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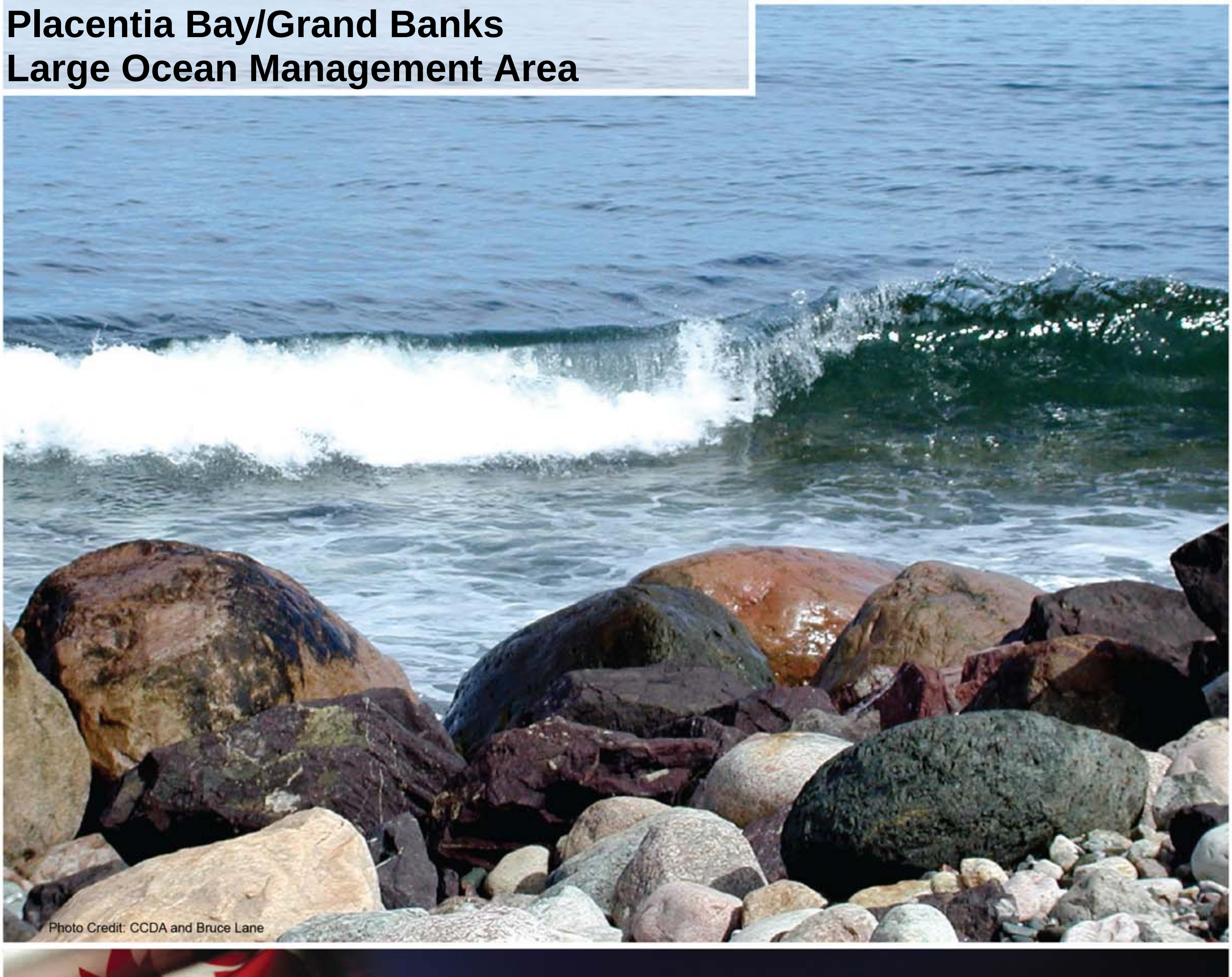
Prioritization of Key Ecosystem Components Based on the Risk of Harm from Human Activities within the Placentia Bay/Grand Banks Large Ocean Management Area



