant for habitat SEC selection in both MPAs included support of biogenic habitat types, sensitive habitats, and habitats providing critical ecosystem functions or services. Abiotic and biogenic habitat types were identified and then further subdivided into habitats. From these habitats, four abiotic habitats were selected in both the EHV and SKB MPAs because they support the highest number of biogenic habitat creating species, endemic and/or rare invertebrates, and formed the structural basis of the MPA communities. These habitat SECs also encompass the habitats of zooplankton and microbial species and, therefore, should capture the risk of harm to both the habitat and those organisms living within them. The importance of the physical habitat in both MPAs was noted, but not included in the risk assessment because the methodology is designed to assess risk to living organisms and habitats that are able to regenerate on ecological timescales rather than geological timescales.

Communities within the each MPA exhibit a high degree of interconnectivity, making it difficult to isolate one community from another in the present applications of the Level 2 risk assessment. The approach used to identify community SECs consisted of categorizing functional trophic groups (primary producers, consumers, etc.) and then the relevant community groups. Only one community SEC (benthic clam bed) was selected in EHV MPA and two community SECs (benthic invertebrate and Rockfish assemblages) were identified in SKB MPA. The benthic clam bed community in EHV MPA is unique, ecologically significant, and sensitive to disturbances, but also located within an extremely limited, relatively small area. The benthic invertebrate assemblage and Rockfish assemblage are key nutrient cyclers and important linkages between benthic and pelagic systems, respectively, in the SKB MPA.

Level 2 Risk Assessment

Endeavour Hydrothermal Vents MPA

Twelve stressors impacted species and community SECs in EHV MPA (Figure 2), with the exception of *Macroregonia macochira* (spider crab), which was impacted by nine stressors. Four stressors impacted the habitat SECs. Overall, cumulative risk scores estimated for species and community SECs were higher than cumulative risk scores estimated for habitat SECs. The highest cumulative risk scores were estimated for both of the tubeworm *Ridgeia pisescae* phenotypes (Figure 2). The Sulfur worm *Paralvinella sulfincola* and benthic clam bed community SECs had similar cumulative risk scores, while the Spider crab *Macroregonia macrochira* had the lowest score of the species SECs, coinciding with the lowest number of impacting stressors (9). The estimated cumulative risk to Habitat SECs were lower than risk estimated for other SECs because consequence scores were low and the number of stressors impacting habitat SECs was lower (four stressors) than the number of stressors impacting other SEC types (9-12). Inactive hydrothermal chimneys had the highest estimated cumulative risk of the habitat SECs, and diffuse venting basalt flows had the lowest estimated cumulative risk (Figure 2).

The number of SECs contributing to Potency scores (cumulative risk by stressor estimated by adding the risk for each stressor across SECs) ranged from six to ten (Figure 3). *Debris* had the highest Potency score and *Substrate disturbance (crushing)* from *sampling* and *submersible operations* had the second and third highest Potency scores, respectively. Debris, oil spills and aquatic invasive species (AIS) were scored as potential stressors on a worst-case scenario basis. While the top three stressors have 10 SECs contributing to their Potency score, the number of SECs did not necessarily translate to the highest Potency score. For example, *substrate disturbance (crushing)* from equipment installation also has 10 SECs contributing to the Potency score, but is ranked seventh. *Substrate disturbance (sediment resuspension)* from *sampling, submersible operations*, and *equipment installation* have the lowest Potency scores (six SECs each), along with *sound generation* from seismic testing/air guns (Figure 3).

