Identification of Regionally Significant Habitats in the Gulf of Maine

A Report on the Peer Review of the Great Bay and Quoddy Region Pilot Projects

Panel Members:
Peter Auster, Co-Chair
University of Connecticut at Avery Point, National Undersea Research Center, Groton, CT 06340
Syma Ebbin, Co-Chair
University of Connecticut at Avery Point, Marine Sciences & Technology Center, Groton, CT 06340
Tundi Agardy
World Wildlife Fund, Washington, D.C. 20037
Richard Burroughs
University of Rhode Island, School of Marine Affairs, Kingston, RI 02881
Glen Jamieson
Department of Fisheries & Oceans, Pacific Biological Station, Nanaimo, British Columbia V9R 5K6
Francine Mercier
Parks Canada, Hull, Quebec K1A 0M5
Roman Zajac
University of New Haven, Dept. of Biology & Environmental Studies, West Haven, CT 06515

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Introduction

The Gulf of Maine Council (GOMC) developed an Action Plan outlining the need to identify "regionally significant habitats" in the Gulf of Maine (GOM) for protection, restoration, and enhancement. A Habitat Panel, formed by the GOMC, agreed that such habitats could be identified as those areas of greatest importance to highly regarded species. The Gulf of Maine Project of the U.S. Fish & Wildlife Service then conducted a survey of Habitat Panel members and developed and ranked a list of "priority species" based upon a variety of social and ecological criteria. Two pilot projects were conducted to demonstrate approaches to delineating regionally significant habitats; one each in Great Bay and Passamaquoddy Bay.

This document is a report of the results of a Peer Review Panel which was convened to evaluate the results of the pilot projects and assess the projects based on general and technical acceptability of the findings, and the methods applied.

At the outset, the members of the Peer Review Panel would like to acknowledge the extensive amount of effort and expertise which went into the development of the two pilot projects. Individually, they are good examples of approaches to identification of significant habitats and were well presented, although they admittedly represent the results of projects constrained by time and available funds. In addition, the Panel appreciates the highly informative project presentations given by Drs. Arnold Banner (US Fish and Wildlife Service) and Mick Burt (Huntsman Marine Science Centre), at the start of the review session.

The Peer Review Panel was charged with reviewing the two pilot projects based on a specific set of criteria. Overall, the objective was to review the pilot projects in regards to using the methodologies for expansion into the greater Gulf of Maine region. The two pilot projects provided good examples of different approaches to delineating regionally significant habitats and to the effects of varying spatial scale.

This document summarizes the discussions of the panel which address each of the review criteria. In preparing this report, we attempted to eliminate redundancy in some of the major discussion points, although some aspects of the discussion were repeated when dealing with multiple evaluation criteria. Also, several questions and points were raised during the discussions which required further elaboration. Those regarding the specific and long-term objectives of the GOMC are included at the end of this document in the section entitled "Recommendations, Caveats and Conclusions". Discussion points for each of the review criteria are summarized below, in the order they were addressed.
Review Criteria and Discussion

1. Evaluate methods for selecting the subset of evaluation species from the GOMC ranked priority list (including methods for participation by local biologists) and methods for selecting evaluation species of local interest (e.g., conservation, economic) including methods for participation by stakeholders.

The panel acknowledged that the single species approach which utilizes a list of "high priority" species would encourage local acceptance of the validity of the process, and ultimately actions needed to protect or restore habitat. However, the validity of the original priority species list was questioned. It was noted that although part of the species selection was rigorous and quantitative, part was also subjective and value-laden. Ultimately it was felt, the process was judgmental. In addition, based on the materials provided, it was felt that there was inadequate documentation of the species selection methodology, limiting the ability of experts in other areas to duplicate the protocols developed in these studies.

The goal of the GOMC was questioned in terms of whether the ultimate objective of this exercise is the preservation of species, which have been mapped, or the protection of the habitats, which have been inferred. Additionally, there was discussion as to whether the list includes enough species to insure that habitats which will require protection or restoration are identified.

