Proceedings of the National Comparative Trawl Workshop, November 28-30, 2017, Nanaimo, BC

M.E. Thiess, H. Benoit, D.S. Clark, K. Fong, L.G.S. Mello, F. Mowbray, P. Pepin, N. Cadigan, T. Miller, D. Thirkell, and L. Wheeland

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PROCEEDINGS OF THE NATIONAL COMPARATIVE TRAWL WORKSHOP, NOVEMBER 28-30, 2017, NANAIMO, B.C.

by

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EXECUTIVE SUMMARY

Among other responsibilities, Fisheries and Oceans Canada (DFO) is directed to contribute to a clean and healthy environment and sustainable aquatic ecosystems through oceans management, and ecosystems research, which includes extensive at-sea surveys on all coasts. These surveys are critical to stock assessments and support science-based decision making for informing fishery management, marine protected areas, species-at-risk, and for ensuring Canada fulfills its commitments under international agreements for a variety of transboundary fisheries. Presently, survey programs on the Atlantic and Pacific coasts are preparing to transition from existing research trawl platforms to new offshore fisheries science vessels (OFSVs). As part of the transition, vessel inter-calibration work (also referred to as comparative work or comparative fishing) is an essential undertaking to ensure DFO has the long-term ability to track changes in the marine ecosystems for which it is responsible.

Inter-calibration work must be conducted between DFO's existing research vessels and the OFSVs to ensure there is continuity of the data series on which all assessments and ecosystem monitoring programs rely. Changes to survey platforms or protocols affect the catchability of the species being monitored. Such differences stem from two primary sources: vessel-specific noise signatures which impact vessel avoidance by fish; and vessel-specific trawl performance due to differences in power (vessel and/or winch) and trawling systems (technology and geometry). The OFSVs include significant changes in both areas: they are both quieter and more powerful than the current vessels and, unlike the CCGS Alfred Needler, they will utilise an Autotrawl system. Failure to account for these inter-vessel differences will break the monitoring time series, potentially leaving DFO Science incapable of monitoring ecosystem changes or providing sound advice to fisheries and ecosystem management for a prolonged period.

DFO Science staff, Coast Guard crew and invited subject matter experts convened a workshop to discuss the study design, resource requirements and operational constraints of (acoustic and trawl) calibration studies on both Atlantic and Pacific coasts. The workshop was held in Nanaimo, B.C. from November 28 to 30, 2017 with 44 representatives from five DFO Science regions, two Coast Guard regions, and National Headquarters, in addition to three external subject matter experts. The goal of this workshop was to determine the resources necessary to efficiently transition DFO's marine ecosystem research programs to the new OFSVs and to summarize best practices for any future vessel replacements.

General conclusions arising from the workshop include: recognition that vessel inter-calibration work is an essential component of the overall OFSV implementation project; that to be effective, inter-calibrations must be conducted throughout the standard range of the surveys to ensure conversion factors are applicable over the range of conditions where they will be applied; and, conversion factors will be required for all species currently recorded during the surveys, to ensure the ongoing ability to meet national and international obligations (for example, data requirements for Species at Risk Act assessments, to inform rebuilding strategies or to support third-party certification processes undertaken by First Nations or stakeholders). Further, improved communication to client groups of the risks associated with the new vessel transitions must occur, including the likelihood that some annual DFO Science deliverables may not be possible during the transition, given the additional time required for analyses and review of calibration study results. Finally, it was recognized that further cooperative effort would be required by DFO Science and Coast Guard to develop and implement effective calibration study plans and that a national working group should be supported through 2022 to oversee these efforts.

REGION-SPECIFIC CONSIDERATIONS

Atlantic

- Given that the CCGS Alfred Needler conducts the bulk of the Atlantic Zone trawling (236 days versus 139 for the Teleost), it is essential that direct calibration work be conducted with the CCGS Alfred Needler.
- All East Coast vessels need to be operational through 2020 to ensure that calibration work is conducted throughout the standard range of the surveys to ensure applicability of the conversion factors across the range of conditions they will likely encounter.
- Comparison of noise signatures between OFSV#2 and OFSV#3 must be conducted as soon as possible to determine whether they can be used interchangeably during subsequent calibration fishing studies.
- Ensuring there is sufficient data to derive conversion factors for over 100 species, ranging from Georges Bank to Labrador, will require over 1200 calibration tows; this is similar to the number of fishing sets made annually during Atlantic Zonal surveys and should therefore be possible to complete within one year.

Pacific

- As a result of the decommissioning of the CCGS W.E. Ricker in 2017, direct calibration work with the CCGS Sir John Franklin is not possible.
- Depending on the outcome of operationalization and “shake down” operations for the CCGS Sir John Franklin, additional resources (human and financial) may be required to charter a vessel that was considered comparable to the CCGS W.E. Ricker. The charter would then conduct calibration work with the CCGS Sir John Franklin once it is fully operational and in a “steady state” condition.
- Although this approach still presents a moderate risk of not providing continuity in the existing data time series, it is currently the only way to obtain a direct, independent assessment of relative catchability across the change in vessels. Modelling approaches are also available (Martell et al. 2000), but are considered even higher risk of not providing a reliable measure of continuity over the vessel transition period.

SOMMAIRE EXÉCUTIF

L'une des responsabilités confiées à Pêches et Océans Canada (MPO) est de contribuer à un environnement propre et sain et à des écosystèmes aquatiques durables en gérant les océans et en menant des recherches sur les écosystèmes, ce qui comprend la réalisation de vastes relevés en mer sur toutes les côtes canadiennes. Ces relevés sont d'une importance majeure pour les évaluations des stocks et appuient la prise de décisions fondées sur les sciences dans les domaines de la gestion des pêches, des aires marines protégées et des espèces en péril. Ils permettent aussi au Canada de s'acquitter des engagements pris dans le cadre d'accords internationaux pour diverses pêches transfrontalières. À l'heure actuelle, les programmes de relevés sur les côtes de l'Atlantique et du Pacifique s'apprêtent à passer des plateformes existantes de chalut de recherche à de nouveaux navires hauturiers de sciences halieutiques (NHSH). Dans le cadre de cette transition, l'étalonnage internavire (aussi appelé étude comparative ou pêche comparée) est un élément essentiel des travaux pour permettre au MPO de pouvoir, à long terme, faire le suivi des changements intervenant dans les écosystèmes marins dont il est responsable.

Cet étalonnage internavire doit être réalisé entre les navires de recherches actuelles et les NHSH afin d'assurer la continuité de la série de données sur lesquelles toutes les évaluations et tous les programmes de surveillance des écosystèmes sont fondés. Les changements de plateformes ou de protocoles ont une incidence sur la capturabilité des espèces visées par la surveillance. Ces différences viennent essentiellement de deux sources : les émissions sonores propres à chaque navire, qui influent sur l'évitement du navire par les poissons, et le rendement du chalut propre au navire, en raison des différences de puissance (navire ou treuil) et des systèmes de chalutage (technologie et géométrie). Les NHSH introduisent des différences importantes dans ces deux domaines : ils sont à la fois moins bruyants et plus puissants que les navires actuels et, contrairement au NGCC Alfred Needler, ils sont équipés d'un système de contrôle automatique du treuil. Si nous ne tenons pas compte de ces différences entre les navires, la série chronologique de la surveillance sera interrompue et le Secteur des sciences du MPO ne sera peut-être pas en mesure de surveiller les changements écosystémiques ou de fournir des avis solides en matière de gestion des pêches et des écosystèmes pendant une durée prolongée.

Le personnel des Sciences du MPO, des équipages de la Garde côtière et des experts en la matière invités ont participé à un atelier en vue d'étudier la conception de l'étude, les besoins en ressources et les contraintes opérationnelles des études d'étalonnage (émissions sonores et chalut) sur les côtes de l'Atlantique et du Pacifique. L'atelier a eu lieu à Nanaimo (C.-B.) du 28 au 30 novembre 2017 et a réuni 44 représentants de cinq groupes régionaux des Sciences du MPO, de deux régions de la Garde côtière et de l'Administration centrale nationale, ainsi que trois experts en la matière externes. L'objectif était de déterminer les ressources nécessaires pour passer efficacement des programmes de recherche sur les écosystèmes marins aux nouveaux NHSH et de faire la synthèse des pratiques exemplaires pour les futurs remplacements des bateaux.

