

## **Peer Review of Industry-Based Survey for Gulf of Maine Cod**

August 29-30, 2006, Portsmouth, NH  
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### **Introduction**

The following report is a review of a cod industry-based survey (Cod IBS) designed to examine the distribution and demographics of the cod stock in the Gulf of Maine. The survey design utilized a standardized grid as well as randomly selected locations provided by fishermen. An additional objective of the study was to provide information on the age and length structure of cod within rolling closure areas. An external panel was invited to review the technical aspects of this survey following the terms of reference provided in Appendix 1. The organization of this report follows the terms of reference. Participants at the review are listed in Appendix II.

It should be noted that the review was originally intended to also examine the southern New England yellowtail flounder industry-based survey; however, no presentation of the information could be made at the meeting and that review was dropped from the agenda.

### **Main Findings and Conclusions of the Panel**

- The Cod IBS represented an enormous amount of work for the investigators, cooperating fishermen, and NCRPP. Much care was taken in the development of the survey design and gear. An outreach program designed to keep the fishing community and general public aware of survey activity was initiated consuming considerable time and energy. The panel commends the survey team for their thoroughness and dedication.
- The Cod IBS provides valuable information on cod in the Gulf of Maine when no other sources of data are available. The Cod IBS is a good example of a cooperative project.
- The survey provides high resolution information on the spatial and temporal distribution, size composition, maturity and potentially age of cod and augments existing surveys.
- There is some concern that the lack of sampling of cod in water deeper than 75 fathoms may not provide a complete picture of cod distribution particularly during the winter.
- Survey data are useful in determining the location and timing of cod in spawning condition as well as the coincidence of spawning cod with rolling closures.
- It is assumed the efficiency of the four commercial vessels providing data is the same; however, inter-vessel comparisons would be desirable.
- The data presented provide a qualitative spatio-temporal view for a number of parameters; however, further statistical analyses are required to determine if there are significant differences.
- While it may be possible to use the data collected during the survey to derive indices of stock abundance for specific species, a significant number of issues would first need to be examined and resolved.
- Survey design is very good for the objective of examining cod distribution but the mixed design is not easily adaptable for other types of common survey analyses.

1. ***Design and Execution.*** *The review panel should evaluate the statistical and scientific validity of the two survey designs relative to the program goals and objectives, highlighting strengths, weaknesses, and potential biases. In particular:*
  - a. *evaluate the temporal and spatial design elements relative to survey objectives,*

The Cod IBS utilized two independent designs to address their primary and secondary objectives of providing a high-resolution temporal view of cod distribution in the Gulf of Maine in conjunction with rolling closures and provide information on other commercially important groundfish resources. The survey area extended from the Canada-U.S. border south to 41°30' N. latitude and appears to adequately cover the geographic boundaries (excluding Georges Bank) of the Gulf of Maine. The survey area encompasses a depth range of 10 to 75 fathoms and may fall short of describing the entire cod distribution believed to occur out to depths of 90 fathoms, particularly in winter when cod are found in deeper waters. Detailed size composition and maturity data provided an excellent view of the size and maturity distributions of the cod stock from this region. Although collected age structures have not been processed to date, once read, they will provide valuable information on the age composition of the Gulf of Maine resource. Data provided fills gaps in NMFS surveys by sampling different periods as well as inshore areas. Maturity information also fills temporal gaps in data provided by the inshore surveys conducted by the state of Massachusetts and the Maine-New Hampshire inshore cod survey. There is potential for this survey to provide valuable information on cod recruitment but would require further analyses. A secondary objective of the Cod IBS was met by providing quality size composition data throughout the study area for a number of other commercially important groundfish species; although, further improvements in sampling are suggested below.

During each year of the Cod IBS, five cruises spanning the survey area were conducted, providing investigators with adequate opportunity to compare cod distributions temporally. However, due to conflicts with fixed gear and/or encountering untrawlable bottom several stations were dropped during some or all cruises. Users of the data will want to consider this when making direct comparisons between cruises.

