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First Interim Report of the Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA)

20–22 January 2015

ICES HQ, Copenhagen, Denmark

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CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA) met in Copenhagen, from 20–22 January 2015, to discuss the use of survey data and designs in stock assessments.

An evaluation of the methodology used to examine the discrepancy of the between the Q1 and Q3 IBTS surveys in relation to the index calculation used in the North Sea cod assessment for the benchmark process (WKNSEA) was conducted. The approach using spatial GAMs shows promise and the use of more appropriate error distribution assumptions means the indices are more robust and changes in experimental design can be corrected. The improved index was not able to resolve the discrepancy between the Q1 and Q3 indices, and although the WG concluded that there is an increasing migration out of the index area in Q3 and into area VIa, this effect is not of a magnitude that can explain the observed Q1/Q3 discrepancies. However, both indices are internally consistent and in fact similar in the direction of the trend.

The group discussed the calculation of the MIK index, concluded that the current index calculation is ad hoc, and should be revised to deal with the recently developed extended spawning period between subpopulations. It also appears that the index is specifically designed not to include the Downs component, which is inconsistent with the assessment for the entire North Sea herring stock. Changes in the proportion of the different subpopulations will weaken the assessment and reduce the influence of the recruitment index as currently used. Convergence of index and assessment assumptions are considered high priority for the survey and assessment group.

Spawning of mackerel has in recent years greatly expanded spatially so that the resources required to deliver the triannual MEG-survey are over-stretched. An analysis to determine the sources of variation both spatially and temporally was recommended to identify the least disruptive changes to the sampling design. Following the current MEGS protocol, a large number of samples contribute only a small fraction of the total number of eggs. Although the index produced is absolute, it is used in the assessment as a relative index, so that sampling only the areas of high variability will not introduce a bias in the assessment. A modelling approach accounting for spatial and seasonal shifts in the spawning activity is suggested in order to retain the consistency between historic and future sampling.

Although multiple survey indices can be beneficial in an assessment it can be problematic when the signals conflict. The EBS walleye pollock assessment has used both acoustic and survey bottom trawl indices, however the catchabilities are variable, dependent on the vertical positioning of the individuals. Consequently, the indices are negatively correlated. Modelling this process externally to the assessment created a more robust combined index and revealed density-dependent effects in the trawl catchability. The combined index has a potential to increase the weighting of the survey information in the assessment. Correction of the density-dependent effects in the bottom trawl survey index resulted in reduction of the bias and more accurate estimation of uncertainty of the bottom trawl index; however it also suggests that improvements to an acoustic index used in the assessment are warranted.

1 Administrative details

Working Group name:

Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA)

Year of Appointment 2015

Reporting year within current cycle (1, 2 or 3) 1

Chair(s)

Sven Kupschus, UK

Meeting venue

ICES HQ, Copenhagen, Denmark

20–22 January 2015

The group was attended by five people representing five countries. Two ICES survey planning groups were represented (WGMEGS and IBTSWG), and one representative of the 2015 benchmark process (WKNSEA).

2 Terms of Reference a) – z)

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
	Identify with Assessment EG chairs where improvements in survey information could be of benefit to the assessment proceedure, and assign priorities for consideration	The advisory need is to underpin the value of the survey programme in the needs of the assessment and advice cycle. Multiple survey indices are an asset, but inconsistencies and conflict in signal should be handled outside the assessment process, as a science link	4.1	annually	On line catalogue, with prioritization
b	Identify problems with design or index calculation with Survey planning groups. Assign priorities for consideration, and propose solutions	Survey designs, and development of indices are the core work of the survey communities. These will be the main fishery-independent data source for assessment. The role of WGISDAA will be to advise on statisticall robust and appropriate designs and index calculations	4.1	annually	Individual advisory papers with and to the appropriate survey EG.
c	Initiate with ACOM and secretariat a process to identify upcoming issues associated with the use of survey data in benchmarks. This should be initiated as soon as the benchmark process is started	Survey data issues, as in ToR a, are often critical in the benchmarking process. WGISDAA can advise best if involved in this process from the start, can collaborate with the operators and present conclusions at the benchmark	4.1., 5.1., 5.2	As required	Reports and presentations to the appropriate Benchmark workshop.

3 Summary of Work plan

All three ToRs are simultaneously ongoing work because this problems and issues change over time. ToR a) has been completed successfully for 2015, but progress on resolving the issues on the list (ToR b and c) has been problematic because of the requirement of support from other working groups. Where participation was provided the group has managed to provide the necessary help and advice or provided recommendations for progress towards a solution.

4 List of Outcomes and Achievements of the WG in this delivery period

1) Evaluation of the methodology used to examine the discrepancy of the between the Q1 and Q3 IBTS surveys in relation to the index calculation used in the North Sea cod assessment for the benchmark process (WKNSEA)

2) Recommendations to WGALES and HAWG with respect to methods to be applied to the MIK index to improve the robustness of the index used in the North Sea Herring assessment and the utility of the index given the assumptions in the assessment.

3) Advice to WGMEGS on using a modelling approach to improves the efficiency and design of the monitoring program supporting the mackerel and horse mackerel egg production indices in view of the temporal and spatial expanding spawning distribution.

4) Evaluation of methods used to deal with negatively correlated survey indices external to the assessment model. In this case, the method was applied to concurrently sampled acoustic and trawl survey collections with the negative correlation caused by the variation in depth distribution of the target species, but the methodology could be effectively applied to variability of spatial distribution of stocks with respect to multiple partial surveys.

5) Demonstration of density-dependent behaviour effects on catchability, which should be taken into consideration in stock assessments.