Selecting a certain number of species at each trophic level, delineating between primary producers, and primary and secondary consumers, might be a better avenue to developing a single species approach. Requiring a few species from each trophic level would help ensure that all potentially critical habitats are identified. Neither methodology identified keystone species, sensitive, threatened or endangered species, nor primary producers. For example, it was noted that migratory bird species, many of which have special conservation mandates, were not well represented on the GOMC list. Delineating these species, in addition to other significant species, would broaden the scope of potentially significant habitats. The resulting habitat maps for these species should be presented separately due to their potential for dominating the results of the aggregate analyses.

The diversity of values concerning a species of human importance with a species of ecological importance can cause problems with conflicting objectives in assembling a priority species list. For example to protect the resident Canada goose population you might end up identifying the need to protect golf courses. Human values may not serve as a good proxy for ecological values. It was noted that the priority species list includes an introduced species, green crab, and a stocked species, Atlantic salmon.

Allowing local selection of species from the Gulf of Maine list, and identifying locally significant species not found on the master list, restricts the ability to compare the aggregate species maps between projects. The public was invited into the process during the pilot project stage, after the master species list had been compiled. Involvement with stakeholders should begin at the initiation of the project (i.e., the identification of priority species), when objectives are initially set. Obviously, the mix of stakeholders can influence the mix of species selected. In both studies, lobster was selected for analysis but cod was not, despite the regional significance of cod in the Gulf of Maine, its presence on the list of priority species, and the existence of a companion
study supported by the GOMC which identified local cod and haddock spawning grounds (i.e., through the Island Institute and Ted Ames). Stakeholder involvement in the Quoddy region was low, only two of five potential stakeholders actually participated at the meeting. Bringing stakeholders into the process late tends to dilute the desired goals of the GOMC process. In addition, limited participation by stakeholders and the existence of criteria which contain diverse and potentially conflicting values may lead to the over or under emphasis of certain habitats.

The panel questioned the "species ranking criteria" (from: Identification of Species for Priority Habitats, USF&WS, Gulf of Maine Project) regarding how points were apportioned to each of the items. The ten ranking criteria were weighted over a wide range of 5 to 16 points. In particular, criteria A was weighted 16 points, the highest of any, and contained numerous and not necessarily congruent factors. In particular, there are widely different value systems involved in choosing ecologically important species versus commercially important species. Criteria A forces the respondent to integrate those values under the same rubric, and the weighting system places equal and high point values on disparate criteria. Item D, which focuses on species with anticipated declines in population numbers, highlights potentially short term conditions in the population dynamics of a particular species and places time limits on the value of the list as populations recover (and others decline).

The issue of spatial scale of the projects came up several times in discussion. It was noted that the two pilots were of very different geographical scales. The Quoddy Project was significantly larger in geographic size than the Great Bay Project. This had a large influence on the results, affecting the species selected as well as the final differentiation of critical habitat areas on the composite map. While the Great Bay project effectively looked at the entire watershed for some species, the Quoddy pilot limited the analyses to the head of tide. The large scale of the Quoddy project posed a problem during the weighting of species by their area scores which led to an apparent underemphasis on estuarine areas in the final determination of regionally significant habitats. The importance of those species with limited distributions within estuarine gradients should not be underestimated.

The disparity between the scales of the two projects brought into focus the tension which exists between the identification of locally and regionally significant species and habitats and raised questions regarding the overall goals of delineating "regionally significant habitats" and the future intentions of the GOMC. It was questioned at what scale the process would be conducted in the future. It was felt that it was more useful to develop the local scale after the regional scale had been identified.

As an aside, all habitat studies conducted should be presented in an active digital format to allow the audience to change scale by zooming in on smaller selected sub-areas. This was most evident in the Quoddy project where the larger geographic scale of the study area made the detail of near-shore estuarine areas and intertidal habitats too small to delineate. While we realize that users of these products would have the results in a GIS, the review was constrained by the single scale which we had to view.