The survey area was overlaid with a systematic or “fixed” grid background consisting of 9-minute blocks having a sampling station centered in each block. Sampling density achieved under this grid design would be considered high by most bottom trawl surveys used for stock assessment purposes. While a more random approach to sampling populations is often used, systematic grid designs are effectively employed elsewhere to assess and describe fish distributions. The Cod IBS included a second layer of sampling effort based on advice from industry to ensure the centers of cod abundance were sampled. These “industry tows” were placed in 3-minute cells over 16 strata that overlapped selected portions of the background systematic grid, forming a pool of stations that were randomly drawn from on each cruise. It is important to note that industry stations available between cruises within a survey year varied based on fishers’ perception of cod availability. Sampling effort was apportioned between these two designs with 64% of the effort expended on fixed tows and the remaining 36% on industry tows. The combination of both designs was useful for evaluating rolling closure

areas. However, the usefulness of industry tows for other purposes such as analyses involving size and age composition or for computing indices of relative abundances is questionable and combining the data from the two designs does not appear outwardly appropriate for routine statistical analyses.

The Cod IBS originally covered depths ranging from 10 to 60 fathoms during the first year of sampling but was later extended to 75 fathoms based on advice from an external review committee to improve sampling of large mature and spawning cod, particularly during winter. Consideration was given to cover depths out to 90 fathoms, but given financial constraints and the negative impact the additional fixed grid tows would have on reduction of industry tows, a decision was reached to keep sampling within 75 fathoms. The Panel felt, for the purpose of a pilot survey, sampling of the Gulf of Maine Cod stock between the depths of 10-75 fathoms was adequate and in part supported by NEFSC survey findings. However, sampling in water deeper than 75 fathoms may prove worthwhile and should be considered if the survey is continued, even at the expense of losing industry tows.

*b. evaluate random versus industry selected sample stations,*

An ad hoc presentation of the catch comparison between fixed grid and industry tows showed similar distributions. The data from fixed grid tows are appropriate for most standard statistical analyses. The Panel recognizes that a genuine attempt to randomize tows within industry strata was made; however, the inferred area these tows may represent is unclear and likely limited. The Panel recommends further analyses and comparisons between grid and industry tows be made but also notes the outcome may be contrary to industry expectations. The use of industry tows in future surveys may not be warranted. The Panel felt the characterization of cod size and age distribution for the entire area is better accomplished by using only the fixed grid tows.

*c. evaluate the estimation of survey area as it relates to absolute biomass estimates and the validity of such estimates,*

Estimating absolute abundance was not a stated objective of the Cod IBS. Accordingly, the review panel was asked not to address this term of reference as stated, but instead, to offer an opinion as to whether these data could be useful for determining relative indices of abundance. Inter-vessel comparisons would be desirable before using data for this purpose. Should funding be limited, side-by-side comparisons between vessels could be performed in an area of high abundance and varied depths in lieu of obtaining samples from a low productive stratum such as in the east where both station completion and cod distribution was low. In some cases, but not all, fishing power corrections are appropriate on a species-by-species basis. A decision rule on when to apply fishing power correction factors is described by Munro (1998) and may be applicable to these data.

Standardization in the gear and methodology used to conduct bottom trawl surveys is essential for a correct interpretation of catch per unit of effort as a measure of relative abundance. The Panel recommends protocols on station search patterns and fishing operations be clarified, tightened, and targeting of fish sign as is commonly practiced in

“commercial style” towing be monitored constantly and prevented to ensure catch efficiency remains constant between samples. Stations should be assigned randomly between participating vessels rather than having vessels working in different areas and depths. The Panel also expresses concerns over the potential for fish loss during tows sustaining variable magnitudes of net damage and the inclusion of these tows in analyses. Further refinement in the standardization process for tow acceptance is needed and more detailed accounting of questionable tows should be contained in metadata files.

The net mensuration data indicated some vessel differences in the spread of the trawl gear, particularly for the smaller vessel used in the survey. For this reason, area-swept methodology for estimating CPUE, taking into account curvature of the tows, may be preferable to estimates based on time X speed methodology, or at the very least, CPUE could be based on distance fished from GPS (also taking into account curvature of the tows) if net mensuration data were missing for a large number of tows. Perhaps fitting a regression to net spread and wire length data can be used to estimate the area swept for tows without net mensuration data. The use of net mensuration equipment on all tows is highly recommended for future surveys.