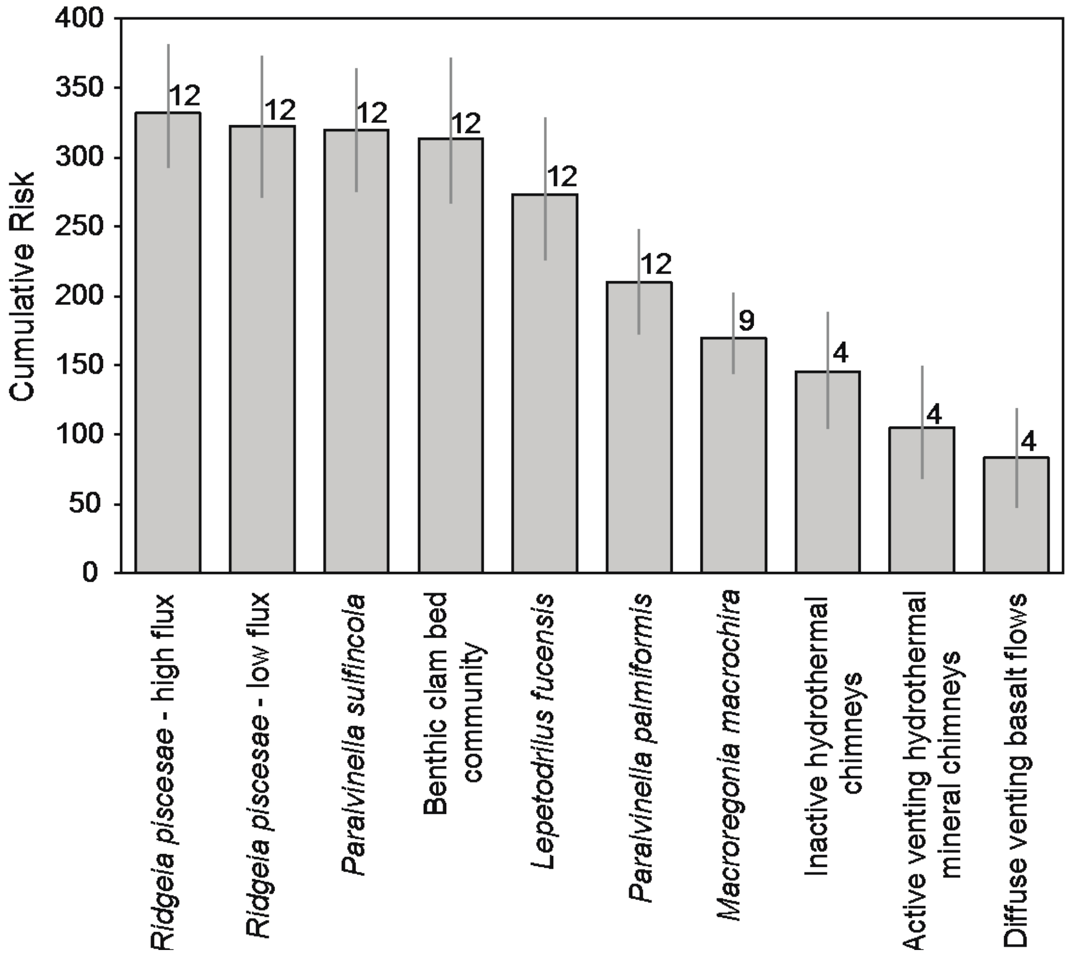


Figure 2. Estimated cumulative risk scores for SECs in the Endeavour Hydrothermal Vents Marine Protected Area. Error bars are the 10th and 90th percentiles of the resampled risk scores for each SEC based on 10,000 replicates. Numbers above each bar are the number of stressors interacting with the SEC.