L'atelier a permis de déboucher sur les conclusions suivantes : l'étalonnage internavire est un élément essentiel du projet global de mise en œuvre des NHSH; pour être efficaces, les étalonnages doivent être effectués sur toute la gamme habituelle des relevés afin de vérifier que les facteurs de conversion sont applicables à l'ensemble des conditions d'utilisation; il faudra définir des facteurs de conversion pour toutes les espèces visées actuellement par les relevés afin de pouvoir continuer de s'acquitter des obligations nationales et internationales (par exemple, les données requises pour les évaluations de la *Loi sur les espèces en péril*, en vue d'éclairer les stratégies de rétablissement ou d'appuyer les processus de certification par des tiers entrepris par les Premières Nations ou les intervenants). Il faut également mieux informer

les groupes clients des risques liés à la transition aux nouveaux navires, en particulier du fait que certains produits livrables annuels du Secteur des Sciences ne seront vraisemblablement pas fournis pendant cette transition compte tenu du temps supplémentaire nécessaire pour analyser et examiner les résultats de l'étude d'étalonnage. Enfin, le Secteur des sciences et la Garde côtière devront collaborer pour élaborer et mettre en œuvre des plans efficaces d'étude d'étalonnage. Un groupe de travail national doit être appuyé jusqu'en 2022 pour superviser ces efforts.

ASPECTS SPÉCIFIQUES À CHAQUE RÉGION

Atlantique

- Puisque c'est le NGCC Alfred Needler qui effectue la majeure partie du chalutage dans la zone atlantique (236 jours contre 139 pour le NGCC Teleost), il est essentiel d'effectuer l'étalonnage direct avec le NGCC Alfred Needler.
- Tous les navires sur la côte Est doivent être opérationnels jusqu'en 2020 pour que l'étalonnage soit réalisé sur la gamme habituelle des relevés de manière à ce que les facteurs de conversion s'appliquent à toutes les conditions d'utilisation.
- Il faudra comparer les émissions sonores du NHSH 2 et du NHSH 3 le plus rapidement possible afin de déterminer s'il est possible de les interchanger pendant les études suivantes sur l'étalonnage.
- Il faudra procéder à 1 200 traits d'étalonnage afin d'avoir suffisamment de données pour calculer les facteurs de conversion pour plus de 100 espèces, entre le banc de Georges et le Labrador; ce nombre étant comparable au nombre de traits de pêche réalisés chaque année pendant les relevés dans la zone atlantique, il devrait être possible d'y parvenir en un an.

Pacifique

- Du fait de la mise hors service du *NGCC W.E.Ricker* en 2017, il n'est pas possible de réaliser un étalonnage direct avec le *NGCC Sir John Franklin*.
- Selon le résultat de l'opérationnalisation et des opérations de rodage du *NGCC Sir John Franklin*, d'autres ressources (humaines et financières) pourraient être nécessaires pour affréter un navire considéré comme comparable au *NGCC W.E.Ricker*. Ce navire nolisé pourrait alors effectuer les travaux d'étalonnage avec le NGCC Sir John Franklin une fois que ce dernier sera pleinement opérationnel et « prêt à l'emploi ».
- Cette approche présente encore un risque modéré de ne pas assurer la continuité de la série chronologique actuelle, mais c'est pour le moment la seule manière d'obtenir une évaluation directe et indépendante de la capturabilité relative entre les navires. Il existe aussi des méthodes de modélisation (Martell et al. 2000), mais elles présentent un risque encore plus grand de ne pas fournir de mesure fiable de la continuité pendant la période de transition entre les navires.

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INTRODUCTION AND CONTEXT

In preparation for the pending transition from existing research platforms to new offshore fisheries science vessels (OFSVs), regional Fisheries and Oceans Canada staff, Coast Guard crew and invited subject matter experts participated in a workshop to discuss study design, resource requirements and operational constraints of comparative trawl studies on both Atlantic and Pacific coasts.

Plans to replace Canada's OFSVs are well-underway, with the first of three new OFSVs currently slated for delivery to CCG Western Region in late 2018. Two additional OFSVs are then planned for delivery to the CCG Atlantic Region in 2019-2020. Ensuring the comparability of trawl catches and acoustic data time series before, during and after the transition period between old and new vessels will be fundamental to ensuring the ongoing utility of existing research survey time series on both coasts.

Calibration studies are used to determine relative fishing efficiencies (catchability) between vessels so that data recorded by different research vessels can be integrated into continuous, standardized time-series. Parallel (side-by-side) trawls have been identified as the gold standard for this kind of study (Bagley et al. 2015). Without this work to assess comparability between vessels, past experience in other jurisdictions has shown that comparability may never be attained between time series from old and new vessels (D. Clarke, DFO Maritimes, pers. comm.). When estimating abundance indices, there is an elevated risk of conflating true abundance changes and changes resulting from a change in survey vessels, gear or protocol without adjusting for the latter effects using proper calibration factors. Even in a best case scenario (i.e., little observed difference between vessels), it could take five to ten years (or longer) before a measure of comparability could be confidently established between the data time series.

Calibration studies of this scale are strategically complex to implement in marine ecosystems due to variability in distributions and behaviour of the species being tracked. In addition, the necessity for coordination among Regions and organizations requires detailed planning. With similar OFSV platforms scheduled for delivery to both coasts affecting five regions (across DFO Science), inter-vessel calibration is an issue of broad importance. A national OFSV Science Working Group has been addressing comparative work issues with project managers and Canadian Coast Guard (CCG) fleet managers in Ottawa since the requirement for this work was recognized by the National Science Executive Committee (SEC) in early 2015. Regional working groups have also formed to coordinate regional comparative study plans and to seek further SEC endorsement as needed.

The goal of this workshop was to equip DFO Science staff and programs with the knowledge and resources necessary to efficiently transition DFO's fishery and ecosystem monitoring programs to the new platforms, while maintaining the integrity of existing data time series and within the practical constraints of finite material and human resources.

GOAL OF THE WORKSHOP

Participants were provided with the following goal and given an opportunity to modify or confirm its intent at the start of the workshop:

"To develop experimental designs and data analysis strategies for trawl vessel calibration studies, and begin coordinated logistics planning to support this work in the Atlantic and Pacific Regions."

WORKSHOP OBJECTIVES

The following objectives were distributed along with the agenda at the start of the workshop. These objectives were derived from preliminary documentation drafted by the planning committee and in discussions with the facilitator in the weeks prior to the workshop.

1. Build a shared understanding of and appreciation for trawl vessel calibration studies and their requirements;
2. Ensure a common understanding of vessel calibration studies to date, challenges facing the Atlantic and Pacific regions with current vessel transitions, and the logistics parameters within which calibration studies will take place;
3. Develop analytic requirements and methods to provide continuity conversion factors during vessel and/or gear changes – including scientifically viable contingencies – in the Atlantic and Pacific regions; and
4. Identify budget, scheduling, and crewing requirements for different logistics scenarios.

WORKSHOP OVERVIEW

The agenda circulated at the start of the workshop is included in Appendix A.

Day 1 discussions focused on the scientific rationale for doing comparative work as well as Coast Guard challenges with maintaining and crewing both new and existing OFSVs simultaneously. A breakout group agenda-building activity at the end of Day 1 helped highlight the common questions arising from the presentations, categorized broadly under Analytic issues and Logistic scenarios. These were used to structure Day 2 activities.

On Day 2, the group split into 2. The logistics session focused on addressing questions related to the Logistic Scenarios. Schedules for east and west coast comparative fishing studies were drafted, based on the current OFSV delivery schedule. The concurrent analytics session heard presentations from regional and international subject matter experts on topics relating to the analysis of comparative fishing data.

Day 3 began with presentations from each of the sub-groups from Day 2, and wrapped up following the establishment of key principles arising from the workshop and next steps to be undertaken.

The workshop was held over 3 days (November 28-30, 2017) at the Coast Bastion Inn, Nanaimo, B.C. Forty-six Science, Coast Guard and subject matter experts participated in the 3-day workshop. There were 39 and 31 participants on Days 2 and 3, respectively. The list of participants is provided in Appendix B.