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PRIORITIZATION OF KEY ECOSYSTEM COMPONENTS BASED ON THE RISK OF HARM FROM HUMAN ACTIVITIES WITHIN THE PLACENTIA BAY/GRAND BANKS LARGE OCEAN MANAGEMENT AREA

by

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ABSTRACT

Canada's *Oceans Act* (1997) calls for the Integrated Management (IM) of all activities in or affecting estuarine, coastal and marine waters. For Large Ocean Management Areas (LOMAs), it is important to set manageable conservation objectives. Within the Placentia Bay/Grand Banks (PB/GB) LOMA, this process started with the identification of ninety-four key ecosystem components which were ranked high, medium or low, based on the ecological significance of the component, without reference to the associated level of risk resulting from human activities. These key ecosystem components, flagged as conservation priorities (CPs), were further prioritized based on an analysis of the level of risk from human activities. This analysis followed a three-phase methodology which identifies key activities/stressors for each CP, and produces a numerical score for the interaction between each key activity/stressor and the CP. This allowed the CPs to be ranked based on a relative analysis of the cumulative risk of harm from human activities and associated stressors. The final ranking is presented here, with the working notes for the individual analyses available as hyperlinked documents within the electronic version. The individual scores for each activity/stressor were also combined to allow the ranking of key human activities/stressors which require priority action within the LOMA.

RÉSUMÉ

La gestion intégrée (GI) de toutes les activités qui s'exercent dans les eaux estuariennes, côtières et marines est une des prescriptions de la *Loi sur les océans* (1997). Dans le cas des zones étendues de gestion des océans (ZEGO), il importe de fixer des objectifs de conservation gérables. Dans la ZEGO de la baie de Plaisance et des Grands Bancs (BPGB), le processus a commencé par la détermination de 94 composantes valorisées de l'écosystème (CVE), qui ont ensuite été classées par ordre d'importance écologique (élevée, moyenne ou faible) sans référence au niveau de risque que posent les activités humaines à chacune des CVE. L'ordre de priorité de ces CVE, désignées comme des priorités en matière de conservation (PC), a ensuite été établi par analyse du niveau de risque associé aux activités humaines. Cette analyse selon une méthode à trois phases a permis d'identifier les activités importantes et les agresseurs pour chacune des CVE et d'obtenir une cote numérique pour l'ampleur de l'interaction entre chaque activité importante ou agresseur et chacune des CVE. Une analyse du risque cumulatif de dommages résultant d'activités humaines et d'agresseurs connexes a ensuite été faite. Le classement final des CVE est présenté dans ce document. Des hyperliens vers les notes de travail pour chaque analyse sont établis dans la version électronique de ce dernier. Les cotes pour chaque activité et agresseur ont aussi été cumulées pour établir le classement des activités importantes et des agresseurs dans la ZEGO de BPGB qui nécessitent la prise de mesures en priorité.

1.0 INTRODUCTION

Canada's *Oceans Act* (1997) calls on the Minister of Fisheries and Oceans Canada (DFO) to lead and facilitate the Integrated Management (IM) of all activities in or affecting estuarine, coastal and marine waters through an ecosystem-based approach. The Placentia Bay/Grand Banks (PB/GB) Large Ocean Management Area (LOMA), shown in Figure 1 below, is one of five priority areas selected for IM Planning under Canada's *Oceans Act*.