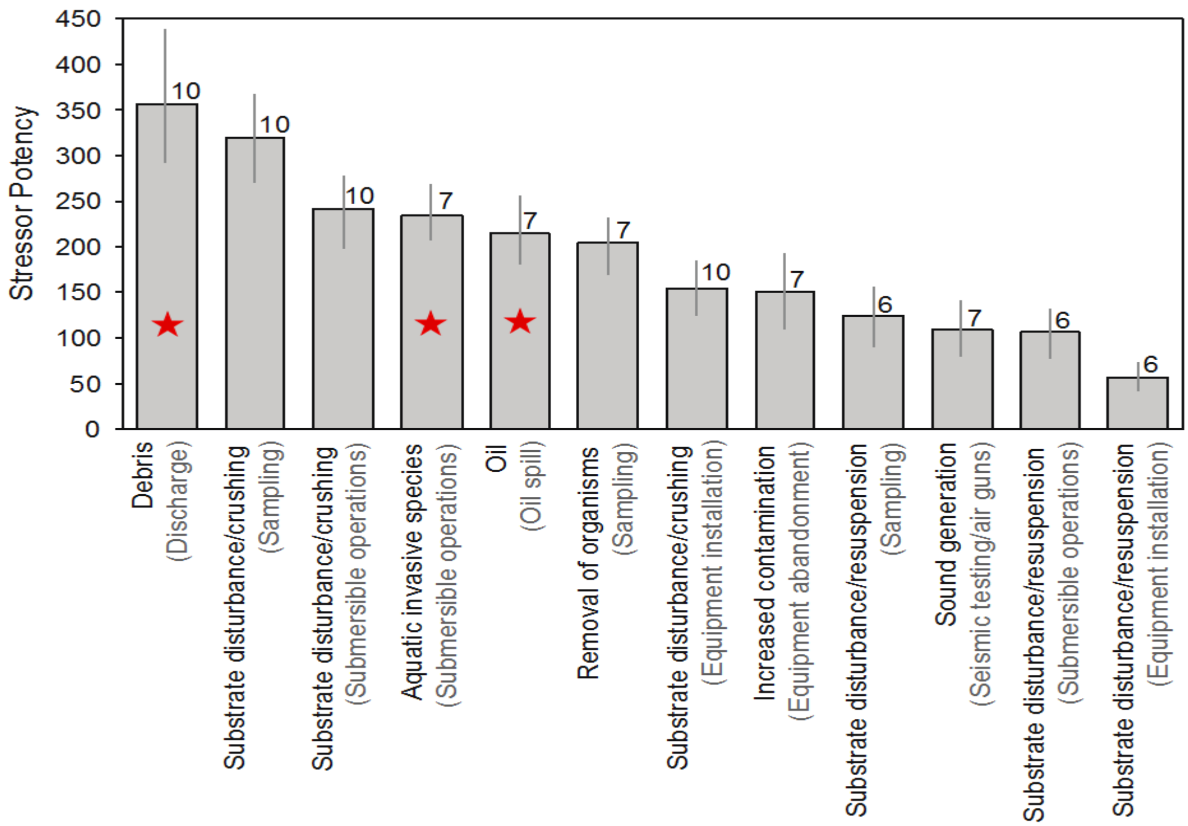


Figure 3. Cumulative risk by stressor (Potency) of stressors in EHV MPA in descending order of potency from left to right. The whiskers on each column are 10th and 90th percentiles of 10,000 replicate samples. Numbers above each bar are the number of SECs contributing to the score. Stressors marked with a red star (★) were scored as potential stressors. All other stressors are current-snapshot stressors.

SGaan Kinghlas-Bowie Seamount MPA

Three sessile invertebrate SECs had the highest cumulative risk scores in the SKB MPA (Figure 4), with the Bamboo Coral *Isidella* having the highest score followed by two biogenic habitat SECs, Corals and Sponges. *Isidella* is exposed to five fewer stressors than the coral and sponge habitat SECs (15 versus 20), mainly because its depth distribution protects it from stressors that occur near the surface or pinnacle of the seamount (Grounding and Discharge stressors) but it still has a higher cumulative risk score because of its sensitivity to stressors. The inclusion of *Isidella* (found generally below 700m in Zone 2 where fishing is permitted), *Primnoa* (found generally in protected Zone 1) and corals as a habitat SEC (depth range encompasses both Zone 1 and 2) provides some contrast in cumulative risk between corals predominantly found where fishing occurs and where fishing is prohibited. The cumulative risk to the coral habitat SEC is driven by exposure to stressors at shallower depths (Grounding) and deeper depths (Trap fishing). Coralline algae has a higher cumulative risk score than Macroalgae despite both groups being present only in Zone 1 of the MPA. This difference is attributed to the higher number of stressors for Coralline algae (18 versus 13) because its encrusting structure enhances sensitivity to activities that cause sediment resuspension.

