Fisheries and Oceans Canada / Pêches et Océans Canada
Science / Sciences

C S A S | **S C C S**

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2011/072 | **Document de recherche 2011/072**

National Capital Region | **Région de la capitale nationale**

Application of Ecologically and Biologically Significant Areas (EBSA) criteria in Canadian Waters – Lessons Learned

Application des critères relatifs aux zones d'importance écologique et biologique (ZIEB) dans les eaux canadiennes – Leçons tirées

Donald G. Cobb

23 Lake Linnet Place
Winnipeg, Manitoba
Canada
R3T4N2

ISSN 1499-3848 (Printed / Imprimé)
ISSN 1919-5044 (Online / En ligne)

Canada

TABLE OF CONTENTS

Correct citation for this publication:

Cobb, D.G. 2012. Application of Ecologically and Biologically Significant Areas (EBSA) criteria in Canadian Waters – Lessons Learned. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/072. vi + 25 p.

ABSTRACT

Since 2005, Fisheries and Oceans Canada (DFO) has undertaken the identification of Ecologically and Biologically Significant Areas (EBSAs) within Canadian waters primarily within the Department's Large Ocean Management Areas (LOMAs). Efforts are now expanding to identify EBSAs outside the boundaries of these established LOMAs, and it is timely to reflect on the lessons learned from these previous exercises. This paper provides a comparison of the approaches and methodologies used to identify EBSAs within each LOMA. Lessons learned were summarized based on the experiences of individuals who encountered challenges and issues in the application of the DFO EBSA criteria. In preparation for the identification of EBSAs in areas outside of a LOMA and areas with limited information, a number of key lessons and recommendations resulted from this review. It was agreed that EBSA criteria have been successfully applied, reflecting the scale of dominant physical/oceanographic features and processes that occur at LOMA scales. There may be a need for further science guidance on approaches to resolve issues of data management, data confidence, variable quantity and quality of data sets, the incorporation of Traditional and Local Ecological Knowledge (which was agreed to be a key component of the EBSA process), assessment and analysis of candidate EBSAs (ranging from Delphic to more analytical methods), and the issue of defining scale.

RÉSUMÉ

Depuis 2005, Pêches et Océans Canada (MPO) assume la responsabilité de désigner les zones d'importance écologique et biologique (ZIEB) dans les eaux canadiennes, principalement dans les zones étendues de gestion des océans (ZEGO) du Ministère. Le Ministère intensifie maintenant ses efforts pour désigner les ZIEB situées à l'extérieur des limites des ZEGO établies. Il est donc opportun de tenir compte des leçons tirées des exercices précédents. Le présent document présente une comparaison des approches et des méthodes utilisées pour désigner les ZIEB situées dans chaque ZEGO. Les leçons tirées ont été résumées en fonction des expériences vécues par les personnes ayant éprouvé des difficultés au cours de la mise en application des critères du MPO relatifs aux ZIEB. En prévision de la désignation des ZIEB situées à l'extérieur d'une ZEGO et dans des zones à l'égard desquelles les données sont limitées, un certain nombre de leçons clés et de recommandations ont découlé de cet examen. Il a été convenu que les critères relatifs aux ZIEB ont été appliqués avec succès, en tenant compte de la portée des principales caractéristiques et des principaux processus physiques et océanographiques qui ont lieu à l'échelle des ZEGO. Cependant, il pourrait être nécessaire d'obtenir davantage de directives scientifiques sur les approches à adopter pour résoudre les problèmes liés à la gestion des données, à la fiabilité des données, à la variation de la quantité et de la qualité des ensembles de données, à l'intégration des connaissances écologiques locales et traditionnelles (on a convenu qu'il s'agissait d'un élément clé du processus relatif au ZIEB), à l'évaluation et à l'analyse des ZIEB admissibles (allant de la méthode Delphi à des méthodes plus analytiques), et à la production d'une échelle.

INTRODUCTION

Canada's *Oceans Act* (1997) authorizes Fisheries and Oceans Canada (DFO) to conserve and protect living resources and their supporting ecosystems through the creation of Marine Protected Areas (MPA) and MPA networks, and to provide enhanced management to areas of the oceans and coasts via the development of Integrated Oceans Management Plans. DFO has developed guidance on the identification of EBSAs (DFO 2004) and has endorsed the Convention on Biological Diversity's (CBD) scientific criteria for identifying ecologically or biologically significant marine areas as defined in Annex I of Decision IX/20 of its 9th Conference of Parties[1] The criteria for the identification of Ecologically and Biologically Significant Areas (EBSAs) are considered to be robust and effective in identifying areas that require a greater-than-usual degree of risk aversion in the management of human activities. The identification of EBSAs requires an inclusive and transparent process that gathers and integrates the best available scientific and traditional knowledge.

Since 2005, DFO has undertaken several initiatives, primarily within the Department's Large Ocean Management Areas (LOMAs), to indentify EBSAs within Canadian waters. Efforts are now expanding to identify EBSAs outside the boundaries of established LOMAs. For example, the current spatial framework for Canada's MPA network contains twelve biogeographic units (DFO 2009), of which six units or portions of these units have not had EBSAs identified. It is therefore, timely to reflect on the lessons learned from previous EBSA exercises within Canadian waters and develop further guidance on the application of criteria and the identification of EBSAs. In particular, guidance on the application of criteria in areas that are considered information poor or scattered and/or where resources are not available for extensive data collection and/or analyses.

As the process to identify EBSAs becomes less driven by comprehensive data sets it is necessary to be sure the approaches used are not inappropriately vulnerable to bias and subjectivity during the evaluation. The objectives of this paper are to:

1. review progress on the application of criteria for the identification of EBSAs within Canadian waters to date;
2. compare and contrast approaches and methodologies for identification of EBSAs, with discussions on lessons learned, and,
3. extract and summarize the lessons learned based on experiences with challenges and issues encountered in the application of EBSA criteria, in preparation for EBSA identification in areas outside of LOMAs and in areas with limited information, or when it is not feasible to easily collect new information.

MATERIALS AND METHODS

The identification of EBSAs within Canadian waters has followed a nationally developed approach to date and has been accomplished through the application of a set of scientific criteria and explicit guidelines (DFO 2004). The EBSA criteria are just one of a suite of scientific guidance documents that were developed to assist in setting Conservation Objectives for LOMAs (DFO 2006, 2008). Ecological and biological properties of various areas within the LOMAs were evaluated for the degree to which they displayed the primary dimensions of

[1] http://www.cbd.int/decision/cop/?id=11663

Uniqueness, Aggregation, Fitness Consequences, and the secondary (or qualifier) dimensions of Resilience and Naturalness. Information from various Canadian Science Advisory Secretariat (CSAS) advisory reports, proceedings, and DFO manuscript reports were used to inform the current report. In addition to published literature, a number of key regional DFO scientists and Oceans practitioners were provided a set of questions related to their experiences in the application of the EBSA criteria (Appendix 1). Feedback from this exercise (n=15) allowed an evaluation of lessons learned not only during the application of EBSA criteria within the LOMAs, but also during the subsequent provision of science advice on Conservation Objectives derived from the EBSAs and the identified Ecologically Significant Species and Community Properties (ESSCPs).

In order to review the overall progress on the application of EBSA criteria, data were tabulated based on the best available information contained within the EBSA proceedings, such as matrices, or EBSA descriptions. Supporting CSAS research documents or ecosystem overviews further informed the compilation of EBSA results. Where the EBSA process is still in progress, such as for the Eastern Scotian Shelf Integrated Management (ESSIM) area, information from the most recent EBSA documentation was used. Regional and national application of the EBSA criteria are compared and contrasted graphically by primary dimension (uniqueness, aggregation, fitness consequences), as well as by the functions that they serve (e.g., spawning/breeding, nursery/rearing, migration, feeding, biodiversity), or owing to their structural properties (e.g., oceanographic properties, physical features, structural habitat, seasonal refugia). There have been several attempts to apply the DFO EBSA criteria to areas outside of the five established LOMAs. For example, Northern Foxe Basin was assessed for EBSAs as a precursor to testing the feasibility of establishing a MPA in that region of Nunavut. The Quoddy region of the Bay of Fundy and the coastal region of ESSIM were also evaluated to assess the utility of applying the EBSA criteria to coastal areas. Although data are not included in the analyses of the five LOMAs, conclusions and lessons learned from attempts to move away from the LOMA-scale are relevant and will be discussed. When appropriate, experiences and lessons learned in the identification of EBSAs at the international level are also considered.

RESULTS AND DISCUSSION

THE EBSA PROCESS

Among the LOMAs the processes followed, information sources considered and the degree of analysis necessary to identify and rank the EBSAs had certain commonalities, but also significant differences (Table 1, Appendix 2). This arose in part because the LOMA work under the Oceans Action Plan was carried out at different paces among DFO Regions, but also because data quality and quantity, spatial and temporal coverage, etc. differed significantly among each LOMA. All Regions generally followed and applied the scientific guidance and criteria for EBSAs (DFO 2004), data permitting. However, some Regions had begun the process of identifying key areas for special management attention prior to the provision of the EBSA guidance (i.e., Ecosystem Overviews and Assessment Reports (EOARs)). In those cases, the identified priority areas for enhanced management and protection may not have been based on a specific set of criteria. The roles of the Oceans Programs Division and Science sector in the application of the EBSA/ESSCP criteria and in the broader EOAR work differed both among Regions and over the course of all work related to the EOARs within particular Regions. The EOAR works were extremely valuable compilations of ecologically important areas, and as such, were directly applicable to the EBSA process. A comparison of findings between those early assessments and the EBSA findings was conducted for ESSIM, and it was concluded that even though the exact shape or boundary of the ecologically important areas differed, a high degree of overlap occurred between areas identified as ecologically significant between the two processes.