SUMMARY OF PRESENTATIONS

DAY 1

Research Survey Objectives and Design, Don Clark, Maritimes Region

Current DFO research surveys are designed to provide estimates of relative abundance for a variety of species throughout the survey area, and with the ability to detect changes over time in stock size and its demographic composition (e.g., physical size or year class structure). Research surveys also collect ancillary data (e.g., biological properties such as maturity, sex ratio, weight, stomach contents; or environmental such as sea surface temperature, salinity, nutrients). Data from research surveys provide inputs for ecosystem modelling, stock assessments, monitoring of bycatch species and species-at-risk, defining MPAs, and monitoring the distribution of a broad suite of species.

Considerations for research survey design include: spatial and temporal coverage, sufficient stratification to reduce variability (within strata) and randomly selected stations within strata to ensure representative sampling.

Consistency is essential to the long-term success of research surveys. Surveys are conducted in the same seasons each year, gear parameters are monitored, trawl net tow lengths and speeds are standardized and tracked. Consistent vessel performance and gear deployment ensure that changes in the observed catch are a reflection of changes in species abundance and distribution and are not caused by changes in how the sampling was conducted.

Individual vessels affect fish capture and trawl net avoidance behaviour directly through variability in vessel noise profile and indirectly through the impact of vessel configuration on trawl dimensions (e.g. factors such as size, or tow point locations will change the size of the net opening and how it tows through the water or contacts the bottom).

The International Council for the Exploration of the Seas (ICES) Study Group on Survey Trawl Standardization reviewed possible impacts of changes and recommended that studies be undertaken when there are changes in trawl gear, method of trawling, season/timing of fishing, or the survey vessel (ICES 2009).

There is a misconception that abundance indices can be quickly re-established when there is an uncalibrated change in survey vessel, gear or protocol. A rule of thumb for Virtual Population Analyses is that at least as many years of data are needed as the commercial life-span of the target species, assuming there is no change in natural mortality rates or fishing practices over that span. These assumptions are often violated. Without scientific catch data from overlapping surveys, there is no link between time series with the old vessel and those obtained with the new vessel. The absence of a linkage increases the risk of making incorrect assumptions with potentially expensive and deleterious implications.

For species with no analytical assessment and no commercial catch-at-age data, survey data provide the only information on biomass trends. If there are changes to the survey with no calibration, there is no way to determine whether changes in survey catch reflect changes in population biomass, or simply changes in survey practices.

As an example, in the Newfoundland and Labrador Region, it was noticed that, for many fish species, there was a substantial increase in catches of smaller fish when the trawl net changed from the Engel trawl to the Campelen trawl starting in 1995. The sudden change could not be explained by population dynamics or recruitment alone. The overall conclusion was that the Campelen trawl was much more efficient in catching small-sized fishes but there was no data available to develop conversion factors.

In the Maritimes Region, a switch was made in 1982 in the trawl used for the Summer Survey from the Yankee 36 trawl to a Western IIa trawl. Spring and fall surveys used the Western IIa in all years, but both of these series were cancelled in the 1980s. There were problems encountered with determining tow speed on one of the vessels during comparative fishing and it was subsequently determined that one vessel was consistently towing faster and farther than the other (Fanning 1985). Calculation of conversion factors was complicated by this discrepancy and conversion factors were never calculated for most species.

Biomass trends were derived for Smooth Skate assuming there was no conversion factor required for the trawl change (Figure 1). The apparent reduction in biomass in the summer survey time-series contributed to the conclusion by COSEWIC that Smooth Skate were of

“Special Concern” (COSEWIC 2012). This assessment has resulted in a great deal of expense associated with species-at-risk reviews and consultations. The spring survey, where there was no change in gear, has been conducted periodically in the last decade. This survey shows Smooth Skate biomass has increased since the 1980s, not decreased. Errors of this nature can only be avoided by ensuring there is adequate comparative work to derive conversion factors for all species.

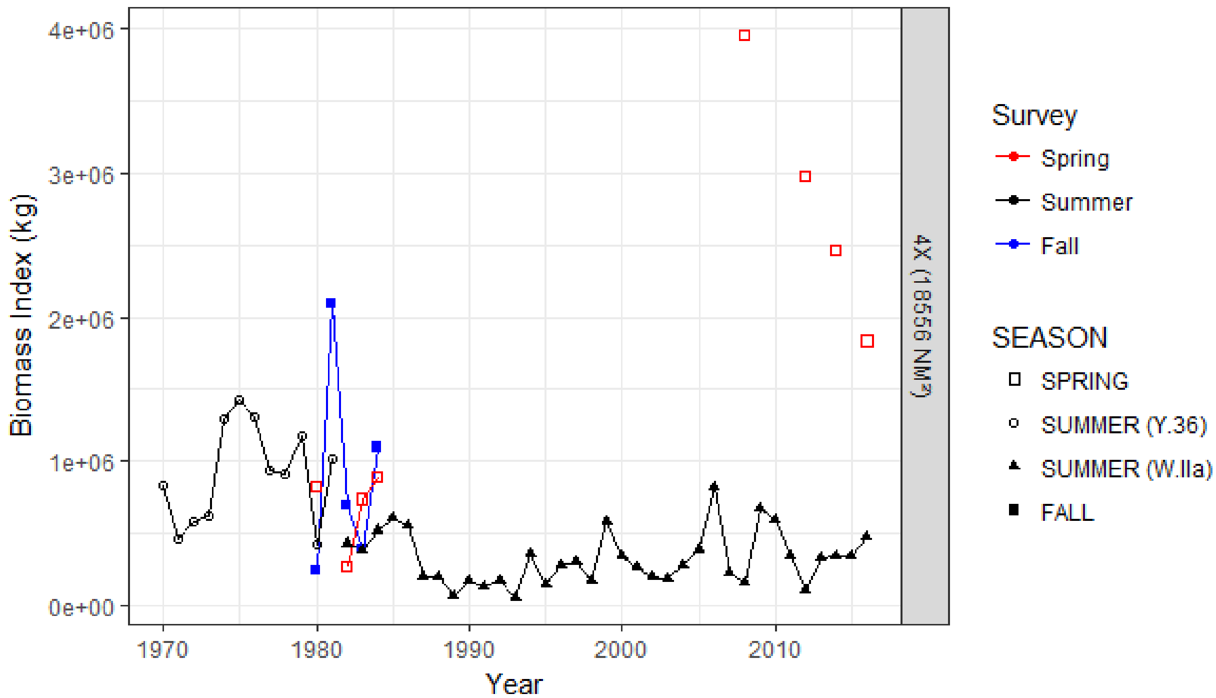

Figure 1. Example of results that were poorly informed by limited comparative trawl studies during the transition phase.

The new OFSVs are larger and are expected to be quieter than the existing OFSVs. In some cases they will use different fishing equipment (e.g., Autotrawl). Considerable differences in fishing efficiency are expected between the new and existing OFSVs. There may even be significant differences among the new OFSVs themselves, even though they are intended to be identical in size and all major components. This difference will be of particular concern on the East coast where the vessels are expected to be interchangeable.

Atlantic Zonal Perspective on Calibration Trawl Studies, Don Clark, Maritimes Region

An overview of the typical annual research survey schedule was provided and potential issues for implementing calibration trawl studies highlighted. With two existing vessels being replaced by two new vessels operating three fishing gear types, attaining full calibrations across all possible combinations will be difficult. At least four sets of different calibration experiments will be required. Within each calibration study, there are scores of species with differing distributions for which conversion factors will be required; a blend of random stations and targeted fishing will be needed. Further, geographic scale and species distribution varies considerably among regions; larger areas will need approximately 400 sets, some random and some targeted, to ensure data are available for all species and strata throughout the Zone. For example, in the Maritimes region, different species assemblages are found in different areas throughout the region (Figure 2). Each area will need calibration fishing effort to ensure there are at least 30 – 50 sets with catch for most species. The same is true for other Regions.

Although standard survey results are still needed for annual assessments, it is likely that standard surveys will be cut-back to create time for directed calibration work. Where possible, calibration studies should occur in the regular survey season.