Rougheye Rockfish had the highest cumulative risk score of the fish and has the fourth highest cumulative risk score of all SECs (Figure 4). Fish SECs that are not reported as bycatch in the Sablefish trap fishery (Yelloweye, Bocaccio, Widow and Prowfish) have lower cumulative risk scores than fish that are removed from the system via fishing (Rougheye, Sablefish, and Halibut). However, for all fish SECs the 10th and 90th percentiles overlap, which is interpreted to mean that fish SECs experience comparable cumulative risk levels. Squat lobsters had the lowest cumulative risk score, well below the other SECs and was impacted by the lowest number of stressors (9) of all SECs. The mobility of Squat Lobster may allow it to behaviourally respond and circumvent benthic impacts that are unavoidable to sessile invertebrates and it tends to recover faster than slow recovering sessile species.

The number of SECs contributing to Potency scores (cumulative risk by stressor across all SECs) ranged between 1 and 14 (Figure 5). Oil Spills, sound generation from seismic testing, and AIS had the highest Potency score of all stressors included in the risk assessment and all were scored as potential rather than current snapshot stressors. Seismic Surveys had the second highest Potency score, driven by its high risk ranking for all fish SECs. However, the high risk associated with this stressor is associated with high uncertainty surrounding the impacts of high-pressure sound on fish populations. The next highest Potency values were well below the top three, and were those associated with debris, contaminants, and substrate disturbance.

Removal of biological material (consisting of the target SEC, Sablefish, and non-target SECs including Rougheye Rockfish, *Isidella*, and Corals) through the Sablefish trap fishery had a Potency score higher than 20 stressors, despite impacting only 6 of 14 SECs at SKB MPA (Figure 5).Other fishing related stressors also had high Potency values relative to the number of SECs they impact (e.g., Substrate disturbance-crushing [trap fishing] only impacts three SECs). With the exception of AIS [submersible operations], stressors associated with research activities (Submersible Operations, Sampling, Equipment installation and Scuba) had relatively low Potency stressors. Stressors that had moderate Potency values included nutrients from discharges, and noise disturbance from vessel traffic.

Sources of Uncertainty

Cumulative risk to a SEC from multiple stressors is estimated based on the assumption that adding risk from each stressor individually is a reasonable first approximation. However, interactions among multiple stressors could also produce synergistic, compensatory or masking effects. These non-additive cumulative risk models were not addressed since knowledge of these different interactions is limited.

The risk estimated in these Level 2 applications of the ERAF represents direct risks to SECs. Capturing indirect risks associated with ecological interactions is challenging, particularly in the SKB MPA.