Not all Regions conducted formal CSAS meetings with formal science advisory reports, but all results were published in readily accessible DFO publications. Some regions published CSAS Research Documents specific to thematic layers (e.g., oceanography, fishes, marine mammals), while others collected expert knowledge through workshops with maps or questionnaires. This information was included in the final EBSA science advisory publications. The advantages of producing CSAS Research Documents is that information/data included within the documentation undergoes a formal peer-review process and allows scientists an opportunity to formally contribute their information and knowledge, obtain recognition for their efforts and provides the audience a list of accessible reference material.

All EBSA identification processes recognized the need for the inclusion of Traditional Ecological Knowledge (TEK) and/or Local Ecological/Experiential Knowledge (LEK) however, not all EBSA processes utilized this information in the process. Some Regions found that when attempting to include of TEK and LEK a new set of challenges arose that in some cases were not solved. Conveying the EBSA criteria language from the national guidance documents to a level of understanding for well qualified people unfamiliar with the terminology was a major hurdle. In addition to this, local knowledge holders often equated areas that they harvested species that were of social, cultural or economic importance as EBSAs. The Maritimes and Central and Arctic Regions explicitly incorporated TEK and LEK into their EBSA processes. Other LOMAs did include traditional and local knowledge in the preparation of data layers (to varying degrees), however no special attention (positive or negative) to the basis of the information was highlighted within the data. Of those that clearly defined the inclusion of TEK and LEK, the Beaufort Sea EBSA process conducted community meetings in order to incorporate TEK, as is the expected practise under the Inuvialuit Land Claims Agreement (Paulic et al. 2009). ESSIM did conduct a study on local fishers knowledge of important areas utilizing a questionnaire (MacLean et al. 2009). These initiatives resulted in the addition of new areas, or confirmed and/or modified boundaries of existing areas as being ecologically important. As such, the inclusion of local knowledge holders significantly increased the level of engagement and buy-in to the process at the local scale.

Regions applied a variety of techniques for EBSA identification, however they all employed a Delphic approach (or some modification thereof) as a starting point. A Delphic process is an expert-based approach to support decision-making that can be used in situations where models are unavailable or compromised by lack of appropriate data. The method aims to develop consensus between experts over several rounds of deliberation based on the assumption that combining the expertise of several individuals will provide more reliable results than consulting one or two individuals (MacMillan and Marshall, 2005). During the EBSA identification processes expert opinion was sought using maps and matrices, and knowledge holders provided their best approximation of the EBSA. The Delphic approach often resulted in a larger list of “candidate” EBSAs than after the resulting evaluations/analysis based on the EBSA criteria (e.g., rankings of low, medium, or high, congruence/overlap analysis, MARXAN). In some instances the difference was dramatic. The Pacific North Central Integrated Management Area (PNCIMA) initially identified 132 important areas, with almost 100% LOMA coverage following the Delphic approach. This was reduced to 15 EBSAs and 44% coverage of the LOMA after applying overlap analysis. In other LOMAs, there were insufficient data to conduct detailed analyses and the results of the EBSA process relied heavily upon consensus building by expert knowledge holders. It should be noted that the Delphic approach can be time consuming if applied to its fullest due to the multiple rounds of iteration required. In some of the LOMA EBSA processes, time did not allow for multiple reviews and the outcomes may have suffered as a result. As a way to get around the time consuming process of this approach, there are Wiki methods that could be explored in the future. The benefits of these methods would likely encourage greater scientific participation, reduce time and expense and allow a greater dialogue when finalizing the EBSAs (IUCN, 2010).

For the Gulf of St. Lawrence Integrated Management (GOSLIM) process a two-step process was applied. Initially, the application of the Delphic approach identified several large potentially important areas within the Region. This was followed by a more analytical approach that was based on available information/data to construct thematic layers. Once the thematic layers were synthesized a number of important areas were again highlighted based on the thematic layers. From here, two general evaluation approaches were used based on each of the three main criteria used separately and the sum of their scores. This method seemed to work well in GOSLIM, since all ten of the resultant EBSAs closely aligned to the areas identified using the Delphic approach, with a mean overlap of 84%.

Based on the encouraging results and accuracy achieved by GOSLIM a similar approach was used in PNCIMA. Both the experiences from GOSLIM and PNCIMA suggest that the most promising approach to the accuracy of EBSA identification is to create a layer based on the physical and oceanographic features that concentrate productivity (e.g., gyres, upwellings, etc.) or that act as bottlenecks in the movement of species. These analyses showed a high degree of overlap between biologically-derived important areas and the suite of physical oceanographically important areas and thus are considered good proxies to use as a basis for EBSA identification (DFO 2009). This approach has potential application in the Arctic, where at a fairly coarse scale there are well defined and reasonably understood physical features and associated oceanographic processes (e.g., bottlenecks, shelf breaks, upwellings, and polynyas). Based on the scale of the currently defined LOMAs, these dominant physical/oceanographic features appear to be acting at the most appropriate LOMA scale and would therefore act as a useful initial layer in the EBSA process. This approach has been the foundation for the identification of important ecological spaces in the terrestrial literature for some time, and it would seem most appropriate to apply in marine situations as well.

Table 1. Summary of EBSA process and key findings for Canadian Large Ocean Management Areas

EBSA Criteria Approach/Results	Large Ocean Management Area					Total
	Pacific North Coast Integrated Management Area (PNCIMA)	**Beaufort Sea Integrated Management Area (BSIM)**	**Gulf of St. Lawrence Integrated Management Area (GOSLIM)**	**Placentia Bay/Grand Banks Integrated Management Area (PBGB)**	**Eastern Scotian Shelf Integrated Management Area (ESSIM)**	
Area (km^2)	88,000	1,107,694	257,280	500,000	325,000	1,952,974
Number of Candidate EBSAs (Important Areas)	132	21	96	11	42	
Number of EBSAs after application of criteria	15	20	10	11	42 (Draft)	98
Area of EBSAs (km^2)	45,182	145,600	77,184	125,000	78,000	470,966
% Coverage by EBSA	44.3	13	30	25	24	24
Formal CSAS Process?	NO	NO	YES	NO	NO	
Inclusion of non-DFO information?	YES	YES	NO	YES	YES	
Evaluation Approach						
Delphic	YES (Phase I: MARXAN)	YES	YES	YES	YES	
Quantitative/Analytical/ Modelling	YES (Phase II)	NO	YES	NO	YES (MARXAN)	
Method of Assessing Important Areas	Overlap/Congruence Analysis	H, M Ranking = EBSA and L Ranking = not an EBSA (no scores assigned)	Two-step process using individual and cumulative important areas, Overlap analysis, H, M, L Ranking (with scores assigned)	H, M, L Ranking (with scores assigned)	Overlap (Benthic data, Oceanography and ESS), Scored and Ranked	
Ranking of EBSAs	YES	NO	YES	YES	YES (Draft)	
Incorporation of TEK/.LEK	NO	YES (Community Workshops)	NO	NO	YES (Included in Questionnaire)	
Discussion of Issues, Recommendations, etc.	YES	YES	YES	NO	YES	
Science Advice of Conservation Objectives	NO	NO	YES	YES	YES (Draft)	

KEY EBSA STATISTICS

The five Canadian LOMAs cover a total area of 1,952,974 km^2 (Table 1). Within all the LOMAs, 98 EBSAs were identified out of a total 302 candidate areas that were originally identified as being important. Cumulatively, the EBSAs covered approximately 24% of all LOMAs, however percent coverage varied between LOMAs, ranging from 13% (Beaufort Sea) to 44% (PNCIMA, Table 1). The PNCIMA rationalised the large percent coverage based on the combination of a relatively small LOMA and the greatest biodiversity of all Canadian LOMAs. The Beaufort Sea is quite large and coincides with the boundaries of the Inuvialuit Settlement Region. It had a relatively low percentage of EBSA coverage since almost 40% of the LOMA consists of remote pack-ice which has limited knowledge associated to the area and therefore could not be assessed against the criteria. If the data poor area with in the ISR was removed from the EBSA identification process, it would raise the EBSA coverage to approximately 22% for the Beaufort Sea, and align more closely with other Regions, resulting in approximately 29% EBSA coverage for all LOMAs. On balance, the EBSA proportion seems to be consistent with the LOMA scale and coincides with large oceanographic processes or physical features and structural habitats functioning at this scale.

The EBSA primary dimensions of uniqueness, aggregation, and fitness consequences accounted for more than 70% of the total number of EBSAs identified in Canadian waters (Figure 1). Aggregation accounted for slightly more than 90% of the EBSAs identified (Figure 1), followed by uniqueness (81%) and fitness consequences (79%, Figure 1).

Only 17% and 41% of EBSAs were accounted for based on the secondary dimensions of resilience and naturalness, respectively (Figure 1). As will be expanded upon later, this does not necessarily mean that ecologically important marine areas are not sensitive to perturbation, or are not areas of naturalness; rather it indicates a problem with the understanding and application of these terms. This is considered an outstanding issue for which further discussion and scientific guidance may be required; as such, no further analyses of these dimensions were conducted for this report.