Because the method is based on distribution of species today, temporal changes and the restoration needs of previously suitable habitats (i.e.; those that are currently degraded) need to be accounted for. Identification of productive potential might be more of more use in planning
management responses. The Panel felt that temporal change needs to be considered in project
development and monitoring programs should be considered to update the status of species
ranges and habitat distributions. It was suggested that all historically documented productive
habitat for a given species be included to avoid any unintentional bias. Historical habitats should
be identified and mapped, but differentiated from existing habitat used by a particular taxa.

2. Evaluate the status and availability of data sets of environmental parameters and
occurrences of the species of interest.

   It was noted that the documentation of data sets was minimal. It was not possible to
recreate what was done from the material presented and archived. There were no sections on
data availability or addressing the problems encountered during data acquisition. There was no
discussion of what data were needed or what steps should be taken if the process is to be
continued. It was not clear if and where all the data that was used is archived, or where it is
available for review. There was some question as to whether the availability of data influenced
the ultimate selection of species used, or if it would influence the species selected in a regional
analysis.

   It would be useful to have an example of the detailed procedure used to calculate the
value for a “cell,” walking the reader through the process step by step. There should be better
documentation regarding the manner in which the aggregation of data for each layer and for the
composite layer was conducted. In addition, there should be documentation of the procedures
used to extrapolate values for cells from non-uniformly distributed point data, such as for salinity
and temperature values in the Great Bay study.

   In the Great Bay Project, it was noted that the profiles for species occurrences were based
primarily on environmental factors and not all relevant data were incorporated into the models.
For example, water clarity could be incorporated into the model of eel grass distribution. In the
Quoody Region, on the other hand, these were based on expert opinions, which relied heavily on
the published literature, and there was no reliance on environmental parameters and no data sets
per se. The Panel recommends that future studies be standardized in approach.

   The way in which data are presented may imply various conclusions. The lack of substrate
data on the outer coast eliminated its use from most maps in Great Bay. The inconsistent
inclusion of the coastal area in the analyses could be perceived as implying that this area is less
critical than others for which there is adequate data. Lacking adequate and consistent data, this
area should have been excluded from the analysis. This was a study of two estuaries and it should
be stated as such.

   There was little quantitative or qualitative way to judge the quality of the data used,
especially for the Great Bay project which used models to develop coverages. It was not clear
what data were used and what data were excluded and for what reason(s). In addition, if data
inclusion criteria existed, they did not always appear to be consistently applied. For example, the
lack of substrate data on the outer coast prevented the mapping of lobster habitat there, yet other
species distributions were based on occurrence data and model output. Sport fishermen were
consulted for information regarding the distribution of some species, such as striped bass, but

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similar information from either sport or commercial fishermen was not utilized in mapping the distribution of other species, such as lobster.

Environmental parameters are often dynamic in nature, but were used statically in the Great Bay Study. There was some question as to whether extreme values were adequately considered, since these may be more important in constraining species distribution than average values.

3. Evaluate the general methods to develop, test, and review species/habitat models.

It was noted that the Quoddy report was not peer reviewed, and that more than one expert should be utilized to develop the species profiles and distributions when using “expert” advice. In addition, more detail was desired regarding the procedure for developing scores based upon the literature.

It was felt that there should be sensitivity testing of the models and the parameters utilized. The model data did not appear to be always accurate, as demonstrated by juvenile pollock, where occurrences were observed much further upstream than predicted by the models. It was stated by Dr. Banner during his presentation that the authors of the Great Bay Study used the model results rather than occurrence data unless there was a very good reason to do otherwise. This needs further elaboration and it is the Panel’s opinion that without any further justification for this decision, occurrence data should supersede modeled estimates. In addition, there should be field verification or empirical data used to confirm the validity of the model predictions or expert observations and statements. The same protocol should be utilized in both areas.

In the Great Bay report there was high level of quantification without any incorporation of uncertainty. This may lend a false sense of precision or security to the results, especially in the detailed delineations of high priority areas in the aggregate map.

4. Evaluate the methods used to assign habitat scores based on species rank, habitat quality for each species, relative abundance, and the habitat aggregated scores. (Are the highest scored areas those of high regional significance; is it likely that stakeholders would agree with the outcomes?)

