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A Numeric Scoring Matrix for use in the Rapid Assessment of Extinction Vulnerability of Marine Fish Species in the NAFO Regions 4VWX, 5Zc

by

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TABLE OF CONTENTS

ABSTRACT

Johnston, T.L. and R.K. Smedbol. 2004. A numeric scoring matrix for use in the rapid assessment of extinction vulnerability of marine fish species in the NAFO regions 4VWX, 5Zc. Can. Tech. Rep. Fish. Aquat. Sci. 2525: v + 84 p.

The Accord for the Protection of Species at Risk (1996) and the Species at Risk Act (2003) are initiatives of the Federal government that were established to provide protection and recovery for species at risk in Canada. Fisheries and Oceans Canada (DFO) is the primary source of information and expertise concerning the assessment of extinction vulnerability of aquatic species. The Maritimes Region of DFO is responsible for compiling biological information concerning status and potential extinction risk of marine fish species that support fisheries along the Scotian Shelf, northern Georges Bank, and in the Bay of Fundy. Given the breadth and importance of this task, it is necessary that a method for rapid analysis be developed that allows for the assessment of potential extinction vulnerability of fish species, and uses assessment criteria that are explicitly defined and relevant to marine species in Canada.

The approach undertaken by the Maritimes Region was to develop a scoring matrix that (1) quantifies the dynamics of a species' abundance and distribution and allows for rapid determination of whether or not that species may be at risk of extinction, and (2) allows for easy comparison across taxa through standardization of scoring. The intention behind the matrix was to create a more intuitive ranking scheme than has been used in the past. The potential extinction vulnerability of each species is graded out of 100. A high score represents a relatively high risk of extinction or extirpation from Canadian waters. Species assigned high scores by this rapid process can then be subjected to further, in-depth evaluation.

The criteria and conditions for the matrix were derived from criteria used by COSEWIC, and DFO's General Status Pilot Project. However, a new set of conditions were developed for some criteria to address several of the deficiencies that existed in the General Status approach, and to accentuate factors that may of greater significance to extinction vulnerability than to the assessment of current abundance.

This exercise was intended to test the validity and utility of a matrix approach for rapid assessment of extinction vulnerability and ease of comparison among species. The matrix is not intended to replace the formal assessment process, but to identify species that may need higher priority for a formal COSEWIC assessment. A prioritized candidate species list was created based on the results of the matrix analysis.

RÈSUMÈ

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L'*Accord pancanadien pour la protection des espèces en péril* (1996) et la *Loi sur les espèces en péril* (2003) sont des initiatives prises par le gouvernement fédéral pour protéger et rétablir les espèces en péril au Canada. Pêches et Océans Canada (MPO) représente la principale source d'information et d'expertise en matière d'évaluation des risques d'extinction des espèces aquatiques. La Région des Maritimes du MPO est chargée de réunir des données biologiques sur l'état et le risque éventuel d'extinction des espèces de poisson de mer qui alimentent des pêches le long du plateau néo-écossais, dans le nord du banc Georges et dans la baie de Fundy. Compte tenu de l'ampleur et de l'importance de cette tâche, il est nécessaire d'élaborer une méthode d'analyse rapide qui permette d'évaluer les risques d'extinction éventuelle des espèces de poisson et d'utiliser des critères d'évaluation explicitement définis et qui convienne aux espèces marines du Canada.

L'approche adoptée par la Région des Maritimes consistait à élaborer une matrice de notation permettant 1) de quantifier la dynamique de l'abondance et de la distribution d'une espèce et de déterminer rapidement si oui ou non cette espèce présente des risques d'extinction et 2) d'effectuer facilement des comparaisons entre les taxons grâce à une normalisation de la notation. Avec la matrice, on cherche à créer un système de notation plus intuitif que les formules utilisées jusqu'ici. Le risque d'extinction éventuelle de chaque espèce est noté sur un total de 100. Une note élevée correspond à un risque relativement grand d'extinction ou de disparition des eaux canadiennes. Les espèces auxquelles une note élevée est attribuée selon cette méthode rapide peuvent ensuite être soumises à des évaluations plus approfondies.

Les conditions et critères utilisés dans la matrice ont été établis d'après ceux du COSEPAC et du projet pilote du MPO sur l'état général. Toutefois, de nouvelles conditions ont été élaborées dans certains cas pour combler les lacunes existant dans le projet pilote sur l'état général et pour accentuer les facteurs pouvant revêtir plus d'importance dans l'évaluation des risques d'extinction que dans celle de l'abondance actuelle.

Les opérations décrites ici visaient à éprouver la validité et l'utilité d'une matrice comme moyen d'évaluation rapide des risques d'extinction et de comparaison facile entre les espèces. La matrice n'a pas pour but de remplacer le processus structuré d'évaluation, mais simplement de cerner les espèces susceptibles de nécessiter en plus haute priorité une évaluation en bonne et due forme du COSEPAC. Une liste priorisée de telles espèces a été établie d'après les résultats de l'analyse au moyen de la matrice.

INTRODUCTION

BACKGROUND

The Federal government has established several initiatives to provide protection and recovery for species at risk in Canada. The Accord for the Protection of Species at Risk (1996) is an agreement between provincial, territorial and federal ministers responsible for wildlife in Canada. The Accord commits the parties to "monitor, assess and report regularly on the status of all wild species". The Species at Risk Act (2003) complements the Accord, by legally protecting wildlife from being extirpated or becoming extinct as a result of human activity.

Assessment of the level of risk of extinction for species is based on information on the biological status of the species. Fisheries and Oceans Canada (DFO) is the primary source of information and expertise concerning aquatic species that are vital to these federal initiatives, and provides data and technical assistance to ensure assessments are based on the best information available.

COSEWIC

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has provided advice on the status of wildlife species in Canada since 1978 and, under the Species at Risk Act (SARA), has been given legal responsibility for the assessment of species status and designation of risk categories. The categories include 'extirpated', 'endangered', 'threatened', 'special concern', 'not at risk', and 'data deficient'. COSEWIC assessments use criteria that have been adopted from the International Union for Conservation of Nature (IUCN) criteria (IUCN 2001). The criteria for each rank can be found in Appendix 1.

COSEWIC assessments form the basis for the recommendations from the Minister of the Environment to the Governor-in-Council concerning the List of Wildlife Species at Risk. A ranking of extirpated, endangered, or threatened will trigger the development of a recovery strategy for the species. Species that are candidates for formal COSEWIC assessment are chosen based on expert recommendation, various international assessment processes, such as the World Conservation Union (IUCN), the Convention on International Trade in Endangered Species (CITES), and NatureServe, as well as the results from ongoing species monitoring processes in Canada, such as the General Status initiative.

General Status

The General Status Project is a result of the commitment undertaken by each province, territory and agency represented in the Accord for the Protection of Species at Risk. The assessment of species is undertaken by the party that has lead responsibility. A set of rankings was developed based on definitions in the Red List Categories of the World Conservation Union, the Criteria for Amendment of Appendices 1 and 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora

(CITES), the Natural Heritage Program and Conservation Data Centers (NatureServe, NatureServe Canada). The ranks include 'at risk', 'may be at risk', 'sensitive', 'secure', 'exotic', 'accidental', 'undetermined', 'data deficient' or 'not assessed'. The criteria for these rankings can be found in Appendix 2.

The General Status assessment is intended to be a rapid appraisal of status, and is not a detailed assessment of extinction risk, such as that done by COSEWIC. In general, only species are assigned general status ranks, rather than subspecies or distinct populations. Relatively few species have been examined closely enough to distinguish candidate subspecies or stocks, and there tend to be disagreement over the precise limits and biological significance of differences observed at this finer scale (Wild Species 2000. http://www.wildspecies.ca/wildspecies2000/en/T03E.html). For terrestrial species, all provinces and territories assign general status ranks to species, and then a national ranking is assigned. The resulting product is a comprehensive and updated list of all species that are known to occur in Canada, an overview of the quality and quantity of information available for each species, and a set of rankings of the general status of each species. The General Status Project identifies species that may be at risk, for which more information is needed, that may require a formal status assessment by COSEWIC, and may require protection under SARA.

The Wild Species 2000 report (CESCC 2001) was published in 2001 as the first of a series of general status reports. Rankings are to be reviewed every 5 yr, and the report updated and published every 5 yr. Marine fishes were not included in the report, as they had not been assessed at the time of publication.

Ranking Marine Fish

As a participant in the General Status Project, DFO is responsible for assessing all marine fishes that inhabit coastal areas and the continental shelf within Canadian waters. For marine species, each fisheries management region is required to assess the species occurring in their management area. Assessment information from each management region will then be combined in one overall assessment of each species, to create a national risk ranking for each species. An initial pilot project was conducted in 2003, and included all Atlantic pelagic marine fish species that occur in Canadian waters less than 200 m in depth. The remaining marine fish species that were not included in the pilot study are to be assessed according to the best methods determined during the pilot exercise.

General Status Criteria

Deficiencies in the methods used in the General Status Project (Appendix 2) became apparent as a result of the Atlantic pelagic pilot project. Scoring criteria used at the beginning of the project were developed for terrestrial species rather than fishes. For example, a terrestrial species considered to exhibit low abundance may contain 1000 individuals. However, this value in marine fish species would represent a very small, even accidental, population in Canada. The thresholds for assignment of categories of

very small, small, medium or large marine fish abundance were not defined at the commencement of the pilot project, and were open to debate and interpretation throughout the project. Consequently, different species with the same abundance estimates may emerge from the ranking scheme with different interpretations of their relative size.

The scoring criteria used during the General Status project are not intuitive, and depend on the opinions and biases of the investigator regarding population dynamics, life history and threats for any given species. For instance, "where there is a lack of consensus on the interpretation of data, the criteria is to be weighed accordingly when determining a rank for that species" (General Status, Section 1.2; J. Perrault, DFO, pers. commun.). Arbitrarily 'weighted' criteria, and ranks based primarily on judgments may prove problematic when creating a comprehensive product. The ranking results for each species provided independently by different investigators using the same data may not match, since investigators' opinions play such a large role in the interpretation of the relevance of those data. Also, subjective rankings cannot be standardized between management units, and combining each region's results to create a national ranking for each species may prove difficult.

Some criteria could not be assessed with confidence, or were simply not relevant to marine fish species. The number of occurrences, or the estimated number of sites where the species persists, is impossible to determine accurately for marine species based on our current knowledge. In the majority of cases, we do not understand the population structure of species on a unit stock level. The main data sources for status are the annual research vessel surveys. These surveys were designed to sample commercially-exploited groundfish species, and may not adequately cover the range of other species of interest. At present, distribution threats are also rarely a factor in risk assessment for marine species.

MARITIMES SCORING MATRIX

The Maritimes Region is responsible for compiling biological information on marine fish species that inhabit the Northwest Atlantic Fishery Organization regions 4VWX, 5YZc, and for assessing each species according to the general status assessment criteria.

The approach undertaken by the Maritimes Region was to develop a scoring matrix that quantifies the dynamics of a species and allows for rapid determination of whether or not that species may be at risk of extinction, and allows for easy comparison across taxa through standardization of scoring. The intention behind the matrix was to create a more intuitive ranking scheme than has been used in the past. The potential extinction vulnerability of each species is graded out of 100. A high score represents a relatively high risk of extinction or extirpation from Canadian waters. Species assigned high scores can then be investigated further and more in depth.

The criteria and conditions for the matrix were derived from criteria used by COSEWIC, and DFO's General Status Pilot Project. However, a new set of conditions were

developed for some criteria to increase the relevance of these criteria to marine fish. For example, the various abundance sizes were explicitly outlined for marine fishes. Explicitly defined criteria and conditions make the ranking scores comparable between investigators and minimize the effects of individual opinions. The matrix scoring also standardizes results, and thus allows rankings to be more easily combined when taken to a multi-regional level. To date however, the assessments undertaken by the Maritimes Region have not been combined with assessment results of other regions. Therefore, the assessments presented in this document reflect the status of species within the Maritimes Region only, and not an overall national assessment.

An 'At Risk' rank is derived by considering available information relating to a set of criteria that collectively reflect the status of a species in a given region. Numeric scores are applied to the set of criteria, and weighted based on their perceived relevance regarding the health of a species. This weighting is developed from COSEWIC and IUCN requirements for designation of extinction risk categories. For example, Abundance and Trends and Mature Abundance and Trends have been given the greatest weight, while distribution threats and population structures have limited or no effect on the scoring (Appendix 3, Table 2). Defining the weight of a criterion within the matrix also minimizes the effects of individual opinions. The results are also standardized to allow scores among various species to be compared; for example species A is potentially more at risk than species B. The matrix can be applied to all marine fish species, and the structure can account to some degree for lack of information concerning maturity and resilience.

METHODS

DATA

Data concerning species status were derived from DFO research vessel (RV) surveys in the Maritimes Region. These surveys are generally considered to be of relatively high quality and resolution, and contain information for a broad range of marine species. (See section 4.2.4 for a discussion of caveats concerning the value and use of RV survey data.) Despite the high degree of survey effort, insufficient data existed to allow for proper analysis of the majority of Scotia-Fundy species. As a result, subsequent analyses were limited to the 30 species of fishes and squid for which DFO holds a sufficient amount of information.

POPULATION INDICES

The Maritimes Region has conducted five annual bottom trawl research vessel surveys, three of which were the primary source for indices of abundance used in the status assessments in the Scotia-Fundy region. These surveys are undertaken in Northwest Atlantic Fisheries Organization (NAFO) Subdivisions 4VWX and 5Z. The summer RV survey (4VWX) has run from 1970 to present, and is the longest running time series. The Georges Bank (5Z) winter survey has run from 1986 to present, and the 4VW Cod spring survey has run from 1987 to present. Two surveys that were not used in the analysis

included a spring RV survey and a fall RV survey, both of which ran from 1979 to 1984. Long-term trends could not be calculated from such short time series and they provided no useful information of current status, since they were discontinued almost 20 yr ago. These two surveys would be included in a comprehensive status assessment wherein subspecies or stocks would be analyzed, but for our purposes only the three most recent series were used. Also, differences in the survey area, vessel, and gear type did not allow us to incorporate the spring RV survey into the 4VW Cod spring survey to create one long time series.

All research surveys are bottom trawl surveys using a Western IIA trawl, and follow a stratified random design, based on depth and geographic area. Sampling sets are standardized to 30-min tows at 3.5 knots, or 1.75 nautical mile tows. There was a vessel change in 1982 for the summer series, and a gear change from a Yankee 36 trawl to a Western IIA trawl in 1982. Generally, the effect of the vessel change on the catchability of most species is unknown. The depth for strata in the RV surveys range from 0-200 m. Deepwater strata, with 200-400 m depths, were added to the summer RV survey in 1995. Data from species with and without the deepwater strata were compared to determine the effects of the addition.

Several industry surveys have been conducted in the Maritimes Region, whose data are standardized and reliable. However, these surveys all began in the mid-1990s and do not contain time series that are long enough to be used in the analysis of long-term trends. Also, the data have limited use for a broad range of species since each survey is directed toward a target species, such as the skate survey, halibut survey and monkfish survey. Therefore, industry survey data were not a major component of the data used for the rapid assessment at this time.

Fisheries-dependent indices are often unreliable data sources for analyses of species status (Hilborn and Walters 1992). Landings are greatly affected by fishery management measures, market demands and bias in the catch method. By-catch may be unreported, and reported by-catch records are often dependent on the presence of fisheries observers and their ability to correctly identify species. A more thorough analysis would be performed in a formal assessment, where commercial data may be useful in identifying population trends and distribution for species for which the RV survey is not representative of their distribution. However, in this rapid assessment, the analysis performed on commercial landings data was extremely limited.

MATRIX CRITERIA

To rank the marine species found in the Maritimes Region, a numeric scoring matrix was created using criteria derived from those used by COSEWIC and the General Status Pilot Project. A score was given to each status criterion, and scores are obtained for each species by using the rules that are outlined in this section. The total score given to each species is an 'At Risk' rank out of 100 possible points. A high score suggests a high vulnerability to extinction or extirpation from Canadian waters, and further analysis is recommended. The Matrix tables are presented in Appendix 3.

Abundance

Abundance is defined as the current estimate of the total number of individuals within an ocean region. Where natural fluctuations occur in abundance, or there is a range of assessed abundance estimates among the surveys, then the most representative value will be used.