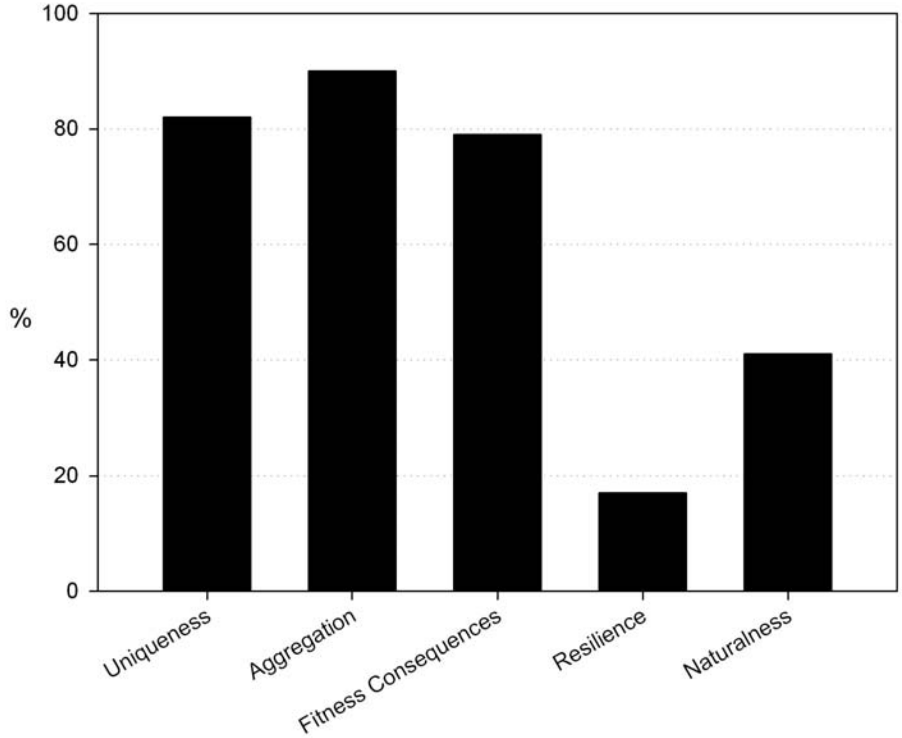

Figure 1. Percentage of identified EBSAs (n=98) meeting the primary dimensions (uniqueness, aggregation, and fitness consequences) and secondary dimensions (resilience and naturalness) for all LOMAs.

In comparing LOMAs, ESSIM had the lowest percentage of EBSAs attributed to each of the three primary dimensions (Figure 2), however considering the high number of relatively small EBSAs it would be expected that more of them were based on a single dimension. As expected, for the other LOMAs the majority of EBSAs met multiple primary dimensions, indicating that the combination of physical/oceanographic characteristics and the key biological processes ongoing in that area are being captured during the EBSA process. For example, an EBSA that has unique oceanographic processes, a high seasonal aggregation of marine mammals for feeding, with high fitness consequences for that species would naturally then meet all three dimensions. In some instances, in the absence of certainty that the annual feeding aggregation of marine mammals is unique because there have been insufficient studies throughout the LOMA, it would be prudent and precautionary to assume that this area is very important and therefore likely unique.

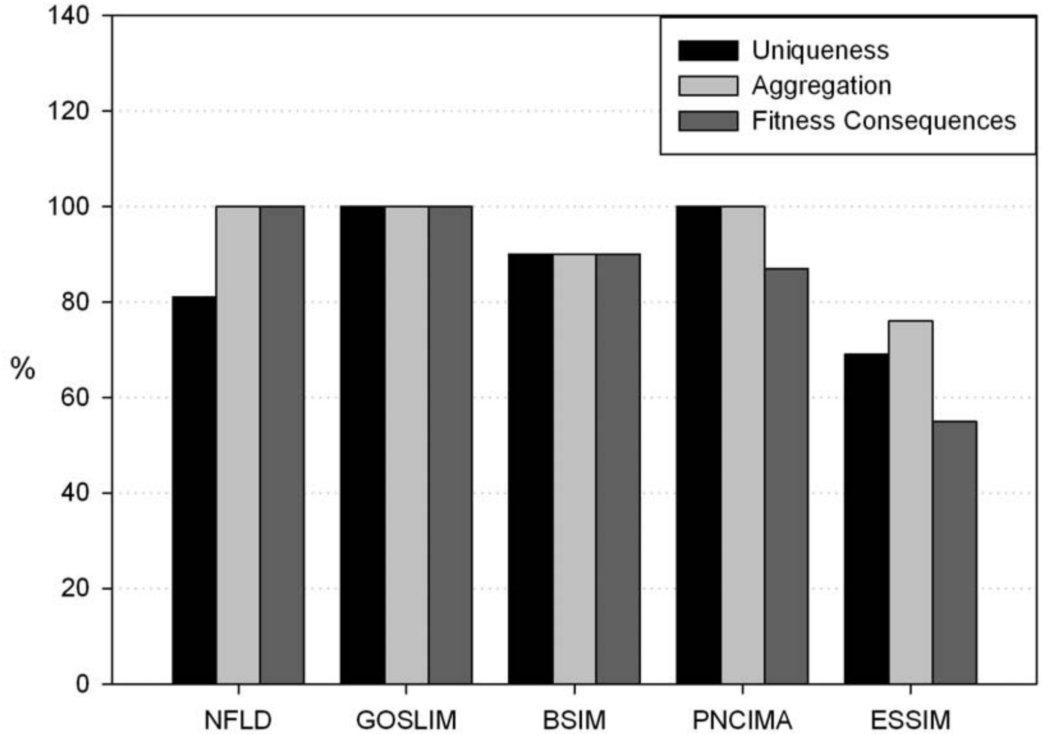

Figure 2. Percentage of EBSAs identified for each of the primary dimensions (uniqueness, aggregation and fitness consequences) by LOMA

Nine physical and functional attributes were associated with each of the primary dimensions (Figure 3). In all LOMAs combined, “feeding” was the most often identified ecologically significant attribute of an EBSA for all primary dimensions (Figure 3). This was followed by spawning/breeding and nursery/rearing (Figure 3). For each of the physical attributes (ocean processes, physical features and structural habitat), uniqueness was the primary dimension most often accounted for by these attributes, followed by aggregation and fitness consequence (Figure 3). Interestingly, only with migration did fitness consequence score higher than uniqueness or aggregation as the primary dimension for an EBSA (Figure 3).

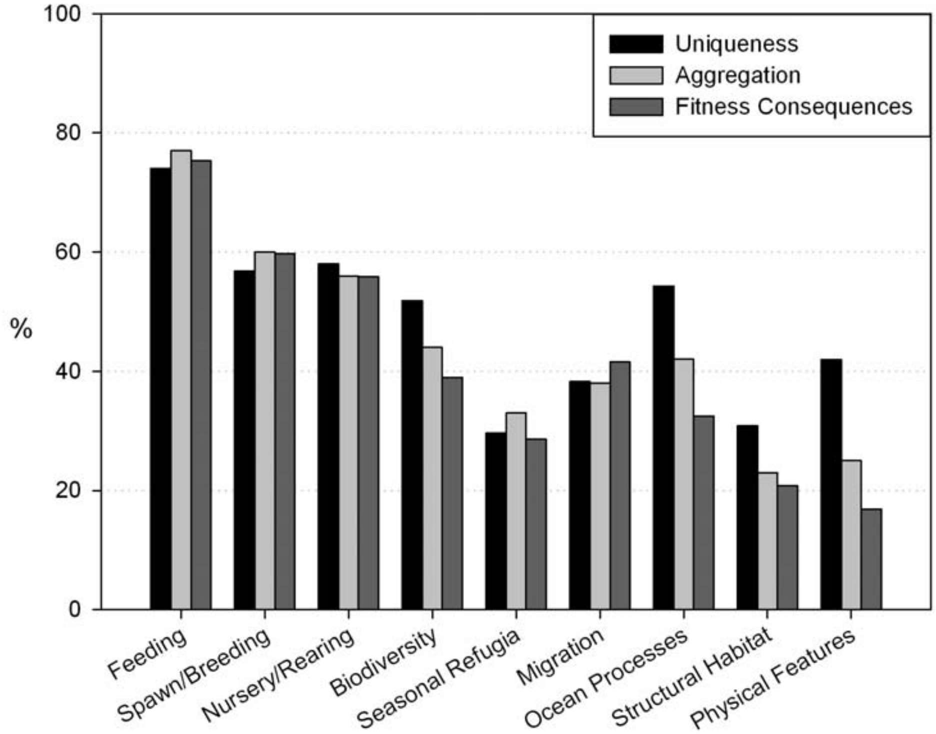

Figure 3. Percentage of all EBSAs represented by the nine functional and physical properties based on the three primary EBSA dimensions (uniqueness, aggregation and fitness consequences).

Individual LOMAs sometimes had very different rankings of the primary dimension functions and properties (Figure 4). This would be expected if the EBSA criteria were sufficiently robust, being interpreted and applied concisely, and reflective of the diversity of marine ecosystems that characterize Canada's three oceans. In PNCIMA and Placentia Bay and Grand Banks (PBGB) biodiversity was accounted for most frequently in the primary dimension of uniqueness, whereas biodiversity ranked relatively low in the Beaufort Sea (Figure 4). This perhaps reflects the lack of knowledge on species diversity in the Arctic, but also the fact that biodiversity in the Arctic is not as high. In the ESSIM LOMA, physical features stood out higher in the dimension of uniqueness (Figure 4). This is likely a function of the number of relatively small EBSAs associated with very unique bottom features and the wealth of long-term benthic ecology and fine-scale biodiversity research that has been conducted in this Region. The same spatial scale of sea-floor sampling has not taken place in the Beaufort Sea LOMA. In GOSLIM, biological processes along with oceanographic processes and seasonal refugia were accounted for most often with the primary dimensions of uniqueness and aggregation suggesting that GOSLIM is used by species for summer/winter feeding (Figure 4). This may be due to the influence of the St. Lawrence River acting in concert with major ocean currents to produce unique environments of high productivity. Similar dynamics are no doubt at play in much of the Beaufort Sea LOMA due to freshwater inputs from the Mackenzie River interacting with the Beaufort Sea gyre, and in parts of PNCIMA associated with bathymetry-driven gyres.