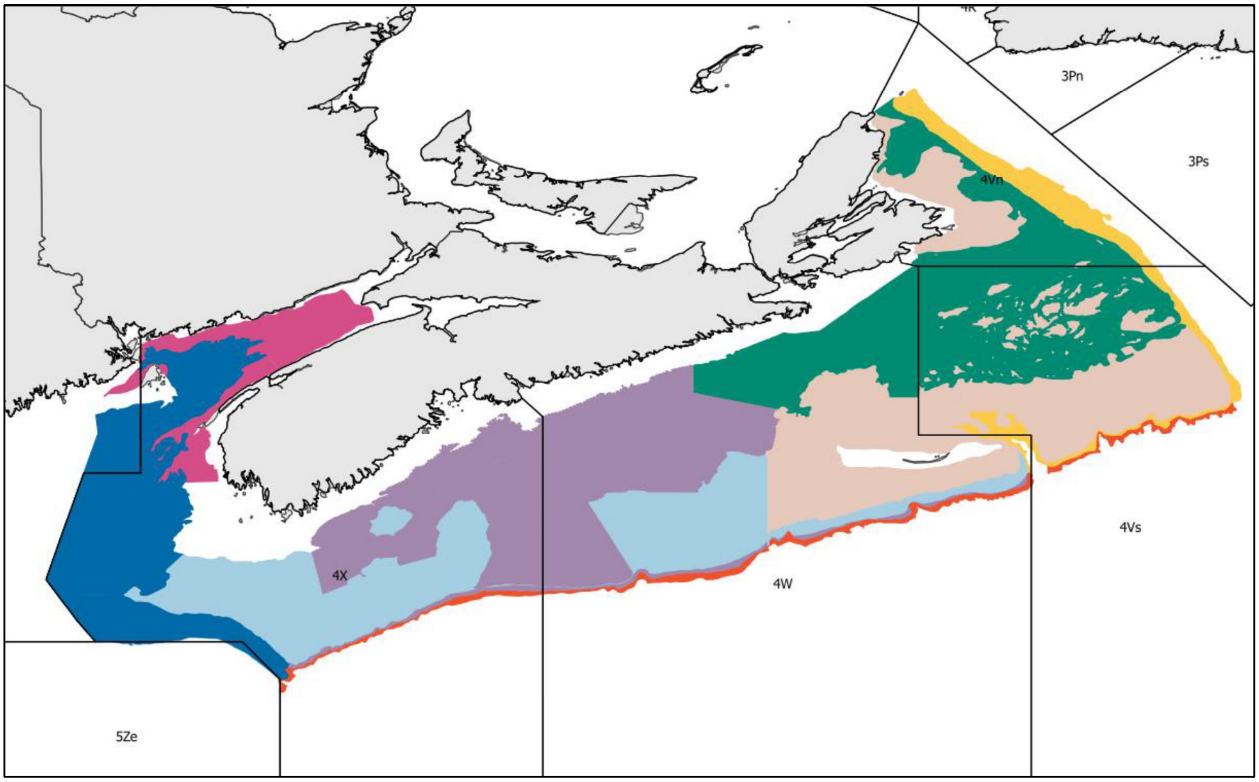

Figure 2. Unique species assemblage areas identified through spatial analyses in Maritimes Region.

Several key issues were identified:

- Preparation: Science and CCG must work together to ensure everything is ready to go in February 2019 and that the schedule provides opportunities for all calibration studies.
- Planning: To the greatest extent possible, Science staff must ensure the stations selected for use in the calibration studies will provide sufficient data for calculating conversion factors for all species.
- Adaptability: Flexibility in the Regional scheduling process will be necessary to respond to problems encountered during the year, to ensure we get minimum coverage for each calibration study (to allow the calculation of conversion factors).

Pacific Region Perspective on Comparative Trawl Studies, Ken Fong, Pacific Region

The last major permanent OFSV transition occurred in 1986 when the R/V G.B. Reed was retired and the CCGS W.E. Ricker was brought into service. Another permanent inshore fisheries vessel transition occurred in 2001, when the CCGS Caligus was replaced by the CCGS Neocaligus. No direct comparative or calibration studies were conducted between these vessels. It was likely not considered at the time. During the CCGS W.E. Ricker's service period, there was some calibration work completed with other vessels (e.g., with commercial fishing vessels such as the F/V Eastward Ho, and NOAA research vessels such as the Bell M Shimada). There has also been research conducted directly comparing catchability between two charter vessels (e.g. rockfish surveys with F/V Ocean Selector and F/V Frosti). Data modelling (stock reconstruction analysis) of offshore shrimp abundance trends identified potential biases in fishing power between the R/V GB Reed and CCGS W.E. Ricker (Martell et al. 2000).

Vessel transition plans for DFO Science (Pacific Region) included the provision of necessary material and human resources to outfit two science vessels (for the CCGS W.E. Ricker and CCGS Sir John Franklin) for calibration studies (including bottom trawl, mid-water trawl, and acoustic calibration surveys); incorporation of calibration work into the CCG Western Region Operationalization and Fleet Operating Plans; and hosting of a national workshop to coordinate calibration work planning among regional DFO Science personnel and invited international subject matter experts.

Calibration studies were expected to require a minimum of one year of field studies in Pacific region plus additional time for completion of data analyses. Most Pacific at-sea ecosystem science surveys are long-term monitoring programs that require completion during regularly scheduled survey time periods (or else forgo regular survey activities in order to complete vessel inter-calibration studies). Further, catchability is known to vary seasonally for many species, so it is important that the timing of calibration fishing experiments closely resemble the timing of the regular surveys.

The decommissioning of the CCGS W.E. Ricker prior to delivery of the first OFSV has prevented direct calibration work. Pacific Region Science is currently working on mitigation plans for its OFSV transition work. Options include: chartering a vessel with noise and towing capabilities that are similar to those of the CCGS W.E. Ricker (i.e., vessels chartered as CCGS W.E. Ricker replacements in the past); simulation modelling (which would only be able to simulate trawl geometry under optimized conditions; catchability would remain unknown); or, previous 3-way vessel comparisons of fishing gear and acoustics (based on work done in the past with specific gear types). Despite the inability to conduct direct calibration studies, it will remain important to allocate additional time/funds/resources to the operationalization phase of the OFSVs to quantify and assess all aspects of the new vessel's scientific operation (e.g., a full suite of noise signature testing, assessment of net towing characteristics, estimates of catchability, etc.).

A number of key issues were identified by Pacific Science staff prior to this workshop:

- The CCGS W.E. Ricker was decommissioned in early 2017. Rather than one year of calibration transition from CCGS W.E. Ricker to CCGS Sir John Franklin, there is now an intervening period (2 or more years) of charter vessel use to confound the data time series.
- Direct calibration experiments between CCGS W.E. Ricker and CCGS Sir John Franklin are not possible.
- This leaves Science programs unable to ensure that "vessel bias" is sufficiently quantified for many long-standing data time-series following the permanent change in platform (i.e., will observed changes in relative abundance represent true population change or change due gear or vessel?).
- Greater uncertainty in stock assessments for the next decade (or possibly longer), translating into increased reliance on precautionary management decisions (and potential loss of economic opportunity).
- The many long-standing data time-series represent significant investments of departmental resources to establish and maintain (i.e. greater $80M for programs on the CCGS W.E. Ricker).

- An inability to directly compare future data assessments against reference points developed from existing data, leading to greater uncertainty and potential errors in determining status under the Precautionary Approach and SARA.
- Ad hoc modelling approaches are the only feasible option to possibly link time-series data, due to decommissioning of the CCGS W.E. Ricker.
- Future vessel transition exercises (e.g., nearshore ecosystem science vessels) also need to include considerations for inter-vessel calibration work.

<u>Canadian Coast Guard Perspectives on Comparative Trawl Studies, Cyndi Byatt (Atlantic), Carolyn Self (NHQ), Darcene Thirkell (Pacific)</u>

An overview of the crewing profile of the OFSVs relative to existing platforms was provided for both coasts (Figure 3 and Figure 4). Notably, an "Electrical Officer" position has been added to the crew profile (and this will require adding an additional cabin as part of post-delivery refits to all three OFSVs; T. Fleming, NHQ CCG Vessel Procurement, pers. comm. February 6, 2018).