Maximum Score: **5**
A relatively low maximum score is assigned, because current abundance does not in itself solely reflect the status of the species. The score is not directly applied to the total score, but is used in the Abundance x Resilience Amplifier (criterion C).

Large Abundance: **2**
More than 100 000 000

Medium Abundance: **3**
10 000 000 to 100 000 000

Small Abundance: **4**
1 000 000 to 10 000 000

Very Small Abundance: **5**
Less than 1 000 000

Resilience

This index is based on the age of maturity and the generation time (the doubling time for a population). Generation time is the average age of parents of the current cohort (age 0+). In those cases where generation time varies under threat, the pre-disturbance generation time should be used. Generation time is calculated as:

$$A_g = A_m + (1/M)$$

where A_g is the generation time, A_m is the average age of 50% maturity for a given species, and M is the natural mortality rate of the fish (see page 12).

Maximum Score: **3**
A relatively low maximum score is assigned, because the resilience of the species does not in itself reflect the health of the species. The score is not directly applied to the total score, but is used in the Abundance x Resilience Amplifier (criterion C).

High Resilience: **0.5**
Age of maturity – up to 2 yr
Generation time – up to 7 yr

Medium Resilience: **1**
Age of maturity – up to 5 yr
Generation time – up to 10 yr

Low Resilience: **2**
Age of maturity – up to 7 yr
Generation time – up to 12 yr

Very Low Resilience: **3**
Age of maturity – more than 7 yr
Generation time – more than 12 yr
Unknown Resilience: **Variable**
Age of maturity of a known species within the same Family
If unknown, assume the worst

Abundance x Resilience Amplifier

Although abundance and resilience do not independently and directly reflect the status of a species, they do significantly reflect the health of a species when these two criteria are considered in combination. For example, long-lived species of low abundance will require more careful consideration than an abundant, short-lived species. This amplifying calculation is performed to give greater significance to the two criteria.

Maximum Score: **15**
A fairly high maximum score is assigned to the amplification, and is applied directly to the total score.

Abundance Trend

Abundance trend is defined as an estimate of the percent change in the number of individuals over time – in the last 10 yr or three generations, whichever is longer.

Maximum Score: **30**
A relatively high maximum score is given, because abundance trends significantly reflect the status of a species.
50% Abundance Decline: **30**
20% Abundance Decline: **20**
Stable Abundance: **10**
Increasing Abundance: **0**

Mature Abundance

Mature abundance is defined as the current estimate of the total number of mature individuals within an ocean region. Where natural fluctuations in abundance occur, or there is a range of assessed abundance estimates among the surveys, then the lowest number is used.

Maximum Score: **2**
A relatively low maximum score is assigned, because the mature abundance does not in itself reflect the status of the species. The score is not directly applied to the total score, but is used in the Mature Abundance x Mature Abundance Trend Amplifier (criterion G).

Large Mature Abundance: **0.5**
More than 100 000 000
Medium Mature Abundance: **1**
10 000 000 to 100 000 000
Small Mature Abundance: **2**
Less than 10 000 000
Unknown Mature Abundance: **Variable**
Assume that the unknown abundance is proportional to the total abundance. The score for the total abundance is divided by 2.5, and then rounded up. This results in a conservative score out of 2 for mature abundance.

Mature Abundance Trend

Mature abundance trend is defined as an estimate of the change in the number of mature individuals over time – in the last 10 yr or three generations, whichever is longer.

Maximum Score: **15**
A relatively high maximum score is assigned, because mature abundance trends significantly reflect the health of a species. The score is not directly applied to the total score, but is used in the Mature Abundance x Mature Abundance Trend Amplifier (criterion G).
Extreme Fluctuations: **15**
Abundance varies widely, rapidly and frequently, with a variation greater than one order of magnitude
10% Decline: **15**
Stable: **7**
Increasing: **3**
Unknown Trend: **15**
Assume the worst for the unknown trend

Mature Abundance x Mature Abundance Trend Amplifier

Although the size of the mature abundance does not reflect the status of a species, this criterion becomes significant when it is considered in combination with mature abundance trends. For example, declining trends in a small population require more careful consideration than decline in a large population. This amplifying calculation is performed to give greater significance to the two criteria.

Maximum Score: **30**
A relatively high maximum score is assigned to the amplification, and is applied directly to the total score.

Spatial Distribution

Spatial distribution is defined as the current percentage of the region contained within the continuous imaginary boundary that can be drawn to encompass all the known

occurrences of the species. This includes areas that are known to be essential at any stage of the survival of the species, including migratory, spawning and feeding areas. It does not include cases of vagrancy. Where natural fluctuations occur, or there is a range of assessed distribution estimates, then the lowest estimate is used.

Maximum Score: **5**

A relatively low maximum score is assigned, because the size of the area occupied may not significantly reflect the status of the species. The score is directly applied to the total score.

Widespread Distribution:	**1**
Regional Distribution:	**2**
Restricted Distribution (4 – 10%):	**3**
Very Restricted Distribution (3%):	**5**

Spatial Distribution Trend

Spatial distribution trend is defined as a change in the distribution range of the species over time – in the last 10 yr or three generations, whichever is longer.

Maximum Score: **20**

A relatively high maximum score is assigned, because trends in the area occupied and the degree of fragmentation significantly reflect the status of a species. The score is directly applied to the total score.

50% Decline:	**20**
20% Decline:	**10**
Stable:	**5**
Increasing:	**0**

Abundance Threat

Abundance threat is defined as any observed, inferred, or projected mortality that may result in abundance declines. They include the effects of direct exploitation, harassment, exotic species, as well as ecological interaction with predators, competitors, parasites or pathogens.

Maximum Score: **10**

It is important to take any threats to a species into consideration. However, any genuine threat that affects the status of a species would be demonstrated in declining abundance trends. A relatively low maximum score is given here, and the score is directly applied to the total score.

Extreme Threat: **10**

Significant
Affects more than 50% of species in the region
Unmitigated

Moderate Threat: **5**
Serious
Affects less than 50% of species in the region
Mitigated by some level of protection
Low Threat: **2**
Less significant to species viability
Mitigated through protective measures
No Threat: **0**

ADDITIONAL POINTS

Spatial Distribution Threat

Spatial distribution threat is defined as any observed, inferred or projected habitat alterations (loss, conversion, degradation, fragmentation) that may result in abundance declines.

Maximum Score: **5**
These are considered 'bonus points' because threats to distribution of temperate marine fish species are relatively uncommon. However, when a threat to a species' distribution is identified, then points are given to reflect its significance. The score is directly applied to the total score.
Extreme Threat: **5**
Significant
Affects more than 50% of species in the region
Unmitigated
Moderate Threat: **3**
Serious
Affects less than 50% of species in the region
Mitigated by some level of protection
Limited Threat: **0**
Less significant to species viability
Mitigated through protective measures
No Threat: **0**

Considerations

These considerations are not given numeric values, since they do not directly reflect the status of a species. The purpose of this criterion is to provide some background information and context for individual species scores.

Existing Protection: **y/n/?**
Species dependence on current conservation measures should be noted.
Population Structure: **y/n/?**
For Atlantic fish species, the detailed data that are required to distinguish subspecies or stocks are often unavailable. It should be noted when it they are available.

Species Significance: **y/n/?**
Economic dependence on the species.
Ecological significance.

Total Score: **100**

The status analysis using the matrix produces a score out of 100 that represents a species' risk of becoming extinct or extirpated from Canadian waters. These rapid analyses of potential extinction vulnerability can be used to develop a prioritized list of all species in the Scotia-Fundy region. This list can provide direction for further research and aid in the development of the COSEWIC candidate species list.

DATA ANALYSIS

In order to test the validity of the Maritimes ranking matrix, species for which DFO possesses sufficient data were analyzed using the matrix criteria. Since RV surveys were the main data source, 30 of the most highly represented species in the groundfish RV database were chosen arbitrarily. An SQL query was performed to determine which species had the greatest numbers, and the results can be found in Table 1.

The **annual indices** of species status presented below were calculated for each of the 30 species, and for each of the three RV surveys analyzed in this document. One result for each criterion was achieved by calculating the average of the results from each survey. Where the survey results varied greatly then the least representative survey, the survey with the fewest number caught, was removed. While other methods for combining surveys may be more rigorous, it is important to recall that this ranking procedure is meant to be rapid and uncomplicated. Species receiving high rankings should be treated as priorities for further investigation.

The **total abundance** can be calculated by multiplying the stratified mean number of individuals captured per normal standardized tow by the total area surveyed. The mature abundance size can be determined by calculating the proportion of individuals in the sample that are equal or greater in length than the average length at maturity:

$$P_m = P_t * (S_m / S_t)$$

P_t is the total abundance, and P_m is the mature abundance. S_t is the total number of sampled fish, and S_m is the number of sampled fish whose length was greater than or equal to length at maturity. Maritimes DFO has undertaken length-at-age analyses for only a few species found in the Scotia-Fundy region. However, estimates for the average length of maturity for several species have been published by other sources. The proportion of fish samples that were of equal or greater length than the estimated length at maturity was assumed to equal the proportion of mature individuals in the total abundance. If estimates of length at maturity were unavailable or unreliable, then the mature abundance was unknown for that species. Total and mature abundance sizes were calculated for each year of each survey, and used to calculate abundance trends over time.

Totals for the current survey year were used as the current estimates of total and mature abundance of that species in the Scotia-Fundy Region.

Resilience can be defined generally as the rate at which population density returns to equilibrium after a disturbance away from equilibrium (Pimm 1991). Estimates of species resilience were obtained from existing documentation and research. FishBase (www.fishbase.org) was used regularly as a quick reference of life cycle information. ishBase uses the minimum population doubling time as an index of resilience. For a species with unknown resilience, another species from the same genus was examined and its resilience was substituted for the species in question, under the assumption that members of the same genus have similar life cycles. If resilience was unknown for the genus, then it was conservatively assigned a low value.

For **spatial distribution**, annual estimates of extent of occurrence were calculated simply as the proportion of standardized sets in a survey wherein the species was caught. If the design of the summer RV survey provides unbiased, representative sampling of the survey area, then the proportion of non-zero survey sets provides a rough snapshot of the extent of occurrence of the species. Estimates of spatial distribution were also acquired from the literature. The annual proportion of total survey area occupied by 75% of the abundance was also calculated. Annual values for extent of occurrence and 75% proportion were both used to calculate trends in spatial distribution.

Abundance and distribution trends were calculated over a number of years based on the exponential growth/decay formula endorsed by COSEWIC:

$$N_t = N_0 r^t$$

N_0 is the intercept, or the abundance at year 0. Time, in years, is noted by t. Abundance at time t is N_t, and the rate of change is r. The rate of change is converted to a percentage change over t years by:

$$P = 100*(r - 1)$$

The General Status Project requires that trends are calculated for 10 yr or three generations, whichever is longest. The **generation time** is the average age, in years, of parents of the current cohort. It is calculated as:

$$A_g = A_m + (1/M)$$

A_g is the generation time, and A_m is the average age of 50% maturity for a given species. Age of maturity could be obtained from published sources. M is the natural mortality rate of the fish, and is assumed to be 0.2 for most fishes unless it has been previously calculated in other research.

The three research survey time series all exceeded 10 yr in length, and we were able to calculate trends beyond this requirement. For several species, however, the length of

three generations surpassed the 16-yr, 17-yr, and even 32-yr time series of the 4VW Cod, Georges Bank and Summer surveys, respectively. Therefore, periods corresponding to three generations were used for the rapid assessment analysis wherever possible. Otherwise, the longest time period that the survey data would allow was used.

Where **catch per unit effort** (CPUE) was calculated for commercial longline and trawl fisheries, longline CPUE was calculated as kilograms per 1000 hooks and trawl CPUE was calculated as kilograms per hour of towing.

Information pertaining to the threats to abundance, threats to the distribution, species significance, population structure and existing protection were obtained from existing research pertaining to the given species, when available.

A complete analysis of one species, thorny skate, can be found in Appendix 3 as an example of the data analysis used for the Maritime matrix assessment.

RESULTS

GENERAL

Thirty species were analyzed in order to test the validity of the Maritimes ranking matrix. The results from the matrix analyses for all species are found in Table 2.

The assessments for the matrix included the deepwater strata that were added to the Summer RV Survey in 1995. For each species, separate abundance analyses were performed which excluded the deepwater strata, and then compared with the results that included the deepwater strata in order to ensure that the inclusion of the deepwater strata in the analyses had no effect on the outcome of the rapid assessments. Differences between the results of the analysis with and without the deepwater strata were minimal for all of the species analyzed, and had no effect on rapid assessment results in this document.

SPECIES SPECIFIC

Of the 30 species that were chosen for analysis, we decided that Redfish would not be assessed using the matrix criteria. Four species of redfish are present in the Northwest Atlantic, and separation of the species is difficult (Sevigny, 2002). Therefore, this genus would not prove useful for testing the validity of the ranking matrix. Also, redfish species have undergone a formal assessment by COSEWIC, and are in the process of being evaluated for extinction vulnerability and, therefore, would not require a rapid assessment.

American Plaice (*Hippoglossoides platessoides*) received a score of 51. The species exhibits a relatively low resilience, maturing at 8 yr old, and its abundance has declined moderately over time. However, American plaice continues to exhibit large abundance. Length at maturity, has been reported as either 20+ cm or 30+ cm, so analyses for the mature abundance were performed for both lengths. Results for both lengths rated the

same for the rapid assessment criteria; a medium sized mature abundance with high rates of decline. The species is widespread and spatial distribution levels have remained stable over time. American plaice received a relatively low score for risk of extinction due to its high abundance and widespread, stable spatial distribution. American plaice is protected by Total Allowable Catch (TAC) quota limits for flatfish. The worksheet and matrix results for American plaice are found in Appendix 4, Table 1.

Atlantic Cod (*Gadus morhua*) received a score of 75. The species has medium abundance levels and medium resilience, and the total abundance has experienced high rates of decline over time. The mature abundance is small, and the mature abundance has also greatly declined over time. Spatial distribution is widespread with moderate decreases over time. Atlantic cod received a relatively high score due to its large declines in abundance, and it small mature abundance levels. Atlantic cod in the Maritimes Region is currently listed as 'Special Concern' by COSEWIC, and 'Vulnerable' by the IUCN Red List. The worksheet and matrix results for cod are found in Appendix 4, Table 2.

Haddock (*Melanogrammus aeglefinus*) received a score of 21. The species has large total and mature abundance and medium resilience. Its abundance trends for total and mature abundance have increased and remained stable, respectively, over time. Its spatial distribution is widespread with moderate decreases over time. Haddock received a relatively low score due to its high abundance and widespread, stable spatial distribution. This species is protected by TAC quota limits and on-going monitoring. The worksheet and matrix results for haddock are found in Appendix 4, Table 3.

Thorny Skate (*Raja radiata*) received a score of 84. Although the species has medium abundance levels and medium resilience, the total abundance has experienced high rates of decline over time. The mature abundance is small, and the mature abundance has also greatly declined over time. Spatial distribution is widespread; however its distribution has greatly decreased over time. The threats to thorny skate abundance are extreme, due to the low production of egg sacs each year and the low survivability for these eggs to reach hatching. We found no specific threats to the species' spatial distribution that would cause high declines. Thorny skate received a relatively high score due to its extreme declines in abundance and spatial distribution, its small mature abundance, as well as extreme threats to the abundance. There is currently no protection for thorny skate. The worksheet and matrix results for thorny skate are found in Appendix 4, Table 4.

Silver Hake (*Merluccius bilinearis*) received a score of 52. The species has a high abundance and high resilience, but its abundance levels have greatly declined over three generations. The mature abundance has also declined, but medium abundance levels remain. The species' spatial distribution is widespread and has increased over three generations. Silver hake received a relatively low score due to its high total and mature abundance levels and its widespread, stable spatial distribution. This species is protected by TAC quota limits and fishing areas are restricted to protect immature fish. The worksheet and matrix results for silver hake are found in Appendix 4, Table 5.