These findings indicate that the identification of EBSAs are adequately capturing the intent of the national DFO criteria, not only in the primary dimension of uniqueness, aggregation, and fitness consequences, but also in the biological/physical attributes of each of the dimensions.

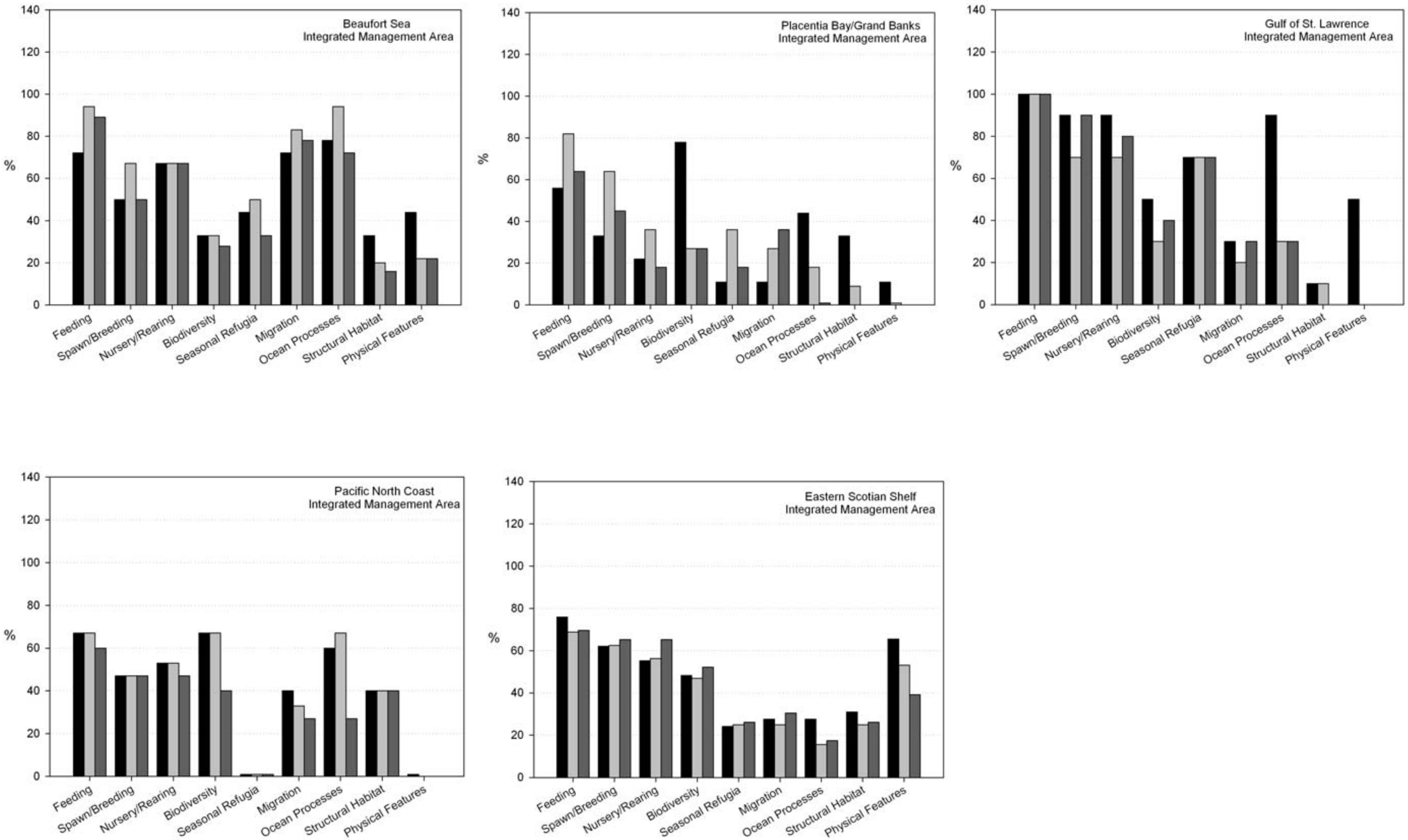

Figure 4. Percentage of function and properties for EBSA primary dimensions (Black=Uniqueness, Light Gray=Aggregation, Dark Gray=Fitness Consequences) in each LOMA

LESSONS LEARNED DURING THE APPLICATION OF THE EBSA CRITERIA

A number of recurrent themes became apparent during the review of EBSA reports and from the responses to the questionnaire that was distributed to key Regional experts. Some of the issues encountered were sufficiently resolved during the EBSA process, while others remain outstanding and require further discussion and scientific guidance. Some of the issues will undoubtedly benefit from subsequent experiences at international levels where the application of EBSAs is being conducted under the auspices of the CBD, IUCN, etc.

A number of positive experiences resulted from past EBSA exercises. Most scientists, although cautious about putting lines to maps without first explaining on all the various caveats and although cautious about how this information would be used in Oceans management, accepted the value of the exercise and contributed to the process. Once engaged, scientists were provided the opportunity to see how their work meshed with other researchers within DFO and also with other agencies/Departments. Although in some instances there was mixed success in applying all of the EBSA criteria, consensus was reached in most cases on areas that should receive heightened risk-averse management and thus qualified as EBSAs. In the PNCIMA process the application of EBSA criteria resulted in some resistance until it was understood that the EBSA process should parallel the identification of ESSCPs to ensure consideration of all information for regionally significant species and the areas that they inhabit (Jamieson in: DFO 2009/035). In the Arctic, most researchers have been focusing on stock assessments for marine mammals and anadromous fish species that are harvested primarily for subsistence purposes; the move to consider these data in an ecosystem context was and still remains challenging. Ecosystem science in the Arctic is in its infancy and has only accelerated in the last decade with a renewed focus on hydrocarbon development and with major research programs on climate change impacts. Many of these studies are still underway and results will no doubt add a huge body of literature to enhance the information/data and knowledge which aids EBSA identification processes. In spite of the fact that there is a large body of scientific information to draw from with respect to the four other LOMAs, much of the historical data were collected in support of commercially harvested fish and invertebrates, concerning some scientists who were asked to apply that information to EBSA identification.

Application of Primary and Secondary Criteria

The EBSA criteria make sense from an ecological perspective. They have been well thought out and are closely aligned with international criteria (i.e., CBD), and thus will serve DFO well in the future. The science-based approach to EBSAs provides for effective articulation of conservation objectives in support of Ocean Management when applied along with identified ESSCPs, degraded areas, and depleted species. At the operational level, the actual application of the EBSA criteria was somewhat problematic for different reasons, depending upon the Region. Most scientists were concerned that the application of the criteria was done without sufficient time to ensure that a robust analysis of layers was conducted and that all available experts were given the opportunity to participate. There were also concerns about using historical data, or data collected for quite different reasons, and thus bias in space and time and between species.

Of the three primary dimensions, both uniqueness and aggregation were relatively easy to moderately easy to apply in the majority of cases, followed by fitness consequences (Figure 5). However, one exception to this was for the Arctic, where both aggregation and fitness consequences were found to be tightly linked and easier to apply than uniqueness, which was found to be problematic based on the issue of scale. The entire Arctic seems unique on some scale or another and without a complete knowledge of every area of the Arctic, or LOMA, it is hard to decide what is unique to a greater degree than some other area.

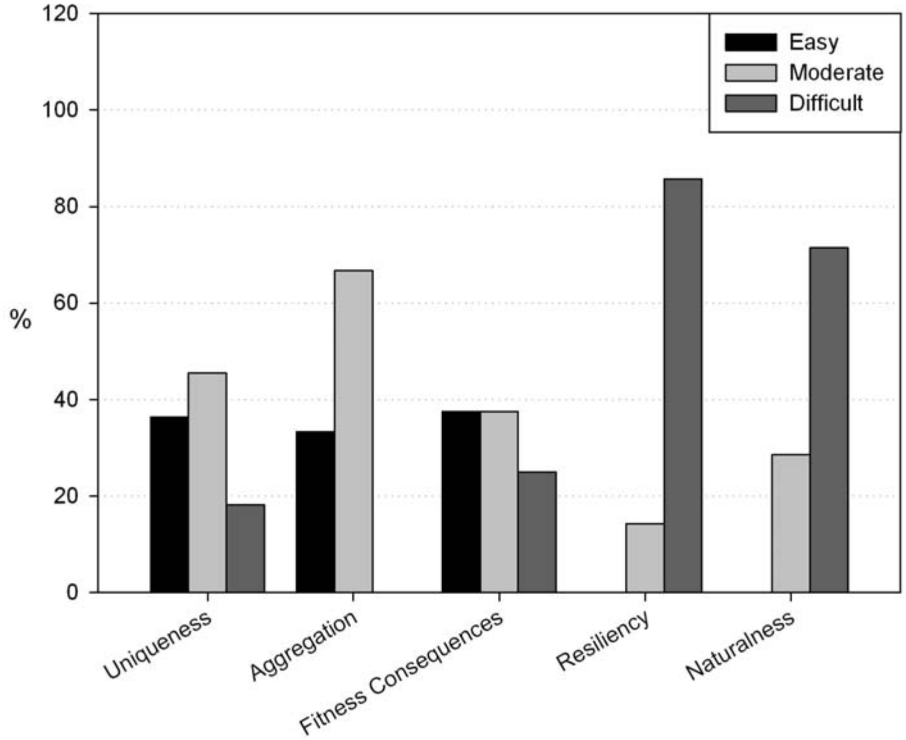

Figure 5. Degree of difficulty experienced in applying the primary EBSA dimensions in Canadian waters.