5 Progress report on ToRs and workplan

5.1 ToR a) Identify with Assessment EG chairs where improvements in survey information could be of benefit to the assessment procedure, and assign priorities for consideration

Throughout the year and in association with the benchmark steering group, WGISDAA and the assessment working groups have been identifying survey related assessment issues. Although a list of topics has been identified, WGISDAA is unable to make progress on these without the participation of assessment groups as issues are specific to the assessment procedure used. The assessment expertise concerning the methodology, the assumptions, species biology and fisheries operation are too extensive to acquire for each individual case. The assessment working groups have this knowledge and are therefore an essential part of the process along with the survey groups that have detailed knowledge of the methodology and the consistency of the survey timeseries. Working down a list of priorities without the necessary cooperation is not feasible. Instead, the working group is prioritizing those issues that are presented to the working group as well as evaluating methodologies that can be used to assess surveys for assessment purposes. The remainder of this section describes the problem in more detail and develops some initiatives to make progress towards a more effective working group collaboration.

Attendance in the working group has shrunk since its inception in 2012. At present, it still has a large number of listed members; however, participation at the meeting has been low. In 2015, five participants have attended the group meeting. The dominant reasons for members declining participation were a lack of resources for travel, low national priority for the group, conflicts in timing between WGISDAA and other work / ICES commitments, and the short interval between release of the Torso and the meeting with insufficient time to develop contributions.

In contrast, ICES views the meeting as a key contributor to the ICES benchmark process and is hoping that the group can improve the quality of advice and the efficiency of survey data usage in both stock assessments and the ecosystem approach to management. WGISDAA is not in a position to reconcile the difference in opinion between the national and ICES perspectives with regards to its work, but instead are seeking to both demonstrate the importance of the group by working on examples that demonstrate the utility of the work conducted and developing alternate approaches to meeting its ToRs.

Simply prioritizing the assessment issues (ToR a) is insufficient for WGISDAA to make progress on specific assessment issues as its members rarely have the detailed knowledge of the specific survey or assessment process to propose resolutions to the problem. The group represents a reservoir of knowledge and experience of methods for examining and surveys and applying this knowledge in assessments, but requires the knowledge and expertise of survey and assessment groups to resolve specific issues. Therefore, attendance and contributions of those groups at WGISDAA is essential to the group to address its ToRs in relation to specific assessment or survey problems.

The WG discussed the barriers to participation of its own members as well as those experts from the other WG required to meet its ToRs in relation to the aims and objectives set by ICES. The group concluded that a first step in facilitating better communication and coordination is to move the meeting to a less restrictive time of the year, such as June / July following the completion of the advisory process. This does not fit

in well with the current ICES idea of including the work of WGISDAA in the formal benchmark process. However, the current timing just before the benchmark meeting does not offer much opportunity to refine or improve work conducted by the data workshops so that the group would merely evaluate the work rather than improve or guide the development of new approaches. The group feels that this would in essence duplicate the work of the benchmark experts and as such provide little additional value to the process.

Waiting until after the formal initiation of the benchmark process before considering issues seems counter intuitive, particularly since the cause of some issues cannot necessarily be traced back to a single source of information. Some assessment issues cannot be immediately tracked back to a specific survey (ToR a) and some survey inconsistencies and design problems (ToR b) may not be immediately apparent in the assessment. A more general approach to understanding assessments and surveys is to make the expertise and experience of the group available to everyone wishing to examine a specific survey or assessment and the results of such diagnostics and analyses can then be used to initiate a specific benchmark process once some opportunities for resolution have been identified. More advantageous and less restrictive would be a less formal involvement in the benchmark process when the problems in assessments are still fresh in the minds of assessors and there are few surveys at sea so as to maximize the opportunities for communication between groups. The alternate timing is also more consistent with the proactive approach suggested in ToR c).

Improving the participation of and communication with assessment and survey WG is essential to WGISDAA and this is a priority for the group as a whole at this time. To make progress on the ToRs in the meantime the group is examining and collating some tools that can help survey and assessment scientists to examine the characteristics of survey information and to diagnose bias or variance problems that could help improve the use of the information in assessments.

5.2 ToR b) Identify problems with design or index calculation with Survey planning groups. Assign priorities for consideration, and propose solutions

Two survey / index related issues were presented to the working group with a view to developing methodologies to improve their use in the assessment (MIK net index for NS herring recruitment) and the survey efficiency in face of a spatially expanding monitoring requirement under increasingly constrained monitoring resources. (MEG survey used in the mackerel and horse mackerel assessments). WGISDAA recommended methodologies to apply to the two datasets, which will be intersessionally applied by the survey working groups with help from WGISDAA and results presented to the working group in 2016 in order to develop recommendations as to how to proceed. What follows is a discussion of the specific issues and the agreed approaches to resolve problems.

5.2.1 MIK

HAWG recommends that the data and protocols associated with the MIK survey and output data are investigated in conjunction with the appropriate experts from IBTSWG, WGALES and WGISDAA (where it would form an ideal case study). The specific points to investigate are: a. Historical development of the survey gears and methods, b. Standardization of current gears and sampling protocols, c. Calibration and intercomparison of existing gear types, d. Data storage both at the co-ordinator

and ICES level, e. Data analysis and generation of indices for use in stock assessment and scientific research.

The MIK survey provides an abundance index for large herring larvae (around and > 20 mm SL) that is used in the assessment as a recruitment index for North Sea herring. It takes place during first quarter IBTS with Germany, Denmark, Sweden, Norway, Scotland, the Netherlands and France participating. Sampling is done following the IBTS survey strategy of randomly sampling in the various statistical ICES rectangles in the North Sea, Skagerrak, Kattegat and Channel area. In principal, two Nations are responsible for each rectangle where two MIK hauls have to be done per each participant. Sampling is done with a 2 m ring trawl with 1600 µm mesh down to a maximum depth of 100 m or 5 m above the seabed. Herring larvae are sorted from the samples, counted and measured to the nearest 1 mm standard length (SL) below. Catches are standardized to abundance of herring larvae per m^2 and from those values; an index for larval abundance is calculated for the entire survey area. In order to exclude the small, rather abundant but patchily distributed larvae of the Downs component from the index calculation, all stations south of 54 °N with a mean herring larvae length < 20 mm SL are excluded from the estimation.