The reports were useful in that they utilized different methodologies and the implications of these different approaches (models versus expert-derived polygons) could be compared. There was, however, some question as to the ultimate usefulness to the GOMC and the regional relevance of the results derived from the two approaches. The lack of a consistent methodology for the two studies impeded the ability of the Review Panel to compare the two fully. The best methodology might be one which combines the approaches used in the two pilot studies: modeling, known occurrences, and expert knowledge. The different approaches could be used to provide some validation for each other. For example, whale occurrences could be modeled using depth and current data and verified using expert knowledge. Overall, a consistent approach needs to be used in all of these studies so that at the end it is possible to determine the regional
significance of any particular habitat or habitat type, comparing the results of all the studies with some confidence in their validity.

The importance and scarcity of the various habitat types within the region as well as the local area should be assessed. There needs to be some linkage between the subarea focus of the pilot projects and the GOM region as a whole, a means of evaluating and comparing how well-represented a habitat is within a subarea as well as within the entire GOM region. Potentially, habitats could be given two scores, one for local importance or scarcity and one denoting regional importance or scarcity. These could be calculated as the ratio of the existing area of a given species' habitat to the total amount of that type of generalized habitat within the local area or the total amount of that habitat type within the GOM region.

The issue of local versus regional scarcity and representativeness needs to be resolved. For example, how important, regionally, is an area which is of particular significance to a species at the outer limit of its distributional range, such as the Arctic tern and Atlantic puffin? These species may not be numerous locally or even regionally within the GOM, but may have substantial populations in other areas. The question posed then is: how much importance should small colonies of these species be given, both on the local and regional scale? This might be answered by identifying the habitats or species which characterize the Gulf of Maine as an eco-region and then identifying these at local scales.

The aggregate maps in the Great Bay study primarily reflect species richness, not necessarily the overall importance of the habitats per se. The significance of some critical species and habitats appears somewhat diminished as a result. Aggregating the data by trophic levels on separate maps would be more useful in this regard. The resulting maps should identify habitat important to multiple species, not necessarily all species at once, as well as highly ranked GOMC list species.

The results were based on how many species utilized a given habitat and were significantly influenced by the mix of species chosen. For example, if estuarine species are primarily selected, the resulting aggregate map(s) will delineate critical estuarine habitats and the ultimate conclusions of the study will differ from those of an analysis in which primarily marine species are selected.

The lack of a map indicating human impacts in the watershed limits the usefulness of the study for use as a tool in local land-use planning and other management decisions. The inclusion of a map delineating existing human development and uses within the watershed area would facilitate the usefulness of these projects for selecting high priority sites at both regional and local levels.

No summary or conclusions were presented in either report indicating which habitats were regionally or locally significant. Habitat profiles should be developed to accompany the aggregate maps, providing some interpretation for the diversity of colored zones indicated on the map(s). For example, in the Great Bay study it appeared from the aggregate map that eelgrass beds along deeper water channels within the Bay were more important than eelgrass beds elsewhere. In the Quoddy region the deep waters off western Grand Manan appeared to be of greater importance than other areas.

The GOMC needs to identify a consistent methodology to quantify and score habitats. This methodology should be developed to best meet the stated goals of the GOMC and should be
implemented in a consistent manner for all future studies in order to obtain comparable results between areas. In other words, the scores for the various types of habitats, such as those used for breeding, as nurseries, or for the general adult population should be scored consistently for all species. In addition, the use of basic habitats subdivisions, such as intertidal, shallow subtidal (e.g., <20 m), or deep water (e.g., > 20 m), would facilitate the quantification of relative area and relative scarcity.

In the Quoddy Project, the area scores were not scaled to retain real area relationships, and were thus meaningless for all but two species with the “rarest” habitat. In addition, it was not clear how the habitat rankings related to the maps.

It was not clear how the general habitat rankings were achieved in the Quoddy Project. Again, an example would greatly facilitate understanding. Habitat values were arbitrarily assigned by the project manager based on information provided by experts. There was no table or explanation regarding how each of the various habitats were ranked, i.e.; critical, general, breeding. There did not appear to be any consistency between species, reflecting the individual approaches taken by the various experts. When the habitat scores were overlapped, inconsistencies were therefore magnified. In addition, there were inconsistencies in what the different colors represented on the habitat maps included in the Appendix.

