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Science | Sciences
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/044

RISK-BASED ASSESSMENT FRAMEWORK TO IDENTIFY PRIORITIES FOR ECOSYSTEM-BASED OCEANS MANAGEMENT IN THE PACIFIC REGION

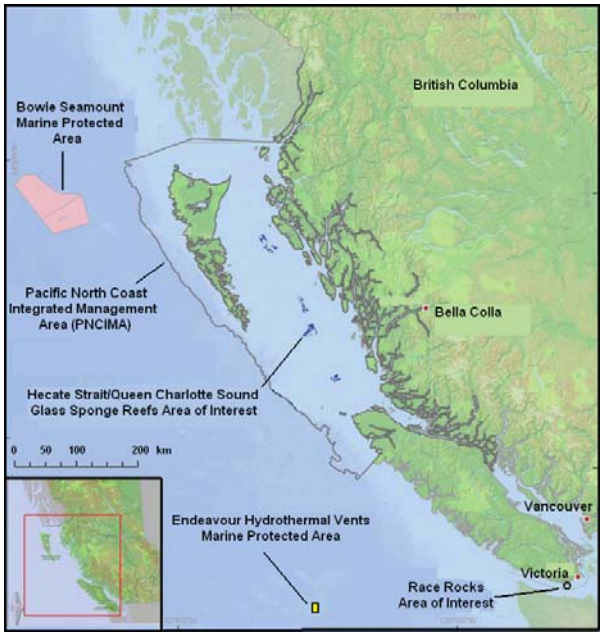

Figure 1: DFO Pacific Region Marine Protected Areas (MPA), Areas of Interest (AOI), and the Pacific North Coast Integrated Management Area (PNCIMA). Map from DFO (2010) available at: http://www.pac.dfo-mpo.gc.ca/oceans/docs/oceanspamphlet-brochure-eng.pdf

Context :

DFO has committed to a sustainable, precautionary and integrated ecosystem approach to oceans management through Canada's Oceans Act and Oceans Strategy. The development of science-based conservation objectives represents an important step toward meeting these commitments because they provide the foundation for the conservation and protection of important characteristics and components of ecosystems. However, to date a systematic, science-based, and defensible approach for arriving at measurable conservation objectives has not been available in the Pacific Region.

Ecosystems Management Branch Oceans staff requested science advice in reviewing an ecological risk assessment framework to ensure that the approach and component frameworks are sound. This framework is intended to be a tool to support Oceans managers in developing specific, measurable, achievable, realistic and time-sensitive (SMART) conservation objectives for Pacific Region marine protected areas (MPAs) and to support ecosystem-based integrated oceans management in the Pacific North Coast Integrated Management Area (PNCIMA).

The framework described in this review does not address non-biological (e.g., social or economic) objectives, strategies or actions. These components will be considered and evaluated as part of DFO's development of an ecosystem-based oceans management framework for the PNCIMA plan and subsequent implementation in Pacific Region.

This Science Advisory Report is from the May 8-10, 2012 Regional Peer Review meeting reviewing: An Ecological Risk Assessment Framework (ERAF) for Ecosystem-based Oceans Management. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canadian Science Advisory Secretariat website at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