CCGS W.E. Ricker

Complement	20	
Berths (Total/Crew)	17	13

Crew	Level
Commanding Officer	SO-MAO-09
Chief Officer	SO-MAO-06
Fishing Master	SO-MAO-06
Second Officer	SO-MAO-03
Boatswain	SC-DED-06
Leading Seaman x4	SC-DED-03
Deckhand x2	SC-DED-02
Chief Engineer	SO-MAO-08
First Engineer	SO-MAO-06
Second Engineer	SO-MAO-03
Oiler x2	SC-ERD-03
Chief Cook	SC-STD-05
Cook	SC-STD-03
Steward x2	SC-STD-01

CCGS Sir John Franklin

Complement	23	
Berths (Total/Crew)	36	23

Crew	Level
Commanding Officer	SO-MAO-10
Chief Officer	SO-MAO-07
Fishing Officer	SO-MAO-06
Second Officer	SO-MAO-04
Boatswain	SC-DED-05
Twinehand x8	SC-DED-03
Chief Engineer	SO-MAO-09
Senior Engineer	SO-MAO-07
Electrical Officer*	SO-MAO-05
Second Engineer	SO-MAO-04
Third Engineer	SO-MAO-03
Engine Room Assistant	SC-ERD-03
Supply Officer*	SO-MAO-03
Chief Cook	SC-STD-05
Cook/Steward	SC-STD-03
Steward	SC-STD-01

*Approved in Principle

Figure 3. Crew profile for the CCGS Sir John Franklin compared to the CCGS W.E. Ricker.

CCGS Alfred Needler			OFSV #2 & #3			CCGS Teleost		
Complement	21		Complement	23		Complement	22	
Berths (Total/Crew)	32	21	Berths (Total/Crew)	36	23	Berths (Total/Crew)	34	22

Crew	Level	Crew	Level	Crew	Level
Commanding Officer	SO-MAO-09	Commanding Officer	SO-MAO-10	Commanding Officer	SO-MAO-10
Chief Officer	SO-MAO-06	Chief Officer	SO-MAO-07	Chief Officer	SO-MAO-07
Fishing Officer	SO-MAO-06	Fishing Officer	SO-MAO-06	Fishing Officer	SO-MAO-06
Second Officer	SO-MAO-03	Second Officer	SO-MAO-04	Second Officer	SO-MAO-04
Boatswain	SC-DED-05	Boatswain	SC-DED-05	Boatswain	SC-DED-05
Twinehand (x8)	SC-DED-03	Twinehand (x8)	SC-DED-03	Twinehand (x8)	SC-DED-03
Chief Engineer	SO-MAO-08	Chief Engineer	SO-MAO-09	Chief Engineer	SO-MAO-09
Senior Engineer	SO-MAO-06	Senior Engineer	SO-MAO-07	Senior Engineer	SO-MAO-07
-	-	Electrical Officer*	SO-MAO-05	-	-
Second Engineer	SO-MAO-03	Second Engineer	SO-MAO-04	Second Engineer	SO-MAO-04
-	-	Third Engineer	SO-MAO-03	Third Engineer	SO-MAO-03
Engine Room Assistant (x2)	SC-ERD-03	Engine Room Assistant	SC-ERD-03	Engine Room Assistant	SC-ERD-03
-	-	Supply Officer*	SO-MAO-03	Logistics Officer	SO-MAO-05
Chief Cook	SC-STD-05	Chief Cook	SC-STD-05	Chief Cook	SC-STD-05
Cook/Steward	SC-STD-03	Cook/Steward	SC-STD-03	Cook/Steward	SC-STD-03
Steward	SC-STD-01	Steward	SC-STD-01	Steward	SC-STD-01
		*Approved in Principle			

Figure 4. Crew profiles for OFSV #2 and #3 compared to the CCGS Alfred Needler and CCGS Teleost.

Historic and future schedules were highlighted for both coasts. On the west coast, CCGS Sir John Franklin is expected to have approximately the same number of operational days as the average schedule of the CCGS W.E. Ricker. On the east coast, scheduling is more complex due to the coordination of multiple vessels, gears and regions. It was noted that crewing will be a significant challenge when trying to staff CCGS Alfred Needler, OFSV#2, and CCGS Teleost in warm layup while still providing crew for familiarization training and/or transit of OFSV#3 in early 2019.

Projected operating costs of the OFSVs compared to the existing platforms were provided for both coasts (Table 1 and Table 2). All costs were taken from the National Fleet Costing Model (NFCM) which uses historical vessel expenditures and operational day data to project future vessel costs. Estimated operating costs for all three OFSVs are based on the current NFCM 3-year average for the CCGS Teleost (2014/15 to 2016/17), which is the most comparable platform currently in operation. It is important to note that, although these estimates are based on reliable data from a comparable vessel, the costs provided for the OFSVs are projections only. Actual expenditures will be subject to geographic and program-specific differences in vessel operations, among other factors.

Ecosystems and Oceans Science (EOS) sector staff developed a proposed calibration trawl schedule based on the following assumptions:

- CCGS Alfred Needler replacement (OFSV #2) is expected to arrive three months behind CCGS Sir John Franklin.
- It will take approximately two months after delivery from the shipyard for each OFSV to arrive on the East Coast.
- In order to develop calibration trawl timelines and build in schedule slippage, EOS has an estimated “ready for service” date on the East Coast as the beginning of 2019.

Table 1. Projected operating costs of CCGS Sir John Franklin (OFSV#1) compared to the CCGS W.E. Ricker. Projected costs for all three OFSVs are based on the CCGS Teleost.

Line Item	3-Year Average Cost (2014/15 to 2016/17) CCGS W. E. Ricker	Estimated Cost CCGS Sir John Franklin	Increase
Salary	$ 2,900,129	$ 4,102,215	$ 1,202,086
O&M	470,068	889,854	419,786
Fuel	501,856	1,143,587	641,731
Total	3,872,053	6,135,656	2,263,603
Operational Days	205	205	0

Table 2. Projected operating costs of OFSV#2 and #3 compared to the CCGS Alfred Needler. Projected costs for all three OFSVs are based on the CCGS Teleost. Although there is a minor reduction in operational days, the majority of the projected operating costs of OFSV#2 and #3 are fixed, and do not decrease in direct relation to a reduction in operational days.

Line Item	3-Year Average Cost (2014/15 to 2016/17) CCGS Alfred Needler	Estimated Cost OFSV#2/OFSV#3	Increase
Salary	$ 3,315,948	$4,118,083	$ 802,135
O&M	795,390	904,830	109,439
Fuel	553,304	1,533,727	980,423
Total	4,664,642	6,556,640	1,891,998
Operational Days	296	280	-16

The following potential concerns and operational issues were identified by Coast Guard:

- Based on the proposed schedule, the CCGS Alfred Needler will be required in spring and early summer 2019, requiring it to remain in service until 2020 (reliability and serviceability are concerns);
- Accommodating both calibration fishing and standard survey objectives for the NL Fall trip will not be simple to schedule and could result in the program extending to late December 2019;
- CCGS Sir John Franklin will be capable of other program delivery (e.g., SAR) consequently the vessel may be utilized for other program work when not tasked for Science purposes;
- Limited Fleet platform capability due to planned vessel life extension activities; new trawl vessels may offer relief (which could conflict with regular trawl survey programs; e.g., if the CCGS Sir John Franklin is tasked as the CCGS John P. Tully replacement during its vessel life extension); and
- CCGS Sir John Franklin will operate from IOS while work is undertaken to determine possibility of home porting at PBS or other wharfage options in Nanaimo.

Scheduling questions and subsequent considerations raised by EOS include:

1. Is it possible to carry out calibration fishing between CCGS Teleost and CCGS Alfred Needler in 2018?
    - This approach may result in only one set of conversion factors required for the Newfoundland fall survey from the existing vessels to the new OFVSs (if sufficient calibration fishing tows can be completed).
    - Would reduce the amount of directed calibration work needed in 2019, freeing the OFSV to contribute to standard survey objectives.
    - Newfoundland and Labrador Region conducted 29 successful inter-vessel calibration tows between the Needler and Teleost during Fall 2017. Calibration fishing between these vessels will be needed to ascertain and correct for any differences between vessels for occasions/areas where the vessels have been used interchangeably (due to unexpected vessel break-downs or for logistic reasons).
2. Can calibration work continue beyond 12 months into 2020?
    - This approach would result in annual refit and maintenance work for both vessels and would further impact crewing.
    - Berthage space may be a challenge with the increased number of vessels.
    - On the Atlantic coast, charter vessels are under consideration by EOS to assist with Science programs during the calibration trawl phase in 2019.