Longhorn Sculpin (*Myoxocephalus octodecemspinos*) received a score of 56. This species exhibits medium-sized total abundance. However, very little is known about the longhorn sculpin's life cycle. Information regarding age or length at maturity is unknown, so resilience and maturity analyses could not be performed. The species has had moderate declines in total abundance and spatial distribution over time, but its distribution is widespread. Longhorn sculpin received a relatively low score due to its high total abundance and its widespread spatial distribution. The worksheet and matrix results for longhorn sculpin are found in Appendix 4, Table 6.

Yellowtail Flounder (*Limanda ferruginea*) received a score of 60. The species' total and mature abundance is medium, but has declined significantly over time. Resilience is medium, with individuals maturing at 3-6 yr. Yellowtail flounder has a widespread spatial distribution, which has decreased slightly over time. This species received a relatively low score due to its medium sized abundance, medium resilience and widespread spatial distribution. Yellowtail flounder is protected by TAC quota limits for flatfish, and is listed as "Vulnerable" in the IUCN Red List. The worksheet and matrix results for yellowtail flounder are found in Appendix 4, Table 7.

Witch Flounder (*Glyptocephalus cynoglossus*) received a score of 49. Resilience for this species is very low, due to maturation occurring at over 7 yr old. However, the total abundance has a medium size and has increased over time. The mature abundance is small, and has declined over time. Witch flounder has a widespread spatial distribution, which has remained stable. This species received a relatively low score due to its medium sized total abundance, increases in total abundance over time, and widespread, stable spatial distribution. Witch flounder is protected by TAC quota limits for flatfish. The worksheet and matrix results for witch flounder are found in Appendix 4, Table 8.

White Hake (*Urophycis tenuis*) received a score of 66. Resilience for the species is medium, but the total abundance is small with moderate declines over time. The mature abundance is small, and has declined over time. White hake has a widespread spatial distribution, which has declined moderately. White hake received a relatively moderate score due to its small, declining abundance and declining spatial distribution. This species is protected by TAC quota limits. The worksheet and matrix results for white hake are found in Appendix 4, Table 9.

Short-fin Squid (*Illex illecebrosus*) received a score of 64. Total abundance for this species is medium, with extreme declines over time. Very little is known about the shortfin squid's life cycle. Information regarding age or length at maturity is unknown, so resilience and maturity analyses could not be performed. The species' spatial distribution is widespread and has remained stable. Short-fin squid received a relatively moderate score due to its declining total abundance. There is currently no protection for short-fin squid. The worksheet and matrix results for short-fin squid are found in Appendix 4, Table 10.

Pollock (*Pollachius virens*) received a score of 65. The species' resilience is medium, and its total abundance is medium size and has declined slightly over time. The mature abundance is also medium size. There are discrepancies in abundance trends between the summer and spring surveys. There are also discrepancies in the spatial distribution trends. Pollock move inshore in summer months and offshore during winter months, which may explain these fluctuations in trends. Pollock have a widespread spatial distribution. Pollock received a relatively low score because of its medium sized, increasing abundance. Pollock is protected by TAC quota limits. The worksheet and matrix results for pollock are found in Appendix 4, Table 11.

Atlantic Herring (*Clupea harengus*) received a score of 9.5. The total and mature abundance is large, and has been increasing over time. Resilience is medium, with fish maturing at age 3 yr. Atlantic herring has a widespread spatial distribution, which has been increasing over time. Atlantic herring is protected by TAC quota limits. The worksheet and matrix results for Atlantic herring are found in Appendix 4, Table 12.

Sea Raven (*Hemitripterus americanus*) received a score of 61. This species has a small total abundance that has remained stable over time. Very little is known about the sea raven's life cycle. Information regarding age or length at maturity is unknown, so resilience and maturity analyses could not be performed. The species has a widespread spatial distribution that has increased over time. Sea raven received a relatively moderate score due to its small, but stable total abundance. The worksheet and matrix results for sea raven are found in Appendix 4, Table 13.

Winter Skate (*Raja ocellata*) received a score of 85. The total abundance is small and has declined over time. The species' resilience is low, and the mature abundance is very small and declining. Winter skate has a widespread spatial distribution, which has declined slightly over time. The threats to the winter skate abundance are extreme, due to the low production of egg sacs each year and the low survivability for these eggs to reach hatching. We found no distinguished threats to the species' spatial distribution that would cause high declines. Winter skate received a relatively high score due to its declines in abundance and spatial distribution, its small total abundance, as well as extreme threats to the abundance. There is currently no protection for winter skate. However, it is currently being evaluated by COSEWIC for designation as a species at risk for extinction. The worksheet and matrix results for winter skate are found in Appendix 4, Table 14.

Spiny Dogfish (*Squalus acanthius*) received a score of 74. The species resilience is very low, reaching maturity at 10 yr old. Its total abundance is medium, and has declined over time. The mature abundance is small, and there are discrepancies in abundance trends among the various surveys. Spiny dogfish has a widespread, stable spatial distribution. The species is at risk of overfishing, due to its small mature abundance and its tendency to aggregate for various life activities. Spiny dogfish received a relatively high score due to its low resilience, small mature abundance and overfishing threats. There is currently no protection for spiny dogfish. The worksheet and matrix results for spiny dogfish are found in Appendix 4, Table 15.

Ocean Pout (*Macrozoarces americanus*) received a score of 73. This species has a very small total and mature abundance, which has declined over time. Its resilience is low, reaching maturity at 7 yr of age. Ocean pout has a regional spatial distribution that has declined over time. The species received a relatively high score due to its low resilience, and very small declining abundance. There is currently no protection for ocean pout. The worksheet and matrix results for ocean pout are found in Appendix 4, Table 16.

Monkfish, Goosefish, Angler (*Lophius americanus*) received a score of 61. Its total abundance is very small. However, resilience is fairly high and abundance trends have remained stable over time. The mature abundance is also very small, and has severely declined. Monkfish have a regional spatial distribution that has declined slightly over time. The Scotia-Fundy population is exposed to a by-catch fishery in area 4X. Declines in area 4VW may be indicative of fishery effects, or unknown environmental conditions that may be threatening the species. Monkfish received a relatively low score due to its high resilience and stable abundance trends. The worksheet and matrix results for monkfish are found in Appendix 4, Table 17.

Smooth Skate (*Raja senta*) received a score of 86. The species' abundance is small, and has dramatically declined over time. Little is known about the smooth skate's life cycle. Information regarding age or length at maturity is unknown, so maturity analysis could not be performed. Resilience is unknown, but it is assumed to be comparable to that of known skate species. Thorny and little skate both have medium resilience, and this value was used to evaluate smooth skate. Spatial distribution is regional for smooth skate, and has declined greatly over time. The threats to smooth skate are extreme, due to the low production of egg sacs each year and the low survivability for these eggs to reach hatching. We could not distinguish any threats to the species' spatial distribution that would cause high declines. Smooth skate received a relatively high score due to its extreme declines in abundance and spatial distribution, as well as extreme threats to the abundance. There is currently no protection for smooth skate. The worksheet and matrix results for smooth skate are found in Appendix 4, Table 18.

Red Hake (*Urophycis chuss*) received a score of 67. The species' resilience is medium. However, its total and mature abundance is small. Abundance trends have increased in Summer RV Survey, but decreased in the 4VW Cod Survey. Therefore a conservative 20% decline estimate was adopted for abundance trends. The species is found regionally, and spatial distribution has had moderate declines over time. Red hake received a relatively moderate score due to its small, declining abundance and declining spatial distribution. There is currently no protection for red hake. The worksheet and matrix results for red hake are found in Appendix 4, Table 19.

Winter Flounder (*Pseudopleuronectes americanus*) received a score of 28. The total and mature abundance is small, but has remained stable over time. Resilience is medium. The species has widespread spatial distribution that has remained stable over time. Winter flounder received a relatively low score due to its stable abundance and

distribution trends. Winter flounder is protected by TAC quota limits for flatfish. The worksheet and matrix results for winter flounder are found in Appendix 4, Table 20.

Striped Atlantic Wolffish (*Anarhichas lupus*) received a score of 75. The species' resilience is low, maturing at 6 yr of age. The total abundance is small, and has declined greatly over time. The mature abundance is very small, and has also declined. The species is regionally distributed, and its spatial distribution has declined over time. Striped Atlantic wolfish received a relatively high score due to its small, declining abundance and low resilience. Striped Atlantic wolffish has been listed as 'Special Concern' by COSEWIC. The worksheet and matrix results for striped Atlantic wolffish are found in Appendix 4, Table 21.

Little Skate (*Raja erinacea*) received a score of 46. Little skate's resilience is medium. Its total abundance is small, and has increased over time. The spatial distribution is regional and has been increasing over time. It should be noted that little skate were often misidentified as winter skate on earlier RV surveys, and this misclassification may explain the increasing trends in recent years. Information regarding length at maturity is unknown, so the maturity analysis could not be performed. The threats to little skate are extreme, due to the low production of egg sacs each year and the low survivability for these eggs to reach hatching. However, little skate received a relatively low score due to its small, but increasing total abundance. The worksheet and matrix results for little skate are found in Appendix 4, Table 22.

Atlantic Halibut (*Hippoglossus hippoglossus*) received a score of 72. The species resilience is very low, and both its total and mature abundance is very small. Total abundance has declined over time, while the mature abundance has remained stable. Research indicates that larger halibut are somehow more evasive, and abundance results may reflect this. Atlantic halibut are regionally distributed, and their spatial distribution has declined somewhat over time. Atlantic halibut received a relatively high score due to its small abundance and very low resilience. The species is listed as 'Endangered' by the IUCN Red List. The worksheet and matrix results for Atlantic halibut are found in Appendix 4, Table 23.

Moustached Sculpin (*Triglops murrayi*) received a score of 69. This species has a small total abundance that has declined somewhat over time. Very little is known about the moustached sculpin's life cycle. Information regarding age or length at maturity is unknown, so resilience and maturity analyses could not be performed. The species has a regional spatial distribution that has increased over time. Moustached sculpin received a relatively moderate score due to its small, declining total abundance. The worksheet and matrix results for moustached sculpin are found in Appendix 4, Table 24.

Alewife (*Alosa pseudoharengus*) received a score of 26. Alewife is an anadromous fish, and it should be noted that this assessment only includes the marine portion of the alewife life cycle. Analysis would not be complete without studying the freshwater portion of its life history as well. Alewife has a medium resilience. Its total and mature abundance is small, and have both increased over time. The species is regionally distributed and its

spatial distribution has remained stable. Abundance and distribution threats are moderate, due to the species migratory, anadromous nature. Alewife received a relatively low score due to its increasing abundance trends. The worksheet and matrix results for alewife are found in Appendix 4, Table 25.

Atlantic Argentine (***Argentine silus***) received a score of 69. The species' resilience is medium. However, its total and mature abundance is small and abundance trends have declined over time. The species has a restricted spatial distribution, which has been declining over time. Atlantic argentine received a relatively moderate score due to its small, declining abundance and declining spatial distribution. The worksheet and matrix results for Atlantic argentine are found in Appendix 4, Table 26.

Longfin Hake (***Phycis chesteri***) received a score of 58. The total abundance is small, but has been increasing over time. Little is known about the longfin hake's life cycle. Information regarding age or length at maturity is unknown, so maturity analysis could not be performed. Resilience is unknown, but it is assumed to be comparable to that of known hake species. Red hake and white hake both have medium resilience, and this value was used to evaluate longfin hake. The species spatial distribution is restricted and has declined slightly over time. Longfin hake received a relatively low score due to its increasing trends in abundance. The worksheet and matrix results for longfin hake are found in Appendix 4, Table 27.

Windowpane (***Scophthalmus aquosus***) received a score of 49. The species' resilience is medium, maturing at 3 yr of age. Windowpane's total abundance is very small, and trends have increased over time. The mature abundance is very small, and there are discrepancies in the trends between the different surveys. Spatial distribution is restricted and has declined somewhat over time. Windowpane received a relatively low score due to its fairly high resilience and increasing total abundance. Windowpane is protected by TAC quota limits for flatfish. The worksheet and matrix results for windowpane are found in Appendix 4, Table 28.

Cusk (***Brosme brosme***) received a score of 90. The species' resilience is low, and its total and mature abundance is very small. Extreme declines in abundance have occurred over time. Cusk's spatial distribution is very restricted and has also declined over time. Cusk received a relatively high score due to its very small, declining abundance and it's very restricted, declining spatial distribution. Cusk is currently listed as 'Threatened' by COSEWIC. The worksheet and matrix results for cusk are found in Appendix 4, Table 29.

DISCUSSION AND CONCLUSIONS

Fisheries and Oceans Canada is responsible for compiling biological information on marine fish species that inhabit Canadian waters, and for reporting on the general status of each species. In this document we have developed a method for the rapid assessment of extinction vulnerability of marine fish species, wherein the assessment criteria are

explicitly defined and relevant to marine species in Canada, and the results of analyses are comparable across taxa.

RAPID ASSESSMENT RESULTS

The Maritimes scoring matrix was applied to 29 species in order to roughly determine their current status. Potential vulnerability to extinction (status) is scored on a scale from 0 to 100. A high score, equal or greater than 70, represents a relatively high risk of extinction or extirpation from Canadian waters. As mentioned earlier, the results from the Maritimes matrix analyses for all species are found in Table 2.

Species that received matrix scores greater than 70 are cusk, smooth skate, winter skate, thorny skate, striped Atlantic wolffish, spiny dogfish, common ocean pout, and Atlantic halibut.

Little skate is the only skate that received a matrix score lower than 70. The possible misidentification of this species in earlier surveys (Simon, 2003) may partially explain its increasing trends, as well as the other skates' declining trends. However, its low score may also be due to the assumptions that were made regarding maturity and resilience criteria for the matrix. Compared to the rest of the skate family, little is known about the life cycle of little skate. It was assumed that little skate's resilience was comparable to that of thorny and smooth skate. It was also assumed that little skate's mature abundance was comparable to its total abundance. These assumptions affected the scoring of the abundance, and the use of accurate information for these criteria may have altered the matrix score.

Three members of the Order Scorpaeniformes are among the 30 highly represented species in the surveys. The moustached sculpin and sea raven both received moderately high scores. However, very little is known about their life history, and assumptions were made regarding maturity and resilience criteria. Further knowledge about the life cycle of the Scorpaeniformes may alter their matrix score.

The Maritimes ranking matrix appears to be successful in identifying species that have already been identified as at risk for extinction by other means, despite the fact that matrix criteria are scored based on data at the species level, rather than at the more detailed subspecies or stock level. There are nine species that have received high matrix scores or scores equal or greater than 70. Four of these species are already recognized as being at risk for extinction. Cusk was listed as 'Threatened' by COSEWIC in 2003. Atlantic cod populations in the Maritimes region were listed as 'Special Concern' by COSEWIC in 2003. Striped Atlantic wolffish was listed as 'Special Concern' by COSEWIC in 2000. Atlantic halibut was listed as 'Endangered' by the IUCN Red List in 1996. There are nine species that received moderate matrix scores, or scores between 60 and 69. From these species, yellowtail flounder was listed as 'Vulnerable' by the IUCN Red List in 1996. A notable exception is haddock. This species was listed as 'Vulnerable' by the IUCN Red List in 1996, but received a very low matrix score of 21. According to the 2002 Stock Status Reports, haddock had previously shown signs of

decline, but has seen increases in abundance and reductions in exploitation rates since the early 1990s. Therefore, the matrix may be able to identify species in recovery.

VIABILITY OF THE MARITIMES MATRIX

This exercise was intended to test the validity and utility of the Maritime matrix approach to rapid assessment, and to address several of the deficiencies that were found to be in the General Status approach.

Criteria that are Relevant to Marine Fish

The ranking criteria being used for the General Status approach were originally geared toward terrestrial species rather than fishes. This was considered a deficiency of the General Status Project, and a new set of conditions and criteria were developed for the matrix in order to increase the relevance to marine fish. Given that the matrix was able to identify species that were identified by other, more in-depth assessments, such as COSEWIC and IUCN, the criteria used for the matrix appear to be representative of the marine species, and suggest efficacy exists in the Maritimes matrix analysis approach.

Criteria that are Explicitly Defined

The General Status criteria were not clearly defined at the outset of the assessment process, and were open to debate and interpretation throughout the project. This resulted in species with the same status indicator estimates emerging from the ranking scheme with different interpretations of their relative value. In the ranking matrix, the criteria are explicitly defined, making the ranking scores easily replicable between investigators, minimizing the effects of individual opinions and eliminating the use of guess-work. Criteria that are well defined also make the assessment process faster, since analyses can be easily automated and scores can quickly be found for each criterion.