SUMMARY

- The ecological risk assessment framework (ERAF) reviewed in this process supports the identification of risks and threats to valued ecosystem components (VECs) as a guide for the development of objectives, strategies and actions and it is a necessary component for the implementation of DFO's ecosystem-based integrated oceans management in the Pacific North Coast Integrated Management Area (PNCIMA) and Pacific Region Marine Protected Areas (MPAs).
- The ERAF builds upon methodology from existing ecological risk assessment frameworks, but it is specifically tailored for the goals and purposes of ecosystem-based management in Pacific Region. The ERAF improves on existing risk assessment frameworks by taking an ecosystem-based approach rather than considering individual issues in isolation, and can communicate a broader view of anthropogenic impacts and risks singly or cumulatively to VECs.
- The ERAF is endorsed as suitable for identifying, and assessing the relative risk of harm to VECs from human activities and their associated stressors, and for ranking the significance of activities and stressors based on the relative risks to VECs in support of ecosystem-based integrated oceans management in the PNCIMA and Pacific Region MPAs.
- The ERAF focuses on VECs of ecological significance (not social or economic) and uses pathways of effects (POE) models to identify mechanistic linkages between human activities and stressors impacting VECs. The development of a library of activity-based POE models to facilitate future applications of the ERAF is recommended. A modular risk assessment methodology is applied to determine single and cumulative risk of harm to VECs, and ultimately, rank stressors/VECs based on single and cumulative risks. It also assesses the relative risk to ecosystem properties and provides methods for explicitly capturing and reporting uncertainties in data quality.
- Use of the ERAF is expected to facilitate the communication of the relative risk of ecological consequences of anthropogenic stressors on VECs, ranking of those risks, and discussion of acceptable levels of risk to VECs.
- The ERAF does not identify the most appropriate management responses to risk(s) or the societal costs and benefits associated with managing ecosystem risks nor does it provide a probabilistic assessment of absolute risk at the first two risk assessment levels.
- The ERAF explicitly considers uncertainty in communicating risk scores at different stages, since clear documentation of uncertainty informs interpretation of these scores and may inform management strategies and actions.
- It is recommended that outputs from the initial application of the ERAF to PNCIMA or MPAs in Pacific Region be reviewed by a future CSAP process to assess the performance of the framework with respect to transparency, consistency, compatibility, and repeatability.
- It is expected that knowledge gaps and data uncertainty will be a challenge when the ERAF is initially applied in terms of both structural components (e.g., scoring metrics, cumulative risks, assumptions related to the nature of biological effects, the recovery time of ecosystem components) and biological data inputs (e.g., lack of spatial/temporal data for some species, habitats, communities). Modifications to the ERAF will be needed to address these challenges, but these modifications cannot be precisely specified in the absence of experience in applying the framework.
- Development of the ERAF was guided by best practices and recommendations from risk assessment processes in other countries and risk frameworks developed within DFO for

other purposes. This Pacific Region ERAF may be useful in informing a future national process as DFO implements ecosystem-based management.

INTRODUCTION

Rationale for Assessment

The establishment of the Pacific North Coast Integrated Management Area (PNCIMA) and Pacific Region Marine Protected Areas (MPAs) presents a broad range of ecosystem-based challenges and opportunities for oceans management. A key step in meeting these challenges and opportunities is the development of a risk-based assessment framework founded on sound science that (i) identifies and prioritizes ecosystem issues within MPAs and Large Ocean Management Areas (LOMAs), and (ii) informs the development of specific conservation objectives and management strategies to address these risks.

A risk-based approach was recommended to identify indicators in order to monitor the achievement of Pacific Region MPA conservation objectives (DFO 2011). This approach was further developed and its scope was extended to incorporate PNCIMA, creating a structured framework to assess the potential risk(s) to valued ecosystem components (VECs) from human activities (and their associated stressors) in this larger management area. The outputs from this ecological risk assessment framework (ERAF) are intended to provide managers with science advice on the ecological risk(s) of anthropogenic stressors to VECs, together with the processes and tools that can be used in the development of conservation objectives and management measures in MPA initiatives and PNCIMA in Pacific Region.

DFO Science was asked to provide advice on the suitability of this risk-based framework for identifying and ranking activities and associated stressors that have the potential to affect valued ecosystem components (VECs) in Pacific Region MPAs and PNCIMA. Specific issues considered in addressing the suitability of the framework include:

- Methodology used to categorize and identify Valued Ecosystem Components (VECs);
- Pathways of effects (POE) models to elucidate the potential effects of activities and associated stressors to VECs;
- Risk assessment methodology used to determine relative risk of harm to VECs and rank activities/stressors based on these risks;
- Assessment of uncertainty at different stages in the risk assessment;
- Flexibility of the risk-based assessment framework to allow for application at different management scales (e.g. Environmental Impact Assessments, Habitat) if appropriate;
- Adaptability of the risk-based framework to allow integration of additional information as it becomes available; and
- Recommendations on the completeness and appropriateness of the framework for identifying VECs, threats to VECs, risk of harm to VECs and a ranking of threats based on relative risk of harm that are appropriate for the development of conservation objectives for Pacific Region MPA initiatives and management strategies for PNCIMA.

Background

The PNCIMA extends from Canada's northern border with Alaska south to Bute Inlet on the mainland, across to Campbell River on the east side of Vancouver Island and the Brooks Peninsula on the west side of Vancouver Island (Figure 1). Its western boundary is offshore at the base of the continental shelf slope. PNCIMA boundaries were determined based on oceanographic processes, watershed boundaries that influence the marine area, and the northern political boundary with the USA.