In Table 1 of the Quoddy Report, criteria A through J need to be defined since they did not appear to correlate to the new GOMC criteria and rankings as documented on the errata sheet of Appendix I of the Great Bay report. It was assumed that they referred to the old GOMC criteria.

Species rankings should be based on the GOMC list in order to have a consistent quantification of regional significance, rather than on a local re-ranking of species utilized by the Quoddy Project. In order to be consistent and have regional relevance, local species should be added without changing the GOMC rankings. The Great Bay project, on the other hand, used GOMC species rankings. Neither project, therefore, was comparable nor were they consistent with respect to this criteria.

The relative area scores given in the Quoddy project were difficult to understand. The scores were based on a sliding scale of one to eight, with scarce habitats given higher scores than plentiful habitats. The Panel felt that these habitat areas should be compared to the total suitable area within the study rather than the total study area itself. This would be far more useful and informative. For example, the established area of rockweed would be compared to the total area of intertidal habitat within the study area. A few examples using specific species should be presented to show how the relative area scores were developed.

The scoring of habitats in the Quoddy Project appeared somewhat arbitrary, thus impeding our understanding of both the habitat scores and their ramifications. The project wasn’t rigorous quantitatively, although the areas delineated as significant habitats were recognized by others as ecologically significant as well. Other potentially significant habitats, however, were not delineated due mainly to the large geographic scale of the Quoddy region and problems with the area score weighting procedure used.

The Review Panel generally had confidence in the single species maps produced by the Quoddy Project but the methodology used to aggregate regionally significant areas onto one map
was not perceived as reliable. Although a copy of the final aggregate map was not included in the report, one was available during the presentation. Thus our evaluation of the final results of the Quoddy Study was somewhat limited. The final map was internally consistent and delineated important areas for local species and was therefore of use at the local level, but of less value in the larger GOM regional context. The approach was less useful when applied to the regional scale since the species rankings were locally relevant rather than regionally relevant. If the GOMC list and rankings had been used, the areas of “regional significance” may have been delineated differently.

Bathymetry and substrate data need to be integrated into the Quoddy report in order to define suitable habitat and to better calculate relative area values for each species/habitat.

5. Suggest alternative or supplemental methods to map regionally significant habitats. (Alternative methods should be reviewed in terms of their potential accuracy and practicality.)

The Panel suggests that a working group be charged to identify available data sets which could be used to further the goals of the GOMC. The Panel developed three alternative approaches which are described below. Overall, the Panel recommends using a region wide approach rather than a piecemeal, iterative approach.

**APPROACH I. Local Area Species-Based Approach**

This is essentially the approach taken to date (Fig. 1). This is a species-based approach focused at the local scale. The Great Bay pilot is an example of this approach. If this approach is to be implemented, a consistent methodology should be applied in each sub-area. It would also be useful to calculate local and regional scarcity as a ratio of species distribution area to the amount of that type of area in both the sub-area and GOM region.

In brief, Approach I consists of the following:

1) Use the GOMC list. Ensure that species used in each area cumulatively represent all trophic levels in an equitable manner. Use the same priority species and the same rankings derived from the GOMC list in each sub-area investigation.

2) Add local species of importance to foster local involvement, but do not use those species in determining species of regional significance.

3) Map habitats using species occurrences, models, and opinion of a panels of experts for each taxonomic group. Test models and expert opinions by ground-truthing; subject models to peer review.

4) Accumulate the results over several sub-regions in the Gulf of Maine.
APPROACH I - Local Approach/Species Based

- Sub-Areas Chosen *a priori*
- Species chosen from GOM List
  - Add species of local importance
  - Conduct analysis at local level
  - Accumulate over multiple areas to build up to regional coverage
  - Species from list refined and used consistently

Trophodynamics groups added
5) Assemble a regional picture of significant habitats.

Pros

-- This method incorporates species of local interest which is of value. Further, if consistent methods are adopted, it can be funded incrementally.

-- This method potentially maximizes community interest and involvement.