The matrix's explicitly defined criteria proved effective in addressing the effects of the addition of deepwater strata in the Summer RV survey in 1995. Analysis showed that the addition of the deepwater strata had little effect on abundance for every species tested. Any variability with and without the deepwater strata was not significant enough to change the scoring of the criteria.

Results that are Standardized

In the General Status Project, criteria that were not explicitly defined resulted in subjective rankings for each management unit that could not adequately be combined to create a national ranking for each species. An explicitly defined assessment method and criteria allow rankings to be more easily combined when taken to a multi-regional level. Scores among various species can also be directly compared and, as a result, we were able to create a comprehensive list of prioritized species for candidacy for formal COSEWIC assessments, based on the scores produced by the Maritimes matrix.

CAVEATS

The Maritimes matrix is not intended to replace the formal, in-depth assessments used to determine 'At Risk' designations by COSEWIC. There are limits to the effectiveness of the rapid assessment and, hence, is intended only as an initial screening for species that may require further attention. Issues regarding data deficiencies and species-specific catchability still remain. The rapid assessment is highly dependent on the results from research surveys that are designed to sample commercially-exploited groundfish species and may not be effective in catching several marine species. Bottom trawls are unable to sample rough, rocky bottom, and effort is concentrated only on the trawlable shelf bottom, generally at depths of 200 m or less. Therefore, research surveys only sample a portion of many species' distribution. There is also no measure of how gear and vessel changes throughout the years have affected catchability. Issues concerning catchability for some species, such as Atlantic halibut, monkfish and skates, may lessen as the time series for species-specific industry surveys become long enough to be useful in the analysis of long-term trends.

The Maritime matrix assessment, in keeping with the General Status program, is not a detailed assessment of extinction risk, but rather a rapid appraisal of species' status. The Maritimes matrix assessment is intended to be an initial screening that identifies species that may require a detailed assessment of extinction risk, such as that done by COSEWIC. Rankings are assigned at the species level, rather than at the subspecies or stock level, for the NAFO regions 4VWX, 5YZc. To date, the assessments done by the Maritimes Region have not been combined with results of other regions. Therefore, the rankings presented in this document only reflect the status of species *within* the Maritimes Region, and not an overall national assessment.

PRIORITIZED SPECIES LIST

A prioritized list of candidate species that require formal assessments of risk for extinction by COSEWIC was created based on the results of the matrix analysis. Those species that have undergone formal assessments by COSEWIC, and have either been ranked or are in the process of being ranked for endangerment were removed.

High Priority:
Smooth skate
Thorny skate
Spiny dogfish
Common ocean pout
Atlantic halibut

Medium Priority:
Moustached sculpin
Atlantic argentine
Red hake
White hake

Pollock
Short-fin squid
Sea raven
Monkfish, goosefish, angler
Yellowtail flounder

Lower Priority:
Longfin hake
Longhorn sculpin
Silver hake
American plaice

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Table 1: An overview of the 50 most highly represented species in the Maritimes Groundfish database. The shaded species, Redfish Unseparated, was not assessed using the rapid assessment process.

	Species		Species	RV survey samples		
	Latin	Common	Code	Sets	Numbers	Weight
1	*Hippoglossoides platessoides*	American Plaice	40	7246	218280	56882.41
2	*Gadus morhua*	Atlantic Cod	10	7172	272749	313544.5
3	*Melanogrammus aeglefinus*	Haddock	11	6269	734000	475018.3
4	*Raja radiata*	Thorny Skate	201	5390	53863	41101.64
5	*Merluccius bilinearis*	Silver Hake	14	4675	731229	82140.95
6	*Myoxocephalus octodecemspinosus*	Longhorn Sculpin	300	4659	249294	47728.79
7	*Limanda ferruginea*	Yellowtail Flounder	42	4293	234012	59421.17
8	*Glyptocephalus cynoglossus*	Witch Flounder	41	4075	55415	16092.47
9	*Sebastes Sp.*	Redfish Unseparated	23	3780	883664	237248
10	*Urophycis tenuis*	White Hake	12	3774	70217	59872.86
11	*Illex illecebrosus*	Short-Fin Squid	4511	3724	240716	25719.21
12	*Pollachius virens*	Pollock	16	3162	84420	149575.2
13	*Clupea harengus*	Atlantic Herring	60	2984	399215	58387.09
14	*Hemitripterus americanus*	Sea Raven	320	2955	11876	11857.01
15	*Raja ocellata*	Winter Skate	204	2755	44496	68103
16	*Squalus acanthias*	Spiny Dogfish	220	2668	305200	385559
17	*Macrozoarces americanus*	Ocean Pout (Common)	640	2356	11048	8399.561
18	*Lophius americanus*	Monkfish,Goosefish,Angler	400	2264	4934	12215.91
19	*Raja senta*	Smooth Skate	202	2172	7022	2832.12
20	*Urophycis chuss*	Squirrel or Red Hake	13	2098	34527	7411.766
21	*Pseudopleuronectes americanus*	Winter Flounder	43	1859	32424	16295.86
22	*Anarhichas lupus*	Striped Atlantic Wolffish	50	1801	6398	12155.24
23	*Raja erinacea*	Little Skate	203	1676	33446	20619.94
24	*Hippoglossus hippoglossus*	Atlantic Halibut	30	1543	3245	11335.04
25	*Triglops murrayi*	Mailed Sculpin	304	1405	15863	117.264
26	*Alosa pseudoharengus*	Alewife	62	1292	38423	5591.522
27	*Argentina silus*	Atlantic Argentine	160	1213	55625	9218.395
28	*Phycis chesteri*	Longfin Hake	112	1034	32918	2444.302
29	*Scophthalmus aquosus*	Brill/Windowpane	143	994	17080	4024.555
30	*Brosme brosme*	Cusk	15	979	2776	7583.361
31	*Scomber scombrus*	Atlantic Mackerel	70	951	97855	18101.23
32	*Homarus americanus*	American Lobster	2550	811	2544	3688.645
33	*Aspidophoroides monopterygius*	Alligatorfish	340	811	2867	12.5237
34	*Ammodytes dubius*	Northern Sand Lance	610	795	269638	6080.939
35	*Asteroidea S.C.*	Asteroidea S.C.	6100	732	13380	1103.782
36	*Chionoecetes opilio*	Snow Crab (Queen)	2526	723	13936	2606.222
37	*Enchelyopus cimbrius*	Fourbeard Rockling	114	723	1736	65.73
38	*Nezumia bairdi*	Marlin-Spike Grenadier	410	708	5683	318.127
39	*Mallotus villosus*	Capelin	64	698	378734	5405.327
40	*Lycodes vahlii*	Shorttailed Eelpout (Vahl)	647	659	9565	1030.319
41	*Reinhardtius hippoglossoides*	Turbot,Greenland Halibut	31	654	6585	3735.132
42	*Myxine glutinosa*	Northern Hagfish	241	588	1607	200.15
43	*Artediellus uncinatus*	Arctic Hookear Sculpin	306	522	2529	4.5284
44	*Cancer borealis*	Jonah Crab	2511	485	1234	211.243
45	*Peprilus triacanthus*	Butterfish	701	466	17454	1084.609
46	*Citharichthys arctifrons*	Gulf Stream Flounder	44	422	1748	21.675
47	*Lumpenus lumpretaeformis*	Snake Blenny	622	421	3041	57.688
48	*Cyclopterus lumpus*	Lumpfish	501	404	674	1949.264
49	*Helicolenus dactylopterus*	Rosefish (Black Belly)	123	403	7185	451.219
50	*Alosa sapidissima*	Shad American	61	388	1852	1144.22

Table 2: A list of the 30 most highly represented species in the Maritimes Groundfish database, ordered according to their matrix scores.

Species score	Species name		Species code
	Latin	Common	
N/A	Sebastes Sp.	Redfish Unseparated	23
90	*Brosme brosme*	Cusk	15
86	*Raja senta*	Smooth Skate	202
85	*Raja ocellata*	Winter Skate	204
84	*Raja radiata*	Thorny Skate	201
75	*Gadus morhua*	Atlantic Cod	10
75	*Anarhichas lupus*	Striped Atlantic Wolffish	50
74	*Squalus acanthias*	Spiny Dogfish	220
73	*Macrozoarces americanus*	Ocean Pout (Common)	640
72	*Hippoglossus hippoglossus*	Atlantic halibut	30
69	*Triglops murrayi*	Mailed Sculpin	304
69	*Argentina silus*	Atlantic Argentine	160
67	*Urophycis chuss*	Squirrel or Red Hake	13
66	*Urophycis tenuis*	White Hake	12
65	*Pollachius virens*	Pollock	16
64	*Illex illecebrosus*	Short-Fin Squid	4511
61	*Hemitripterus americanus*	Sea Raven	320
61	*Lophius americanus*	Monkfish, Goosefish, Angler	400
60	*Limanda ferruginea*	Yellowtail Flounder	42
58	*Phycis chesteri*	Longfin Hake	112
56	*Myoxocephalus octodecemspinosus*	Longhorn Sculpin	300
52	*Merluccius bilinearis*	Silver Hake	14
51	*Hippoglossoides platessoides*	American Plaice	40
49	*Scophthalmus aquosus*	Brill/Windowpane	143
49	*Glyptocephalus cynoglossus*	Witch Flounder	41
46	*Raja erinacea*	Little Skate	203
28	*Pseudopleuronectes americanus*	Winter Flounder	43
26	*Alosa pseudoharengus*	Alewife	62
21	*Melanogrammus aeglefinus*	Haddock	11
9.5	*Clupea harengus*	Atlantic Herring	60

APPENDIX 1: COSEWIC's ASSESSMENT PROCESS AND CRITERIA

Determining eligibility of species for status assessment.

A) Taxonomic validity

COSEWIC would normally only consider species and subspecies or varieties that have been established as valid in published taxonomic works or in peer reviewed communications from taxonomic specialists. COSEWIC would not normally consider populations unless of "national significance" (refer to Guidelines for Listing Nationally Significant Populations, Appendix F5). Justification for considering a population of "national significance" must be provided.

B) Native species

COSEWIC would normally only consider native species. A native species is an indigenous species that occurs in Canada naturally, or is a species that occurred in North America naturally and expanded its range into Canada on its own, has produced viable populations, and has persisted in Canada for at least 50 yr.

C) Regularity of occurrence

COSEWIC would normally only consider species which occur regularly in Canada, excluding vagrants.

D) Requires habitat in Canada

COSEWIC considers species that are year-round residents in Canada. COSEWIC also considers a species which, although not a full-time residents in Canada, meet the other eligibility criteria and require habitat in Canada for a key life history stage.

E) Special cases

Notwithstanding the above guidelines, a taxon may be considered eligible if there are clear conservation reasons for consideration (for example high risk of extinction). In particular, a species which does not meet the eligibility criteria but which is at risk in its primary range outside of Canada could be considered for designation.

Reasons for considering a special case must be presented and supporting information must be provided; this should normally be reviewed and agreed to by COSEWIC before a status report is prepared.

COSEWIC quantitative criteria and guidelines for the status assessment of species.

COSEWIC's revised criteria to guide the status assessment of species. These were in use by COSEWIC by November 2001, and are based on the revised IUCN Red List categories (IUCN 2001). An earlier version of the quantitative criteria was used by COSEWIC from October 1999 to May 2001.

	Endangered	**Threatened**
A. Declining Total Population		
Reduction in population size based on any of the following 4 options and specifying a-e as appropriate:		
	$\geq 70\ \%$	$\geq 50\ \%$
1) population size reduction that is observed, estimated, inferred, or suspected in the past 10 yr or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any combination of a-e below.		
	$\geq 50\ \%$	$\geq 30\ \%$
(2) population size reduction that is observed, estimated, inferred or suspected over the last 10 yr or 3 generations, whichever is longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any combination of a-e below.		

(3) population size reduction that is projected or suspected to be met within in the next 10 yr or 3 generations, whichever is longer (up to a maximum of 100 yr), based on (and specifying) any combination of b-e below.

(4) population size reduction that is observed, estimated, inferred, projected or suspected over any 10 yr or 3 generation period, whichever is longer (up to a maximum of 100 yr), where the time period includes both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of a-e below.

a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, *competitors or parasites*

	Endangered	**Threatened**
B. Small Distribution, and Decline or Fluctuation		
1. Extent of occurrence	< 5,000 km^2	< 20,000 km^2
Or		
2. Area of occupancy	< 500 km^2	< 2,000 km^2
For either of the above, specify at least two of a-c:		
(a) either severely fragmented or known to exist at # locations	≤ 5	≤ 10
(b) continuing decline observed, inferred or projected in any of the following: i) extent of occurrence ii) area of occupancy iii) area, extent and/or quality of habitat iv) number of locations or populations v) number of mature individuals		
(c) extreme fluctuations in any of the following: i) extent of occurrence ii) area of occupancy iii) number of locations or populations iv) number of mature individuals	> 1 order of magnitude	> 1 order of magnitude
C. Small Total Population Size and Decline		
Number of mature individuals and 1 of the following 2:	< 2,500	< 10,000
(1) an estimated continuing decline rate of at least:	20% in 5 yr or 2 generations (up to a maximum of 100 yr in the future)	10% in 10 yr or 3 generations (up to a maximum of 100 yr in the future)
(2) continuing decline, observed, projected, or inferred, in numbers of mature individuals and at least one of the following (a-b):		
(a) fragmentation-- population structure in the form of one of the following:	(i) no population estimated to contain >250 mature individuals	(i) no population estimated to contain >1,000 mature individuals
	(ii) at least 95 % of mature individuals in one population	(ii) all mature individuals are in one population
(b) extreme fluctuations in the number of mature individuals		
D. Very Small Population or Restricted Distribution		

(1) Number of mature individuals	< 250	< 1,000
(2) Applies only to threatened: Population with a very restricted area of occupancy or number of locations such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus is capable of becoming highly endangered or even extinct in a very short time period.	(not applicable)	area of occupancy typically < 20 km^2 or number of locations ≤ 5

E. Quantitative Analysis

Indicating the probability of extinction in the wild to be at least:	20% in 20 yr or 5 generations, whichever is longer (up to a maximum of 100 yr)	10% in 100 yr

Special Concern:

those species that are particularly sensitive to human activities or natural events but are not endangered or threatened species.

Species may be classified as being of Special Concern if:

a. the species has declined to a level of abundance at which its persistence is increasingly threatened by genetic, demographic or environmental stochasticity, but the decline is not sufficient to qualify the species as Threatened; or
b. the species is likely to become Threatened if factors suspected of negatively influencing the persistence of the species are neither reversed nor managed with demonstrable effectiveness; or
c. the species is near to qualifying, under any criterion, for Threatened status; or
d. the species qualifies for Threatened status but there is clear indication of rescue effect from extra-limital populations.

Examples of reasons why a species may qualify for "Special Concern":

- A species that is particularly susceptible to a catastrophic event (e.g., a seabird population near an oil tanker route)
- A species with very restricted habitat or food requirements for which a potential threat to that habitat or food supply has been identified (e.g., a bird that forages primarily in old-growth forest, a plant that grows primarily on undisturbed sand dunes, a fish that spawns primarily in estuaries, a snake that feeds primarily on a crayfish whose habitat is threatened by siltation)
- A recovering species no longer considered to be Threatened or Endangered but not yet clearly secure

Examples of reasons why a species may not qualify for "Special Concern":

- A species existing at low density in the absence of recognized threat (e.g., a large predatory animal defending a large home range or territory)
- A species existing at low density that does not qualify for Threatened status for which there is a clear indication of rescue effect

COSEWIC definitions associated with quantitative criteria.

Area of occupancy: Area of occupancy is defined as the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data. To avoid inconsistencies and bias in assessments caused by estimating area of occupancy at different scales, it may be necessary to standardize estimates by applying a scale-correction factor. It is difficult to give strict guidance on how standardization should be done because different types of taxa have different scale-area relationships.

Continuing decline: A continuing decline is a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken. Fluctuations will not normally count as continuing declines, but an observed decline should not be considered as a fluctuation unless there is evidence for this.