The PNCIMA area is unique due to its diverse ocean ecosystems, which provide habitat for many species and marine resources that contribute to coastal societies, economies, and communities. A variety of year-round and seasonal activities occur in the offshore and coastal areas. A much broader range of activities occur in nearshore areas, including traditional fishing and food gathering, aquaculture, ecotourism, utility and communications lines, ports, ferry landings, and community harbours. The PNCIMA initiative's purpose is to ensure a healthy, safe and prosperous ocean area by engaging all interested parties in the collaborative development and implementation of an integrated management plan for PNCIMA.

Marine protected areas (MPAs) are geographically defined areas in the marine environment dedicated and managed for the long-term conservation of nature. Fisheries and Oceans Canada (DFO) designates MPAs under Canada's Oceans Act in order to protect and conserve:

- Commercial and non-commercial fishery resources, including marine mammals, and their habitats;
- Endangered or threatened marine species, and their habitats;
- Marine areas of high biodiversity or biological productivity;
- Unique habitats; and
- Any other marine resource or habitat as is necessary to fulfill the Minister's mandate (of Scientific Research) (DFO)

Four MPA initiatives have been identified by DFO in Pacific Region (Figure 1) to date: Bowie Seamount, Endeavour Hydrothermal Vents, Race Rocks in Juan de Fuca Strait, and the Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs. These MPAs range in size from 2.7 km^2 (Race Rocks) to approximately 15,000 km^2 (Bowie Seamount), but they are relatively small compared to the larger scale of PNCIMA (~102,000 km^2).

Science-based conservation objectives have not been developed yet for PNCIMA, but some guidance on the subject is provided by the draft Ecosystem-Based Management (EBM) goals and provisional objectives. These goals and objectives focus on conserving and protecting ecosystem properties such as biodiversity, productivity, physical environmental quality, and minimizing cumulative impacts affecting ecosystem components. In contrast, each MPA has a single overarching Conservation Objective (CO) outlining the key components that require protection in that particular MPA. These COs focus on properties that are considered significant in each system, including biodiversity, productivity and ecosystem function.

A systematic, scientifically defensible risk-based assessment process to identify ecosystem priorities is a key step in support of the transition from high-level aspirational principles and goals to more tangible and specific conservation objectives, strategies and actions that could be implemented in PNCIMA and MPA initiatives in Pacific Region.

The risk-based framework reviewed by Science is intended to evaluate ecological components rather than socio-economic and cultural issues. The framework is one tool in a broader toolbox for the evaluation of priorities and development of management objectives in PNCIMA and

Pacific Region MPAs. Outputs from the ERAF will be integrated in decision-making along with stakeholder input, outputs from other decision support tools, legislative and regulatory responsibilities and policy priorities into final management direction for these areas. The flow chart below provides an outline of where the ERAF fits into a broader adaptive management (AM) framework in Pacific Region (Figure 2), although this general framework may be modified depending on management needs. VECs are identified/defined during the ecosystem assessment and characterization step (Step 1) in the AM framework (Figure 2) and these VECs may be used in the ERAF, providing a strong linkage between the AM framework and the ERAF. Therefore, identification/definition of appropriate VECs at Step 1 in the AM framework is important because using these VECs may have operational implications for the treatment of some VECs and activities/stressors within the ERAF.

Stakeholder engagement and input are critical throughout the adaptive management cycle, and stakeholders are expected to be involved in several aspects of the risk assessment process as shown in Figure 2.