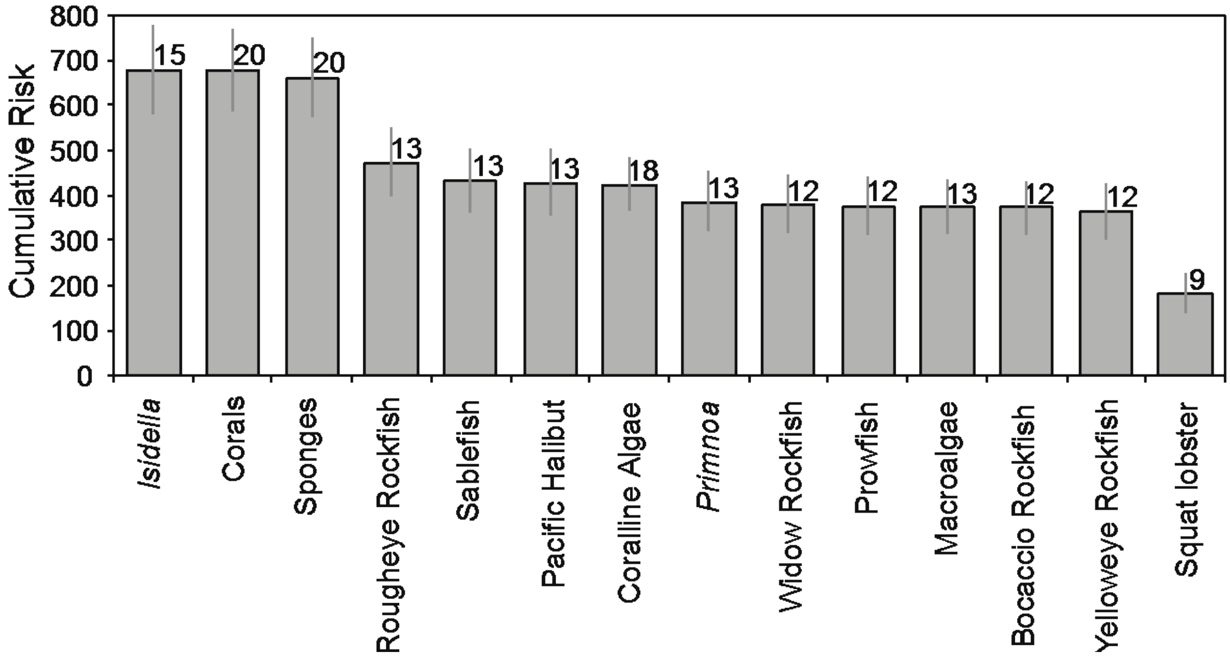


Figure 4. Estimated cumulative risk scores for SECs in the SGaan Kinghlas-Bowie Seamount Marine Protected Area. Error bars are the 10th and 90th percentiles of the resampled risk scores for each SEC based on 10,000 replicates. Numbers above each bar are the number of stressors interacting with the SEC.