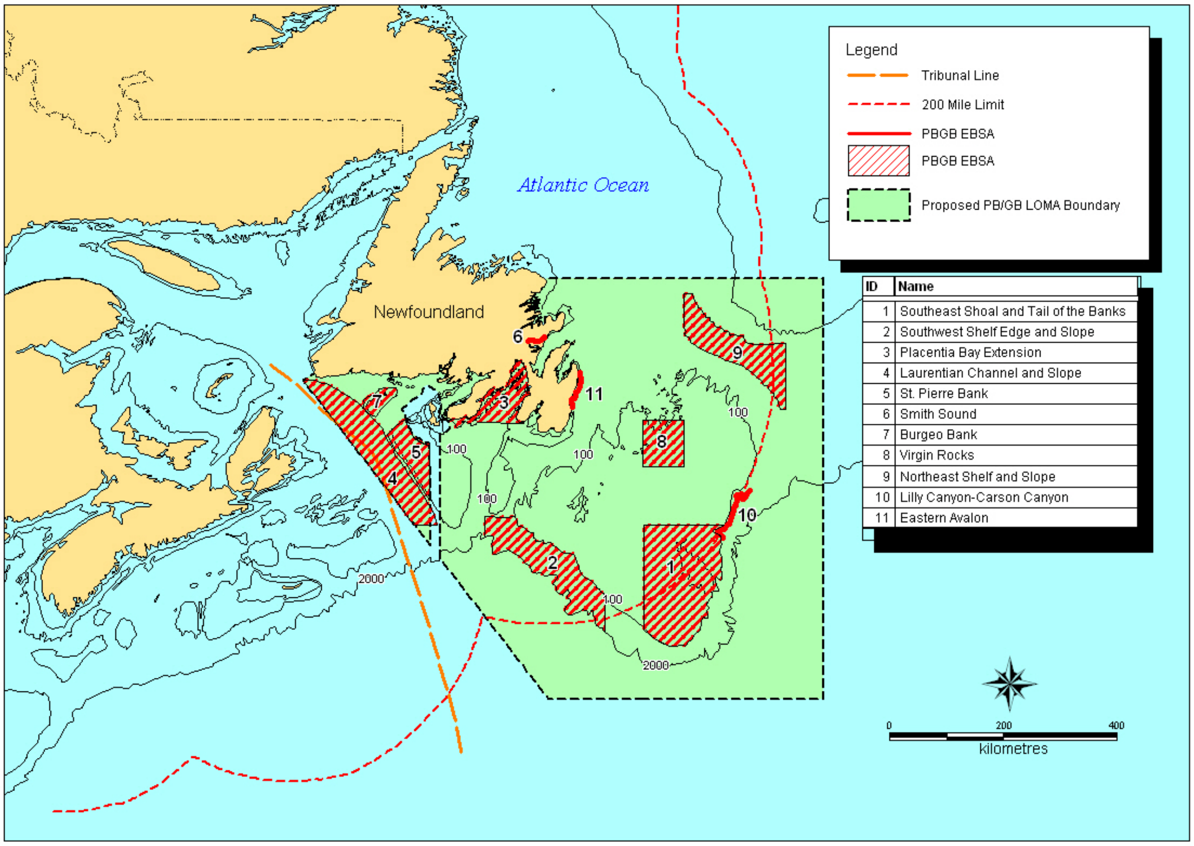

Figure 1: Map of Placentia Bay Grand Banks (PB/GB) Large Ocean Management Area (LOMA) and Ecological and Biologically Significant Areas (EBSAs)

Within an IM plan, objectives are set for conservation as well as for social, economic, cultural, and governance purposes through a collaborative and integrated process which involves government and stakeholder representatives. Strategies and associated management actions are then developed to meet each objective. Ecosystem-based management requires a holistic management approach, addressing key aspects of ecosystem structure and function. However, a limited number of actions can be implemented within each planning cycle and therefore careful prioritization is critical to the development of an effective plan.

Conservation priorities (CPs) within the PB/GB LOMA were identified in several steps. A Science-based process identified 66 significant ecosystem components associated with 11 ecologically and biologically significant areas (EBSAs) (see Figure 1). In addition, 28 ecologically significant species (ESSs) and depleted species (DSs) were also identified (Templeman, N. D., 2007,Fisheries and Oceans Canada, 2007b), for a total of 94 potential CPs.

These ecosystem components were ranked as high, medium or low, based solely on ecological significance without reference to the associated level of risk resulting from human activities. Further prioritization was required. Consequently, the 59 high priority CPs and the 11 CPs associated with the medium priority EBSAs were assessed based on the level of risk from human activities and associated stressors using a three-phase methodology (Park, L. P. Beresford L. A. and M. R. Anderson, 2010). Major categories of human activities and stressors that were considered include harvesting, seabed and coastal alteration, disturbance, pollution, climate change, and harmful species.

This document presents a summary of the results, including the final scores for each of the high and medium priority CPs. The detailed working notes for the analyses used to derive the scores for each individual CP are available as hyperlinked documents within the electronic version of this publication.