Crewing challenges were identified by Coast Guard as a significant risk to program deliverability during the OFSV transition period. In response, CCG Western Region is overstaffing vessels and stations to ensure that crew receive the necessary familiarization/training prior to being assigned to any new vessel or station. There are additional staffing concerns relating to: known mariner shortfalls within industry, ongoing Phoenix pay system impacts (e.g., crew leaving Coast Guard due to Phoenix pay issues), and an increase in the number of employees needed within the CCG due to the introduction of the Ocean Protection Planning (OPP) program. Crewing concerns are ongoing for some positions, in some regions, resulting in limited or no relief for current crew. For the OFSVs, these positions include Fishing Master, Electrical Officer, Cook, Boatswain, Twinehand and, in the Atlantic Region, Chief Engineer. CCG is developing mitigation strategies to ensure continuous staffing for these positions. Other challenges include: staffing replacements for in-year leave/holidays for crew, training requirements for crew and increased need to have supernumerary CCG personnel (e.g., cadets) onboard the vessels with limited berth capacity (often impacting Science staffing capacity on vessels during Science programs). Initial concerns about crewing OFSV#2 during its transit to the East Coast in late 2018 have been alleviated (by potentially using a mix of Needler and Teleost crew). If delivery is delayed into the next operational cycle, this may again become an issue.

Under the current Service Level Agreeement (SLA), Coast Guard can assist with calibration trawling by:

- Providing operational advice and recommendations to EOS in the areas of Operations and Technical Services (service delivery, safe operations, technical solutions) (section 5.14).
- Providing appropriately trained Ships’ Officers and Crew (section 5.7).
- Providing support to EOS where possible, in chartering a vessel when no suitable CCG resource exists (section 11.1, and CGFO 122.00, section 1.1).

- Providing costing for new EOS program vessels from the National Fleet Costing Model, based on historical days and costs, as well as collective agreement increases, and crewing profiles.
- Providing advice on vessel planning and vessel scheduling to facilitate program objectives.

It is important to note that CCG assets that are operated for EOS programs, use EOS funding as dictated by section 12 of the SLA. This applies to both fixed and voyage costs, wherever costs are incurred.

Vessel and gear transition for Northeast Fisheries Science Center bottom trawl surveys, Timothy J. Miller, NOAA

An overview of the design of the annual bottom trawl surveys and of the calibration trawl study undertaken by the Northeast Fisheries Science Center for the transition from the *Albatross IV* to the *Henry B. Bigelow* was provided. The bottom trawl surveys cover the entire Northeast US shelf (Cape Hatteras to Scotian Shelf), are conducted using a stratified random design, and target multiple species of interest. Within the stratified random design of the annual bottom trawl surveys, station locations are randomly selected within geographic strata defined by bottom depth and region. Tows are conducted according to standardized protocols for tow speed and direction, and there are consistent sampling protocols for the catches for size, maturity states, ageing structures, and food habits by species.

The overall objectives of the annual bottom trawl surveys are to:

1. Monitor trends in abundance, biomass and recruitment;
2. Monitor the geographic distribution of species;
3. Monitor ecosystem changes;
4. Monitor trends in biological parameters (growth, mortality and maturation rates) of the stocks; and
5. Collect environmental data.

Two potential approaches to calibration study design were outlined:

1. Model-based calibration: use of paired tows; had been used extensively to calibrate previous vessel and door changes; requires a large number of tows; and
2. Design-based calibration: uses parallel survey but not necessarily paired tows (targeted stations); a reasonable amount of coordination effort could produce many common stations.

Either approach would assess simultaneous changes in vessel and gear. As in the regular bottom trawl surveys, protocols were standardized with respect to tow speed and direction, but trawl warp technology (fixed brake vs. Autotrawl) and net mensuration systems varied between existing and new vessels (this was incorporated into the calibration). Ultimately, the realized study design differed from the proposed study design in a number of ways:

1. The calibration study was conducted within the survey stratified random design (by depth and latitude) and although all surveys were planned as paired tow studies, additional targeted stations (approach 2) were conducted in both the fall and summer surveys to achieve sample size requirements for some species;
2. The number of realized stations was less than half the number originally planned; and
3. The planned spatial offset (300m) between vessels ended up as spatial and temporal offsets of roughly 0.5nm and 20 minutes apart, with some variability.

The following conclusions and considerations were offered:

- Proposed changes have significant short term costs, but long term benefits.

- Transitions done without sufficient planning and resources will result in significant disruption to stock assessment and management systems.
- Close coordination between survey, vessel, stock assessment and management personnel is critical.
- Other possible considerations are: 1) whether there are more than two gears to calibrate simultaneously; 2) disturbance effects of gear deployments close together in space and time (see Lewy et al. 2004); 3) size and diel effects on calibration; 4) variation in density and relative catch efficiency between paired observations; and 5) whether old indices should be calibrated to the new indices or vice versa.

Introduction to Trawl Monitoring and Performance – Protocols for Comparative Fishing, Truong Nguyen, Newfoundland and Labrador

The survey trawl is a scientific instrument that needs to be standardized and calibrated. Standardized surveys should minimize the variability typical in commercial fisheries data and thus generate more consistent indices of stock abundance. An essential feature of research surveys is maintaining consistency from one survey to the next. Consistency can be achieved by ensuring constancy in sampling efficiency of the trawl, i.e. ensuring constancy in construction and repairs, and fishing procedures. Without standardization, changes in survey biomass estimates of stock size could be attributed to a change in survey procedures, rather than an actual change in the population.

The philosophy of ownership and responsibility was outlined as follows:

- Maintenance and calibration of ship board hardware used in fishing operations is owned by CCG.
- Survey planning is owned by Science.
- Purchasing, construction and repairs of trawls and issues related to procedures during trawling operations are jointly owned by Science and CCG.

The success of any standardization program depends on: good teamwork existing between officers/crew and scientific staff; and both ship's crew and Science staff having a good and common understanding of the mechanics of trawling, and the basis of research surveys and data collection. A critical element for success of the standardization program is the partnership between all players.

An introduction to the components of the Northwest Atlantic Fisheries Centre Standardization Program was provided (Figure 5). Specifications are maintained in an operations manual, including a complete series of net drawings, rigging profiles, part lists and trawl checklists.

Components of the NAFC Standardization Program

1. Standardized Trawl Plans to ICES specifications
2. Quality Control on Purchasing
3. Quality Control on Construction & Repairs-Survey Gear Checklist
4. Quality Control on Survey Protocols - Fishing
5. Quality Control on Trawl Monitoring
6. Training of Both Vessel and Scientific Staff in survey and fishing operations

Figure 5. Summary components of the North Atlantic Fisheries Centre Standardization Program.

Standardized survey protocols include the following specifications and requirements (these will be used during Newfoundland's calibration fishing studies):

1. Measure survey gear before and at regular intervals during the survey;
2. The scope ratio must be followed;
3. Each tow has a target speed of 3 knots;
4. Each tow has a target duration of 15 minutes;
5. Direction of tow must be tracked;
6. A standardized definition of "untrawlable" bottom must be used;
7. The procedures to deal with damaged gear and unsuccessful tows must be standardized; and,
8. There must be a randomized selection process to determine tow starting position.

The following thoughts were offered for consideration and further discussion during the workshop:

- In multi-vessel surveys, standardization of fishing protocols is essential and will be important for calibration fishing (CF);
- Modelling of CF data to derive conversion factors should consider using tow-specific swept-area calculations (adjustments) based on Scanmar trawl wing-spread measurements and estimated distances for each tow (if wing-spread adjustments are part of the regular ongoing survey protocol). Accuracy of the derived conversion factors depends on employing the ongoing standardization protocols during the CF experiments and data analysis;
- Sufficient time should be set aside for shakedown trials between old and new vessels so both vessel and scientific staff are fully coached in proper standardized survey protocols before beginning calibration fishing work;
- Sea trials must be conducted with new vessel prior to CF to test the trawling gear system and survey fishing protocols; and
- Carrying out simultaneously paired tows is the preferred method for calibration fishing studies.