With the increasing importance of the Downs component in total North Sea herring SSB it became apparent that the current algorithm for calculating the MIK herring larvae index became more likely to produce biased results. This was particularly true for the 2014 MIK survey when large numbers of small herring larvae originating from the Downs component resulted in an extraordinarily high MIK index. Part of this biased result originated from the undersized mesh utilized by some participants particularly in the southern survey area where Downs larvae are most abundant. However, the major problem with these small larvae stems from the index calculation algorithm itself. The current algorithm deals with the small larvae as follows:

It is assumed that small Downs larvae are only abundant south of 54 °N. Consequently, only for stations south of that latitude, an exception rule is implemented. The mean larval length for each of those stations is calculated, and if that value is < 20 mm all data from that station is excluded from the index calculation.

In 2014, this rule lead to the exclusion of 37 stations from the index calculation but also, and more importantly because of that all or nothing rule, to the inclusion of a number of stations with high to very high abundances of small larvae, where either the mean length was > 20 mm or the station was north of 54 N. These stations contributed to almost 40% of the total index.

WGISDAA discussed the methods and results of the MIK survey and concluded that in first place the Herring Assessment Working Group (HAWG) should evaluate the importance of the MIK index for the assessment of the North Sea herring stock. If the index turns out to be of importance, it is crucial to investigate the contribution of the single-stock components inside and outside the North Sea to the MIK index. Furthermore, with the increasing importance of the Downs component, it appears necessary to investigate whether the MIK index, which should only represent autumn spawned herring larvae from the Buchan/Shetland component, is still a good predictor of North Sea herring recruitment as a whole.

It became clear that the rigid exclusion criterion for small herring larvae needs to be thoroughly revised where in first place the 54°N boundary needs to be removed and the all or nothing rule replaced.

The working group also stressed that growth and mortality of herring larvae should have implications for the index, e.g. the same abundance index of larger larvae should have a higher value for recruitment than that of smaller ones. Consequently, an improved index could/should also contain information from the extensive length data that is already available, but not utilized, in the MIK data. Individual based drift models in combination with different sampling schemes could be utilized to assess the effects of growth and survival on the index.

5.2.2 MEGS

The mackerel egg survey (MEGS) delivers the only fishery-independent data for the assessment of Northeast Atlantic mackerel and horse mackerel. The survey is carried out every 3 years and covers the entire spawning area and season of both target species. It starts in early February west and southwest of the Iberian peninsula and progresses northwards along the European Shelf Edge with time until July to as far north as Scotland. Only recently, the survey area had to be extended northwestwards to Iceland. The survey time between February and July is subdivided into periods according to roughly the cruise schedules of the participating nations, assuring that there is representative sampling during the whole spawning time across the entire area. Ten institutes from nine countries participate in the survey dividing survey time and area among them utilizing research and commercial vessels. Total annual egg production is calculated from counts of freshly spawned eggs taken from plankton samples from tows with Gulf VII type samplers. Plankton samples are taken on stations on predefined zonal transects every full half degree latitude using the alternate transect strategy, i.e. during the first half of each cruise the assigned survey area is sampled on every other transect and the remaining transects filled in during the second half. By this, a reasonable representation of both, spatial and temporal, variability should be achieved. In addition, survey participants are requested to follow an adaptive strategy while following their transects, i.e. each transect should only be finished after encountering zero counts of freshly spawned mackerel eggs on two consecutive stations. Total annual egg production (TAEP) is then calculated by converting the estimated number of freshly spawned eggs by sampled area to daily egg production and raising that value the to complete spawning season (for details see ICES 2014). With the fecundity values estimated during the same survey, the TAEP of mackerel is then converted into an SSB value for mackerel, which is, used an index in the assessment. For horse mackerel, the TAEP is used directly as an index for SSB in the assessment.

With increasing extension of both mackerel spawning season and area, and the concomitant decreasing available ship time (e.g. participants dropping out of the survey without replacement) the complete coverage of the survey area at the desired spatial resolution is increasingly impeded. Extension of the spawning area necessitated leaving out of every other transects in order to achieve a full coverage. In particular the double zero rule (see above) forced participants to extend transects far beyond the standard survey area boundary while losing valuable ship time. Additionally, it also became increasingly difficult to represent the annual egg production for both target species of the survey, mackerel and horse mackerel, as their time of peak spawning appears to drift further apart. This raised concern that the current survey design will not be able to provide reliable and defendable estimates of TAEP and SSB for mackerel and TAEP for horse mackerel, in future. WGMEGS therefore requested WGISDAA for support in analysing the current survey design with respect to a possible modification in order to facilitate a proper representation of mackerel and horse mackerel egg production in future.

WGISDAA discussed the details of the monitoring design and concluded that in order to minimize any detrimental effects of the increased monitoring effort requirements associated with a temporal and spatial expansion of the stocks and their relative spawning seasons under constant or decreasing resources an analysis of the importance and variability of daily egg production in space and time is essential. For example, the distribution maps indicated that in the extended northwestern survey areas mackerel egg production was small and stable, while the core area further south appeared to be more temporally variable and larger in absolute terms. This suggests that reducing sampling in the core area is likely to increase variability of the index for the limited benefit of small reduction in bias of the estimate. Although undesirable in an absolute index, a slight bias reduction should be much less significant in relative index such as MEGS TAEP index than an increase of its variability. Similarly, the current requirement to continue sampling along a transect until 2 consecutive samples contain no mackerel eggs is less important for an index used relatively since the variability is low in this area and a higher cut-off is likely to produce a more efficient sampling design.

5.3 ToR c) Initiate with ACOM and secretariat a process to identify upcoming issues associated with the use of survey data in benchmarks. This should be initiated as soon as the benchmark process is started.