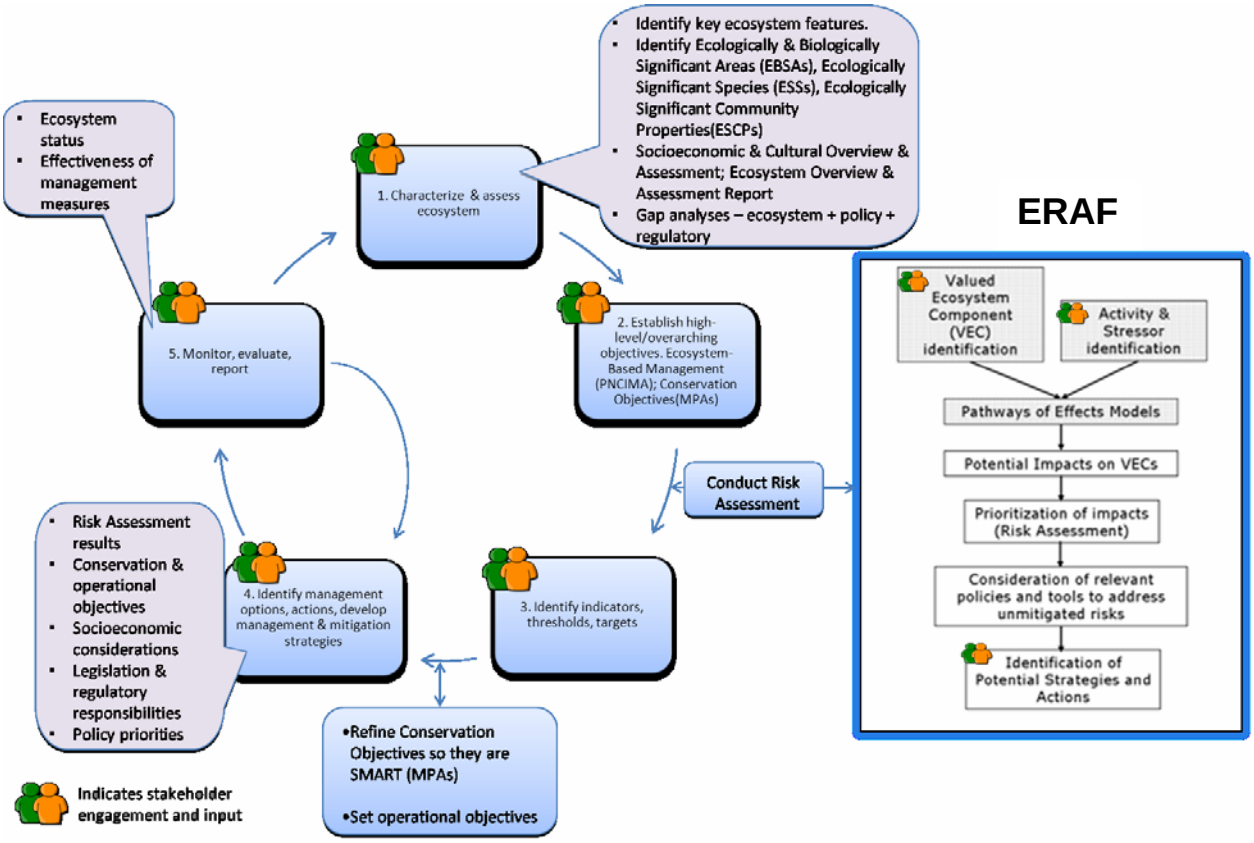

Figure 2. Overview of DFO Oceans – Pacific Region adaptive management (AM) framework and the relationship of the ERAF to this framework.

ASSESSMENT

The ERAF was developed to estimate the potential risk to VECs from human activities and their associated stressors and it has two key phases:

1. Scoping:
    - identification of the key features or properties of the system (VECs), including species, habitats and community/ecosystem properties;
    - identification of the activities and stressors that have the potential to affect these VECs using pathways of effects models (POEs); and,
2. Risk assessment:
    - assessing the risks of harm to each VEC from each activity and associated stressors using appropriate criteria and scoring methodology.

An overview of the methodology used in the proposed ERAF is outlined in Figure 3.