Extent of occurrence: Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat) (but see 'area of occupancy'). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

Extreme fluctuations: Extreme fluctuations can be said to occur in a number of taxa when population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e., a tenfold increase or decrease).

Generation: Generation length is the average age of parents of the current cohort (i.e. newborn individuals in the population). Generation length therefore reflects the turnover rate of breeding individuals in a population. Generation length is greater than the age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once. Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.

Location/Site: a geographically distinct area where a group of individuals of a species is (or has been) found. The total population or a population may comprise a number of sites.

Mature individuals (Number of): The number of mature individuals is the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity, the following points should be borne in mind:

- Mature individuals that will never produce new recruits should not be counted (e.g. densities are too low for fertilization).
- In the case of populations with biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals which take this into account.
- Where the population size fluctuates, use a lower estimate. In most cases this will be much less than the mean.
- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals).
- In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.
- Re-introduced individuals must have produced viable offspring before they are counted as mature individuals.

A population: A population is defined as a geographically or otherwise distinct group (a portion of the total population) that has little demographic or genetic exchange with other such groups (populations) -- typically one successful migrant individual or gamete per year or less.

Quantitative analysis: A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. Population viability analysis (PVA) is one such technique. Quantitative analyses should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate of extinction risk (for instance, estimating the impact of stochastic events on habitat). In presenting the results of quantitative analyses, the assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must all be documented.

Reduction: A reduction is a decline in the number of mature individuals of at least the amount (%) stated under criterion A over the time period (years) specified, although the decline need not be continuing. A reduction should not be interpreted as part of a fluctuation unless there is good evidence for this. The downward phase of a fluctuation will not normally count as a reduction.

Severely fragmented: The phrase 'severely fragmented' refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated populations (in certain circumstances this may be inferred from habitat information). These small populations may go extinct, with a reduced probability of recolonization.

Total population: Population is here defined as the total number of individuals of the taxon in Canada. For functional reasons, primarily owing to differences between life forms, population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

COSEWIC species definition and status categories.

Species - Any indigenous species, subspecies, variety, or geographically or genetically distinct population of wild fauna and flora.

Extinct (X) - A species that no longer exists.

Extirpated (XT) - A species no longer existing in the wild in Canada, but occurring elsewhere.

Endangered (E) - A species facing imminent extirpation or extinction.

Threatened (T) - A species likely to become endangered if limiting factors are not reversed.

Special Concern (SC) - A species that is particularly sensitive to human activities or natural events but is not an endangered or threatened species.

Data Deficient (DD) - A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.

Not At Risk (NAR) - A species that has been evaluated and found to be not at risk.

APPENDIX 2: GENERAL STATUS ASSESSMENT PROCESS AND CRITERIA

General Status Criteria Definitions and Interpretation for Marine Fishes:

1A Population Size/Abundance:

Population size is defined as the current estimate of the total number of mature individuals capable of reproduction. Where populations are characterized by natural fluctuations, the minimum number should be used. Likewise, if the population is characterized by biased breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals that will take this into account (eg. estimates of the effective population size). In the case of taxa obligatory dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used. For many species, a figure of less than 1 000 individuals has been found to be an appropriate guideline of what constitutes a small population. Where there is a range of values in a population assessed, the lowest number is used. Figures are presented as general guidelines because it is impossible to give numerical values that are applicable to all taxa. It is likely that different definitions of what constitutes a small population will need to be developed for different taxonomic groups. For example, the use of this criterion's numeric rating scale is not applicable for the assessment of many invertebrates.

1A Population Size Interpretation for Marine Fishes:

In the context of marine fishes, 'population' refers to the total abundance for species within the jurisdiction or ocean region in question. For total abundance estimates in a particular jurisdiction, marine fishes assessments will use the following qualitative measures: very small, small, medium and large. These criteria will be interpreted relative to all other species and taxa, including other marine fishes. For example, the interpretation for 'small' will likely refer to long-lived, relatively non-abundant species groups while species characterised as large will include the fast-growing species with high fecundity. Numerical values used for this criteria by other taxa (where a 'large' population constituted >10, 000 individuals) will not be used.

For the purpose of marine fishes, natural rarity will refer to infrequent occurrences throughout all or part of the range and not species with substantial declines from historical biomass.

Abundance of mature marine fishes is defined as the number of individuals that are reproducing. Biomass can be used where numerical estimates are not available. An attempt was made in the pilot project to characterise marine fish as 'small, 'medium', or 'large' in relation to expected or historical abundance. This was concluded not to be a valid approach.

Comment options

- Extrapolation from population density
- Extrapolation from small-scale study
- Educated guess based on anecdotal evidence, landings information, dock interviews.

Considerations

- Is the species naturally rare? If so criteria should be weighted more heavily for population declines than for population size.
- Are the data from fishery independent or dependent sources?
- Consider both numerical abundance
- Consider biomass for a reflection of population reproductive potential if numbers are not available.
- Sex-changing or biased sex-ratio fish? If so, weight population size criteria accordingly.
- See calculation for concentration and prevalence as a proxy for population size in Zwanenberg et al. CSAS Research Document, 2002/010

1B Number of Occurrences:

Number of occurrences is defined as the estimated number of sites where the species currently persists. Each occurrence should represent habitat that sustains or otherwise contributes to the survival of a population. Occurrences are locations or places where a species is found, in which a single event may affect the individuals of the taxon (ie. species). The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one event, location should be defined by considering the most serious plausible threat. Occurrences may be defined differently for different species depending on their natural history. An occurrence should have practical conservation value for the species as evidenced by known or reasonable inference of recurrence at a given location. The basis for including this attribute as an indicator: very few site occurrences would make a species "very susceptible to any number of ecological disturbances, both predictable and unpredictable".

1B Number of Occurrences Interpretation for Marine Fishes:

For marine fishes, absolute number of occurrences will have limited utility in determining the status because definitions or units are not likely to be comparable across species. In addition, marine fishes tend to occupy large geographical areas with sporadically dispersed suitable habitat. Further, most marine fish work is based on point sampling and it is often impossible to translate results into discrete 'occurrences'. An occurrence for marine fishes can be defined as a stock, location, depth, area or habitat type or an isolated and discontinuous island of suitable habitat for a particular species.

In this exercise, an occurrence will be used as a proxy for partially isolated populations. This measure will not likely be scored for most species due a lack of information or where available information requires detailed analysis for interpretation. However, species that have very few occurrences are more vulnerable to the potential threat of an isolated event and should be flagged as such. If a species is known to no longer occur in a particular area or areas where it once did, this can be taken into consideration when providing a status rank for that species. This trend information would not otherwise be captured in the trend in distribution criterion that only measures a change in area occupied over time. For trend in occurrence, the change in diversity would be associated with a number and not an area.

Trends in the number of occurrences over time may be considered and outlined in the comments field of the occurrence or distribution trend criteria. The trend in the number

of occurrences can be in rapid decline or decline (over the past 10 yr or 3 generations), stable or increasing.

Additional distribution indices that have become standard calculations in East coast fish stock assessments could be used for Atlantic species where information is available. Calculations include prevalence (proportion of non-zero sets), concentration (total survey area occupied by to top Nth percent of the total annual population estimate) and local density (catch per unit effort). These measures reflect the distribution of a species as it relates to population size and whether species distribution is expanding or contracting over time and must be applied in conjunction with geolocated data.

1C Geographic Distribution:
Distribution is defined as the current percentage of the provincial/territorial/ocean region area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of occurrence, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distribution of a taxon (e.g. large areas of obviously unsuitable habitat). For migratory species, the geographic distribution is the smallest area essential at any stage for the survival of the species.

1C Geographic Distribution Definition for Marine Fishes:
Distribution for marine fishes will be based on extent of occurrence and/or area of occupancy depending on available information. Area of occupancy is the preferred measure according to IUCN criteria for marine fishes. The percentage of distribution for marine fishes will include all areas that are known to be essential at any stage for the survival of the species, including migratory, spawning beds or feeding areas. The area will also include areas where the species have been known to stray into occasionally. Sources will include fishery dependent data, observer data, fishery independent data, research data, websites, personal communication etc. and use of sources (interpretation of range maps) must be well documented (eg. where fish occur, x% of year with 'y' degree of certainty, number of studies, frequency of appearance in studies etc.). An appendix can be included with generated distribution maps for marine fish species. A written description of the distribution maps would also be useful.

Comment options
- Extrapolation from population density
- Extrapolation from small-scale study
- Educated guess based on anecdotal evidence, landings information, dock interviews.
-

Considerations
- Is this species endemic in the jurisdiction or Canada?
- Are the data from fishery independent or dependant sources?

Geographic Area Descriptions:
Atlantic Ocean - Canadian continental shelf waters from the United States border north to Cape Chidley.
Arctic Ocean - Canadian waters divided by Wildlife Management Boards boundaries due to requirement for jurisdictional input (North West Territories: FJMC www.fjmc.ca and Nunavut: NWMB www.nwmb.com).

Pacific Ocean - Canadian West Coast waters from United States border north to Alaskan Coast.

2A Trends in Population Size:

Population trend is defined as an estimate of the change in the number of mature individuals over time. Rapidly declining is defined as a decrease of 50% in the last 10 yr or three generations, whichever is longer. Declining is defined as a decrease of 20% in the last 10 yr or three generations, whichever is longer. Natural fluctuations will not normally count as part of a decline, but an observed decline should not be considered part of a natural fluctuation unless there is evidence for this.

2A Population Size Trend Interpretation for Marine Fishes:

For the purpose of assessing marine fishes under the General Status definition a population decline will be measured using two levels, both early and late in the time series data. Each level will represent the average of a few years' information. For example, an average of 5 yr of data for each point can represent the beginning and end point of the decline. A stable population includes those that are experiencing natural fluctuations in population size. Increasing population trends can be at any rate of population increase using the two average point method to represent the beginning and end point of the series. At least 10 yr or three generations (taken as mean age of spawners) of data will be needed in order to make an assessment. For the purpose of marine fishes, natural rarity will refer to infrequent occurrences throughout all or part of the range and not species with substantial declines from historical biomass.

In some instances, it may be useful to use data from the United States or other non-Canadian waters if there are no Canadian data available and it is felt that the external data is likely to reflect the overall trends in Canadian waters as well. This would be true for highly migratory species for which there is only one population moving between the borders, or where there is reason to believe that population declines in one area are likely to occur in the entire range of the species.

Such estimates of decline would more likely be feasible for migratory species with a widespread, sporadic distribution. If data from outside Canada are used in scoring the population decline criteria, this must be clearly indicated in the comments field and considered to be only an estimation of the situation in Canadian waters. It is important to remember that the General Status exercise is intended to rank the status of a species in Canadian waters only. This is not an attempt to determine the worldwide status of a species, however, external information may assist in determining the possible scenarios in local waters.

Comment options

- Is this a past or present trend?
- Possible reasons for trend increase or decrease?
- Is this an educated guess?
- Density dependent reproduction should be considered where relatively minor decline may correspond to substantial reductions in reproductive potential
- Are there data available for Canadian waters?

Considerations

- Is this species expected to have natural fluctuations in population size?
- Reduction is currently defined as the decline in the number of mature individuals where mature is an individual capable of reproduction
- Reproductive 'capability' may be directly related to density for this species.
- Consider that a small decline over a long period of time may have as great an impact on species as a relatively larger decline over a shorter period of time. This would capture long-term sub-critical trends and possibly lead to a determination of 'sensitive'.

2B Trend in Distribution:

Distribution trend is defined as a decrease in the range of the species over time. Rapidly declining is defined as a decrease of 50% in the last 10 yr or three generations, whichever is longer. Declining is defined as a decrease of 20% in the last 10 years or three generations, whichever is longer.

2B Trend in Distribution Interpretation for Marine Fishes:

At least 10 yr or three generations (taken as mean age of spawners) of data will be needed in order to make an assessment.

Comment options

- Is this a past or present trend?
- Possible reasons for trend increase or decrease?
- Is this an educated guess?

Considerations

- Consider that a small decline over a long period of time may have as great an impact on species as a relatively larger decline over a shorter period of time. This would capture long-term sub-critical trends and possibly lead to a determination of 'sensitive'.

3A Threats to Population Size:

Threats to population are defined as observed, inferred, or projected mortality and include effects of direct exploitation, harassment, exotic species, or ecological interactions with predators, competitors, pathogens, or parasites that may result in population declines. Extreme threats to populations are significant, affect more than half the population, and are unmitigated. Moderate threats are also serious but affect less than half the population or are mitigated by some level of human protection. Limited threats are less significant to population viability or are being mitigated through protective measures.

3B Threats to Habitat:

Threats to habitat are defined as observed, inferred, or projected habitat alterations (loss, conversion, degradation, or fragmentation) which may result in population declines. Extreme threats are significant, affect more than half the population, and are unmitigated. Moderate threats are also serious but affect less than half the population or are mitigated by some level of human protection. Limited threats are less significant to population viability or are being mitigated through protective measures.

3A/3B Threats Interpretation for Marine Fishes:
Major threats should be listed and also the degree to which and how the population is affected by these threats should be mentioned. Also the species dependence on current conservation measures should be noted. Potential threats to a species should also be considered when weighting the threat criteria in an overall ranking.

Roll-up Criteria Scores Towards a Ranking:

General Status Rank Categories:
General status categories are necessarily somewhat broad as they are used for all taxonomic groups. There are two main reasons for this. The large number of species covered precludes the detailed and intensive species assessments that would inform a finer-scaled system and there is variation in the amount of information available for different species.

Weighting criteria:
After scores have been assigned to each of the criteria, criteria scores are rolled up into a rank for that species, if necessary, using the criteria scoring sheet. Although pre-determined rules can act as guidelines towards determining a rank from a series of criteria scores, adequate rationale and documentation should take precedence over rule-based decisions. Criteria scores for each species should be weighted according to the relevant biology and information available for that species. Weighting is done according to the quality or quantity of data, consensus of experts and relevance of the criteria to the overall picture or the specific area in question. For example, even though population size may be scored as 'large', certain species more than others are dependent on extremely large population sizes in order to reproduce effectively. Therefore, the population size score of 'large' would not count as heavily in the roll-up of criteria scores towards a ranking for that species. In other cases, scores extrapolated from non-Canadian data for migratory species could have less weight than scores from actual Canadian data.

Consensus of experts measure:
The group will arrive at a consensus for each of the decided rankings. Notes will be made for dissenting opinions expressed that do not necessarily reflect the consensus of the group. If consensus is not reached for the species ranking or for a particular criteria in question the species may need to be deemed 'Undetermined' due to an apparent difficulty in data interpretation.

Un-scored or Un-scorable criteria:
A blank cell on a score sheet is a criterion that has not been assessed. That is, no information was sought for this criterion. A question mark on a score sheet is a criterion that is undetermined or not determinable based on available information. When rolling up criteria scores towards a rank, question marks and blank cells reflect a lack of information and rank determinations will be based on information from other criteria.

Effort in Searching for and Reviewing Information:
There may be times when there is information available for a species but more effort is required to review the information in order that a rank determination can be made. For example, data may have been collected but not yet electronically entered, analysed or standardized between regions. This information is still valuable as it flags areas requiring

further research for certain species before it can be determined whether a detailed assessment should be made.

Range scores:
A range score may be given where the criterion fall in between two possible descriptors (eg. moderate – extreme). A range rank may be given if the score is different for different management areas (eg. secure in one area and may be at risk in another). Rank determinations based on range scores in certain criteria will require the best judgement of the expert panel. A range score does not necessarily indicate uncertainty with the score or rank, rather it indicates that the existing thresholds for a criteria are not a good fit for the particular species.

General Rules for ranking species based on scored criteria:
There are various rules for rolling up criteria scores into a ranking for a species. In addition to the criteria scores, the final rank is also affected by the quality of information, the degree of certainty with available information and the consensus of experts. If a rank determination is not transparent by the criteria scores, it is important to justify the reasoning behind the decision.

Degree of certainty required for assessed criteria:
Describing the degree of certainty for a criteria score or overall species ranking may be required for a particular species. Possible terms for describing the kind of information that led to certain scores are: qualitative/anecdotal, quantitative/indices, one study or many studies, one expert opinion or several expert opinions. A decision can also be made with a high degree of confidence, medium confidence or low confidence and be flagged as such.