As indicated under ToR a) the WG feels that the identification and initiation process is already covered by the WG and is happy to assist in progressing those issues to a resolution with the assistance of survey and/or assessment groups. In 2015 the WG looked at a survey analysis aimed at identify the reasons for the divergence of the Q1 and Q3 IBTS index for NS cod. This work represents the only specific example where the WGISDAA has fed directly into the benchmark process. Other work conducted by the WG has not been in relation to a specific benchmark process. However, the group has tried to extract more general lessons / recommendations from the examples discussed that can and do apply to similar situations in other assessments or surveys (multiple tuning information with negative correlation and more general estimation of time variant catchability outside the assessment process). This work then presents a more proactive approach to ensuring survey data quality in assessments.

5.3.1 Q1 and Q3 IBTS recent cod index divergence:

WGNSSK had in recent years found that the process of updating the North Sea cod assessment forecast following the completion of the Q3 survey systematically increased the estimates of stock status and predicted yields compared to the earlier WGNSSK assessment using only the Q1 estimates for the terminal year. This had resulted in complete redrafting of the stock advice for cod in recent years. Closer examination of the two indices demonstrated a persistent divergence between the Q1 and Q3 indices. WGISDAA was asked to investigate possible causes of this divergence to assist the 2015 benchmark process.

Two potential causes for the divergence were examined. The current methodology for index calculation and the possibility that there was a differential migration of cod across the ICES division IV and VI boundary north of Scotland. A more flexible method of calculating standardized age-based survey indices utilizing spatially constrained generalized additive models (GAMs) assuming Delta-distributions was presented to and further explored by WGISDAA.

The methodology is described in Berg and Kristensen (2012) and Berg *et al*. (2014) and is implemented in R based on the DATRAS package (see later section for a more detailed description of the package).

The primary purpose of the Delta-GAM model is to achieve model derived survey indices by age, which are more precise. This is accomplished by eliminating nuisance factors caused by changes in sampling conditions not covered by the current IBTS standardization by using covariates to explain some of the variance. The presented model is able to account for differences such as different gears used, steep depth gradients, ship/country effects, day/night effects, and variations in the spatial coverage. The indices are obtained by summing filtered model predictions over a spatial grid.

The results of the analysis suggest that the majority of the accounted for variance was associated with the earlier part of the time-series and are balanced out by the relatively stable survey design in the later years. Indications of such effects are evident in simple residual plots, and several changes in the gear used, proportion of night hauls, haul duration etc. have occurred for most surveys during the entire time-series.

The comparison between standard indices and model indices showed relatively little discrepancy in the recent period and discrepancy over all was small. More over the period of maximal divergence between the Q1 and Q3 survey indices was maximal in the recent most standardize period suggesting that a divergence of standardization or implementation at least for the variables examined was unlikely to be the cause of the inconsistency.

WGISDAA noted however, that the trends of the indices from both quarters (either modelled or raw) were qualitatively highly consistent suggesting a recent increase in the abundance of young cod with both indices being highly internally consistent. What differed was the relative rate of the increase, not its direction and this pattern was consistent across the younger ages despite the entirely independent model estimation for each age.

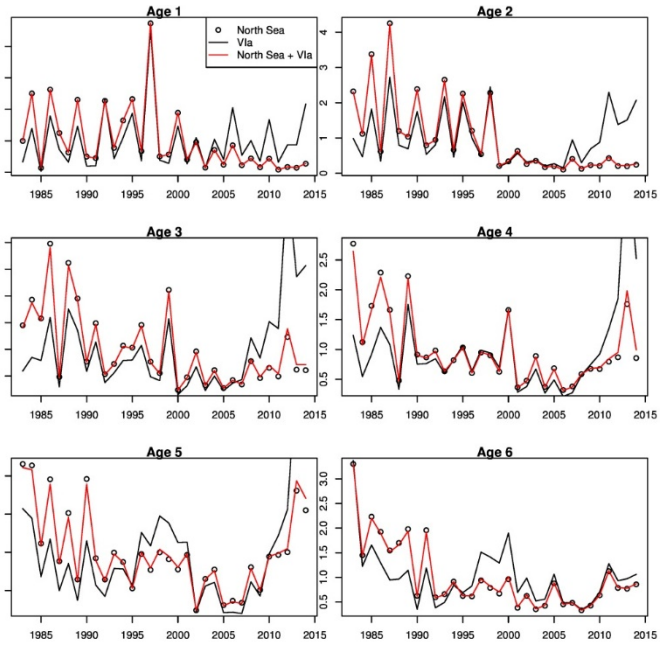

Figure 1. North Sea Cod index abundance-at-age in Q1 calculated with and without the inclusion of VIa IBTS data (SWC-IBTS).

Animations of the model predicted spatial distribution of the stock by age over time were presented. The highest abundances of adult cod are found on the northern and northwestern edge of the assessment area and this was apparent independently for both quarters. More over the highest abundances had shifted to the northwest in recent years. Suggesting a spatial shift in the distribution of the stock at its boundary. This is problematic, since the implied possible migrations in and out of the survey area are not accounted for and may induce considerable uncertainty as well as bias in the stock assessment. Possible migration effects across the assessment area boundaries were explored further by combining the NS-IBTS survey with the adjoining SWC-IBTS survey to produce extended indices and distribution maps over time (Figures 1–2). A combined distributional model was used to calculate the predicted abundance of cod in VIa and IV alone and summed over the entire area. The combined model indicated a more dramatic increase in recent abundance in VIa than in IV for both quarters as expected from the distributional shift observed. However, the index summed over the entire area was very similar to the index in VI alone simply because of the comparatively small area considered a likely refuge for North Sea cod in VIa. Consequently, neither of the indices changed significantly if one were to include even all of the VIa cod so that this is also unlikely to be the cause of the observed divergence between the Q1 and Q3 index. WGISDAA noted that the high abundances of cod are generally found at the edge of the assessment area (not only on the North Sea/IVa border), so problems related to between-year variation in survey coverage of the stock due to migration cannot be ruled out particularly at the boundary with the Norwegian deep. However, no comparable survey data exists in the area to conduct a similar investigation, unfortunately leaving the matter currently unresolved.