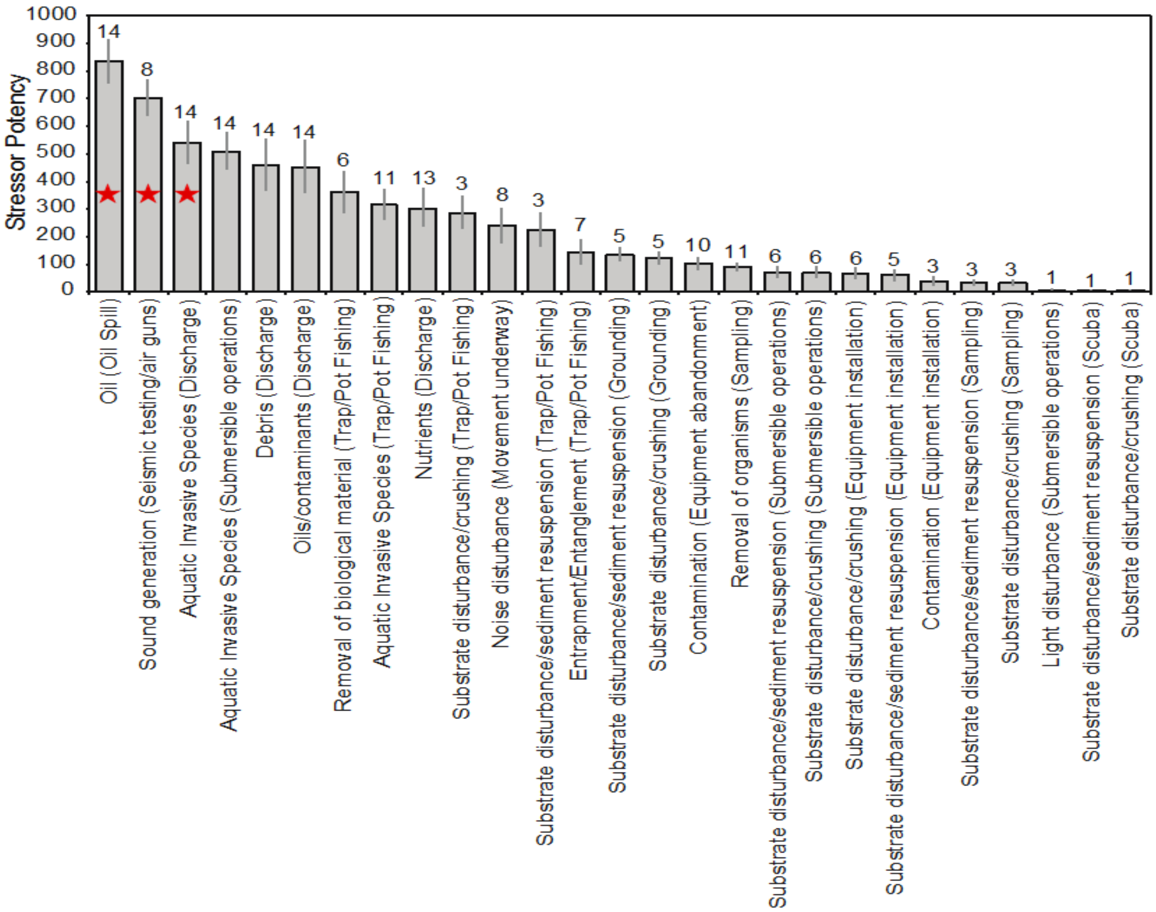


Figure 5. Cumulative risk (Potency) of stressors in SKB MPA in descending order of potency from left to right. The whiskers on each column are 10th and 90th percentiles of 10,000 replicate samples. Numbers above each bar are the number of SECs contributing to the score. Stressors marked with a red star (★) were scored as potential stressors. All other stressors are current-snapshot stressors.

CONCLUSIONS AND ADVICE

The selection of SECs for both risk assessments was confined to components that could be managed at the MPA scale, which excluded transient species such as marine mammals and sea birds, as potential SECs. It should be noted that this selection approach, while potentially justifiable at the MPA level, may have important consequences on the outputs from an ERAF application.

The modifications to the ERAF described in the EHV and SKP MPA Level 2 risk assessment applications improved contrast among SECs, based on estimated cumulative risk scores and provide additional information on stressors (potential and current snapshot) and the drivers of risk to SECs. These operational modifications, along with the direction that SEC selection process be well documented, are recommended for future applications of the ERAF.

The SEC lists and analysis of stressors, and drivers of that risk, are suitable to inform the development of risk-based indicators in EHV and SKB MPAs.

The highest SEC risk scores in both MPAs are driven by high levels of uncertainty in the exposure and/or consequence terms of the risk equation.

The extensive justifications of the POE models, combined with the strength-of-evidence interaction matrices used in the EHV and SKB MPA applications, are considered a suitable approach for proceeding in absence of CSAS peer-review of the POE models.

Recommendations

Using SMEs to review scoring decisions prior to estimating risk scores is recommended for future applications of the ERAF.

The other major structural changes implemented in the EHV and SKB applications of the ERAF (changes to the scoring grids, the splitting of the intensity term, use of the geometric means to calculate exposure) combined with fine-scale identification of stressors during the scoping phase improved contrast among SECs based on estimated cumulative risk scores. These operational modifications also are recommended for future applications of the ERAF.

It is recommended that additional considerations be added to the SEC selection process into order to overcome the challenge of capturing the extreme species endemism in the EHV MPA.

It is recommended that SEC exposure to potential stressors (noise from vessels, sound generation from air guns used for seismic testing), and fishing be quantified at each MPA so that the risks from each of these stressors can be better understood.

The ERAF is an iterative process that can be updated as new information becomes available through monitoring or research or as a result of new activity proposals. It is recommended that work be conducted to identify triggers for updates to the ERAF assessments of an area.

OTHER CONSIDERATIONS

These applications of the Level 2 ERAF are a science process focusing on ecological SECs and are part of a broader iterative process in DFO's ecosystem-based integrated Oceans management. This broader process will bring together science-based SECs along with social and economic dimensions to derive objectives, strategies and actions for the EHV and SKB MPAs.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 11-13, 2014 and March 13, 2015 Application of an Ecological Risk Assessment Framework to Inform Ecosystem-based Management for SGaan Kinghlas-Bowie Seamount and Endeavour Hydrothermal Vents Marine Protected Areas. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2012. Risk-based Assessment Framework to Identify Priorities for Ecosystem-based Oceans Management in the Pacific Region. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/044. (Accessed May 6, 2015)

DFO. 2014. 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. (Accessed May 6, 2015)

O, M., Martone, R., Hannah, L., Greig, L., Boutillier, J. and Patton, S. 2015. An ecological risk assessment framework (ERAF) for ecosystem-based oceans management in the Pacific Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/072. vii + 59 p. (Accessed May 6, 2015)

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MPO. 2015. Application d'un cadre d'analyse du risque écologique visant à guider la gestion écosystémique des zones de protection marine du mont sous-marin Bowie (SGaan Kinghlas) et du champ hydrothermal Endeavour. Secr. can. de consult. sci. du MPO, Avis sci. 2015/037.