Uniqueness was not easy to apply in coastal applications. There may be sufficient data to characterise various stretches of coastline, and some of those stand out as unique. However, there are difficulties in interpolating between data points that are relatively close. As a result, there are situations where there are insufficient data to resolve the meaningful scales of patchiness, and this can be problematic in the application of "uniqueness" in a coastal setting.

For offshore pelagic species (i.e., fish eggs, larvae and decapod larvae), it was difficult to define clear boundaries that would have clearly identified species-specific areas. All three primary dimensions were difficult to apply to LEK and TEK, the main difficulty being in the application of "to a greater degree than". This concept of relativity seemed to get lost during interviews with locals who knew where they harvested and thus considered these areas as important (in some cases they may have been EBSAs, in other cases just areas that were safe and easy to access but not necessarily unique). Uniqueness in the Arctic was problematic for some respondents, for example the whole Arctic Archipelago (permanent ice pack) is unique and it was unclear how EBSA criteria would apply. Some further guidance on appropriateness of EBSA versus some other spatial tool might be required.

In some cases, the secondary dimensions were not considered due to the vagueness of the term or the subjective nature of dealing with them. The difficulty in application of the secondary dimensions is evident in Figure 5. One exception was in the case of structural habitat associated with the secondary dimension of "resiliency" in the PNCIMA exercise. Corals clearly fit this dimension due to their sensitivity to perturbation. However, since corals also met the primary dimensions of uniqueness and aggregation the secondary dimension was not required to assess the EBSAs. Naturalness is again difficult to deal with in the Arctic, where almost 100% of the area is still 'natural'. Scientific guidance to define a more objective approach is recommended for the secondary dimensions to remove their subjective nature.

Spatial and Temporal Scale

Spatial and temporal scale presented some difficulties in the EBSA process (Figure 6). Most ecologists recognize that dealing with scale in ecological applications is problematic (Levin 1992), due to the inherent variability in both space and time for different life stages of species or of physical properties. When applying EBSA criteria, the guidance from CBD (2009) is that there is no one correct scale for application of any of the criteria. The guidance on scale suggests: "If *specific* questions are posed, appropriate scales are usually self-evident, such as the range of an individual, the distribution of a species, or the persistence of an upwelling event." Moving between coastal and offshore areas of LOMAs was also identified as an issue. For example, where is the boundary between coastal and offshore EBSAs, and how are transition zones dealt with? Along coastlines, should all river mouths/estuaries be considered EBSAs, especially when dealing with different stocks of fish that exhibit site fidelity?

Even more problematic was dealing with scale in a non-LOMA offshore area which lacked initial management boundaries within which to work. This was resolved in Northern Foxe Basin by using physical and oceanographic features as the template which helped define the boundaries. However, the scale at which Science was asked to identify EBSAs was quite small relative to what might have been examined at an international, eco-region, or sub eco-region scale within an integrated management context. Rather than three separate EBSAs within Northern Foxe Basin, there might only have been a single area identified encompassing the entire Northern Foxe Basin. The issue of spatial scale of EBSAs is also evident when comparing Canadian versus International initiatives. For example, in a recent IUCN exercise to identify circum-Arctic EBSAs, the Beaufort Sea was identified as a "super EBSA" because it met all of the CBD criteria (IUCN 2010). However, the DFO LOMA-scale EBSA exercise was conducted at a finer resolution, and several EBSAs were identified within the Beaufort Sea. Temporal scale was also identified as an issue for species which are seasonally migratory, or for areas that have seasonally high variability. Spatial and temporal scale was an issue in seasonally ice covered areas.

Not all respondents had difficulty in considering temporal scale. Several respondents concluded that if an area is important in some period of the year, then it is an EBSA and can be dealt with using appropriate management measures. Climate change and EBSAs were discussed by some respondents as an issue for temporal scale, since with changing oceanographic conditions, there may be regime shifts and areas used by species will change. However, the international CBD (2009) guidance on climate change suggests that attention be given to whether data used to evaluate the area as an EBSA has temporal trends. As such, climate change impacts can be dealt with through monitoring, adjusting EBSA boundaries as needed and adaptive management into the future. Some EBSAs will continue to function even with shifting climactic regimes because they are areas controlled by bathymetry and oceanographic processes (IUCN 2010).

Data-Poor Situations

Data-poor situations were less problematic for EBSA expert respondents (Figure 6). In spite of efforts to ensure that as much data are gathered as possible, there is recognition of the reality of dealing with insufficient data in large ocean spaces and limited resources to sample all aspects of the ecosystem. Most LOMAs recorded data-poor situations (or mapped sampling effort), and recommended that data poor areas be flagged for future research efforts. Some fauna were simply not assessed when data were inadequate. In dealing with data-poor situations identification of major physical features and oceanographic properties as proxies for ecological functions seemed to be the key recommendation as an initial step in dealing with EBSA identification.

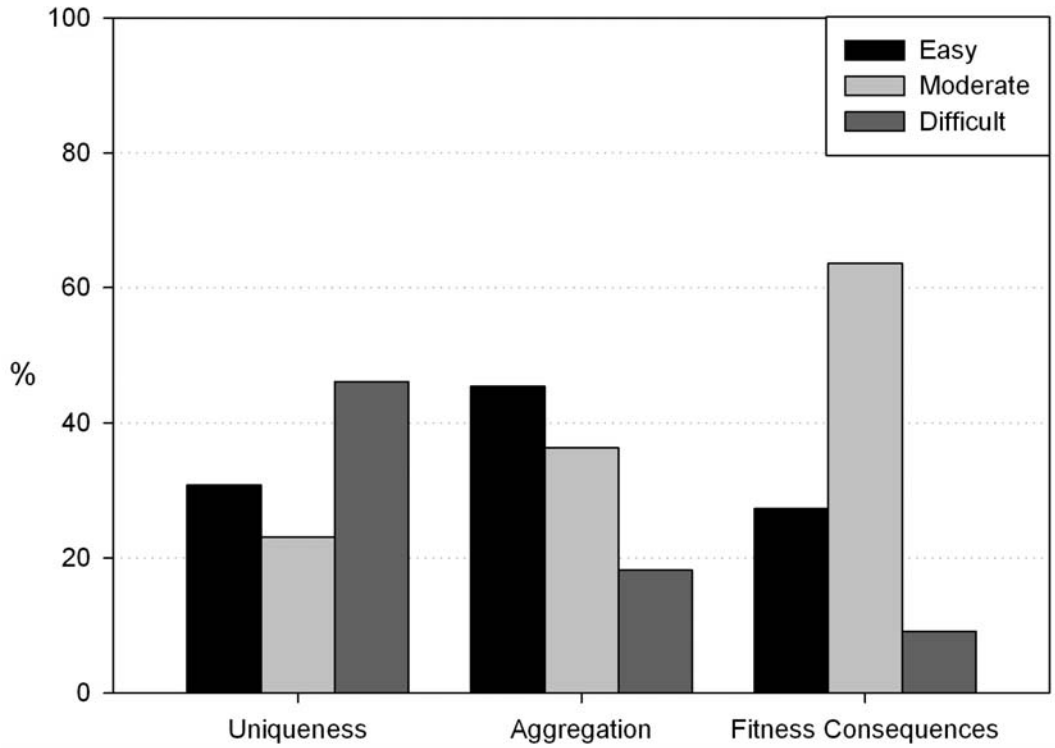

Figure 6. Degree of difficulty in dealing with scale (spatial and temporal), data poor situations, and data confidence in the application of EBSA criteria.

Data Confidence

Data confidence was moderately problematic for many respondents (Figure 6). Some respondents suggested that as information is coded, ranked, etc. during the EBSA process, many of the caveats and cautionary notes about data confidence is lost. This can be problematic, however as with data poor situations, there is international guidance available on how to resolve this issue. The CBD (2009) recognized issues of data-poorness and of data confidence (precision, accuracy, and uncertainty), and recommend that “with high uncertainty in data and information, the precautionary approach would support a relatively higher tolerance for false positives than misses”. This means that it is better to erroneously conclude that an area meets one of the criteria, when in reality it does not, than to miss an important area because we didn’t have all the data. As one questionnaire respondent answered, it is hard to return an area to unique once it is harmed. Future EBSA work should focus on ensuring a standardised approach to accounting for data precision, accuracy, and uncertainty and that these issues are well documented for each EBSA.

The EBSA process

There was a great deal of discussion by respondents about “the process” of applying the EBSA criteria. It should be recognized that the provision of scientific advice within the ecosystem approach, and providing the necessary components for setting conservation objectives for integrated management, are being conducted on a continuum in Canada. Some LOMAs started well ahead of others and as national guidance evolved, so did the approach to EBSA identification. For example, the PNCIMA EBSA exercise benefitted greatly from lessons learned during the ESSIM and GOSLIM EBSA exercises. Because of the different pace at which LOMAs progressed, there is a wide variety of opinion about the EBSA process. Four different preferred approaches were mentioned in the responses from regional experts (Figure 7).