2.0 METHOD

This method provides a systematic, objective, and transparent process for analysing the risk of harm from human activities to key ecosystem components of ocean management areas. Key features of the method are provided below – for a more detailed account, please refer to the published methodology (Park, L. P. Beresford L. A. and M. R. Anderson, 2010).

A main feature of the method employed in the ranking process is the numerical scoring system which permits scores to be combined for all activity/stressor interactions with a single CP, thereby allowing CPs to be ranked based on cumulative risk. By focusing on the interaction between a single activity/stressor and a single CP associated with a specific area, a more detailed analysis is possible than if the effects on all ecosystem components are examined at once.

The analysis is conducted in three phases which are summarized below:

- Phase 1 - Scoping: An initial scoping phase provides a systematic way to identify high risk (key) activities/stressors of relevance for further evaluation, while screening out irrelevant or low risk activities/stressors for each CP. **Note that the scoping phase identifies a unique list of key activities and stressors for each CP** from a standardized list of 65 potentially harmful activities and stressors. Although it is unusual to include both activities and stressors in the same list, this provides the flexibility to select the one which best captures the key source of harm to the CP. For example, stressors such as oil pollution may cause significant harm to seabirds, but are associated with a wide range of human activities which would have to be assessed individually if the list was restricted to activities. Similarly the impacts of key activities such as bottom trawling or aquaculture may produce a wide range of stressors which would have to be assessed individually if the list was restricted to stressors. Habitat damage was not included in the list of stressors because significant habitats (e.g. corals, sponges, kelp, eelgrass) were included in the list of CPs being assessed.
- Phase 2 – Risk of Harm: The second phase assesses the *risk of harm* to each CP associated with its interaction with each of the key activities and stressors identified in the scoping phase. The risk of harm analysis is broken down into two basic factors - the Magnitude of Interaction (MoI) and the Sensitivity (S) of the CP to the activity or stressor. Each of these

The Risk of Harm calculation is illustrated in Figure 2 below.

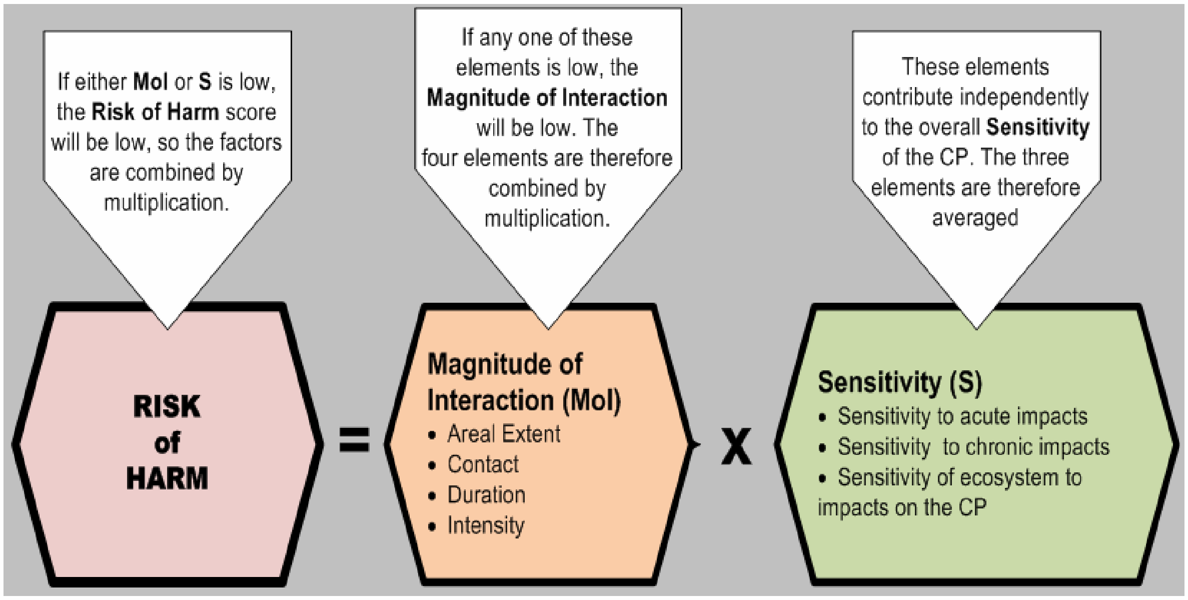

Figure 2: Risk of Harm Calculation

- Phase 3- Cumulative Score: In the final phase, the scores for all key activities and stressors are combined to produce a cumulative score for each CP which is influenced by both the severity and number of key activities/stressors. The CPs are then ranked based on their cumulative Risk of Harm scores. The scores can also be combined to rank areas, key activities/stressors, or groups of similar ecosystem components.