Required consensus of experts:
There will be times where experts do not agree with a species designation based on the existing criteria scores and information that is available. Dissenting opinions should be noted and the degree to which consensus was reached among experts should be documented. 'Undetermined' may be used for the species ranking or a particular criterion if available data are found to be difficult to interpret by the experts.

Considerations:
The following factors should be considered and documented in the comments field. These factors should be taken into consideration when weighing the criteria towards the determination of a rank.

- Number of occurrences/fragility
- Existing protection measures
- Naturally rare, widespread species
- Information availablility/reliability/interpretation

Other Comment Options:

- Existing COSEWIC Priority Candidate – Higher, Intermediate, Lower
- Suggest as Candidate for COSEWIC Update

- IUCN Category on International Red List of species
- Seasonal migrant in Canadian waters
- Mesopelagic or >200m
- Information available for species only outside of Canadian waters
- High, Medium or Low Confidence with decision
- More detailed review required for a proper General Status assessment
- May be at Risk due to low number of occurrences and vulnerability to threats
- Historically very common to abundant
- Dependent on existing management plans/protection measures
- Only non-adult specimens found in Canadian waters
- Common by-catch species
- Outside of 200 mile limit

General Status Definitions

1 - At Risk - species for which a formal detailed risk assessment (COSEWIC assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (i.e., Endangered or Threatened). A COSEWIC designation of Endangered or Threatened automatically results in a general status rank of At Risk nationally. Where a provincial or territorial formal risk assessment finds a species to be Endangered or Threatened in that particular region, then, under the general status system, the species automatically receives a provincial or territorial general status rank of At Risk. (note: provincial and territorial rankings will not apply for marine fishes)

2 - May Be At Risk - species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment.

3 - Sensitive - A category where a species is not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.

4 - Secure - A category for a species that is not believed to belong in the categories At Risk, May Be At Risk, Extirpated, Extinct, Accidental, Exotic or Sensitive. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant. In such instances, the decline should be highlighted by an asterix and by an associated comment.

5 - Undetermined - A species for which insufficient data, information, or knowledge is available with which to reliably evaluate their general status.

6 - Not Assessed - A species that are known or believed to be present in the geographic area in Canada to which the rank applies but have not yet been assessed

7 - Exotic - Species have been moved beyond their natural range as a result of human activity. Regularly occurring species and accidentals should be included in assessment lists. The general status ranking system does not assess a species level of invasiveness.

8 - Accidental - A category for a species occurring infrequently and unpredictably, outside their usual range.

'At Risk' Interpretation for Marine Fishes

Requirements for an 'At Risk' Assessment

For the purposes of assessing the General Status of marine fishes, an 'At Risk' designation will require that an assessment has been done by COSEWIC and found the species to be Endangered or Threatened.

Suggesting COSEWIC Update

The 'At Risk' determination must be made even if there is reason to believe that the status of the species has changed since the last COSEWIC assessment was done. Such evidence should be referenced if possible. A COSEWIC update for these species can be suggested.

Management Plans and 'At Risk' designations

In the event that a management plan has been in place for this species, these protection mechanisms and the species' dependence on them should be documented.

'May be at Risk' Interpretation for Marine Fishes

Minimum required number of assessed criteria

At least 3 criteria must be assessed with a reasonable degree of certainty for a 'May be at Risk' determination to be made. In addition, there must be knowledge of existing threats to the species' habitat and population size as well as some degree of certainty in population trend information. Also, an A or B score in population size AND both threat criteria would result in a 'May be at Risk' designation. As this is not a detailed assessment of species, there is no burden of proof for a 'May be at Risk' designation. If insufficient information is available to make a confident determination, the species should be ranked as 'Undetermined' overall. Difficulties with the interpretation of and confidence in available information (or lack of information) can also be documented.

Degree of documentation

Justification and reasoning behind this designation must be well documented and the degree of confidence for the information that was consulted and the decision made can be flagged (as high, medium or low). Criteria with scores of A-B must provide a compelling body of experience. There is less need for rigorous documentation of criteria with scores of C-D.

'Sensitive' Interpretation for Marine Fishes

Minimum required number of assessed criteria

At least 3 criteria must be assessed with a reasonable degree of certainty for a 'Sensitive' determination to be made. There must also be information available for the population trend criterion. In addition, both threats fields (to species and to distribution) must be completed.

Degree of documentation

Justification and reasoning behind this designation must be well documented and the degree of confidence for the information that was consulted and the decision made can be flagged (as high, medium or low). Criteria with scores of A-B must provide a compelling body of experience. There is less need for rigorous documentation of criteria with scores of C-D although available sources should be referenced where possible. In order that a 'Sensitive' designation can be made, A/B scores will likely appear in population size, threats to habitat or threats to population size criteria.

'Secure' Interpretation for Marine Fishes

Minimum required number of assessed criteria

A minimum of 4 criteria must be assessed with a reasonable degree of certainty, with 3-4 categories appearing as C-D scores for a 'Secure' determination to be made. In order to determine that a population is 'secure' there must be information available on population trends and threats to population size and habitat.

Degree of documentation

For species that are considered to be secure, documentation will need to be less rigorous than those that are designated in the potentially at risk categories ('At Risk', 'May be at Risk', 'Sensitive') although citing the sources of information consulted in making decisions will be important.

'Undetermined' Interpretation for Marine Fishes

Number of criteria without information indicating data deficiency

An 'undetermined' designation will be given to species having information for less than 3 or 4 of the criteria. Otherwise, a species for which no information was sought, is designated as 'not assessed'. It is possible to consider a species as 'undetermined' if the information that is available for the species is inadequate to make a reliable determination. This is especially true if the essential criteria such as population size or threats have not been scored. In other cases, the information that a ranking would be based on may be difficult to interpret or lacking in expert consensus. This would result in an 'Undetermined' designation with documentation to support the reasons why a ranking was not obtained based on the available information. It is possible that within the context of a rapid General Status assessment, more time would be required to reliably interpret available information.

Essential criteria without information

Population size is considered to be an essential criterion to make a General Status assessment of a marine fish. In addition, it is important to have a reasonable degree of certainty with the information that is available for any or all of the criteria that are driving the designation. It is also important to have some information on the potential threats to population size and habitat. Otherwise, the species may be ranked as 'Undetermined'.

How to document insufficient information

For any species, score each criterion based on the information that is available and justify decisions for each criterion where necessary. Due to the fact that an important goal of the General Status assessments is to determine the degree of information that is available as well as the data gaps for each species, it is also important to document where information was sought but not found. An 'undetermined' designation can be flagged as a species for which there is information but is lacking the detailed assessment needed to make a proper determination. The amount of effort made by experts to search for information and to what degree of certainty it is believed that no other work has been done for each particular area of research can also be documented.

'Not Assessed' Interpretation for Marine Fishes

Requirements for a 'Not Assessed' designation

A species that was 'not assessed' is one for which an assessment of criteria and a ranking was not attempted. This species is likely one for which there is a high degree of certainty that no information is available. Experts may decide that the effort to look for information would mostly likely result in an 'undetermined' designation.

Difference between 'Not Assessed' and 'Undetermined'

An 'undetermined' designation is given to species with little or no information on the majority of the criteria. The species is considered to be assessed, yet 'undetermined', if there was an attempt made to look for available information on the species and the information found was not adequate to make a reliable assessment. Otherwise, a species for which no information was sought, is designated as 'not assessed'. "Not assessed' is also useful for species which there is taxonomic uncertainty and for species where it is uncertain whether it is actually a resident in the jurisdiction.

'Accidental' Interpretation for Marine Fishes

Distinction between Rare and Accidental species

It will be important to make the distinction between a species that occurs rarely in a jurisdiction and species that are accidentally straying into Canadian Atlantic waters as part of the northernmost edge of their range, for example. For the purpose of this exercise, an accidental species will be considered that which is known to stray into Canadian waters due to anomalous external factors such as warm water currents.

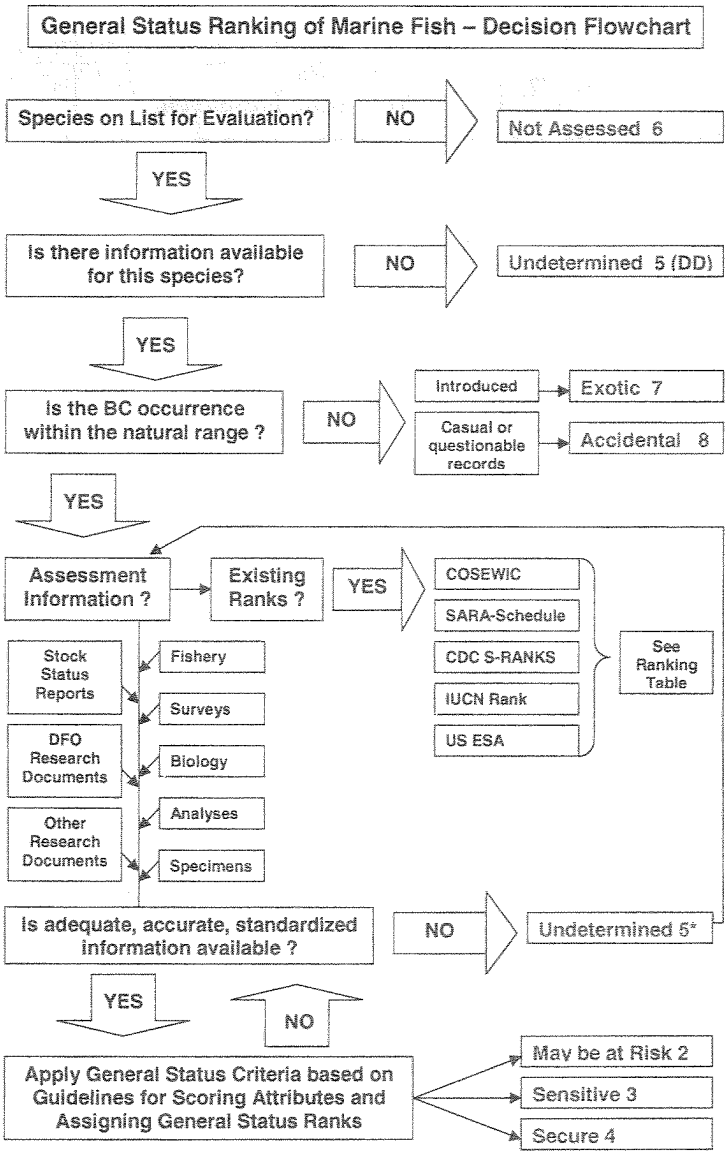
'Exotic' Interpretation for Marine Fishes and Invasive species

Marine fish species considered to be 'invasive' will be given a General Status rank of 'exotic'. Developing a comprehensive list of invasive species in Canada is beyond the scope of the General Status exercise as these species are not considered to be part of Canada's natural biodiversity. However, regularly occurring species, migrants and accidentals should be included in assessment lists.

Ranking Matrix- Table of Scoring Criteria (cheat sheet)

? = undetermined **blank** = not assessed **range** scores possible * see comments	**0.1 Extinct; 0.2 Extirpated; 1 At Risk 2 May be at Risk; 3 Sensitive 4 Secure; 7 Exotic; 8 Accidental 5 Undetermined; 5*Requires further review; 6 Not Assessed**
	SCORE

	Indicator	A	B	C	D
Size	1Aab. Population Size (a= relative/ b= absolute)	Very small	Small	Medium	Large
	1B. Trend in Occurrence	Rapid Decline (> 50% in 10 yr or 3 gen)	Decline (> 20% in 10 yr or 3 gen)	Stable	Increasing (any rate)
	1C. Distribution	Very Restricted (< 3% of area)	Restricted (4-10% of area)	Regional (10 - 50% of area)	Widespread (> 50% of area)
Trend	2A. Trend in Population	Rapid Decline (> 50% in 10 yr or 3 gen)	Decline (> 20% in 10 yr or 3 gen)	Stable (incl. natural fluctuations)	Increasing (any rate)
	2B. Trend in Distribution	Rapid Decline (> 50% in 10 yr or 3 gen)	Decline (> 20% in 10 yr or 3 gen)	Stable (incl. natural fluctuations)	Increasing (any rate)
Threat	3A. Threat to Population	Extreme	Moderate	Limited	None
	3B. Threat to Distribution	Extreme	Moderate	Limited	None
Considerations	# of Occurrences/ Fragility	Very small/ High	Small/ Medium	Medium/ Limited	Large/ Not Fragile
	Existing Protection	High	Moderate	Limited	None
	Naturally Rare, Widespread	Very Rare	Rare	Common	Abundant
	Information	Not Available	Available, not accessible	Accessible, not interpreted	Accessible, not sought
	Confidence	Low	Medium	High	Certain



Documentation of Reasoning/ Justification and a Degree of Certainty measure required for all rankings

*Undetermined 5: limited data available, additional research may provide adequate assessment information
Extinct/Extirpated (0) and At Risk (1) are determined through COSEWIC assessments

APPENDIX 3: MARITIMES MATRIX ASSESSMENT TOOLS

Table 1: Matrix worksheet.

Species:

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – absolute abundance – resilience			
Abundance	**Abundance Trend:** – relative abundance			
Abundance	**Mature Abundance:** – size – trends			
Spatial Distribution	**Spatial Distribution:** – area of occupancy			
Spatial Distribution	**Spatial Dist Trend:** – change in area – fragmentation			
Limiting Factors	**Threats:** – abundance – spatial distribution			
Limiting Factors	**Special Considerations:** – existing protection – species significance – population structure			

Table 2: The ranking matrix used for scoring and calculations.

Species ar Risk - Maritimes Region
Scoring Matrix

Species:

Abundance:	**5**
Large	2
Medium	3
Small	4
Very Small	5
Abundance Score:	

← Input

Spatial Distribution:	**5**
Widespread	1
Regional	2
Restricted (4 - 10%)	3
Very Restricted (3%)	5
Spatial Distribution Score:	

← Input

Resilience:	**3**
High	0.5
Medium	1
Low	2
Very Low	3
Resilience Score:	

← Input

Spatial Distribution Trend:	**10**
50% decline	10
20% decline	6
Stable	4
Increasing	0
Spatial Dist Trend Score:	

← Input

Abundance x Resilience:	**15**
Species Score:	0

Abundance Threat:	**10**
Extreme	10
Moderate	5
Limited	2
None	0
Abundance Threat Score:	

← Input

Abundance Trend:	**30**
50% decline	30
20% decline	20
Stable	10
Increasing	0
Abundance Trend Score:	

← Input

Bonus Points:

Spatial Distribution Threat:	**5**
Extreme	5
Moderate	3
Limited	0
None	0
Spatial Dist Threat Score:	

← Input

Mature Abundance:	**2**
Large	0.5
Medium	1
Small	2
Very Small	2
Unknown	0
Mature Abundance Score:	

← Input

Considerations:	**y/n/?**	
Existing Protection		← Input
Species Significance		← Input
Population Structure		← Input

Mature Abundance Trend:	**15**
Extreme Fluctuations	15
10% decline	15
Stable	7
Increasing	3
Unknown	15
Mature Abund Trend Score:	

← Input

Species Summary:

Matrix Criteria:	**Spec**	**Total**
Abundance:	0	5
Resilience:	0	3
Abundance x Resilience:	0	15
Abundance Trend:	0	30
Mature Abundance:	0	2
Mature Abund Trend:	0	15
Mature Abund x Trend:	0	30
Spatial Distribution:	0	5
Spatial Distribution Trend:	0	10
Abundance Threat:	0	10
Spatial Distribution Threat: *	0	5
Species Score:	**0**	**100**

Mature Abundance x Trend:	**30**
Species Score:	0

Table 3: Total abundance for thorny skate for each year of the three surveys. The 2003 values are highlighted, and were used as the total abundance values. Age of maturity for thorny skate is 4 yr. The time span necessary for three generations as calculated using the formula $A_g = A_m + (1/M)$ is 27 yr. Therefore, data from the last 27 yr of the summer survey, and data from all years of the 4VWCod and Georges Bank surveys, were used to calculate the decline in abundance. The decline in total abundance was calculated using the formula $N_t = N_0 r^t$.