-- The product is more discrete as it is phased.

Cons

-- Because this is a local approach it will take time to build up the number of sub-areas so that regional significance can be defined. An understanding of regionally significant habitats occurs only at the end of the process when all areas have been analyzed and mapped.

-- It is difficult and expensive to obtain data.

-- This method does not allow for comparisons to be made between areas. There may be inconsistencies due to investigator bias or differences in the comprehensiveness of the data or data quality within each sub-region. There is consistency for species on the GOMC list but not for local species.

-- There is still no linkage between local and regional significance, unless relative scarcity/importance is calculated at both the local and regional levels, as previously outlined.

APPROACH II. Regional Species-Based Approach

This approach utilizes the same priority species methodology to perform a single, region-wide analysis (Fig. 2):

1) Undertake "data mining" to identify all datasets applicable at a regional scale. Where data are lacking, use the analysis to highlight immediate research and analysis needs. Use data surveys to determine the optimal cell size to be used throughout and to add local species.

2) Generate a new or modified GOMC master list using local input and data from the surveys to foster local interest in the process. All opportunity for the addition of local species occurs at this point. Local species can not be added to the master list after the initiation of the project in order to maintain a consistent approach.
APPROACH II - Regional Approach/Species Based

Trophodynamics groups added

Species chosen from GOM List

Conduct analysis at regional scale i.e. over Gulf of Maine region

Species from list refined and used consistently

Critical to identify data sources and cell size-use occurrence data, model, and expert knowledge

Test results at local level to validate scale of analysis
3) Map habitats using regional data with the same methods as in Approach I.

4) Assess regionally significant habitats based on areas with the greatest confluence of priority species.

5) Test or ground truth at the local level to address the scale of the data. Once the regional analysis is completed, return to the local level.

Pros

-- Have local participation from the beginning in the creation of a regional list.

-- Consistency is built in, investigator bias has been removed.

-- It is potentially more cost-effective as experts for each taxonomic group usually have knowledge encompassing more than one geographic area.

-- Different geographic areas can be directly compared.

Cons

-- Data requirements are significant. Only regionally comprehensive data can be used.

-- Map products are open to misinterpretation unless they are presented as a compilation of smaller scale maps. Some “thin” regionally significant habitats may not appear as significant when mapped at large regional scales. Thus, the scale of maps is critical, necessitating both regional scale and higher resolution maps.

APPROACH III. Regional Habitat-Based Approach

This is a habitat-based approach implemented at a regional scale to assess regionally significant habitats (Fig. 3):

1) Develop a typology of geophysical coastal units (based upon coastline and bathymetry). For example:
   a) enclosed or sheltered estuarine areas, embayments (e.g., Great Bay)
   b) semi-enclosed shorelines, sheltered waters (e.g., fetch < 30 nm. many bays, inside of islands)
   c) sub-tidal nearshore, exposed outer coast (e.g., fetch > 30 nm. most of outer coast, outsides of islands)
   d) open ocean (e.g., depth > 50 m)
   e) watershed habitats (e.g., upland of estuarine habitats), as needed.
APPROACH III - Regional Approach/Habitat Based

Develop typology of geophysical coastal units

Map biophysical habitat distribution regionally

Develop list of priority species appropriate for each habitat type (revised GOMC list)

Identify, map, and rank distributions within sub units

Score areas within each subunit based on confluence of species or other ecological metric. Sum scores to quantify regional significance. Top scores (e.g. 10%) are regionally significant habitats.

All areas are high priority and designated regionally significant habitats

Plot locations identified as high priority with different colors to avoid making judgments regarding relative importance. All colors have equal weight.
2) Classify these geophysical units into coastal subunits. For example:
   a) intertidal
   b) shallow subtidal (e.g., <30 m)
   c) deepwater or deep subtidal (according to literature and local conditions)

3) Classify and map the distribution of these geophysical units and coastal subunits within the GOM.