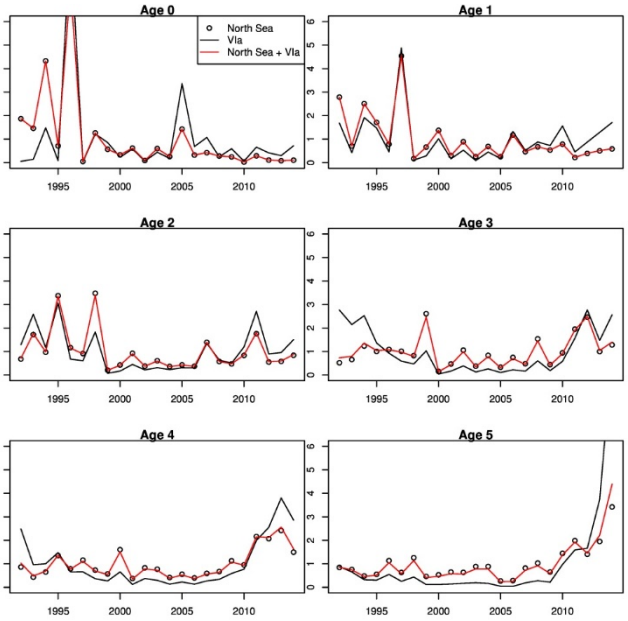

Figure 2. North Sea Cod index abundance-at-age in Q3 calculated with and without the inclusion of VIa IBTS data (SWC-IBTS).

WGISDAA stresses the need to explore haul-by-haul information to detect spatial changes in distribution-at-age in relation to questions about survey design but also for development of new methods of index calculations. Understanding and/or guarding

against spatio-temproal changes in the stock distribution inside and outside the management area are vital as such; dynamics will cause changes in the catchability of survey indices assumed to be constant by many assessments. While comparisons of aggregated indices in assessments will serve to highlight such problems they cannot by themselves explain the inconsistencies. A lack of understanding as to the cause of such changes will frequently lead to the subjective exclusion of one index vs. another (as in the case of NS cod) or the down weighting of an index in the assessment based on its divergence from assessment estimates rather than its tendency for bias.

Multiple survey indices are an asset, but inconsistencies and conflict in signal should be handled outside the assessment process, as a science link.

Indices of abundance from multiple surveys are often used in stock assessments of species for which one survey method cannot cover entire extent of stock distribution. Some demersal species spend periods high in the water column and are inaccessible to the bottom trawls (BT; e.g. Atlantic cod, haddock). On the other hand pelagic species at times are present in the near bottom zone (e.g. spawning herring). In the case of such species abundance indices are often estimated using acoustic or bottom trawl (BT) surveys, both of which sample a fraction of the water column. Acoustic instruments are effective at sampling the water column, but they have a near-bottom acoustic dead zone (ADZ), where fish near the seabed cannot be detected. Bottom trawl surveys cannot account for fish that are located above the effective fishing height (EFH) of the trawl. Currently indices of abundance from these two surveys are commonly used independently in stock assessments. The alternative approach is to use just one of these indices in stock assessment models. Each of these approaches leads to introduction of additional uncertainty into stock assessments. This additional uncertainty arises from year-to-year variation in catchability of both indices of abundance. Variation in catchability can result from variable efficiency of the BT (e.g. Kotwicki *et al.,* 2014), or from variable availability of fish to the survey gear (Kotwicki *et al.,* in press).

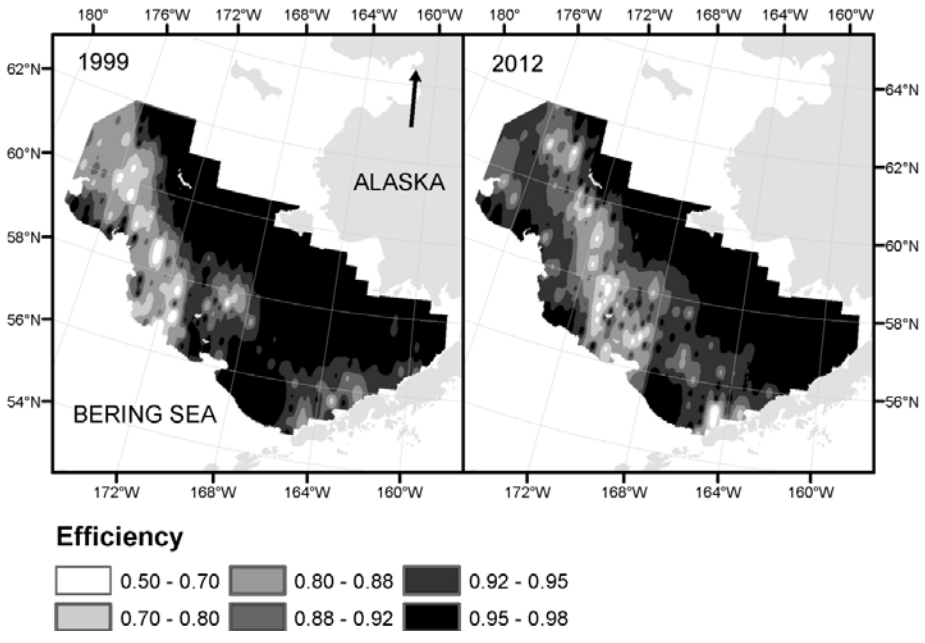

Figure 3. Examples of distribution of EBS survey bottom-trawl efficiency from years 1999 and 2012.