Thorny Skate

	Stratified Total Numbers		
Year	Summer	4VWCod	Georges
1970	17648651		
1971	23142632		
1972	19928567		
1973	37136244		
1974	26876035		
1975	49323786		
1976	27694836		
1977	25682680		
1978	22066029		
1979	22438332		
1980	29364902		
1981	35170353		
1982	32246134		
1983	34258881		
1984	22745186		
1985	33515582		
1986	15436896	15606353	
1987	12024210	28233536	301675
1988	22759389	21839367	143995
1989	17249457	17180519	178916
1990	17818607	15427758	262695
1991	13287410	30565532	316022
1992	12260360	8995569	105819
1993	16602790	8636587	144572
1994	10343321	16120260	142870
1995	16665185	6303579	192584
1996	9881471	7042337	147270
1997	14390643	19757155	17493
1998	10547161		86210
1999	12876270	10640059	151995
2000	6366544	9262744	97330
2001	6118313	6376167	51977
2002	4932119	5665168	54335
2003	10877489	19164159	31449
Slope	0.95	0.94	0.91
Decline	78.24	61.84	79.10

Table 4: Mature abundance for thorny skate for each year of the three surveys. Thorny Skate of lengths equal or greater than 40 cm were considered to be mature fish. The 2003 values are highlighted, and were used as the mature abundance values. The decline in mature abundance was calculated using the formula $N_t = N_0 r^t$.

Thorny Skate

	Mature Stratified Numbers		
Year	Summer	4VWCod	Georges
1970	9520791		
1971	7980531		
1972	9675145		
1973	16367463		
1974	13145535		
1975	21287958		
1976	13322343		
1977	13683909		
1978	11039998		
1979	9068908		
1980	10782398		
1981	13858627		
1982	9341621		
1983	8848792		
1984	9030052		
1985	11595168		
1986	6894679	3049224	
1987	3961064	11360153	144674
1988	6403432	9199129	117738
1989	7736889	4961653	117627
1990	4437276	2471544	158648
1991	4461590	6976619	242439
1992	5322042	1553568	74415
1993	3757197	1480200	59932
1994	2155923	8622706	117999
1995	5129002	1536340	125824
1996	2916409	1404052	90811
1997	3901007	6623115	6307
1998	3109883		50843
1999	6095124	2480979	121184
2000	1998683	2732534	48794
2001	2513255	2473102	37006
2002	1436623	2224364	33102
2003	4830773	1480200	22507
Slope	0.94	0.94	0.89
Decline	82.91	64.11	83.07

Table 5: Extent of occurrence was calculated as the proportion of standardized sets in a survey where thorny skate was caught. The 2003 values are highlighted, and were used to assess the spatial distribution of thorny skate in the NAFO 4VWX, 5Zj,m area. The decline in the extent of occurrence was calculated using the formula $N_t = N_0 r^t$. The decline in extent of occurrence, along with the area of occupancy, was used to assess trends in spatial distribution.

Thorny Skate

	Summer		4VWCod		Georges	
Year	Total Sets	Percent of Species Sets	Total Sets	Percent of Species Sets	Total Sets	Percent of Species Sets
1970	133	66.92				
1971	118	56.78				
1972	147	74.83				
1973	134	76.12				
1974	153	87.58				
1975	143	86.71				
1976	135	78.52				
1977	144	83.33				
1978	141	78.01				
1979	147	74.15				
1980	144	70.83				
1981	143	69.23				
1982	150	74				
1983	146	61.64				
1984	143	63.64				
1985	152	67.76				
1986	171	58.48	77	59.74	77	40.26
1987	188	53.19	92	72.83	71	22.54
1988	177	54.8	68	51.47	132	25
1989	184	54.35	79	49.37	116	22.41
1990	223	42.15	77	50.65	123	26.83
1991	189	50.79	93	55.91	130	17.69
1992	193	45.6	74	54.05	91	14.29
1993	190	45.26	78	51.28	65	18.46
1994	195	36.92	94	46.81	45	22.22
1995	204	42.16	121	55.37	85	14.12
1996	201	41.79	52	53.85	86	12.79
1997	202	42.57	115	51.3	90	6.67
1998	193	41.45			96	8.33
1999	196	39.8	109	52.29	82	12.2
2000	219	31.05	116	44.83	100	12
2001	207	25.12	90	45.56	76	7.89
2002	214	26.64	121	38.02	89	11.24
2003	222	33.33	108	26.85	98	7.14
Slope		0.96		0.97		0.92
Decline		64.99		36.19		75.18

Table 6: The proportion of total survey area occupied by 75% of the thorny skate sampled in the survey was used to describe the area of occupancy. The decline in the area of occupancy was calculated using the formula $N_t = N_0 r^t$. The decline in area of occupancy, along with the extent of occurrence, was used to assess trends in spatial distribution.

Thorny Skate

	Sets Containing 75% of Species	
Year	Summer	4VWCod
1970	0.353846	
1971	0.309735	
1972	0.402985	
1973	0.423077	
1974	0.5	
1975	0.511111	
1976	0.433333	
1977	0.474074	
1978	0.458647	
1979	0.428571	
1980	0.360902	
1981	0.385185	
1982	0.388889	
1983	0.321429	
1984	0.34058	
1985	0.366197	
1986	0.30625	0.308824
1987	0.301775	0.375
1988	0.292683	0.254237
1989	0.295302	0.242424
1990	0.247253	0.25
1991	0.281437	0.258824
1992	0.25	0.271429
1993	0.238372	0.209677
1994	0.201117	0.222222
1995	0.233333	0.272727
1996	0.214286	0.238095
1997	0.24	0.247312
1998	0.22619	
1999	0.212291	0.233333
2000	0.172589	0.191489
2001	0.129213	0.197368
2002	0.145946	0.154639
Slope	0.96	0.97
Decline	66.79	41.17

Table 7: The completed matrix sheet for thorny skate. Calculations for abundance and spatial distribution, and research findings for threats to abundance and distribution, were graded based on the criteria conditions of the matrix.

Species ar Risk - Maritimes Region
Scoring Matrix

Species: Thorny Skate

Abundance Size:	5	
Large	2	
Medium	3	
Small	4	
Very Small	5	
Abundance Score:	3	← Input

Spatial Distribution Size:	5	
Widespread	1	
Regional	2	
Restricted (4 - 10%)	3	
Very Restricted (3%)	5	
Spatial Dist Size Score:	1	← Input

Resilience:	3	
High	0.5	
Medium	1	
Low	2	
Very Low	3	
Resilience Score:	1	← Input

Spatial Distribution Trend:	10	
50% decline	10	
20% decline	6	
Stable	4	
Increasing	0	
Spatial Dist Trend Score:	10	← Input

Abund Size x Res:	15
Species Score:	3

Abundance Threat:	10	
Extreme	10	
Moderate	5	
Limited	2	
None	0	
Abundance Threat Score:	10	← Input

Abundance Trend:	30	
50% decline	30	
20% decline	20	
Stable	10	
Increasing	0	
Abundance Trend Score:	30	← Input

Bonus Points:

Spatial Distribution Threat:	5	
Extreme	5	
Moderate	3	
Limited	0	
None	0	
Spatial Dist Threat Score:	0	← Input

Mature Abundance Size:	2	
Large	0.5	
Medium	1	
Small	2	
Very Small	2	
Unknown	1	
Mat Abundance Size Score:	2	← Input

Considerations:	y/n/?	
Existing Protection	n	← Input
Species Significance	?	← Input
Population Structure	?	← Input

Mature Abundance Trend:	15	
Extreme Fluctuations	15	
10% decline	15	
Stable	7	
Increasing	3	
Unknown	15	
Mat Abund Trend Score:	15	← Input

Species Summary:

Matrix Criteria:	Spec	Total
Abundance Size:	3	5
Resilience:	1	3
Abund Size x Res:	3	15
Abundance Trend:	30	30
Mature Abund Size:	2	2
Mature Abund Trend:	15	15
Mature Abund Size x Trend:	30	30
Spatial Distribution Size:	1	5
Spatial Distribution Trend:	10	10
Abundance Threat:	10	10
Spatial Distribution Threat: *	0	5
Species Score:	**84**	**100**

Mature Abund Size x Trend:	30
Species Score:	30

APPENDIX 4: SCORES OF INDIVIDUAL SPECIES USING THE RANKING MATRIX

Table 1: American plaice matrix results.

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Large Very Low	Summer = 115 million 4VWCod = 24 million Georges Bank = 514 250 Age of maturity = 8 yr	30% of flatfish (yellowtail and american plaice) are identified as undefined.
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = 37% decline 4VWCod = stable Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Medium 10% decline	Length at Maturity = 20 cm, 30 cm Summer = 87 million, 37 million 51% decline, 67% decline 4VWCod = 17 million, 5 million 26% dec, 49% dec	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Greenland to Rhode Island Extent of Occurrence: Summer = 72% of sets 4VWCod = 71% of sets Georges Bank = 46% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Stable	Extent: 75% pop: Summer = 4% decl 3% decl 4VW = 7% decl 6% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Flatfish fishery.	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	Total Allowable Catch allocated for flatfish	

Matrix Criteria:	Species	Total
Abundance:	2	5
Resilience:	3	3
Abundance x Resilience:	**6**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**15**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**51**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 2: Atlantic cod matrix results.

Species: Atlantic cod (*Gadus morhua*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Medium	Summer = 17 million 4VWCod = 3 million Georges Bank = 1.5 million Age of Maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 90% decline 4VWCod = 93% decline Georges Bank = 43% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 50% decline	Length at Maturity = 35 cm Summer = 12 million, 92% decline 4VWCod = 1.2 million, 95% decline Georges = 1.5 million, 48% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	North Atlantic Summer = 46% of sets 4VWCod = 33% of sets Georges Bank = 68% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 39% decl 40% decl 4VW = 35% decl 42% decl Georges = 10% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y Y	Annual fishing quota allocated for cod. IUCN Red List – Vulnerable, COSEWIC – Special Concern Stock Status Reports are divided into Eastern Scotian Shelf, Southern Scotian Shelf and Bay of Fundy, Eastern Georges Bank.	

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	1	3
Abundance x Resilience:	**3**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**75**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	y

Table 3: Haddock matrix results.

Species: Haddock (*Melanogrammus aeglefinus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Large Medium	Summer = 262 million 4VWCod = 204 million Georges Bank = 76 million Age of Maturity = 3 to 5 years	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Large Stable	Length at Maturity = 30 cm Summer = 258 million, increase 4VWCod = 47 million, 57% decline Georges Bank = 25 million, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Cape May, NJ to Strait of Belle Isles Summer = 63% of sets 4VWCod = 40% of sets Georges Bank = 75% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Summer = Extent: 75% pop: 4VW = increase increase Georges 23% decl 20% decl = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y Y	Annual fishing quota allocated for haddock. IUCN Red List – Vulnerable Stock Status Reports are divided into Eastern Scotian Shelf, Southern Scotian Shelf and Bay of Fundy, Eastern Georges Bank.	

Matrix Criteria:	Species	Total
Abundance:	2	5
Resilience:	1	3
Abundance x Resilience:	**2**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	7	15
Mature Abundance x Trend:	**7**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**21**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	y

Table 4: Thorny skate matrix results.

Species: Thorny skate (*Raja radiata*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Medium	Summer = 11 million 4VWCod = 19 million Georges Bank = 31500 Age of maturity = 4 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 78% decline 4VWCod = 62% decline Georges Bank = 79% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 10% decline	Length at Maturity = 40 cm Summer = 4.8 million, 83% decline 4VWCod = 1.5 million, 64% decline Georges Bank = 22500, 83% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Greenland to South Carolina Extent of Occurrence: Summer = 26% of sets 4VWCod = 27% of sets Georges Bank = 7% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	50% decline	Summer Extent: 75% pop: = 4VW = 65% decl 67% decl Georges 36% decl 41% decl = 75% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Extreme Limited	Low survival of egg sacs By-catch, particularly of hake fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	1	3
Abundance x Resilience:	**3**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**10**	**10**
Abundance Threat:	**10**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**84**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 5: Silver hake matrix results.

Species: Silver hake (*Merluccius bilinearis*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Large High	Summer = 400 million 4VWCod = 152 million Georges Bank = 1.9 million Age of maturity = 2 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 45% decline 4VWCod = 71% decline Georges Bank = increase	Silver Hake Trawl = 62% decline
Abundance	**Mature Abundance:** – **size** – **trends**	Medium 10% decline	Length at maturity = 23 cm Summer = 60 million, 64% decl 4VWCod = 63 million, 86% decl	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Newfoundland to South Carolina Extent of Occurrence: Summer = 51% of sets 4VWCod = 38% of sets Georges Bank = 27% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Increase	Summer = / Extent: increase / 75% pop: increase 4VW = / increase / increase Georges = / 26% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery, foreign fishery Immature fish tend to inhabit the inshore, mature inhabit the offshore	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	Annual Total Allowable Catch quota, and fishing is restricted to offshore. Square mesh nets used since 1999 to reduce immature catch.	

Matrix Criteria:	Species	Total
Abundance:	2	5
Resilience:	0.5	3
Abundance x Resilience:	**1**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**15**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**0**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**52**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 6: Longhorn sculpin matrix results.

Species: Longhorn sculpin (*Myoxocephalus octodecemspinos*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Un-known	Summer = 13 million 4VWCod = 13 million Georges Bank = 16 million Age of maturity = unknown	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = increase 4VWCod = 51% decline Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Eastern Nfld to Virginia Summer = 36% of sets 4VWCod = 54% of sets Georges Bank = 66% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = increase increase 4VW = 33% decl 30% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Fisheries by-catch. Eggs are attached to sponge, for use as spawning beds.	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	3	3
Abundance x Resilience:	**9**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**15**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**56**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 7: Yellowtail flounder matrix results.

Species: Yellowtail flounder (*Limanda ferruginea*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Medium	Summer = 34 million 4VWCod = 28 million Georges Bank = 12 million Age of maturity = 3 to 6 yr	30% of flatfish (yellowtail and american plaice) are identified as undefined.
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 42% decline 4VWCod = 72% decline Georges Bank= increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Medium 10% decline	Length at maturity = 25 cm Summer = 27 million, 57% decl 4VWCod = 6 million, 88% decl Georges Bank = 14 million, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Labrador to Chesapeake Bay Summer = 39% of sets 4VWCod = 46% of sets Georges Bank = 58% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: / 75% pop: Summer = increase / increase 4VW = 27% decl / 18% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Flatfish fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	IUCN Red List – Vulnerable Total Allowable Catch allocated for flatfish	

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	1	3
Abundance x Resilience:	**3**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**15**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**60**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 8: Witch flounder matrix results.

Species: Witch flounder (*Glyptocephalus cynoglossus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Very low	Summer = 30 million 4VWCod = 17 million Georges Bank = 0 (no data) Age of maturity = 7+ yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = ?	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 10% decline	Length at maturity = 35 cm Summer = 7.5 million, 76% decl 4VWCod = 2 million, 55% decl Georges Bank = ?	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Grand Banks to North Carolina Summer = 50% of sets 4VWCod = 36% of sets Georges Bank = ?	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Stable	Extent: / 75% pop: Summer = 8% decl / 11% decl 4VW = increase / increase Georges = ?	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Flatfish fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	Total Allowable Catch allocated for flatfish	

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	3	3
Abundance x Resilience:	**9**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**49**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 9: White hake matrix results.

Species: White hake (*Urophycis tenuis*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 15 million 4VWCod = 2.6 million Georges Bank = 5954 Age of maturity = 2-5 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = 9% decline 4VWCod = 45% decline Georges Bank = 83% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 10% decline	Length at maturity = 35 cm Summer = 9.5 million, 31% decline 4VWCod = 684 000, 24% decline Georges Bank = 5945, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Labrador to North Carolina Summer = 37% of sets 4VWCod = 22% of sets Georges Bank = 5% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: / 75% pop: Summer = 33% decl / 34% decl 4VW = increase / increase Georges = 60% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y ? ?	Total Allowable Catch quota	

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**66**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	?
Population Structure	?

Table 10: Short-fin squid matrix results.

Species: Short-fin squid (*Illex illecebrosus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Un-known	Summer = 51 million 4VWCod = 184 000 Georges Bank = 970 000 Age of maturity = unknown	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 41% decline 4VWCod = 64% decline Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Summer = 43% of sets 4VWCod = 5% of sets Georges Bank = 14% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Stable	Extent: Summer = 4% decl 4VW = 58% decl Georges = increase 75% pop: 8% decl increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	By-catch fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	3	3
Abundance x Resilience:	**9**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	1	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**15**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**64**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 11: Pollock matrix results.