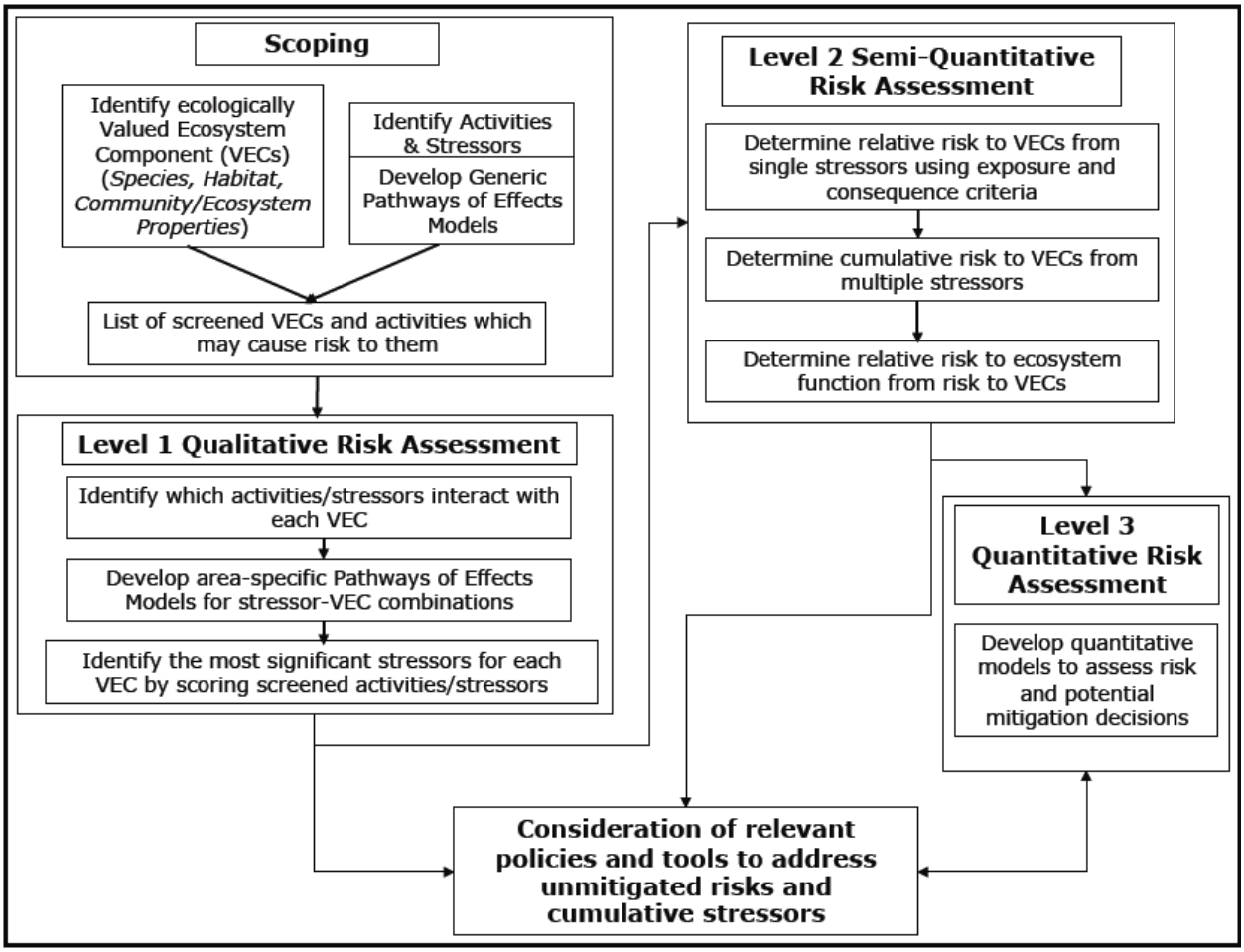

Figure 3. Methodology for the proposed Pacific region ecological risk assessment framework for Ecosystem-Based Management.

All applications of the ERAF begin with a mandatory scoping phase, followed by the risk assessment phase, which has three different levels. The different levels of risk assessment can be applied independently or in series depending on the question(s) asked and the availability of data since the higher level risk assessments impose greater data requirements on users. A

Level 1 assessment is a comprehensive but largely qualitative analysis of risk, a Level 2 assessment provides a more focused and semi-quantitative analysis, and a Level 3 assessment is a highly focused and fully quantitative "model-based" assessment of risk. Many activities and stressors with potentially low ecological risks may not go beyond Level 1, although caution is needed to ensure that the screening out of multiple low risk stressors at Level 1 does not result in the screening out significant cumulative effects on VECs. After the scoping phase, higher risk activities and stressors can either go through a Level 1 assessment and on to the more intensive and increasingly quantitative analyses at Levels 2 and 3 (Figure 3) or they may proceed directly into a Level 2 or 3 assessment, bypassing the lower levels, depending management needs for the ERAF outputs, i.e., the risk assessment phase is not necessarily a linear process proceeding from Level 1 to Level 2 to Level 3. The magnitude and sources of uncertainty are documented and reported alongside risk scores at each level of the risk assessment to aid in interpretation of the risk profile for each VEC. The risk scores, calculated during the different stages of the risk assessment, can be used to rank VECs and/or activities and stressors that may require enhanced management attention.

A significant advantage of the ERAF is that it is scalable and adaptable to different management needs. For example, a Level 1 risk assessment could be used as a rapid assessment tool for developing priorities, while a complete Level 2 assessment would likely provide sufficient detail for managers to develop specific indicators of success for a particular management action, or assess the potential cumulative effects of current activity in an area.

Scoping Phase

The scoping phase is the first element in the ERAF, and requires all the relevant information about the area of interest to be collected and structured in order to inform and set the boundaries for subsequent risk analyses. In this phase, the VECs for the area of interest and human activities and the associated stressors that potentially affecting VECs are identified. These VECs may be externally defined at the first step in the AM framework (Figure 2).