An important feature of the method is the use of a Certainty Checklist for each Risk of Harm analysis, in order to document the level of certainty associated with each score based on the confidence in the data used to inform the process, and to identify significant data gaps and research priorities.

Two information sources of particular importance to the regional assessment include:

- The draft proceedings of a national DFO workshop on qualitative risk assessment of fishing gears (Fisheries and Oceans Canada, 2007a). This workshop was co-chaired by DFO Science, and Fisheries and Aquaculture Management, with participation by Oceans and Habitat Management. The proceedings provide an estimate of *degree of contact* and *degree of harm*, for each gear type in relation to a wide range of marine ecosystem components. These scores are used in the analyses of *contact* and *acute sensitivity* when assessing the impacts of fishing activity, and are referred to as 'Quantitative Fishing Gear Scores'.
- Halpern *et al.* (Halpern, B. S., Selkoe, K. A., Micheli, F., & Kappel, C. V., 2007) produced global maps for a series of anthropogenic threats, which the authors have adapted for us. These maps provided useful reference points for a wide range of activities and stressors, and were frequently used during the analysis of the *intensity* element of *Magnitude of Interaction*.

3.0 RESULTS

Table 1 below provides a summary of the final scores and rank for each CP. These scores reflect the risk of harm from human activities or associated stressors, based on a detailed review of available literature, including primary scientific literature, data collected by government and non-government agencies, consultants, and personal communications with relevant experts.

Detailed working notes, including scores for individual factors and elements, can be viewed for each CP by clicking on the following link: http://www.dfo-mpo.gc.ca/libraries-bibliotheques/toc-tdm/342998-eng.htm.

Table 1: Analysis of Risk of Harm from Human Activities/stressors in the PB/GB LOMA

CONSERVATION PRIORITY (CP)	AREA	THEME	RANK (SCORE)
Rockweed and kelp	LOMA	Habitat	1 (142.3)
Cod, cunner, plaice, capelin and other species nursery habitat	PB EXT	Habitat	2 (119.3)
Seabird aggregation, feeding, nesting, and refuge	PB EXT	Seabirds	3 (116.9)
Unique groundfish biomass	SW Slope	Groundfish	4 (102.8)
Atlantic cod migration	SW Slope	Groundfish	5 (101.3)
Phytoplankton	LOMA	Plankton	6 (98.2)
Control the spread and abundance of invasive species	LOMA	Harmful Species	7 (95.8)
Large gorgonian corals	LOMA	Corals &Sponges	8 (95.6)
Structural habitat provided by corals	SW Slope	Corals & Sponges	9 (94.8)
Eelgrass	LOMA	Habitat	10 (92.5)
Corals and sponges	LOMA	Corals & Sponges	11 (82.9)
Haddock aggregation and spawning	SW Slope	Groundfish	12 (82.6)
Haddock	LOMA	Groundfish	13 (82.4)
3NO Capelin	LOMA	Forage Fish	14 (79.6)
Capelin (important food supply)	LOMA	Forage Fish	15 (77.8)
Otter aggregation and reproduction	PB EXT	Seals & otters	16 (73.5)
Atlantic cod (depleted or rare species)	LOMA	Groundfish	17 (73.1)
Atlantic cod > 35cm (influential predator)	LOMA	Groundfish	18 (70.3)
Offshore capelin spawning	SE Shoal	Forage Fish	19 (70.2)
Control the spread and abundance of harmful and toxic species	LOMA	Harmful Species	20 (65.0)
Zooplankton	LOMA	Plankton	21 (59.1)
Unique coral concentrations and biodiversity	SW Slope	Corals & Sponges	22 (50.9)
Area of highest overall benthic biomass on the Grand Banks	SE Shoal	Benthos	23 (50.4)
Atlantic cod spawning biomass	PB EXT	Groundfish	24 (50.3)
Prevent non-authorized introduction of invasive species	LOMA	Harmful Species	25 (50.0)
Leatherback aggregation, feeding and migration	PB EXT	Cetaceans & turtles	26 (49.8)
Unique shallow, sandy habitat with glacial history	SE Shoal	Habitat	27 (46.4)
Harp seals (influential predator)	LOMA	Seals & otters	28 (44.8)
Redfish spawning	SW Slope	Groundfish	29 (43.8)
Cetaceans	LOMA	Cetaceans & turtles	30 (43.8)