4) Develop an appropriate species list inclusive of all coastal subunits within the GOM
   a) For example, use the top 20 appropriate species from the “revised GOMC list”. The appropriate species are constrained by ecological factors (e.g., whales would not be identified in enclosed habitats). To foster local interest and involvement, give local organizations the opportunity to nominate additional species. Sum suggestions regionally and include top 5-10 of those additional species nominated.
   b) Create a special list of “species of special concern”, such as those species which are endangered or threatened, or rare because they are at the limit of their range, etc.

5) Identify, rank and map distributions of above species within coastal subunits using the criteria previously identified.

6) Score areas within each coastal subunit based on confluence of species or other ecological metric (e.g., areal extent of habitat, productivity of habitat, degree of degradation of habitat or distance from pollutant source). Sum scores to produce regionally important locations within that coastal subunit. Do an additional layer of analysis to uncover critical areas for regionally important species of special concern. For the revised GOMC list, identify locations of high priority (e.g., the top 10% of the regionally important coastal subunits). For the list of species of special concern, all areas are high priority.

7) On two maps (any scale desired) plot all locations identified as high priority, representing the revised GOMC list and species of particular concern, with a different color for each habitat type to avoid making judgments regarding the relative importance of each type. All colors have equal weight.

8) Areas where high priority locations in different habitats are close geographically may be particularly worthy of regional protection.

Pros

-- The method is based on a smaller subset of areas that are perceived as being more similar.
-- It is possible to make comparisons throughout the region, within similar habitat types.
-- The process is more easily perceived as a regional activity.
-- Data needs are similar to other approaches identified.

Cons

-- Need region-wide habitat coverages based on the geophysical units selected.
-- There is a risk of missing unique or rare habitats, especially if the secondary analysis indicated for species of special concern is not undertaken along with the main analysis.
-- The result may yield numerous habitats analyzed in a fragmented fashion.
-- The classification of geophysical units and coastal subunits dictates, to some extent, the kinds of regionally significant habitats that will be highlighted.

This approach may seem more complex than the first two. However, given that the first two approaches are based on the protocols of the studies already completed, we eliminated much of the detail which would have been required to fully illustrate the process.

6. Compare and evaluate the results of the two studies.

Both projects generated individual species and composite maps that should prove useful for local planning purposes after some modifications, including more similar presentation scales, additional discussion of the data and maps, as well as providing a written interpretation and discussing the implications for management. The results of the two studies may, however, be of considerably less value with regard to the determination of critical habitats for the region as a whole due to their different geographic scales and incomparable methodological approaches.

Inconsistencies which were identified to be problematic include:

1) Inconsistent species sub-groups from the GOMC list were used in the two projects.
2) The two projects used ranking systems which were not comparable. The Quoddy Project utilized a modified GOMC species ranking.
3) Both projects used different approaches for mapping the habitat distributions of the species.
4) The Great Bay approach utilized occurrence data and species models to map habitats and related habitat values whereas the Quoddy project relied on expert opinion. The panel felt that each approach had its pros and cons, and that direct comparisons were problematic because of these differences.
5) Maps produced in both studies utilized color schema that lacked consistency between species maps with respect to the meaning or representational value of the colors used. A consistent color scheme would aid in the interpretation of the results.

6) The goals of the two projects as stated in the reports which were reviewed were not consistent.

For both studies it was felt that better documentation of the ranking and scoring methods needed to be provided. It was suggested that a panel of experts evaluate the scoring methodology and models to be used in the final product. Methodological consistency for future GOMC habitat projects was perceived to be of preeminent importance.

For the Great Bay Project, the use of several layers of data through a system of grids may mask or magnify the uncertainties and existing errors in the data. This may impact or obscure interpretations of the individual species and aggregate habitat maps. Some quantification or measure of the level of uncertainty inherent in the data and analyses would enhance the usefulness of the results. In addition, these uncertainties should be expressed in the mapped products. Also, some ground-truthing of the models is necessary.

For the Quoddy Region study, the expert opinion maps may be considered highly subjective without a clearly expressed set of criteria from the GOMC and a detailed justification from the experts as to why they drew the habitat distributions as they did. The modeling approach used in the Great Bay Study was more defensible technically but needed a more detailed protocol which could be applied throughout the GOM region.