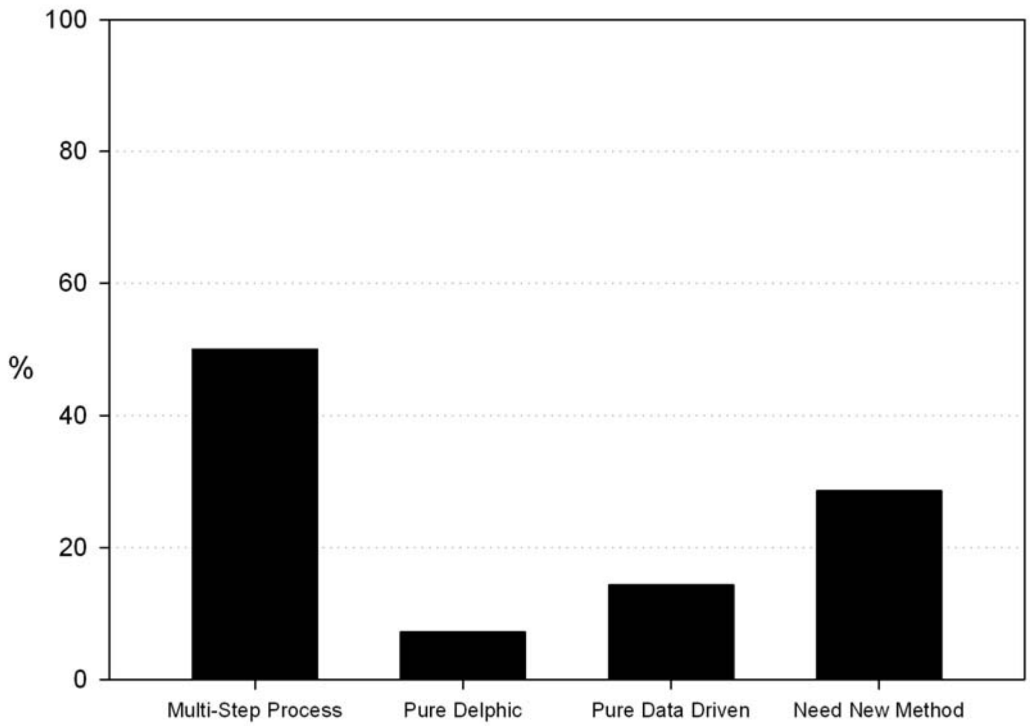

Figure 7. Suggested approaches to applying the EBSA criteria in Canadian waters.

The different opinions are quite valid and it really depends upon the situation as to which approach is most appropriate. By far the most frequently recommended approach is a multi-step process (two steps as a minimum). This combines a form of the Delphic approach where experts contribute thematic layers of important areas, followed by a second step consisting of some further analyses, using procedures such as overlap, congruence, or multi-dimensional analysis. There is a recognition that inherent weaknesses exist in this approach, including variability of available data for certain thematic layers and bias of data in space and time in other thematic layers. There seems to be national agreement in the approach of using physical features and oceanographic processes as a first approximation (template) over which biological themes are laid. This is followed by a scoring system of high, medium, and low (or other coding system), resulting in the nomination of an important area as an EBSA. The advantage of this approach is that it works in both data-rich and data-poor or remote areas, where the likelihood of mounting an expedition to collect more data is highly unlikely in the near future.

The purely Delphic approach was recommended for dealing with TEK; the use of maps and interviews is an approach that most people can easily relate to. This removes the issue of translating technical scientific language into lay language. In some LOMAs, a purely data driven approach was preferred. This could work in areas where a decadal scale of repetitive sampling over the LOMA has occurred. Finally, many respondents called for scientific guidance on a nationally-agreed upon approach (perhaps a new method) to resolve the issues surrounding the subjective nature of the Delphic and layering approach. It was also suggested that there should be a more comprehensive database of pertinent information, including data sources, references, caveats, data deficiencies, and confidence limits to the data so that an EBSA can be examined in the appropriate way. International examples of this approach could be useful for Canadian EBSA applications. Under the CBD, the Global Ocean Biodiversity Initiative (GOBI; http://www.gobi.org/) has excellent examples of high seas EBSAs with data layers and descriptions contained within Geographic Information System (GIS) maps. This approach may alleviate many of the current concerns on issues of data confidence, and transparency of process.

Applying EBSA criteria outside of LOMAs and in coastal areas

This report has focused primarily on the application of EBSA criteria for the five existing LOMAs. One of the goals of exploring lessons learned from previous LOMA EBSA exercises is to identify areas for which further scientific guidance is required prior to ultimately identifying EBSAs in coastal regions, or large ocean areas outside of current LOMAs. There have been several recent attempts to apply the criteria in other areas. EBSAs were successfully identified in the coastal Scotian Shelf and the Quoddy region of the Bay of Fundy. However, based on experiences in these two applications, and as discussed in the PNCIMA reports, the scale of coastal EBSAs and their connectivity to larger LOMA scale EBSAs should be discussed and scientific guidance provided. Is it adequate to identify all estuaries and river mouths as EBSAs, since all of these areas play important roles for migratory fish species (some currently and some historically)? It appears guidance is needed on how to adequately “nest” EBSAs within larger coastal areas. For example, although the Quoddy region of the Bay of Fundy is ecologically important and should be managed with caution, smaller areas within the larger region were selected and evaluated against the EBSA criteria and scientists were able to identify several areas that fit the primary criteria. However, they cautioned about dividing the whole of the Quoddy region into discrete areas, since the smaller areas identified as EBSAs and those areas that did not fit the EBSA criteria, are all interconnected. The inclusion of ecosystem modelling might be a way to demonstrate the connectivity of smaller patches in coastal applications like the Quoddy region, and would provide a site specific basis for higher than normal risk averse management of an area as a whole.

There is a relatively data-poor transition zone between the very near coastal area and the offshore EBSAs in the Scotian Shelf resulting in part from the capabilities of the DFO research trawler vessel which has an inshore limit of 50 fathoms. This results in relatively few EBSAs extending from inshore outward to 12 nm. The importance of the land/water interface and the mixing zone between freshwater and estuarine waters will no doubt be major factors in the EBSA coastal regions. This will require a whole other body of scientific expertise, and broaden the EBSA scope and scale of effort.

Conducting EBSA processes in large ocean spaces outside of existing LOMAs will require initial syntheses of existing literature in the absence of an EOAR, which were very valuable in the LOMA EBSA exercises. The issue of scale will be an important issue in the absence of LOMA boundaries and science guidance will likely be required to determine the appropriate geographical scale that is appropriate within which to begin the process of applying the EBSA criteria.

SUMMARY OF KEY LESSONS LEARNED

1. The EBSA criteria were applied successfully in each of the LOMAs, and the selected EBSAs reflect the scale of dominant physical/oceanographic features that occur at LOMA scales.

2. There is a need for scientific guidance on an approach that, for each EBSA, will allow users to see all the caveats, limitations, and level of confidence surrounding the data that was used to assess the important area against the EBSA criteria. The use of geo-referenced interactive maps should be explored as this may address many of the concerns that scientists expressed during the EBSA process, and will be invaluable to Ocean managers who have to explain their management decisions. A common look and feel for resultant EBSA products (matrices, maps, etc.) should be developed. This would make synthesis, analysis, and use by managers and external clients more amenable.

3. In order to alleviate concerns scientists had about retaining all the caveats and confidence around data, and to provide opportunities to import new information when it becomes available, EBSAs should be "living" entities. Databases should be maintained and routinely updated, and boundaries should be re-assessed periodically to ensure that changing oceanographic conditions related to climate change are not resulting in shifts in the distribution of species that utilize the EBSA. This will be crucial in moving from established LOMAs to areas which are data-poor or are difficult to gather new information.

4. The incorporation of TEK/LEK should become a key component of all EBSA processes. This information will be particularly important when moving from offshore to coastal EBSAs. The process of being more inclusive will present challenges, but will promote greater engagement and buy-in when conservation objectives are set and management actions follow.

5. Scientific guidance is required regarding the best approach to conduct the EBSA process. The Delphic approach has been applied; however some consideration should be given as to a common application of the Delphi system to ensure that contributors are confident they have reached consensus. Some consideration to Wiki approaches may be valuable to engage a larger body of experts, and may also save time, which can be a problem in traditional Delphi processes. Moving from a Delphic to a more analytical approach (overlap, congruence etc.) was successful in some LOMAs, and the approach of using physical features and oceanographic processes as a first approximation should be further assessed. Scientific guidance is needed for nationally-consistent analytical approaches. A variety of scoring methods were used to assess important areas against the dimensions, this could be standardised.

6. The secondary dimensions of resilience and naturalness should be revisited, and further guidance provided.

7. Scientific guidance on the issue of scale will be required when moving from LOMAs to coastal and non-LOMA offshore areas. Coastal areas may require a higher degree of "nesting" of scales, and the transition zone between coastal offshore areas will be an issue. Non-LOMA offshore areas are likely to suffer from lack of data and lack of synthesis from EOARs. Some guidance on the issue of scale (i.e., ecoregion or ecozone) would assist in the application of EBSA criteria.