CONSERVATION PRIORITY (CP)	AREA	THEME	RANK (SCORE)
Cetacean aggregation, feeding, and migration	St. P. Bank	Cetaceans & turtles	31 (40.3)
Cetacean aggregation and feeding	PB EXT	Cetaceans & turtles	32 (40.3)
Harbour seal aggregation and reproduction	PB EXT	Seals & otters	33 (38.9)
Multi-species (fish, cetacean, pinniped) migration	Laurent.Ch	Biodiversity	34 (37.3)
Leatherback turtle	LOMA	Cetaceans & turtles	35 (37.3)
Cod, cunner, plaice, capelin and other species spawning activity	PB EXT	Biodiversity	36 (36.4)
Blue whale	LOMA	Cetaceans & turtles	37 (36.3)
Atlantic cod spawning	SE Shoal	Groundfish	38 (34.0)
Benthos	LOMA	Benthos	39 (33.8)
Greenland halibut < 40cm	LOMA	Groundfish	40 (33.4)
Unique yellowtail nursery	SE Shoal	Groundfish	41 (32.5)
Unique black dogfish pupping and aggregation	Laurent.Ch	Skates & Sharks	42 (32.3)
3LNO American plaice	LOMA	Groundfish	43 (31.5)
Sea scallop spawning and feeding	St. P. Bank	Benthos	44 (30.7)
Unique relict populations of blue mussels & wedge clams	SE Shoal	Benthos	45 (30.2)
Ichthyoplankton concentrations (cod, cunner, plaice, capelin & others)	PB EXT	Plankton	46 (29.4)
American plaice (nursery habitat)	SE Shoal	Groundfish	47 (28.5)
2J3KL and 3NO witch flounder	LOMA	Groundfish	48 (26.8)
Reproduction & survival of striped wolfish	SE Shoal	Groundfish	49 (26.0)
3LN Redfish	LOMA	Groundfish	50 (25.0)
Smooth skate (< 30cm) nursery/rearing	Laurent.Ch	Skates & Sharks	51 (24.7)
Unique sea scallop concentrations	St. P. Bank	Benthos	52 (24.6)
South coast herring	LOMA	Forage Fish	53 (22.6)
Atlantic halibut concentration	SW Slope	Groundfish	54 (20.5)
Unique northern Atlantic cod refuge	Smith Sound	Groundfish	55 (18.7)
Unique seabird biodiversity	SW Slope	Seabirds	56 (17.3)
Cetacean aggregation and feeding	SW Slope	Cetaceans & turtles	57 (17.2)
Seabird aggregation and feeding	SW Slope	Seabirds	58 (17.0)
Spiny dogfish pupping	St. P. Bank	Skates & Sharks	59 (16.8)
Northern Atlantic cod spawning, nursing, migration, and refuge	Smith Sound	Groundfish	60 (15.6)
Leatherback aggregation and feeding	SW Slope	Cetaceans & turtles	61 (14.7)
Spiny dogfish aggregation	St. P. Bank	Skates & Sharks	62 (14.6)
Unique species biodiversity	SW Slope	Biodiversity	63 (13.7)
Unique spawning area for northern Atlantic cod	Smith Sound	Groundfish	64 (11.2)
Greenland halibut > 40cm (influential predator)	LOMA	Groundfish	65 (10.8)
Seabird aggregation & feeding	SE Shoal	Seabirds	66 (9.0)
Sandlance (forage/prey species)	LOMA	Forage Fish	67 (8.8)
Porbeagle shark	LOMA	Skates & Sharks	68 (5.0)
Cetacean aggregation & feeding	SE Shoal	Cetaceans & turtles	69 (0.9)
Piscivorous small pelagics (influential predators)	LOMA	Forage Fish	70 (0.0)

The analyses are comprehensive, amounting to more than 2,400 pages and 1,000 references and provide a useful compilation and synthesis of relevant information, local experts and key references for each CP, and each activity/stressor.