Identifying Valued Ecosystem Components

A VEC is defined by the Canadian Environmental Assessment Agency (CEAA) as an environmental element of an ecosystem that has scientific, social, cultural, economic, historical, archaeological or aesthetic importance. The focus of the ERAF is on VECs of ecological significance to an area in order to inform DFO's implementation of ecosystem-based management. VECs of ecological significance are identified by a process that structures the ecosystem into species, habitats, and community/ecosystem properties and applies component-specific criteria to select VECs. These selection criteria are based on best practices and advice in the literature from several other similar processes using risk-based frameworks (e.g., Hobday et al. 2007; 2011; Park et al. 2010; Samhouri and Levin 2012). Properties or subcomponents of each of these component groups are identified and examples of relevant measures are provided. The components and subcomponents are representative of the objectives identified in the PNCIMA planning process, as well as MPA conservation objectives and the intention is that they will be inputs into the risk assessment phase of the ERAF.

Identifying Human Activities and their Associated Stressors

Pathways of effects (POE) models are used to identify activities and stressors and evaluate their potential impacts on VECs, and have been identified by DFO as a central tool to provide the background information needed for risk analysis processes. POE models represent cause-and-effect relationships between human activities, their associated stressors, and their impacts and so can help to prioritize and focus resources on identifying, managing and regulating those

activities with the greatest potential to produce negative effects on the ecosystem. Although POE models have various forms, activity-based POE models were considered to be the most appropriate formulation for the ERAF. At present, the availability of off-the-shelf activity-based POE models for impact evaluation is limited and as a result initial applications of the ERAF may involve the development of new POE models.

Risk Assessment Phase

Risk assessment is used in this framework to estimate the risk that a VEC will experience adverse consequences due to exposure to one or more identified stressors. More specifically, the risk assessment evaluates the degree to which human activities and their associated stressors interfere with the achievement of broad ecosystem-based management and conservation objectives related to particular VECs. In order to meet these objectives, risk assessments need to be conducted relatively quickly, be adaptable to data limitations, address uncertainty, be easily updateable and flexible and be repeatable by multiple users.

The ERAF uses activities and stressors identified as potentially impacting VECs in the scoping phase to:

- rank relative risks and filter out those activities and stressors that are lower risk and/or those VECs that show lower vulnerability to stressors; and
- identify the mechanisms by which different activities and stressors impact different VECs and their subcomponents, which is useful for both identifying cumulative effects and guiding mitigation strategies.

The modular risk assessment approach of the ERAF leads to rapid identification of high-risk activities, which in turn can lead to immediate risk management responses and was developed based on guidance from risk assessment processes in other countries (e.g., Hobday et al. 2007, 2011; Samhouri and Levin 2012) and frameworks developed in DFO for other LOMAs or other purposes (e.g., Park et al. 2010).

Uncertainty is clearly described when communicating risk scores at different levels because clear documentation of uncertainty will inform the interpretation of these scores. Uncertainty can occur during exposure (e.g., overlap in space and time between VEC and activity/stressor is not known) or in terms of consequences (e.g., nature and magnitude of acute or chronic response) and may be related to data gaps or knowledge gaps (e.g., the mode of action of a particular stressor). Communicating the drivers of uncertainty as explicitly as possible (exposure, consequence) is important as it may guide management strategies and actions.

Level 1—Qualitative Risk Assessment

The Level 1 risk assessment is based on qualitative information, scientific literature, and expert opinion and is used to provide a rapid assessment of vulnerable VECs and the activities and stressors that potentially impact these VECs. The goal of this process is to ensure that the risks of harm from all potential activities/stressors are considered and to select the most significant stressors for each VEC and the most vulnerable VECs for elevation to a more detailed Level 2 risk assessment. A Level 1 risk assessment consists of the following steps:

(1) determine which activities and associated stressors potentially interact with each VEC;

(2) develop area-specific POE models; and,

(3) based on risk scores, rank the most significant stressors for each VEC.

Level 2—Semi-Quantitative Risk Assessment

The Level 2 assessment has sufficient flexibility to assess risks to ecosystem components at different spatial scales, for example PNCIMA as a whole, or selected MPAs. The goal of this process is to assess three types of risk to VECs:

1. The relative risk to a VEC from the different stressors that affect it within the area assessed;
2. The cumulative risk to a VEC from the different stressors that affect it within the area assessed; and
3. The relative risk to ecosystem function within the area assessed from the loss of the different VECs included in the risk assessment.