LIST OF REFERENCES

National Science Advisory Processes

DFO, 2004. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006. http://www.dfo-mpo.gc.ca/csas/Csas/status/2004/ESR2004_006_e.pdf

DFO, 2006. Identification of Ecologically Significant Species and Community Properties. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/041. http://www.dfo-mpo.gc.ca/csas/Csas/status/2006/SAR-AS2006_041_E.pdf

DFO, 2006. National Science Workshop: Development of Criteria to Identify Ecologically and Biologically Significant Species (EBSS). DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/028 http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2006/PRO2006_028_B.pdf

DFO. 2008. Further Guidance on the Formulation, Prioritization, and Use of Conservation Objectives in an Ecosystem Approach to Integrated Management of Human Activities in Aquatic Ecosystems. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/029. http://www.dfo-mpo.gc.ca/CSAS/Csas/Publications/SAR-AS/2008/SAR-AS2008_029_E.pdf

Rice, J. (Editor). 2006. Background Scientific Information for Candidate Criteria for Considering Species and Community Properties to be Ecologically Significant. DFO Can. Sci. Advis. Sec., Res. Doc. 2006/089. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2006/RES2006_089_e.pdf

Placentia Bay – Grand Banks Large Ocean Management Area

DFO, 2007. Placentia Bay-Grand Banks Large Ocean Management Area Conservation Objectives. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/042. http://www.dfo-mpo.gc.ca/csas/Csas/status/2007/SAR-AS2007_042_E.pdf

Templeman, N., 2007. Placentia Bay – Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec., Res. Doc. 2007/052. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_052_e.pdf

Estuary and Gulf of St. Lawrence Large Ocean Management Area

Castonguay, M., and Valois, S., 2007. Ecologically and biologically significant areas for demersal fishes in the northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/014. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_014_f.pdf

DFO, 2006. Proceedings of the Zonal Workshop on the Identification of Ecologically and Biologically Significant Areas (EBSA) within the Gulf of St. Lawrence and Estuary. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/011. http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2006/PRO2006_011_B.pdf

DFO, 2007. Ecologically and Biologically Significant Areas (EBSA) in the Estuary and Gulf of St. Lawrence: identification and characterization. DFO Can. Sci. Advis. Sec., Sci. Adv. Rep. 2007/016. http://www.dfo-mpo.gc.ca/csas/Csas/status/2007/SAR-AS2007_016_E.pdf

Lavoie, D., Starr, M., Zakardjian, B. and Larouche, P. 2007. Identification of ecologically and biologically significant areas (EBSA) in the Estuary and Gulf of St. Lawrence: Primary production. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/079 http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_079_e.pdf

Lesage, V., Gosselin, J.-F., Hammill, M., Kingsley, M.C.S. and Lawson, J. 2007. Ecologically and biologically significant areas (EBSA) in the Estuary and Gulf of St.Lawrence: a marine mammal perspective. DFO Can. Sci. Advis. Sec. Res. Doc., 2007-046. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_046_e.pdf

Ouellet, P., 2007. Contribution to the identification of ecologically and biologically significant areas (EBSA) for the Estuary and the Gulf of St. Lawrence: The fish eggs and larvae and crustacean decapods larvae layer. DFO Can. Sci. Advis. Sec. Res. Doc., 2007/011. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_011_E.pdf

Savenkoff, C., Bourassa, M.-N., Baril, D. and Hugues, B.P., 2007. Identification of Ecologically and Biologically Significant Areas for the Estuary and Gulf of St.Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc., 2007-015. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_015_e.pdf

Swain, D.P., and Benoît, F., 2007. Ecologically and biologically significant areas for demersal fishes in the southern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/012. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2007/RES2007_012_e.pdf

Eastern Scotian Shelf Large Ocean Management Area

Breeze, H. 2004. Review of criteria for selecting ecologically significant areas of the Scotian Shelf and Slope: a discussion paper. DFO. Oceans and Coastal Management Report 2004-04. http://www.dfo-mpo.gc.ca/Library/283936.pdf

Buzeta, M-I. and Singh, R. 2008. Identification of ecologically and biologically significant areas in the Bay of Fundy, Gulf of Maine. Volume 1: Areas identified for review, and assessment of the Quoddy Region. Can. Tech. Rep. Fish. Aquat. Sci. 2788: vii + 80 p. http://www.dfo-mpo.gc.ca/Library/336749.pdf

DFO, 2006. DFO/FSRS Workshop on Inshore Ecosystems and Significant Areas of the Scotian Shelf, January 16-19, 2006. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/002. http://www.mar.dfo-mpo.gc.ca/science/rap/internet/pro2006_002.pdf

DFO. 2007. Eastern Scotian Shelf Integrated Management Plan: Strategic Plan. http://www.dfo-mpo.gc.ca/Library/333115.pdf

Doherty, P. and Horsman, T.. 2007. Ecologically and Biologically Significant Areas of the Scotian Shelf and Environs: A Compilation of Scientific Expert Opinion. Can. Tech. Rep. Fish. Aquat. Sci. 2774: 57 + xii pp. http://www.dfo-mpo.gc.ca/Library/331606.pdf

MacLean, M., Breeze, H., and Doherty, P. 2009. Using Fish Harvesters' Local Ecological Knowledge (LEK) in Support of Identifying Ecologically and Biologically Significant Areas (EBSAs) on the Offshore Eastern Scotian Shelf. DFO Oceans and Habitat Report 2009-01. http://www.dfo-mpo.gc.ca/Library/337212.pdf

Beaufort Sea Large Ocean Management Area

Cobb, D., H. Fast, M.H. Papst, D. Rosenberg, R. Rutherford and J.E. Sareault (Editors), 2008. Beaufort Sea Large Ocean Management Area: Ecosystem Overview and Assessment Report. Can. Tech. Rep. Fish. Aquat. Sci. 2780: ii-ix + 188 p. http://www.dfo-mpo.gc.ca/Library/331896.pdf

Paulic, J.E., Papst, M.H., and Cobb, D.G. 2009. Proceedings for the Identification of Ecologically and Biologically Significant Areas in the Beaufort Sea Large Ocean Management Area. Can. Manuscr. Rep. Fish. Aquat. Sci. 2865: ii + 46 p. http://www.dfo-mpo.gc.ca/Library/337292.pdf

Pacific North Coast Large Ocean Management Area

Clarke, C.L., and Jamieson, G.S. 2006. Identification of ecologically and biologically significant areas in the Pacific North Coast Integrated Management Area. Phase I, Identification of important areas. Can. Tech. Rep. Fish. Aquat. Sci. 2678: 59 p. http://www.dfo-mpo.gc.ca/Library/326795.pdf

Clarke, C.L., and Jamieson, G.S. 2006. Identification of ecologically and biologically significant areas in the Pacific North Coast Integrated Management Area: Phase II – Final Report. Can. Tech. Rep. Fish. Aquat. Sci. 2686: V+25p. http://www.pncima.org/pdfs/PNCIMATechReports/PNCIMATechReport2686.pdf

DFO, 2009. Proceedings of a national science advisory process to review Canadian experiences with ecologically and biologically significant areas (EBSA) in the Northeast Pacific, 29-30 June 2009, Nanaimo, British Columbia. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/035. http://www.dfo-mpo.gc.ca/Library/339321.pdf

International Processes and relevant literature

CBD, 2009. Defining ecologically or biologically significant areas in the open oceans and deep seas: Analysis, tools, resources and illustrations. A background document for the CBD expert workshop on scientific and technical guidance on the use of biogeographic classification systems and identification of marine areas beyond national jurisdiction in need of protection, Ottawa, Canada 29 September – 2 October 2009 https://www.cbd.int/doc/meetings/mar/ewbcsima-01/other/ewbcsima-01-multiorgs-en.pdf.

Defining EBSAs in the High Seas. http://www.gobi.org/

Levin, S.A. 1992. The problem of pattern and scale in ecology. Adapted from the Robert H. MacArthur Award Lecture, presented Aug. 1989, Toronto, ON, Canada. Ecology, 73(6): 1943-1967. www.esa.org/history/Awards/papers/Levin_SA_MA.pdf

MacMillan, D.C. and Marshall, K., 2006. The Delphi process – an expert-based approach to ecological modelling in data-poor environments. Animal Conservation **9** (2006) 11–19. http://onlinelibrary.wiley.com/doi/10.1111/j.1469-1795.2005.00001.x/full

Speer, L., and Laughlin, T. 2010. IUCN/NRDC Workshop to Identify Areas of Ecological and Biological Significance or Vulnerability in the Arctic Marine Environment, Workshop Report, November 2-4, 2010, La Jolla, CA http://data.iucn.org/dbtw-wpd/edocs/Rep-2011-001.pdf

APPENDIX 1: QUESTIONS PROVIDED TO REGIONAL SCIENTISTS ON THEIR EXPERIENCES IN APPLICATION OF EBSA CRITERIA

1. For each of the three primary and two secondary EBSA dimensions, what if any were the key strengths or challenges experienced by you in their application:

   Primary dimensions:
   a. Uniqueness
   b. Aggregation
   c. Fitness Consequences

   Qualifying dimensions:
   d. Naturalness
   e. Resilience

2. Scale issues often arise when starting an EBSA process. For example on a global scale vs. a LOMA scale, a quite different set of EBSAs might result, this could be compared to a "nesting" exercise as occurs in other disciplines. As we move away from established LOMAs into other ocean spaces, the issue of scale may become even more problematic. Additionally, the issue of temporal scales can provide a challenge. Some areas are used at certain times of a year or a life cycle, and can be challenging to capture in a static process. Were spatial and temporal scales problematic, and if so, did you resolve it to your satisfaction?

3. Identification of EBSAs in data poor situations can be challenging. How did you deal with data poor situations and were you satisfied with the outcomes?

4. The process of EBSAs should be fully transparent; do you feel the issue of "data confidence" has been adequately dealt with to allow a fully transparent process?

5. The method of assessing and ranking EBSAs can be problematic, this has been well documented. The expertise available (and inclusiveness of stakeholders), personalities of those in a workshop can affect the outcome of the process. Of the methods you employed to identify EBSAS (Delphi, overlap analysis, congruency, or combinations of methods), do you feel one approach worked most effectively and why, or do you feel more work is needed on the methodology?