Variable catchability in the index of abundance is of concern because it is not usually represented in the main structure of the stock assessment model and can lead to bias in the estimates of depletion levels and contribute substantially to the uncertainty in stock assessment results and estimates of management quantities (e.g. Maunder and Piner, 2014). Kotwicki *et al.* (2014) showed that density-dependence in BT efficiency can lead to variable cachability of walleye pollock in BT surveys (Figures 3 and 4). Additionally, it has been shown that availability of walleye Pollock to the BT and acoustic surveys changes in response to environmental factors (Kotwicki *et al*., in press).

To address problems associated with variable catchability of the BT and acoustic surveys work has been undertaken at Alaska Fishery Science Centre on methods to combine BT and acoustic data to improve abundance estimates. Semi-pelagic walleye pollock (*Gadus chalcogrammus*) was chosen as a case study for this work because they are a dominant species with important commercial and ecological roles in the North Pacific.

A model combining a subset of acoustic and BT data were developed to estimate ADZ correction and BT efficiency parameters (Kotwicki *et al.,* 2013). Fitting this model to the data provided estimates of the bias ratio between BT and acoustic data, the effective fishing height (EFH) of the BT, and the density-dependent efficiency of the BT. Estimates of experimentally-derived ADZ correction and BT efficiency parameters were then used to develop a model predicting BT efficiency as a function of BT catch rate. It was found that BT efficiency decreased with increasing bottom trawl catches resulting in hyperstability of the abundance index derived from BT survey. Density-dependent BT efficiency resulted in spatially and temporarily variable bias in survey cpue (Figure 3) and biased population age structure derived from survey data. Logistic regression models were developed to predict the availability of pollock to both acoustic and BT gears using environmental predictors and fish length (Kotwicki *et al.,* in press). Findings indicated that on average, availability of pollock in the EBS to the BT was larger than to the acoustics. Availability to both gears depended mostly on bottom depth, light conditions, and fish length, and to a lesser extent on sediment size. Availability to the acoustic gear also depended on surface temperature. Currently a new method is being developed for combining pollock abundance estimates from BT and acoustic data using estimates of bias ratio and overlap between BT and acoustic data. Preliminary results indicate that combined estimates provide relatively precise (CV~. 0.15 – 0.20) index of abundance corrected for variable catchabilty of the BT and acoustic gear. This methodology differs from previous attempts to combine BT and acoustic data (i.e. CATEFA project; Bouleau *et al.,* 2004) by incorporating specific processes associated with BT and acoustic sampling (i.e. bottom trawl efficiency parameters and existence of ADZ) into modelling process.

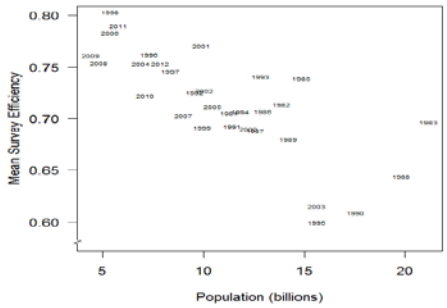

Figure 4. Negative relationship of mean BT survey efficiency vs. total abundance indicates hyperstability of the BT survey index of abundance.

Although this work specifically addresses the assessment of walleye pollock in the EBS it has general applicability in the assessment of other species that can be enumerated using both BT and acoustic gear. Methods being developed can be applied to other species to obtain estimates of ADZ correction or BT efficiency parameters. Similarly, methods for estimating density-dependence of the BT, availability to the BT and acoustic gears, and combining BT and acoustic abundance estimates can be applied to other species.

5.3.2 Correcting density-dependent effects in abundance estimates from bottom-trawl surveys

Indices of abundance are important for estimating population trends in stock assessment and ideally should be based on fishery-independent surveys to avoid problems associated with the hyperstability of the commercial catch-per-unit-effort (cpue) data. However, recent studies indicate that the efficiency of the survey bottom trawl for some species can be density-dependent, which could potentially affect reliability of survey-derived indices of abundance. Density-dependent effects of the BT have been identified as factors that may affect reliability of abundance estimates from BT surveys (Godø *et al.*, 1990; Godø and Wespestad, 1993; Godø, 1994; Aglen *et al.*, 1997; Kotwicki *et al.*, 2013). For example, survey trawl capture efficiency for Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinis*) increases with fish density (Godø *et al.*, 1999). The opposite effect was observed for capelin *(Mallotus villosus*; O'Driscoll *et al.*, 2002), Atlantic croakers (*Micropogonias undulates*) and white perch (*Morone americana*; Hoffman *et al.*, 2009), and walleye pollock (*Gadus chalcogrammus*; Kotwicki *et al.*, 2013). Despite these findings, evaluations of the spatial and temporal variability of density-dependent BT survey efficiency are lacking, and methods which correct time-series of survey abundance indices are unavailable. Kotwicki *et al.* (2014) proposes to use a function $q_e \sim f(u)$ developed at the sample level, where q_e is bottom-trawl efficiency and u is a catch rate, obtained using experimentally-derived acoustic dead-zone correction and bottom-trawl efficiency parameters obtained from combining a subset of bottom-trawl catch data with synchronously collected acoustic data from walleye pollock (*Gadus chalcogramma*) in the eastern Bering Sea (EBS). We found that q_e decreased

with increasing bottom-trawl catches resulting in hyperstability of the index of abundance derived from bottom-trawl survey. Density-dependent q_e resulted in spatially and temporarily variable bias in survey cpue (Figure 4) and biased population age structure derived from survey data (Figure 5). We used the relationship $q_e \sim f(u)$ to correct the EBS trawl survey index of abundance for density-dependence. We also obtained a variance–covariance matrix for a new index that accounted for sampling variability and the uncertainty associated with the q_e. We found that incorporating estimates of the new index of abundance changed outputs from the walleye pollock stock assessment model. Although changes were minor, we advocate incorporating estimates of density-dependent q_e into the walleye pollock stock assessment as a precautionary measure that should be undertaken to avoid negative consequences of the density-dependent q_e.