Relative risk to a VEC describes the likelihood that a VEC will experience harm due to a particular activity in terms of higher or lower exposures and consequences. Cumulative risk incorporates relative risk of a VEC to more than one stressor, and can be used to determine overall risk to a given VEC. Ecosystem risk is a reinterpretation of cumulative risk based on the perceived contribution of a VEC to ecosystem structure and function or its role within the ecosystem.

Level 3—Quantitative Risk Assessment

Level 3 is a fully quantitative model-based risk assessment to determine the cumulative impacts to VECs from multiple stressors. The framework does not identify a specific methodology for a Level 3 assessment because the choice of model will be based on the VEC and cumulative stressors identified in the Level 2 risk assessment. Several candidate methods and approaches for Level 3 assessments of species, habitats, and community/ecosystem properties are available in the literature. Existing processes for species include quantitative single species stock assessment models that include environmental and human impact factors other than direct capture from fishing, quantitative encounter-response models for risk from specific threats, and population viability analyses (PVA) for risks to VECs from multiple stressors. Benthic species impact models are available for quantitative assessments of habitat components and there are several ecosystem models that could be used to address impacts to community and ecosystem properties. The challenge in conducting a Level 3 risk assessment lies in adopting a method that addresses multiple stressors and different types of ecological components. The ERAF described here does not provide specific guidance to meet this challenge nor does it develop new quantitative risk approaches for DFO Pacific Region.

Several generic examples were provided to illustrate how the ERAF can be used to identify VECs and activities/stressors that would potentially merit further management attention. The goal of this exercise was to demonstrate that the ERAF can be applied in a clear and consistent manner, rather than an assessment of the outcome of these applications.

The ERAF can be used to evaluate measures to mitigate risk to VECs from activities/stressors. The framework assumes that existing mitigation measures for a VEC (e.g., fishery quota, total allowable catch or TAC) remain in place unchanged and evaluates risk to the VEC on this basis. If the mitigation measure is changed (e.g., increased quota or TAC), then the risk profile of the VEC should be re-evaluated.

Sources of Uncertainties

Several data and information gaps were identified that contribute to uncertainty in the application of the framework and expected outcomes from the ERAF. Further data collection and research may be needed to close some of these gaps.

It is expected that knowledge gaps and data uncertainty will be a challenge as the ERAF is applied in terms of both its structure (e.g., scoring metrics, cumulative risk, assumptions related to the nature of biological effects, the recovery time of ecosystem components, etc.) and data inputs (e.g., lack of spatial/temporal data for some species, habitats, communities). Although modifications to the ERAF will be needed to address these challenges, they cannot be precisely specified in the absence of experience in applying the ERAF.

Cumulative risk from multiple stressors on VECs is estimated based on the assumption that adding risk from each stressor individually provides a reasonable first approximation of cumulative risk. However, interactions among multiple stressors could also produce synergistic, compensatory or masking effects. Since existing knowledge concerning the effects of these different interactions is limited, they are not addressed in the ERAF. In addition, screening out multiple low level stressors during a Level 1 assessment could result in significant cumulative effects being screened out of the assessment. This issue is not addressed by the ERAF at present.

Level 3 risk assessments in the ERAF are fully quantitative model driven analyses. These models cannot be precisely described because they will depend on the issue(s) being addressed, but could include single-species statistical catch-at-age stock assessment models or trophic interaction-based ecosystem models. However, further research is required to find methods that address multiple stressors with cumulative impacts and disparate ecological components simultaneously.

CONCLUSIONS

- The ERAF supports the identification of risks and threats to VECs as a guide for the development of objectives, strategies and actions in PNCIMA and MPA initiatives and it is a necessary component for the implementation of DFO's ecosystem-based management in Pacific Region.
- The ERAF uses a modular risk assessment methodology to determine single and cumulative risk of harm to VECs, and ultimately, rank stressors/VECs based on single and cumulative risks. It also assesses the relative risk to ecosystem properties and provides methods for explicitly capturing and reporting uncertainties in data quality, which may guide management strategies and actions. The assessment methodology has three levels of risk assessment. The use of different levels of risk assessment is context-specific (i.e., modular) and as a result not every VEC will go through all three levels. This risk assessment methodology is considered appropriate for the flexible design of the framework, although some modifications may be needed for the scoring of risk at different stages and the additivity assumption for cumulative risk.
- The ERAF is endorsed as suitable for identifying and assessing the relative risk of harm to VECs from human activities and their associated stressors, and for ranking the significance of activities and stressors based on the relative risks to VECs in support of ecosystem-based integrated oceans management in the PNCIMA and Pacific Region MPAs.