A stratified random survey design could be considered to replace the Cod IBS mixed survey design, given the difficulty of obtaining some fixed station samples each year and the analytical problems associated with using industry-selected tows. Fisher acceptance of such a survey design might be explored by presenting the distribution of tows from the surveys completed to date and those resulting from a stratified random selection, which may adequately cover hot spots and address concerns about the lack of sampling of potentially high abundance areas.

d. *evaluate sampling protocols, sub-sampling procedures and onboard processing of biological materials and total catch, and*

The Cod IBS utilized 4 commercial vessels of similar class, skippered by 4 captains having adequate trawling experience. The survey gear seemed appropriate given the objectives of the survey. Each vessel utilized the same survey gear from the doors aft (no information on trawl wire specifications was provided). Assurances of proper gear maintenance was given to the Panel; however, it is understood that trawls sustaining repetitive damage in the range of 10-30% would be difficult to maintain to survey standards while at sea. It was unclear as to the standards used for proper wire measurement or if monitoring of differential wire lengths by side was regularly performed. Detailed descriptions of the process used to set and retrieve the gear, critical to the use of multi-vessel surveys, were also absent from the report, although they were briefly touched upon in the presentation.

Catch sampling protocols were appropriate paralleling those employed by the NEFSC. Maturity and age information collections were adapted to new levels as recommended by outside sources during the second year but may have been excessive. Collection rates for maturity and age should be further evaluated should the Cod IBS be continued. If a smaller sample size is needed more time can be spent on collecting information from other species. The use of high precision Marel basket scales to calculate total catch

weight and catch weight by species is commendable. Small amounts of fish and individual fish weights were taken with a spring scale but could be improved by using a smaller capacity Marel scale. Subsampling methodology was good. Subsampling tows having large numbers of cod could potentially make more time available for the collection of data on other species.

To make the survey more useful, the collection of comprehensive data for other species should be done more consistently. This would imply establishing minimal sampling levels and/or cyclical sampling levels based upon life history. Otoliths must still be processed and interpreted so that the temporal and spatial distribution of ages can be examined.

e. *evaluate data post-processing procedures and archival policy.*

Attention to detail was adequately applied during all phases of the data editing process as described to the Panel during the presentation of survey results. Both manual and automated processes were used. The data were provided to the NEFSC for archival with appropriate measures taken for control of its use. A metadata file describing protocols, towing and catch sampling procedures and anomalies to the data contained in the database (particularly for tows sustaining varied degrees of net damage) should be developed and stored along with the database. This would be useful in data interpretation over the long term.

**Comment: Not clear to me what is meant here. Do you mean:** The Panel suggests that end users of the Cod IBS database make recommendations for the collection of potential additional data that would be essential for analyses related to the objectives of the survey.

2. **Data Utility.** *The review panel should evaluate the surveys' utility in assessing:*

a. *the efficacy of fishery closure areas,*

The Cod IBS has provided additional data on cod in locations and during times when data are not available from any other fishery-dependent or fishery-independent sources. The Cod IBS has also provided good data on the temporal coincidence of spawning cod and rolling closures; therefore, potentially providing information on the adequacy of these closure in reducing fishing mortality and protecting spawning individuals.

The utility of the Cod IBS data relative to the fishery closure areas (rolling closures) lies mostly in the identification of the areas containing spawning fish during specific times of the year. Generally, the monthly closed areas matched well with the areas where the highest catches of spawning fish could be found. In that respect, the survey data are useful to determine the location and timing of cod in spawning condition.

During the winter, the utility of the survey to identify areas containing spawning fish would likely be enhanced by extending the Cod IBS to deeper waters. It was also noted that the presence of spawning fish in May suggests cod in spawning condition may also be present in the area during summer months.