Vessel Noise Signatures: The importance and measurement of underwater sound radiation, Fran Mowbray, Newfoundland and Labrador

Underwater vessel radiated noise has been shown to impact fish behavior in areas near an operating vessel, affecting availability to acoustic surveys and catchability to fishing gear. Underwater noise is also known to vary significantly among vessels. The amplitude and frequency of noise impacting fishes varies among species depending on their unique sound sensitives (Figure 6).

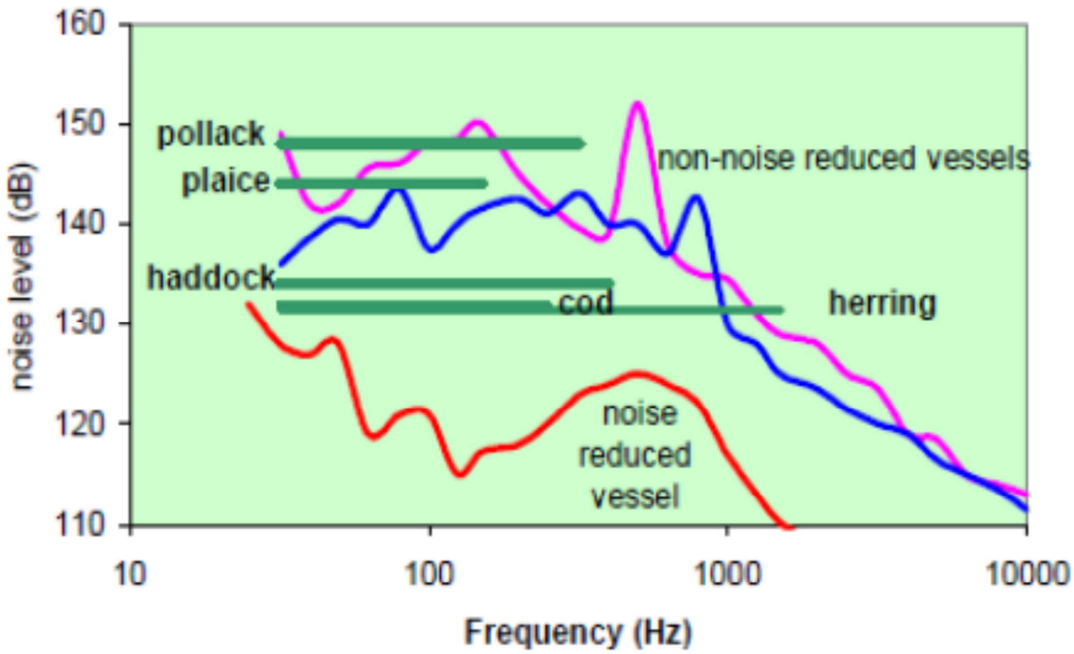

Figure 6. The reaction levels of five fish species in relation to frequency, and noise signatures of three research vessels (De Robertis et al. 2008).

In the early 1990s, scientists worked together internationally to produce recommendations for the construction of research vessel so as to reduce ship-avoidance bias in fishery surveys. This work culminated in a set of recommendations published by ICES (Mitson 1995) (Figure 7). These standards have been widely applied in subsequent research vessel builds around the world. In addition to reducing fish avoidance the move to these 'quiet' ships addresses concerns over the production of anthropogenic noise and improves shipboard habitability.

Results of several acoustic calibration surveys involving noise reduced and non-noise reduced vessels were reviewed (De Robertis et al. 2008; Ona et al. 2007). Although not many studies have been conducted to evaluate the effectiveness of a noise-reduced vessel in terms of reducing fish avoidance, consistent differences between vessels have been observed. Studies to date have been limited to vessel noise when not trawling. Findings indicate that the stimuli causing vessel avoidance and efficacy of noise-reduction in minimizing avoidance responses under survey conditions are complex and remain poorly understood. Consequently characterizing the underwater acoustic radiation signature of research vessels by itself is not enough to correct for vessel differences, comparisons of catchability such as those attained from calibration fishing exercises over a range of habitats and conditions will be required in order to use data series derived from old and new research vessels . However measuring underwater noise radiation remains an important step in ensuring survey consistency over time.

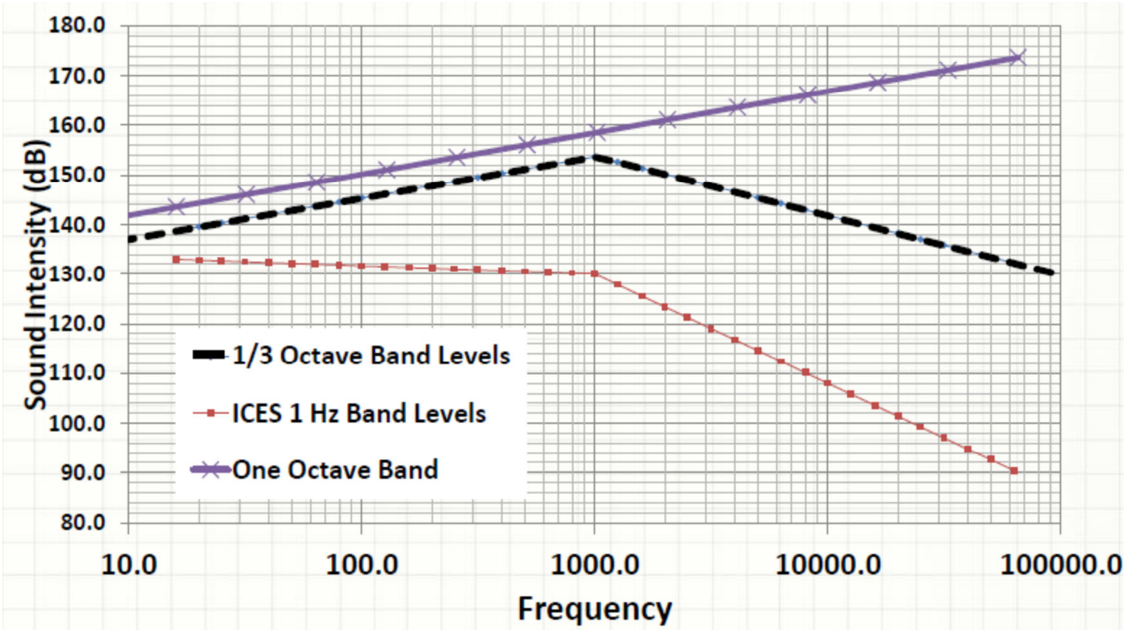

Figure 7. ICES design standards for radiated noise profiles for survey vessels constructed since the late 1990s.

Building quiet research vessels is more costly than standard design and requires a number of main elements including a quiet hull design, a diesel electric propulsion system with resilient mounts and a low noise, fixed pitch propeller. While the new OFSVs construction has not employed all the noise reduction specifications, most of the principles have been implemented and a noise consultant contracted to oversee this issue during the design process. For this reason it is anticipated that the new vessels will be significantly quieter than the older vessels, although the degree to which this objective has been achieved will not be known until the vessels are functioning.

Some measurements of radiated noise will be conducted by the shipyard prior to vessel delivery, but additional testing will be required upon delivery on all vessels. Past experience on the construction of noise reduced vessels in other countries has shown that even ships built with the same specifications can have differing noise signatures. For this reason it will be critical for science to ascertain the degree of similarity among our vessels as this will impact the amount of calibration fishing required, e.g. whether old vessels need to be compared with just one vessel or both. In addition, it has been documented that ship radiated noise levels can change over time (De Robertis et al. 2008; Harmia 2010); therefore it is important that the radiated noise profile of research vessels used for fish surveys is monitored at regular intervals over the life of the vessel.