Species: Pollock (*Pollachius virens*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Medium Medium	Summer = 20 million 4VWCod = 14 million Georges Bank = 5 million Age of maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = 10% decline 4VWCod = 83% decline Georges Bank = 10% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Medium Fluctuate	Length at maturity = 40 cm Summer = 16 million, increase 4VWCod = 89 000, 99% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Greenland to North Carolina Summer = 34% of sets 4VWCod = 7 % of sets Georges = 19% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: / 75% pop: Summer = increase / increase 4VW = 72% decl / 67% decl Georges = 47% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Commercial fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y Y	Total Allowable Catch quota.	

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	1	3
Abundance x Resilience:	**3**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**65**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	y

Table 12: Atlantic herring matrix results.

Species: Atlantic herring (*Clupea harengus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Large Medium	Summer = 400 million 4VWCod = 245 million Georges Bank = 400 000 Age of maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Large Increase	Length at maturity = 25 cm Summer = 337 million, increase 4VWCod = 93 million, increase Georges Bank = 240 000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Summer = 55% of sets 4VWCod = 48% of sets Georges Bank = 40% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Increase	Extent: 75% pop: Summer = increase increase 4VW = increase increase Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y Y	Total Allowable Catch Quota	

Matrix Criteria:	Species	Total
Abundance:	2	5
Resilience:	1	3
Abundance x Resilience:	**2**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	0.5	2
Mature Abundance Trend:	3	15
Mature Abundance x Trend:	**1.5**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**0**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**9.5**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	y

Table 13: Sea raven matrix results.

Species: Sea raven (*Hemitripterus americanus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Un-known	Summer = 2 million 4VWCod = 750 000 Georges Bank = 300 000 Age of maturity = unknown	
Abundance	**Abundance Trend:** – **relative abundance**	Stable	Summer = increase 4VWCod = 13% decline Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Labrador to Chesapeake Bay Summer = 22% of sets 4VWCod = 22% of sets Georges Bank = 55% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Increase	Extent: 75% pop: Summer = increase increase 4VW = 2% decl increase Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Fisheries by-catch. Eggs are attached to sponge, for use as spawning beds	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	3	3
Abundance x Resilience:	**15**	**15**
Abundance Trend:	**10**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**0**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**61**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 14: Winter skate matrix results

Species: Winter skate (*Raja ocellata*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Low	Summer = 4 million 4VWCod = 2 million Georges Bank = 1.5 million Age of maturity = 6 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = increase 4VWCod = 88% decline Georges Bank = 39% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small 10% decline	Length at maturity = 65 cm Summer = 411 000, 67% decline 4VWCod = 227 000, 95% decline Georges Bank = 563 000, 24% decl	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Newfoundland to North Carolina Summer = 10% of sets 4VWCod = 28% of sets Georges Bank = 70% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = increase increase 4VW = 48% decl 38% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Extreme Limited	Low survival of egg sacs By-catch, particularly of hake fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	2	3
Abundance x Resilience:	**8**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**10**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**85**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 15: Spiny dogfish matrix result.

Species: Spiny dogfish (*Squalus acanthius*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – absolute abundance – resilience	Medium Very Low	Summer = 34 million 4VWCod = 215 000 Georges Bank = 9 million Age of maturity = 10+ yr	
Abundance	**Abundance Trend:** – relative abundance	20% decline	Summer = increase 4VWCod = 99% decline Georges Bank = 93% decline	
Abundance	**Mature Abundance:** – size – trends	Small Fluctuate	Length at maturity = 75 cm Summer = 9 million, increase 4VWCod = 34 000, 99% decline Georges Bank = 4 million, 89% decl	
Spatial Distribution	**Spatial Distribution:** – area of occupancy	Wide-spread	Greenland to Argentina Summer = 25% of sets 4VWCod = 7% of sets Georges Bank = 26% of sets	
Spatial Distribution	**Spatial Dist Trend:** – change in area – fragmentation	Stable	Extent: / 75% pop: Summer = increase / increase 4VW = 47% decl / 41% decl Georges = increase	
Limiting Factors	**Threats:** – abundance – spatial distribution	Extreme Limited	Commercial, by-catch overfishing due to late maturity and tendency to aggregate for feeding, spawning, birth	
Limiting Factors	**Special Considerations:** – existing protection – species significance – population structure	N ? ?	Some international fisheries are managed.	

Matrix Criteria:	Species	Total
Abundance:	3	5
Resilience:	3	3
Abundance x Resilience:	**9**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**10**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**74**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 16: Ocean pout matrix results.

Species: Ocean pout (*Macrozoarces americanus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very small Low	Summer = 800 000 4VWCod = 39 000 Georges Bank = 142 000 Age of maturity = 7 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = increase 4VWCod = 99% decline Georges Bank = 37% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small Fluctuate	Summer = 534 000, increase 4VWCod = 7000, 99% decline Georges Bank = 142 000, 37% decl	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Labrador to Delaware Summer = 13% of sets 4VWCod = 4% of sets Georges Bank = 40% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: / 75% pop: Summer = increase / increase 4VW = 99% decl / 14% decl Georges = 37% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	By-catch	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	2	3
Abundance x Resilience:	**10**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**73**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 17: Monkfish matrix results.

Species: Monkfish, goosefish, angler (*Lophius americanus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very Small Medium	Summer = 2 million 4VWCod = 91 000 Georges Bank = 12 000 Age of maturity = 5 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Stable	Summer = increase 4VWCod = 34% decline Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small 10% decline	Length at maturity = 43 cm Summer = 80 000, 69% decline 4VWCod = 19 000, 36% decline Georges Bank = 6000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Gulf of St Lawrence to Florida Summer = 22% of sets 4VWCod = 8% of sets Georges Bank = 12% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 22% decl 22% decl 4VW = increase increase Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Moderate	By-catch fishery – mostly in 4X Research points to environmental concerns regarding mature population declines.	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y ? ?	By-catch fishery is monitored Possibly northern and southern populations.	

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	1	3
Abundance x Resilience:	**5**	**15**
Abundance Trend:	**10**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	3	5
Species Score:	**61**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	?
Population Structure	?

Table 18: Smooth skate matrix results.

Species: Smooth skate (*Raja senta*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 2 million 4VWCod = 844 000 Georges Bank = 23 000 Age at maturity = unknown (4 yr)	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 59% decline 4VWCod = 47% decline Georges Bank = 84% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Newfoundland to New Jersey Summer = 15% of sets 4VWCod = 19% of sets Georges Bank = 5% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	50% decline	Extent: 75% pop: Summer = 65% decl 62% decl 4VW = 20% decl 45% decl Georges = 23% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Extreme Limited	Low survival of egg sacs By-catch	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**10**	**10**
Abundance Threat:	**10**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**86**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 19: Red hake matrix results.

Species: Red hake (*Urophycis chuss*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 10 million 4VWCod = 2 million Georges Bank = 263 000 Age of maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = increase 4VWCod = 64% decline Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 10% decline	Length at maturity = 24 cm Summer = 8 million, 11% decline 4VWCod = 2 million, 70% decline Georges Bank = 175 000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	South Nova Scotia to North Carolina Summer = 28% of sets 4VWCod = 18% of sets Georges Bank = 12% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = increase increase 4VW = 21% decl 40% decl Georges = 36% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Silver Hake fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**67**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 20: Winter flounder matrix results.

Species: Winter flounder (*Pseudopleuronectes americanus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 13.5 million 4VWCod = 226 000 Georges Bank = 341 000 Age of maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Small Stable	Length at maturity = 30 cm Summer = 6 million, increase 4VWCod = 116 000, 78% decline Georges Bank = 291 000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Wide-spread	Labrador to Georgia Summer = 22% of sets 4VWCod = 7% of sets Georges Bank = 43% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Stable	Extent: 75% pop: Summer = increase increase 4VW = 26% decl 12% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Flatfish fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	Total Allowable Catch allocated for flatfish	

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	7	15
Mature Abundance x Trend:	**14**	**30**
Spatial Distribution:	**1**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**28**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 21: Striped Atlantic wolffish matrix results

Species: Striped Atlantic wolffish (*Anarhichas lupus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Low	Summer = 6 million 4VWCod = 675 000 Georges Bank = 24 100 Age of maturity = 6 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = increase 4VWCod = 56% decline Georges Bank = 80% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small 10% decline	Length at maturity = 55 cm Summer = 397 000, 72% decline 4VWCod = 0, 100% decline Georges Bank = 24 100, 74% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Greenland to Cape Cod Summer = 14% of sets 4VWCod = 7% of sets Georges Bank = 3% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	50% decline	Extent: 75% pop: Summer = 36% decl 37% decl 4VW = 51% decl 52% decl Georges = 80% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y ? ?	Designated as 'Special Concern' by COSWIC	

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	2	3
Abundance x Resilience:	**8**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**10**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**75**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	?
Population Structure	?

Table 22: Little skate matrix results.

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Species: Little skate (*Raja erinacea*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 3 million 4VWCod = 2 million Georges Bank = 230 000 Age of maturity = 4 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Nova Scotia to North Carolina Summer = 11% of sets 4VWCod = 8% of sets Georges = 75% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Increase	Extent: 75% pop: Summer = increase increase 4VW = increase increase Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Extreme Limited	Low survival of egg sacs By-catch	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**0**	**10**
Abundance Threat:	**10**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**46**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 23: Atlantic halibut matrix results.

Species: Atlantic halibut (*Hippoglossus hippoglossus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very Small Very Low	Summer = 612 000 4VWCod = 265 000 Georges Bank = 2757 Age of maturity = 14 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 18% decline 4VWCod = 58% decline Georges = 99% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small Stable	Length at maturity = 115 cm Summer = 138 000, increase 4VWCod = 104 000, 4% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Summer = 14% of sets 4VWCod = 18% of sets Georges Bank = 2% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 21% decl 24% decl 4VW = 14% decl 12% decl Georges = 97% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y Y ?	IUCN Red List – Endangered Species	

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	3	3
Abundance x Resilience:	**15**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	7	15
Mature Abundance x Trend:	**14**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**72**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	y
Population Structure	?

Table 24: Moustache, mailed sculpin matrix results.

Species: Mailed sculpin (*Triglops murrayi*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Un-known	Summer = 5 million 4VWCod = 2 million Georges Bank = 133 000 Age of maturity = unknown	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = increase 4VWCod = 32% decline Georges Bank = 58% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length at maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	Greenland to Cape Cod Summer = 15% of sets 4VWCod = 16% of sets Georges Bank = 2% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Increase	Extent: 75% pop: Summer = increase increase 4VW = increase increase Georges = 79% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Fisheries by-catch. Eggs are attached to sponge, for use as spawning beds	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	3	3
Abundance x Resilience:	**12**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**0**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**69**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 25: Alewife matrix results.

Species: Alewife (*Alosa pseudoharengus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 3 million 4VWCod = 17 million Georges Bank = 6125 Age of maturity 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Small Increase	Length at maturity = 11 cm Summer = 3 million, increase 4VWCod = 17 million, increase Georges Bank = 6125, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Regional	St Lawrence to North Carolina Summer = 9% of sets 4VWCod = 16% of sets Georges Bank = 12% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	Stable	Extent: 75% pop: Summer = increase increase 4VW = increase 80% decl Georges = 6% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Moderate	Anadromous fish, may be greater threats in freshwater	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	? ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	3	15
Mature Abundance x Trend:	**6**	**30**
Spatial Distribution:	**2**	**5**
Spatial Distribution Trend:	**4**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	5	5
Species Score:	**26**	**100**

Considerations:	y/n/?
Existing Protection	?
Species Significance	?
Population Structure	?

Table 26: Atlantic argentine matrix results.

Species: Atlantic argentine (*Argentine silus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very Small Medium	Summer = 926 000 4VWCod = 466 000 Georges Bank = 0 Age of maturity = 5 yr	
Abundance	**Abundance Trend:** – **relative abundance**	20% decline	Summer = 27% 4VWCod = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Small 10% decline	Length at maturity = 30 cm Summer = 3.5 million, 74% decline 4VWCod = 266 000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Restrict	Davis Strait to Southern Nova Scotia Summer = 8% of sets 4VWCod = 5% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 24% decl 37% decl 4VW = increase increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Directed fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	1	3
Abundance x Resilience:	**5**	**15**
Abundance Trend:	**20**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**3**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**69**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 27: Longfin hake matrix results.

Species: Longfin hake (*Phycis chesteri*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Small Medium	Summer = 4 million 4VWCod = 1.5 million Georges Bank = 0 Age of maturity = unknown (3 yr)	
Abundance	**Abundance Trend:** – **relative abundance**	Stable	Summer = 9% decline 4VWCod = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Un-known Un-known	Length of maturity = unknown Trends are unknown	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Restrict	Labrador to Florida Summer = 11% of sets 4VWCod = 6% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 8% decl 35% decl 4VW = increase increase Georges =	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Fishery	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	N ? ?		

Matrix Criteria:	Species	Total
Abundance:	4	5
Resilience:	1	3
Abundance x Resilience:	**4**	**15**
Abundance Trend:	**10**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**3**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**58**	**100**

Considerations:	y/n/?
Existing Protection	n
Species Significance	?
Population Structure	?

Table 28: Windowpane matrix results.

Species: Windowpane (*Scophthalmus aquosus*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very Small Medium	Summer = 121 000 4VWCod = 124 000 Georges Bank = 385 000 Age of maturity = 3 yr	
Abundance	**Abundance Trend:** – **relative abundance**	Increase	Summer = increase 4VWCod = increase Georges Bank = increase	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small Fluctuate	Length at maturity = 22 cm Summer = 50 300, 87% decline 4VWCod = 52 000, 99% decline Georges Bank = 368 000, increase	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Restrict	St Lawrence to Florida Summer = 1% of sets 4VWCod = 5% of sets Georges Bank = 58% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	20% decline	Extent: 75% pop: Summer = 99% decl 25% decl 4VW = increase 12% decl Georges = increase	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited	Flatfish fishey	
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y ? ?		

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	1	3
Abundance x Resilience:	**5**	**15**
Abundance Trend:	**0**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**3**	**5**
Spatial Distribution Trend:	**6**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**49**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	?
Population Structure	?

Table 29: Cusk matrix results

Species: Cusk (*Brosme brosme*)

	Indicator	Score	Comments	
			Maritime Research	Maritime Observer – Commercial/Industry
Abundance	**Abundance:** – **absolute abundance** – **resilience**	Very Small Low	Summer = 158 000 4VWCod = 0 Georges Bank = 2655 Age of maturity = 7 yr	
Abundance	**Abundance Trend:** – **relative abundance**	50% decline	Summer = 93% decline 4VWCod = 100% decline Georges Bank = 99% decline	
Abundance	**Mature Abundance:** – **size** – **trends**	Very Small 10% decline	Length at maturity = 45 cm Summer = 85 500, 95% decline 4VWCod = 0, 100% decline Georges Bank = 2655, 95% decline	
Spatial Distribution	**Spatial Distribution:** – **area of occupancy**	Very Re-stricted	Grand Banks to New Jersey Summer = 3% of sets 4VWCod = 0% of sets Georges Bank = 1% of sets	
Spatial Distribution	**Spatial Dist Trend:** – **change in area** – **fragmentation**	50% decline	Extent: 75% pop: Summer = 86% decl 86% decl	
Limiting Factors	**Threats:** – **abundance** – **spatial distribution**	Moderate Limited		
Limiting Factors	**Special Considerations:** – **existing protection** – **species significance** – **population structure**	Y ? ?	Listed as threatened by COSEWIC Annual Catch Quota.	

Matrix Criteria:	Species	Total
Abundance:	5	5
Resilience:	2	3
Abundance x Resilience:	**10**	**15**
Abundance Trend:	**30**	**30**
Mature Abundance:	2	2
Mature Abundance Trend:	15	15
Mature Abundance x Trend:	**30**	**30**
Spatial Distribution:	**5**	**5**
Spatial Distribution Trend:	**10**	**10**
Abundance Threat:	**5**	**10**
Spatial Distribution Threat:	0	5
Species Score:	**90**	**100**

Considerations:	y/n/?
Existing Protection	y
Species Significance	?
Population Structure	?