No data were presented on the assessment of the efficacy of the fishery closure areas. However, it was noted the objectives of the fishery closure areas remain somewhat unclear. The original objective of the fishery closure areas was to reduce fishing mortality by displacing fishing effort to areas and periods of lower aggregation. A perceived objective is that the fishery closure can lead to improved recruitment by

avoiding potential negative effects of fishing activity on spawning behavior and/or spawning success. If the objectives and rationale for the fishery closures were confirmed, an assessment of the efficacy of the fishery closures relative to the objectives could be attempted. The Panel considered this assessment would require data on a broader scale as well as data of a different type (e.g. fishing mortality or estimates of spawning success depending on the objectives) than those provided by the Cod IBS in the Gulf of Maine. The utility of the Cod IBS would be limited for the evaluation of the efficacy of fishery closure areas.

*b. stock abundance,*

The Cod IBS was not designed to estimate stock abundance. It has the potential to provide an index of abundance for cod in the future. However, some modification of the survey would probably be needed to meet the needs of assessment biologists. At the outset, the main objective of the Cod IBS was 'to define a broad scale distribution of cod aggregations in the Gulf of Maine, in space and time, by age and size composition'. The survey was; therefore, not designed to produce indices of stock abundance.

While it may be possible to use the data collected during the survey to derive indices of stock abundance for specific species, a significant number of issues would first need to be examined and resolved. One of the first issues to be considered is the survey area encompasses the entire distribution (or at least a high and constant proportion) of the species stock under consideration. Secondly, the current mixed design of the survey (grid stations and industry stations selected on a stratified random basis) is not amenable to the calculation of an index of abundance using traditional statistical techniques. An index derived from the grid stations only could be valid but, given that a number of grid stations could not be fished during each survey, the construction of an abundance index would require the same common set of stations be used from year to year. Using the same common set of grid stations may mean a significant portion of the species distribution is not sampled which may invalidate the use of the series as an index of abundance.

It was noted that it may be possible to derive valid indices of abundance for particular species with the existing data using geospatial techniques (e.g. kriging). The panel recommends that this be investigated if it is desired to derive abundance indices while maintaining the current survey design. Alternatively, the design of the survey could be changed to a stratified random design such as that used in the NEFSC, Maine-NH and Massachusetts surveys.

c. *migratory or movement patterns,*

The Cod IBS was not designed specifically to examine migratory or movement patterns. The data collected during the survey appear to provide some insights into the migratory patterns of a number of species. For example, the data provided suggested that cod and witch flounder appear to move to deeper waters while winter flounder does not appear to exhibit a significant migration. However, the absence of coverage in waters deeper than 75 fathoms limits the interpretation of survey results in that regards. It should be noted that seasonal surveys are an indirect way of inferring migratory patterns. Validation of the patterns uncovered through direct methods such as tagging programs is desirable. In that regard, a separate tagging study for cod in the Gulf of Maine has been conducted.

d. *reproductive demographics,*

The Cod IBS is successful in describing the spatial and temporal distribution of mature as well as spawning male and female cod with respect to time period and stratum. Currently, the Cod IBS is the only source of maturity information for Gulf of Maine cod. The seasonal nature of the Cod IBS also provides opportunities to collect samples for studies of reproductive dynamics (fecundity, egg viability, etc.).

e. *and other biological characteristics such as age and growth parameters.*

The temporal and spatial distribution of age and growth of cod cannot be described because otoliths have not been processed and interpreted by the NEFSC. In general, the utility of the survey for this purpose is potentially high for cod. It is noted that individual lengths and weight of cod have been collected and these data could be used to examine the spatio-temporal variation in fish condition in the area. Ageing material collected during the spring and fall Cod IBS could particularly be useful to augment the sample size for larger fish in aged-length keys.

3. ***Consistency.*** *The review panel should evaluate the consistency and comparability among temporal and spatial sampling frames in relation to field procedures, gear selection and maintenance, vessel comparability, data acquisition, and analysis.*

The Cod IBS experienced some problems affecting the consistency of annual sampling. Completion rates of the expected number of tows was lowest during the first year of sampling due to inexperience of the samplers, problems with the identification of towable bottom, and the presence of fixed gear. The presence of fixed gear in sampling grids, particularly off Maine has continued to pose an impediment to the completion of the specified number of stations during Years 2 and 3. As a result, some of the nine-minute grids have not been completed each year. However, despite these problems, the survey has obtained a very good picture of the spatio-temporal distribution of cod in the Gulf of Maine. Shorter tows off Maine might reduce interaction with fixed gear as well as hard bottom.