The individual numerical scores for each CP-activity/stressor interaction can be combined in a number of ways, allowing an examination of cumulative effects associated with each CP, as well as area-based or activity-based analyses. The ranking process allows a planning initiative such as the PB/GB LOMA to focus efforts on managing activities that pose the greatest risk of harm to conservation priorities. Priority management themes can also be identified within the high ranking CPs by combining scores for related ecosystem components.

Cumulative Effects

Cumulative effects are difficult to quantify and even predict. This methodology provides a workable approach to cumulative effects assessment and one that is open to scientific scrutiny and review. This is very important both in terms of documenting the information on which decisions are based and in terms of moving cumulative effects assessment beyond the expert opinion approach. It is recognized that these interactions are complex and in some cases non-linear, and that some activities/stressors will have more than an additive effect while others may diminish the impacts of another. However, it is believed that adding the individual activities/stressors scores will provide a reasonable indication of the over all level of threat to an ecosystem component despite inherent inaccuracies and can contribute to the development of effective IM planning.

Area-based analysis

To assist in spatial planning, scores for all CPs within an area (EBSA, protected area, or other area of interest) can also be combined to provide information on the relative risk of harm for each area. These scores reflect both the total number of CPs identified by the area and the number and severity of key activity/stressors. Table 2 below shows the relative rank within PB/GB LOMA and the high and medium priority EBSAs:

Table 2: Analysis of the Relative Risk of Harm to CPs from Human Activities/stressors within specific areas of the PB/GB LOMA

AREA	Number of CPs	RANK
PB/GB LOMA	28	1
SW Slope	12	2
Placentia Bay Extension	9	3
SE Shoal	10	4
St. Pierre Bank	5	5
Laurentian Channel	3	6
Smith Sound	3	7

Ecosystem Themes
Scores for related ecosystem components can also be combined to help identify priority management themes. Several key themes were identified for the PB/GB LOMA through this process and following a Conservation Priorities Workshop for the IM Plan Working Group of the PB/GB LOMA Committee, four key themes emerged:

- Habitat
- Atlantic Cod
- Corals and Sponges
- Harmful Species

For a more detailed account of this workshop please refer to the published workshop proceedings (Fisheries and Oceans Canada, Oceans Division, 2010).

Activity-based Management
Similarly, to assist in activity-based management planning, scores for each activity/stressor can be combined to allow a ranking of key human activities which require priority action. The relative scores provide a measure of each activity/stressor's contribution to the risk of harm and help guide activity-based management planning.

Figure 3 below provides an illustration of the contribution to Risk of Harm from major activity/stressors within the PB/GB LOMA, and their relative ranking.