The Quoddy Project had better characterization of current and potential human impacts to the species selected in the analysis than did the Great Bay project. This information is necessary in order to use the product for management, regulation and conservation purposes.

The species profiles in the Quoddy Project were presented as summaries of the species life modes and life histories which helped provide some context for understanding the maps and perhaps for using them in applications at a later time. The Great Bay profiles were mainly focused on parameterizing the models, which was useful in making the mapping approach relatively more objective. The Review Panel felt that the profiles should blend the two approaches.

No basic environmental data, such as temperature, salinity, substrate type, land-use, that would be needed to develop model systems, was presented in the Quoddy Project. The Great Bay Project lacked much of this information for the New Hampshire coast. These data need to be collected for each sub-region for a regional approach to be implemented.

The amount of local participation differed between the two projects. The Quoddy Project proceeded with less input from local stakeholders than did the Great Bay Project. The breadth and diversity of local stakeholder participation may have a significant impact on the selection of species, in turn affecting the determination of regionally significant habitats.

7. Assess the validity and usefulness of the methodology for continued application and/or recommend modifications or alternatives if appropriate.

The panel felt that a hybrid species occurrence/modeling/expert knowledge approach, applied in any of the three alternatives presented above, may be more useful for the entire GOM
region rather than either of these approaches used alone. The modeling and occurrence data approach can be validated and reparameterized as needed, allowing more flexibility for incorporating temporal changes, “what if” scenarios and new data. The validity of the models should be evaluated for each species after a detailed protocol is developed.

The usefulness of the method to the region will be dependent on developing consistent species lists, analytical methods, and databases and by using the same GIS software.

**Recommendations, Caveats and Conclusions**

The GOMC needs to be much more explicit in stating what the specific objectives of these projects are and how it intends to use the findings. There needs to be greater elaboration of how the report finding will be operationalized. Concern was expressed by the Panel of the danger of cumulative small-scale impacts to habitats, a “death by one thousand cuts,” which is a substantial problem in urban areas, rather than the collapse of major ecological systems. The application of a triage concept whereby the potential for restoration or recovery of degraded habitats is assessed might be considered. Allowing some moderately degraded habitats to recover to their full potential may in fact be more cost-effective than protecting only the remnant fragments that are relatively pristine.

Habitats were delineated narrowly without buffers. The lack of a map locating human impacts and infrastructure obscures where potential impacts may be coming from. Knowledge of habitat location alone is insufficient for making management decisions. Therefore, it should be noted that the habitat maps are but one tool to be used in conjunction with others, for habitat planning, management protection and restoration.

Local participation should be encouraged at the onset (when objectives are set and the studies are designed) of any process which is ultimately selected to be implemented region-wide.

It was noted that the pilot projects produced maps of species but did not, nor were the contractors asked to, identify critical linkages to other factors and habitats that can impact the survival or health of a species. For example, changes in land use can affect eel grass survival if stream flows and/or sedimentation rates change in a manner which affects turbidity and sedimentation patterns. The utilization of upland areas can impact estuarine habitats. Species and habitat profiles should describe any existing or potential threats to their integrity. These could be used to design appropriate management interventions and to illuminate the dynamics driving current patterns of distribution.

The Review Panel wished to add a cautionary note that since the colors in the aggregate maps reflect the number of species, the results are sensitive to the initial list of species selected and may not reflect species critical in those systems, or overall patterns in biodiversity. This perceptual artifact may have important ramifications when the results are utilized by policymakers in environmental decision-making. One way of addressing this would be to produce a series of summary maps in which the critical “bottleneck” areas for individual species or taxonomic groups or trophic levels are highlighted. In addition, the importance of selecting a species list which includes representative species of all trophic or taxonomic levels was emphasized by the Panel.
The issue of scale also has potential to significantly impact the way in which the results are interpreted.

The Review Panel recommends that the GOMC conduct a feasibility study to identify, assess and compile the existing data and data sources which are currently available for application in a regional scale study. To conclude, the Review Panel recommends using a region-wide approach, as outlined in alternatives 2 and 3, rather than a localized sub-area approach.