6. Other general comments (positive and negative) on the application of EBSA criteria.

APPENDIX 2: SUMMARY OF EBSA PROCESS FOR EACH LOMA

Pacific North Coast Integrated Management Area (PNCIMA)

In Phase I of the PNCIMA EBSA identification process, regional scientific experts were surveyed to identify areas of PNCIMA that met the five criteria using a modified Delphic process; these areas were called Important Areas (IAs). Thematic layers produced included species of fish, invertebrates, marine mammals, and reptiles, oceanographic features, provincial eco-units and Parks Canada areas of interest. Experts were also asked to provide rankings of each IA they identified according to each of the five EBSA criteria. The final list of 132 species-related IAs is captured in 40 thematic layers (Clarke and Jamieson 2006).

In Phase II three categories of unique physical features were used as the basis for EBSAs (Clarke and Jamieson, 2006). The physical features chosen for PNCIMA include oceanographic features, bottleneck areas and the sponge bioherms. For PNCIMA, 15 of these features were identified and mapped and are presented as EBSAs. The overlap of these features with the remaining IAs was analysed; the one excluded was “River Mouths and Estuaries. In total, 95 of the original IAs overlapped with the 15 EBSAs for a correlation of 73%. The biological congruence of each of the EBSAs with the IAs was also examined. The 15 EBSAs had a total area of 45,182 km2 (44.3% of PNCIMA). Individual EBSAs were profiled and their rationalisation using EBSA criteria was provided. It should be noted that Large Ocean Management Area (LOMA)-scale EBSAs are largely non-existent in the archipelago-fjord complex that characterises the mainland coast of British Columbia. This should not imply that regionally important EBSAs do not exist there, but rather that EBSAs there would be more appropriately identified through Coastal Management Area-scale EBSA analyses.

Beaufort Sea LOMA (BSIM)

In order to collect ecological data to identify Ecologically and Biologically Significant Areas (EBSAs) in the Beaufort Sea Large Ocean Management Area (LOMA) two workshops were held, one with the scientific community and one that brought together local community representatives, federal and territorial government departments, and co-management partners. The purpose of these workshops was to: 1) discuss the process of selecting EBSAs; 2) to discuss its application in the Beaufort Sea; and 3) to attempt, for the first time in the Canadian Arctic, to apply the EBSA process. Once the candidate lists were compiled from these initial workshops, a community tour was held in February/March 2007 to give all community members the opportunity to comment on candidate area selection. Each candidate area was then put through the National Evaluation Framework for EBSAs (DFO 2004) which both considers and evaluates each area based on a ranking system against the main dimensions (i.e. uniqueness, aggregation, fitness consequences) and the additional dimensions (i.e. resilience and naturalness) outlined in the Framework. The evaluation process for candidate areas produced a total of 21 candidate areas, of which a total of 20 EBSAs were identified (10 EBSAs, 10 EBSA data deficient) and one rejected EBSA. These results were published in the Beaufort Sea Ecosystem Overview and Assessment Report (Cobb et al. 2008).

Gulf of St. Lawrence Integrated Management (GOSLIM)

A zonal workshop was held in order to launch the EBSA identification process for the Gulf of St. Lawrence Integrated Management (GOSLIM) initiative (DFO, 2006). This meeting, based on a scientific knowledge advisory approach (consultative or "Delphic" approach), identified 96 potential large important areas (IAs) for this ecosystem. A second approach, of a more analytical nature and based on available information layering, was suggested as the next step for EBSA identification in the Estuary and the Gulf of St. Lawrence. Eight thematic (information) layers were therefore identified, and Research Documents were produced for: topography and physical processes, primary production, secondary production, meroplankton (fish and invertebrate larvae), benthic invertebrates (molluscs, crustaceans, anthozoa, etc.), pelagic fish, demersal fish, pinnipeds and cetaceans. For each thematic layer, different IAs have been identified based on the best scientific information available (geographically referenced data). Except for the "topography and physical processes" layer for which other processes were used for IA identification, experts also provided rankings of each IA they identified according to the three primary EBSA dimensions.

A second workshop was held in order to synthesize the information across thematic layers (DFO 2007). The IAs were analyzed based on: (1) each of the three main criteria used separately and (2) the sum of their scores. The first analysis is justified because an area can be identified as an EBSA if it ranks highly on one or more of the three main dimensions, uniqueness, aggregation and fitness consequences for a single species or habitat feature (DFO, 2004). The three main dimensions were therefore considered independently, overlaying across thematic layers only the IAs in which a high rank was reported. The main potential EBSAs were identified as the regions with the largest number of overlapping high-ranking IAs from the thematic maps. The second type of analysis considers the cumulative importance of a wide range of attributes (dimensions). By doing so, areas that possess a low or intermediate rank across a large number of EBSA dimensions and thematic layers can also be considered potential EBSAs. Criteria scores were summed over thematic layers and criteria, and then binned into quantiles to produce a new index for mapping. However, because justification for identifying an area as an EBSA is stronger when it ranks highly in at least one feature/dimension (DFO, 2004), a second approach was also taken, in which such a constraint was added. The IAs for each thematic layer with at least one high rank for one of the three dimensions were selected. The scores were then summed over thematic layers and dimensions, and again binned into quantiles for mapping. The analysis resulted in 10 EBSAs for GOSLIM.

Placentia Bay/Grand Banks LOMA (PBGB)

The identification of EBSAs within the boundaries of the PBGB LOMA was undertaken through a three step process (Templeman 2007). First, information which stood out during the composition of the PBGB Ecosystem Overview and Assessment Report (EOAR) was recorded for areas that were noted for having structural and/or functional significance in the PBGB LOMA. Second, a literature search was carried out that led to the identification of several key documents detailing demersal fish distribution across the Grand Banks (Kulka et al. 2003), the distribution and timing of spawning for 10 commercially important species (Ollerhead et al. 2004), the ecological importance of the southern area of the Grand Banks (Fuller and Myers 2004), as well as other species specific research documents (Kulka 2006; Walsh et al. 2001). Finally, using a questionnaire and a map, key scientists in the region where given the opportunity provide input on those areas that they felt could be deemed significant based on their knowledge and experience. Several instances of personal communication with knowledgeable persons provided much useful unpublished information. Significant species and habitat features identified through the above processes were evaluated to be 'high', 'moderate' and 'low' against the EBSA dimensions. The justification for identifying an area as Ecologically and Biologically Significant is stronger when an area is listed as 'high' on several dimensions. Assigned EBSA site scores derived from the evaluation matrix were based on an assigned value of 1 point for each ‘high’ functional, structural or biodiversity feature related to a primary dimension and ¼ point for each ‘moderate’ functional, structural or biodiversity feature of the same. Dimensions classified as ‘low’ were not included in the final matrix and did not receive any value towards individual site scores. In addition, no scores were given for any of the secondary dimensions since these are to be considered as modifiers in the process of determining priority status for areas that rank similarly on the primary dimensions. Based on the above scoring regime, EBSAs identified for the PBGB LOMA were listed in order from highest to lowest total score. Since not all information was based on quantitative data or existing maps (e.g. some marine mammals, some fish, some benthic invertebrates, seabirds and habitat) some inferences had to be made, and EBSAs were mapped based on best fit of overlapping distribution, biogeography, and bathymetry.

Eastern Scotian Shelf Integrated Management (ESSIM)

A draft report on the context and approach for setting conservation objectives describes the EBSA process for ESSIM (Dougherty, pers. com). All proposed EBSAs were initially classified according to the Scotian Shelf Benthic Classification Scheme proposed by Kostylev (DFO 2006). The benthic habitat categories used were based on Scope for Growth and Natural Disturbance Indices estimated for the Shelf as a whole. These were as follows:

> Type I – Areas characterized by low scope for growth and low natural disturbance indices. Benthic invertebrate fauna in these areas are likely to be highly vulnerable to bottom disturbance and will likely have low recoverability. These are the areas that will likely be most vulnerable to human bottom disturbances and will recover most slowly from any such disturbance.
>
> Type II- Areas characterized by low scope for growth and high natural disturbance indices. Benthic invertebrate fauna in these areas are likely to have low vulnerability to bottom disturbance but once disturbed will recover most slowly from any such disturbance.
>
> Type III- Areas characterized by high scope for growth and low natural disturbance indices. Benthic invertebrate fauna in these areas will be highly vulnerable to bottom disturbance but will have will have high recoverability.
>
> Type IV- Areas characterized by high scope for growth and high natural disturbance indices. Benthic invertebrate fauna in these areas will show a low vulnerability to bottom disturbance and will show high recoverability. These are areas that will be least vulnerable to human bottom disturbances and will recover most quickly from any such disturbance.

Any previously identified rationale for affording an area special status was considered sufficient to identify an area as unique over and above its ranking and evaluation during this process.

Since all areas are to some extent ecologically and biologically important a ranking scheme was developed to give some indication of the relative importance of areas identified as ecologically and biologically significant. An initial overarching ranking was provided by classification of areas into benthic habitat types as outlined above. In order of importance those falling into habitat type I are ranked highest because of their sensitivity to disturbance and low scope for growth, those areas falling into habitat type IV are ranked lowest because of their low sensitivity to disturbance and high scope for growth. Areas within each habitat type were further ranked on the basis of the number of EBSSs and processes that occur there. Each area was ranked based on the average density of each EBSS and those areas with a ranking of 1, 2, or 3 for any of these species were given a point score of 1 for each species present. An area was given a point score of 3 for high densities of each depleted species. Each area was also ranked for the fish diversity an area was given a score of 1 for low diversity (bottom third of observed diversity measures), 2, for moderate diversity (middle third), and 3 for high diversity (top third).

The processes outlined above resulted in 42 proposed EBSAs for ESSIM.