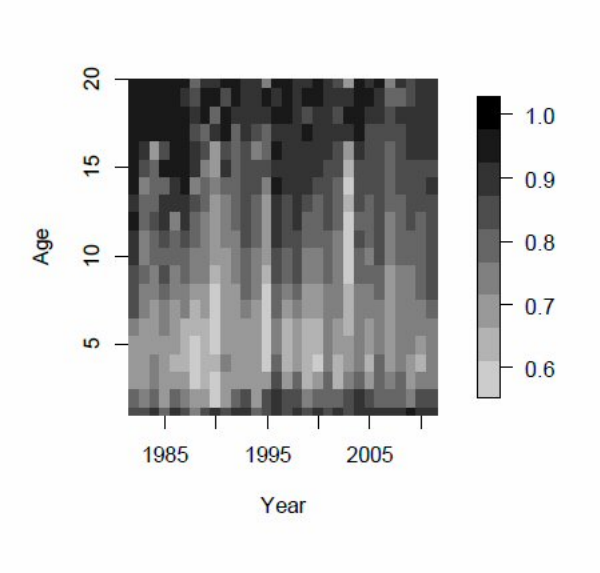

Figure 5. Bottom-trawl survey efficiency by year and age.

This method can be directly applicable for estimating efficiency of the BT for other species given availability of acoustic data collected during trawling. The advantage of this method is that in contrast to the survey independent experiments it can be easily incorporated into regular BT survey protocol and can cover the entire spatial extent covered by the survey. In Kotwicki *et al.* (2014) it was found that BT efficiency was density-dependent. However, for some pelagic species it is known that the abundance estimates from acoustic gear can be density-dependent due to shadowing effect. In such case, it should possible to account for shadowing effect by including density-dependent effect in the acoustic data model. More over similar models are also possible for any situation where two independent enumeration methods are used simultaneously, given that appropriate model is proposed.

5.3.3 General conclusions:

The two talks presented by Stan Kotwicki underscore the utility of collecting acoustic data during BT surveys. It has been shown that the acoustic data collected simultaneously with the BT data can be used to improve abundance estimates in at least two ways. First, abundance indices for many fish species can be improved by combining BT and acoustic data. Combining the data from these two sources has a potential for providing more reliable indices of abundance than can be obtained from single survey

method. Second, acoustic data can be used to estimate BT efficiency. If such an investigation results in finding that BT efficiency is variable in time and space corrections can be made to account for this variability of efficiency by building a model relating efficiency with BT catches.

6 References

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7 Other business

WGISDAA spent some time adapting the code (based on the DATRAS package) used to evaluate the Q3 IBTS survey for cod to examine and evaluate the data for VIa herring, making use of the expertise from WGIPS meeting in Copenhagen at the same time. The work is ongoing and no firm conclusions were reached, but the exercise demonstrated the utility of the analytical approach to quickly examine a number of different options for converting length information to age information. It also provides some potential to account for changes in survey design, gear or even missing data which is a feature of the IBTS data recently in the VIa area.

The issue of estimating survey variance, still remaining unresolved from previous ToRs was briefly discussed. The WG concluded that a variance estimate based on observational variation is inappropriate for use in likelihood based stock assessments as this will tend to overestimate the uncertainty in variation because of the systematic spatial variation in the distribution of catches. In addition, while the practice of estimating the effective sample size in stock assessments such as SS3 persists there seems little point in developing more sophisticated methods of variance estimation because of the predictable relationship between variance and sample number.

A brief discussion was also had regarding a proposed new survey for Monkfish and Megrim in the Celtic Sea, west of Ireland and north into VIa. The aspiration is to tie in with the existing UK beam trawl survey in the Celtic Sea as a potential source of a recruit index. In addition to link in with the demersal trawl survey of UK Scotland in VIa to extend survey index for adults on the shelf. Both the beam trawl and demersal trawl time-series have resource considerations given the former is a broad ecosystem survey and the latter endeavours to produce absolute abundance estimates. If the resources are available to dovetail entirely with both these designs then survey design should be reasonably straightforward. Plans were not advanced enough at the time of the meeting to conclude that however so specific issues may arise for next year's meeting.

Format to include:

- *Progress by ToR*
- *Changes/ Edits/ Additions to ToR*
- *Cooperation with other WG*
- *Cooperation with Advisory structures*
- *Science Highlights*

8 Revisions to the work plan and justification

(As deemed necessary based on progress report (Section 5), highlight changes in summary table. (new ToRs, if applicable. Typically 1 page).

Current ToR a) Identify with Assessment EG chairs where improvements in survey information could be of benefit to the assessment procedure, and assign priorities for consideration

Providing an online catalogue with prioritization of assessment issues, does not in the eyes of WGISDAA provide a useful means of making progress. Assessment working groups are best placed to prioritize issues and in fact, they already do this as part of their ToR's. What WGISDAA should be doing is assisting the assessment groups with the resolution of these issues through their understanding of the interactions between surveys and assessments. WGISDAA is not in a position to resolve the problems independently as the specifics of the assessment and survey methodology would take too much time to acquire. WGISDAA in the first instance is prioritizing specific issues not by way of their importance, but by the likelihood by which the issues can be resolved. Paramount in this is the participation of both assessment and survey working groups. We will continue to talk to assessment working groups to identify problems and individuals that can help with the resolution of issues at the WGISDAA meetings.

A better ToR would be:

'To work together with assessment working groups to provide resolution to assessment issues prioritized by the assessment working groups.'

The deliverable would be:

Specific resolutions to individual assessment issues with a report to feedback into the assessment, or where necessary into the benchmark process. In addition, cataloguing and classification of issues and review of methods used to resolve problems in order to provide "self-help" options to resolve similar issues in other assessments.