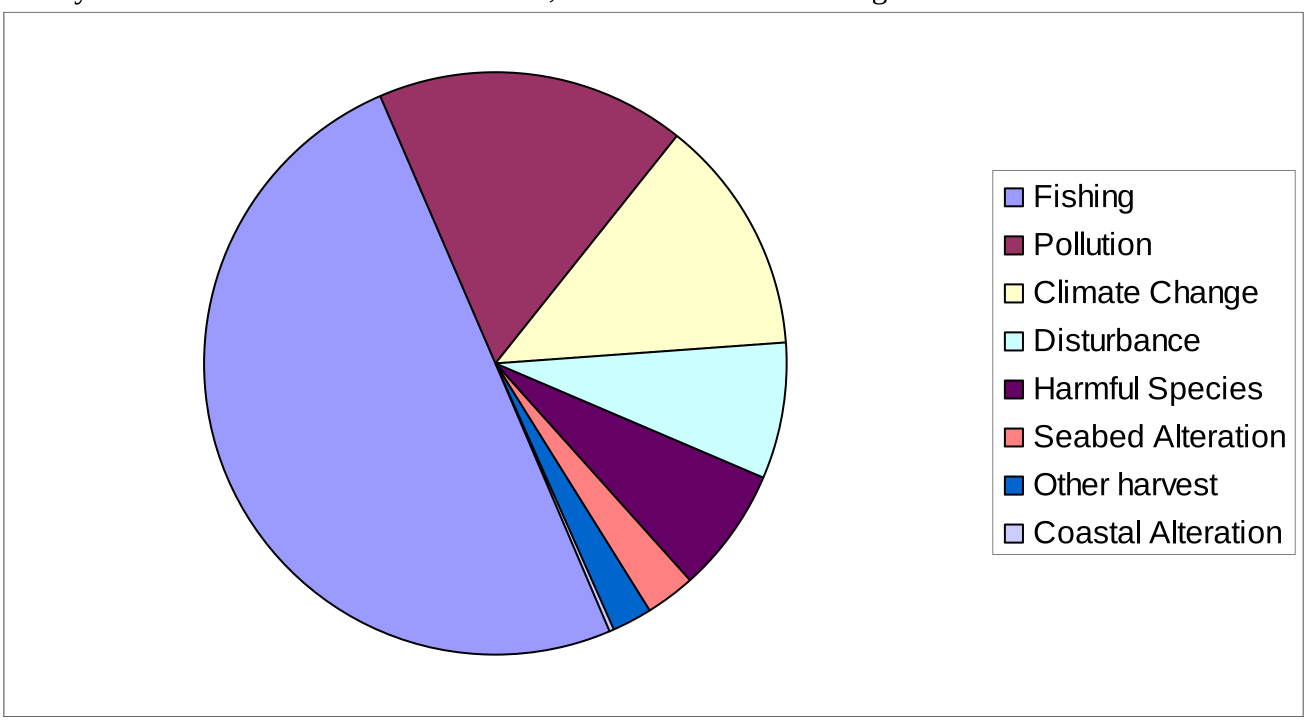

Figure 3: Risk of Harm based on activity/stressors for PB/GB LOMA

Key activities and stressors can also be ranked for areas of interest or conservation themes.

4.0 DISCUSSION

The *Oceans Act* recognises that a new approach to oceans management is required. In response, Fisheries and Oceans Canada has been moving from a single species, single sector management model toward a more holistic model based on the IM of all activities affecting estuarine, coastal, and marine waters. The results presented here support the traditional focus on fisheries management since fisheries make the single largest contribution to the risk of harm. At the same time, the results validate the move towards ecosystem-based IM because the combined contribution of non-fishing related activities pose an equivalent risk to the contribution of fishing, and must be considered if the oceans are to be managed sustainably.

The results are versatile and can be presented in a number of ways depending on the management approach. The method allows the ranking of significant ecosystem components (species, habitats, areas, communities, biological processes, etc.) based on the risk of harm from human activities and provides a workable approach to cumulative effects assessment. The results can also be used in an area-base analysis to identify priority areas or to rank key human activities which require priority action to support an activity-based approach.

The methodology is labour intensive but provides a useful compilation of information and a clear record of the rationale for each score, providing a level of transparency that is critical to a successful collaborative process. The methodology has been adapted for use in the Gulf of St. Lawrence Integrated Management (GOSLIM) project, including the development of an Excel application which automates the calculations, provides templates and links which minimize repetition and eliminate formatting, and produces colour graphs of the results. This type of application can significantly reduce the level of effort required without compromising the transparency or quality of the results.

5.0 CONCLUSIONS

This methodology provides a workable approach to cumulative effects assessment and is flexible enough to be useful for a wide number of approaches. Although a broad range of conservation objectives and associated strategies will be included in the IM plan for the PB/GB LOMA, the conservation themes and the key activities and stressors identified through this process will provide a major focus for action planning. The information and references compiled in the analyses will provide detailed information to guide the working groups as they develop appropriate and realistic management actions to address each conservation objective and the associated strategies. This work will be integrated with that for social, economic, cultural, and governance aspects to produce a comprehensive IM plan.

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