The same gear type has been used throughout the study period. Furthermore, the same protocol has been used in deployment of the gear by different vessels. However, protocol

could be enhanced to ensure that if different skippers or vessels were used in the future data would not be compromised.

Although the investigators have made efforts to ensure data are collected in a consistent manner among vessels, a vessel comparability study has not been conducted. The cost of conducting such an effort would affect the number of samples collected. One possible method to obtain the needed information would be to forego sampling in a less productive stratum (i.e. stratum 1 or 6) and thereby enable side-by-side comparisons in a more productive stratum (i.e stratum 2 and 3). While data would be lost for one season in a stratum, the small study would help ensure data between vessels were being consistently collected and are comparable.

The data have been collected in a fairly consistent manner by the investigators. All cod are weighed and measured. Occasionally large samples of age 1 cod are subsampled for length. One change made in data collection procedures was to increase the number of cod retained for biological sampling from 1 per centimeter to 3 per centimeter. This change was based on a recommendation from a subcommittee who qualitatively determined sample size should be increased. However, it might be better to quantitatively estimate the appropriate sample size for age and maturity data. The current number of age and maturity samples might be adequate, more than needed, or less than needed. If fewer biological samples are needed from cod, then more emphasis could be placed on obtaining length information and biological samples from other species taken on tows.

Originally the Cod IBS sampled out to depths of 60 fathoms for cod. The Cod IBS provides good information on cod distribution, reproductive state, length and age structure within depth range of sampling, particularly during winter when there are no fishery independent data collected. However, the distribution of cod during the winter extends deeper than the original 60 fathom boundary of the Cod IBS design. Therefore, a change was made to the program to expand sampling from 60 fathoms out to 75 fathoms. There is some concern that there may be some cod as deep as 90 fathoms during winter. Expansion of sampling into deeper water would reduce the number of inshore stations that could be sampled and the vessel expense of sampling in deeper water would be greater. However, by not sampling in water deeper than 75 fathoms, the Cod IBS may not completely meet its primary objective of evaluating the spatial and temporal distribution of cod in the Gulf of Maine. Data from the NEFSC trawl survey could be compared to Cod IBS data to determine potential for cod in water deeper than 75 fathoms.

Sampling is somewhat inconsistent for species besides cod. Although samples are usually obtained for all species on a tow, a standard protocol should be identified for sampling species besides cod especially when catches are very large. Data are examined in a consistent manner; however, some statistical analyses are needed to determine if apparent differences in various parameters are significant. Comparisons of length frequency data are presented by stratum and time period. However, these comparisons include data pooled from grid and industry based stations. Before these data are pooled, the data from the different surveys should be analyzed to determine if they are

statistically significant. Furthermore, length frequency comparisons between strata and time period should be analyzed to determine if there are significant differences.

4. **Quantitative Analysis.** *The review panel should evaluate quantitative analysis techniques, measures of statistical precision, and recommend design or analytical processes that will improve the utility of existing survey data.*

Quantitative analysis of the data is lacking for the Cod IBS. Results presented appear to be qualitatively different with respect to time period and stratum; however, it is unknown if these apparent differences are significant. Comparisons could be made to determine if CPUE of cod from grid and industry sampling designs are significantly different. Comparisons between designs could be made within a stratum. Furthermore, similar comparisons could be made for lengths and age (once available) between grid and industry based tows. Once this is established, statistical comparisons of these parameters can be made between strata and time period.

Based on discussions at the workshop, it was unclear to the Panel whether expanded rather than raw tow data were contained within the database. The best practice would be to have raw data within the database to enable expansion through programming. Furthermore, it was not clear if all data contained in the field logs were contained within the database. Efforts should be made to ensure all data from field logs are entered into the database. Building maximum flexibility in the database would be obtained by recording and coding as much information as possible.