- Use of the ERAF is expected to facilitate the communication of the relative risks of ecological consequences of anthropogenic stressors VECs and discussion of acceptable levels of risk to VECs.
- The ERAF identifies VECs at risk and the degree and source of risk to those VECs, but it does not identify the most appropriate management responses to these risk(s) and it is not intended to provide an assessment of absolute risk in the first two levels nor does it include an assessment of societal benefits associated with assuming ecosystem risks.
- It is recommended that outputs from the initial application of the ERAF to PNCIMA or MPAs in Pacific Region be reviewed by a future CSAP process to address the performance of the ERAF with respect to transparency, consistency, compatibility, and repeatability.
- The ERAF is intended to address biological VECs, although non-biological criteria (e.g., social, economic) could be used to define VECs, depending on the needs of managers. However, this flexibility in defining VECs may have operational impacts in applying the framework since, for example, the choice of criteria used for habitat/community screening prior to a Level 1 risk assessment may be dependent on the choice of VECs.
- POE models are an appropriate method for identifying mechanistic linkages between human activities and stressors impacting VECs. However, there are other, equally valid approaches that can be used to identify these linkages if no POE model for a particular activity/stressor combination is available. The development of a library of activity-based POE models to facilitate future applications of the ERAF is recommended.
- Multiple sources of information ranging from peer-reviewed scientific papers to expert opinion can be used simultaneously in the ERAF as it is intended to assess relative rather than absolute risk to VECs and uncertainties related to information are captured for interpretation of risk scores The ERAF can also be used to screen risks posed by potential future human activities and it can be applied iteratively as new information/interpretations become available.
- The ERAF explicitly documents uncertainty in communicating risk scores at different stages since clear documentation of uncertainty informs interpretation of these scores. It is recommended that the results of Level 1 and Level 2 assessments incorporate risk scores and uncertainty with explicit justification for the score, including identification of the term (exposure or consequence) and specific sub-term(s) driving the uncertainty and the risk scores.
- Development of the ERAF was guided by best practices and recommendations from risk assessment processes in other countries and frameworks developed within DFO for other purposes. It is recommended that the ERAF be considered as an example of a Pacific Region Science approach to assessing VEC risk profiles to inform a future national process on developing objectives, strategies, and actions as DFO implements ecosystem-based management.
- The following advice was provided with respect to the application of the ERAF:
    - ♦ Modifications to operational components and decision rules concerning scoring should be well documented (“lessons learned”) as the ERAF is implemented;
    - ♦ Clear and standardized scoring advice for the risk assessment components should be developed to ensure that results can be replicated between different users;
    - ♦ Developing a library of POEs and a common database of life history characteristics, activities/stressors would be valuable in facilitating future use of the framework; and,

- Comparing Level 1 and 2 risk scores should provide a useful check for internal consistency in scoring risk, as these scores should be similar for VECs elevated to a Level 2 assessment.

OTHER CONSIDERATIONS

The ERAF is a science contribution focusing on ecological VECs and is part of a broader iterative process in DFO's ecosystem-based approach to integrated oceans management. This broader process will bring together outputs from the application of the ERAF along with social and economic dimensions to derive objectives, strategies and actions for PNCIMA or MPAs. However, there are other ways to identify VECs that include socio-economic dimensions at the outset including The Conservation Measures Partnership's Open Standards for the Practice of Conservation (Conservation Gateway - http://www.conservationgateway.org/content/cap-and-open-standards), the British Columbia Conservation Data Centre (CDC) stress assessment process (http://www.env.gov.bc.ca/cdc/), and the Natural Capital Project's Integrated Valuation of Environmental Services and Tradeoffs (InVEST) tool (http://www.naturalcapitalproject.org/InVEST.html).

SOURCES OF INFORMATION

This Science Advisory Report is from the May 8-10, 2012 Regional Peer Review meeting reviewing Working Paper 2012-P46 on Risk-based Assessment Framework to Identify Priorities for Ecosystem-Based Oceans Management in the Pacific Region. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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FOR MORE INFORMATION

Contact: Miriam O
Institute of Ocean Sciences
9860 West Saanich Road
Sidney, British Columbia
V8L 4B2
Tel: 250-363-6618
Fax: 250-363-6323
E-Mail: Miriam.O@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: (250) 756-7208
E-Mail: csap@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs

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