Current ToR b) Identify problems with design or index calculation with Survey planning groups. Assign priorities for consideration, and propose solutions

As with the assessment working groups, WGISDAA does not have the detailed knowledge of every survey that the survey working groups have. Applying analytical skills to examine survey data or recommending survey design modifications is best done in conjunction with the survey groups. This year WGMEGS and IBTSWG provided some working group attendance at WGISDAA in order to resolve two survey related issues. We examined the problem and asked for WGMEGS and IBTSWG to perform some specific analysis that would provide the answer as to the best solution. We will review progress at next year's meeting.

A better ToR would be:

'To work together with survey working groups to provide resolution to problems associated with index calculations, survey design changes (proposed or realized) to ensure efficient and effective use of survey resources.'

The deliverable would be:

Specific resolutions to individual survey issues with a report to feedback into the survey working group. In addition cataloguing and classification of issues and review of the methods used to resolve them in order to provide "self-help" options for survey working groups.

ToR c) Initiate with ACOM and secretariat a process to identify upcoming issues associated with the use of survey data in benchmarks. This should be initiated as soon as the benchmark process is started.

Although the intent of this ToR is clear, it is less clear how this will function in reality. If WGISDAA advises on survey issues, there is no method for ensuring the benchmark process addressing the issue. Only by working through / in partnership with the survey and assessment working groups can WGISDAA assist in the process. Assessment working groups in particular are heavily involved / steer the benchmark process. If the two new suggested ToRs are implemented as intended, then there would be no need for ToR c). WGISDAA is currently in discussions with the benchmark steering group on whether such an implementation would suit the advisory needs currently covered by this ToR. See Annex 2 for Revised Multi-annual ToRs.

9 Next meetings (Interim reports only)

In July 2016, the WGISDAA is planning to meet in Hamburg following the advisory process for the demersal assessment working group.

Consideration for July 2017 is Seattle as a meeting venue to accommodate further collaboration with the experts on the other side of the Atlantic. However, impacts on participation, especially of other WGs on whose expertise we rely may make this counterproductive.

Annex 1: List of participants

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Annex 2: Revised WGISDAA Multi-annual ToRS

2014/MA2/SSGIEOM04 The **Working Group on Improving use of Survey Data for Assessment and Advice** (WGISDAA), chaired by Sven Kupschus UK, will meet in Hamburg, Germany, XX–XX July 2016, to work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2015	20-22 January	ICES HQ	Interim report by 1 March 2015 to SSCIEOM, SCICOM & ACOM	
Year 2016	XX July	Hamburg, Germany	Interim report by 30 August 2016 to SSGIEOM, SCICOM & ACOM	
Year 20XX			Final report by "DATE" to "SGXX", "SCICOM"…	

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Identify with Assessment EG chairs where improvements in survey information could be of benefit to the assessment proceedure, and assign priorities for consideration	The advisory need is to underpin the value of the survey programme in the needs of the assessment and advice cycle. Multiple survey indices are an asset, but inconsistencies and conflict in signal should be handled outside the assessment process, as a science link	4.1	annually	On line catalogue, with prioritisation
New a)	To work together with assessment working groups to provide resolution to assessment issues prioritized by the assessment working groups	Specific resolutions to individual assessment issues with a report to feedback into the assessment, or where necessary into the benchmark process. In addition, cataloguing and classification of issues and review of methods used to resolve problems in order to provide "self-help" options to resolve similar issues in other assessments.			

b	Identify problems with design or index calculation with Survey planning groups. Assign priorities for consideration, and propose solutions	Survey designs, and development of indices are the core work of the survey communities. These will be the main fishery independent data source for assessment. The role of WGISDAA will be to advise on statisticall robust and appropriate designs and index calculations	4.1	annually	Individual advisory papers with and to the appropriate survey EG.
New b)	To work together with survey working groups to provide resolution to problems associated with index calculations, survey design changes (proposed or realized) to ensure efficient and effective use of survey resources.	Specific resolutions to individual survey issues with a report to feedback into the survey working group. In addition cataloguing and classification of issues and review of the methods used to resolve them in order to provide "self-help" options for survey working groups.			
c	Initiate with ACOM and secretariat a process to identify upcoming issues associated with the use of survey data in benchmarks. This should be initiated as soon as the benchmark process is started	Survey data issues, as in ToR a, are often critical in the benchmarking process. WGISDAA can advise best if involved in this process from the start, can collaborate with the operators and present conclusions at the benchmark	4.1., 5.1., 5.2	As required	Reports and presentations to the appropriate Benchmark workshop.

Summary of the Work Plan

Year 1	Initiate process elicitating advice requests from other elements of the ICES system; assessment, survey and benchmarking groups. Identify priorities within requests, and set up meeting and personnel accordingly
Year 2	Continue and update process elicitating advice requests from other elements of the ICES system; assessment, survey and benchmarking groups. Identify priorities within requests, and set up meeting and personnel accordingly
Year 3	As in year 2, plus appraisal of the success of the process, and make proposals for changes and any continuation

Supporting information

Priority	This group will feed the results of its work directly into the assessment and hence advisory process. As such it should be considered central and of high priority
Resource requirements	The key additional resource requirement is the group needs particpation of the key players in the relevant assessment, survey or benchmark group. This would be in addition to work required for the normal operations of htese groups. Essentially, this would involve key personnel attending the relevant WGISDAA meeting, and where rquired, personnel from WGISDAA attending the relevant requesting EG
Participants	Dependant on information requests, but normally 12–15 persons
Secretariat facilities	Identification in particular of upcoming benchmarks and key questions on use of survey data. As early in the process as possible.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	ACOM, Benchmark Steering Group, and assessment EG will be the key clients for the work of WGISDAA
Linkages to other committees or groups	WGISDAA will have strong links to to survey working groups under SSGIOMP, and in particular to the work of WGISUR. Given surveys as an important source of wider ecosystem data there will also be important links to groups under SSGIEA
Linkages to other organizations	None specific