5. **Cost Effectiveness.** *The review panel should compare the cost effectiveness of the IBS program relative to the costs of the NEFSC Bottom Trawl Survey.*

Few data were provided to examine the cost effectiveness of the Cod IBS program as compared to the NEFSC bottom trawl survey. The investigators indicated the commercial vessel cost is \$4,844/day. These costs are somewhat higher than the 70-90' long industry vessels used by the NWFSC bottom trawl surveys on the west coast and lower than the 120-160' long chartered commercial trawlers used by the AFSC. The investigators also indicated the owners provided the vessel at a lower cost than they would to charter because this sampling task was put out for competitive bid and the vessel owners wanted to ensure they obtained the long term support of the IBS program. Federal vessels are higher in cost per day when annual maintenance, fuel and salaries are factored in, but NMFS Centers do not incur a charge for their use.

6. **Integration.** *The review panel should evaluate the potential for integrating the IBS surveys with NMFS or other inshore trawl surveys or fishery independent monitoring programs. This includes interoperability and comparability of NEFSC current (R/V Albatross IV) and future (R/V Bigelow) bottom trawl surveys and states' near shore trawl survey programs. The panel should also evaluate the potential of integrating fixed fishing gear in the IBS program.*

The terms of reference were revised at the meeting and this item was dropped.

7. ***Future of IBS and Other Initiatives.*** *The review panel should be prepared to make recommendations concerning the continuation of IBS program and development of future fishery independent programs under NCRPP.*

The terms of reference were revised at the meeting and this item was dropped.

#### References

Munro, P. T. 1998. A decision rule based on the mean square error for correcting relative fishing power differences in trawl survey data. Fish. Bull., U. S. 96:538-546.

**DRAFT Terms of Reference for Technical Peer Review of the NCRPP Industry Based Survey (IBS) Program**

- 1. Design and Execution.** The review panel should evaluate the statistical and scientific validity of the two survey designs relative to the program goals and objectives, highlighting strengths, weaknesses, and potential biases. In particular:

  - a. evaluate the temporal and spatial design elements relative to survey objectives,
  - b. evaluate random versus industry selected sample stations,
  - c. evaluate the estimation of survey area as it relates to absolute biomass estimates and the validity of such estimates,
  - d. evaluate sampling protocols, sub-sampling procedures and onboard processing of biological materials and total catch, and
  - e. evaluate data post-processing procedures and archival policy.
- 2. Data Utility.** The review panel should evaluate the surveys' utility in assessing:

  - a. the efficacy of fishery closure areas,
  - b. stock abundance,
  - c. migratory or movement patterns,
  - d. reproductive demographics,
  - e. and other biological characteristics such as age and growth parameters.
- 3. Consistency.** The review panel should evaluate the consistency and comparability among temporal and spatial sampling frames in relation to field procedures, gear selection and maintenance, vessel comparability, data acquisition, and analysis.
- 4. Quantitative Analysis.** The review panel should evaluate quantitative analysis techniques, measures of statistical precision, and recommend design or analytical processes that will improve the utility of existing survey data.
- 5. Cost Effectiveness.** The review panel should compare the cost effectiveness of the IBS program relative to the costs of the NEFSC Bottom Trawl Survey.
- 6. Integration.** The review panel should evaluate the potential for integrating the IBS surveys with NMFS or other inshore trawl surveys or fishery independent monitoring programs. This includes interoperability and comparability of NEFSC current (R/V Albatross IV) and future (R/V Bigelow) bottom trawl surveys and states' near shore trawl survey programs. The panel should also evaluate the potential of integrating fixed fishing gear in the IBS program.
- 7. Future of IBS and Other Initiatives.** The review panel should be prepared to make recommendations concerning the continuation of IBS program and development of future fishery independent programs under NCRPP.

Appendix II:  
 List of participants at the Industry Based Survey Peer Review Meeting  
 Portsmouth, New Hampshire, August 29-30, 2006, Convened by: Earl Meredith,  
 NMFS/NERO

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Tuesday, August 29, 2006

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