The OFSV propulsion configuration differs significantly from our existing OFSVs. OFSV noise and vibration testing and trials to be done under vessel construction contracts (i.e., the measurement and analysis work is to be completed by the shipyard), which may or may not accurately reflect conditions encountered during trawl surveys. Monitoring of self and ambient noise (50-60 kHz band using hull-mounted hydrophone) can be used to detect changes in prop performance or resilient mount failure. More detailed underwater radiated noise measurement work is also to be completed by Science after CCG assumes vessel ownership. A portable vessel noise assessment system (suite of three hydrophones and mooring) could be used for this purpose. In this case the OFSVs could be routinely monitored (annually) for changes in noise signature over time. A system like this will not replace high-quality results from Navy sound testing ranges, but may ultimately provide a less costly way to characterize noise signatures in the field, and it would allow for the measurement of noise signatures while trawling, something which cannot be accomplished on Naval sound ranges. Further, it will only require a small amount of additional time during calibration and an initial investment in the hydrophone mooring set-up (approximately $60K). The mooring approach may also be useful in obtaining noise signatures where funds for more rigorous noise range tests are not available. For example, from vessels slated for decommissioning, as well as for chartered vessels employed opportunistically to survey fish stocks.

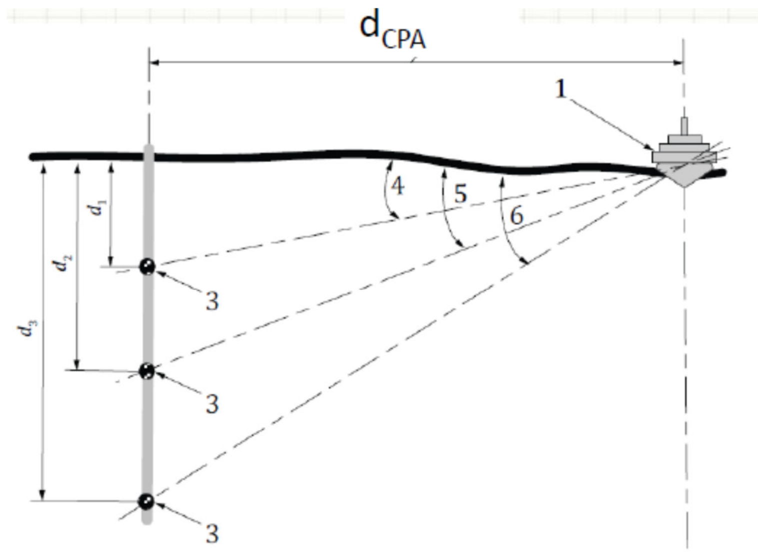

Figure 8. Design of noise signature assessment tool. dCPA is the distance at closest approach to the hydrophones. Hydrophones would then be at angles of 15°, 30° and 45° to the sea surface.

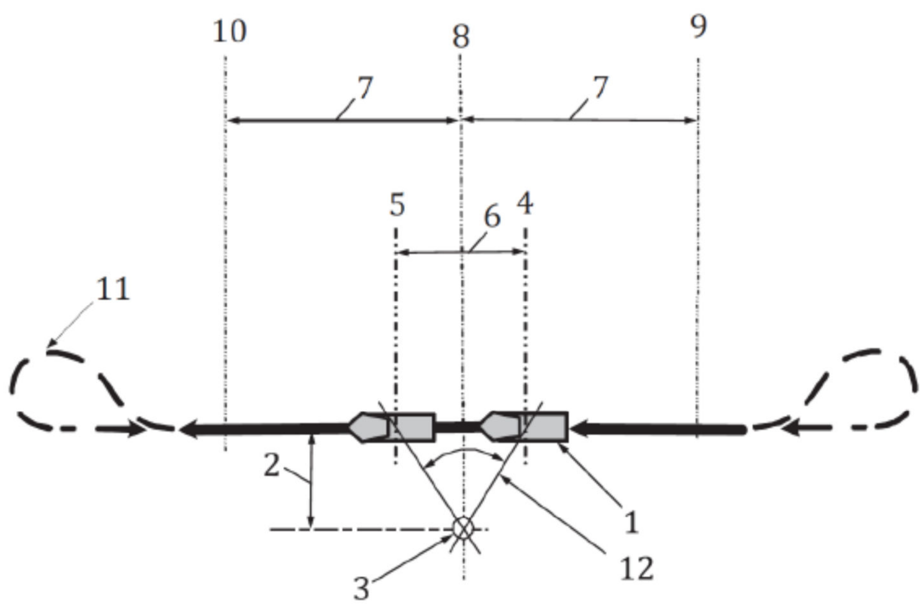

Figure 9. The measurement track to be followed during noise signature testing. Position (3) is the location of the hydrophones. Measurements would start at position (4) and end at position (5). The angle formed between positions (4) and (5), indicated by (12), represents roughly 30°.

In summary, noise levels of the OFSVs are expected to be considerably different from current platforms, and the noise levels may vary considerably between OFSV 1 and 2, and over time. Noise radiation measurements alone cannot be used directly to correct for vessel avoidance, this requires calibration fishing, but will be needed to determine comparability among OFSVs and to monitor noise level measurements over time (e.g., annually). For this purpose, it would be beneficial to develop the capacity to measure noise levels “in-house” as opposed to buying time from nearby Naval sound testing ranges. The new scientific sounder technology on the OFSVs (EK80 vs. EK60) will also require some calibration work in addition to the continuation of the annual calibration of acoustic instruments.

DAY 2

Comparative fishing for redfish species, Noel Cadigan, Fisheries and Marine Institute of Memorial University of Newfoundland

Calibration fishing between the CCGS Teleost and F/V Nautical Legend targeting redfish (*Sebastes* sp.) was conducted in 2015. Catch-conversion rates between the two vessels are necessary to produce a single, standardized survey index. The main objectives of the calibration fishing trial were: to complete as many sets as possible in the allotted survey time; and, to cover a range of depths and fish size distributions typical of the survey series. There were variations in gear (different net specifications) between the two vessels. Both vessels conducted standard tows of 15 minutes on bottom at 3.0 knots and used net monitoring systems to determine bottom contact and net mensuration specifications (door and/or wingspread). Paired tows were conducted side-by-side, with an offset distance of less than 0.5nm (or as close as safely possible). Vessels alternated port and starboard order and towed on the same course. Ideally, the midpoint of each vessel’s tow would correspond as closely in space and time as possible. On steep slopes, one vessel towed ahead of the other, with the choice of lead vessel alternating between tows. For steep slope tows, the end of the tow on the trailing vessel occurred at a position just before the start of the tow on the leading vessel. Overall, a total of 44 successful paired trawls were completed, where a successful set was defined as a minimum of 10 minutes on bottom and no gear damage that affected the catch.

A subsequent analysis of these data resulted in a model to estimate length-based survey gear conversion coefficients for redfish between the CCGS Teleost and F/V Nautical Legend. The underlying assumption of this work is that the stock densities fished by both vessels at each tow location were approximately the same (i.e., they varied only randomly). The model included measured tow distances and subsampling fractions. The details are described in an unpublished research document. The analysis used a generalized linear mixed-effects model (GLMM) with an offset for tow distances and subsampling fit using lmer() in R (R Project 2016). The main conclusion of this work was that, on average, the CCGS Teleost caught approximately twice as many redfish as the F/V Nautical Legend.

This work followed on a similar study completed in 2000 to assess relative catchability of redfish between the CCGS Teleost and the M/V Cape Beaver. This study obtained 24 successful paired trawls. The net configurations were considerably different between the two vessels, but otherwise, the study design was comparable to the one in 2015. The study concluded that there was no significant difference in overall catch rates, but there was a significant length effect resulting from the CCGS Teleost having caught more small fish, while the M/V Cape Beaver caught more large fish.

Overall, using a GLMM approach gave very reliable results over a wide range of spatial variations in densities and it is recommended for analysis of paired-tow survey calibration data (Cadigan and Dowden 2010). Researchers further concluded that the maximum likelihood method based on full-sample negative binomial (NB) distribution provides the best statistical inferences for the ratio of means when paired counts have NB distributions. However, when there is uncertainty about the type of Poisson over-dispersion present, then a binomial random effects model is a good choice (Cadigan and Bataineh 2012).

Using geostatistics to assess scales of spatial heterogeneity of catches, Luiz Mello, Newfoundland and Labrador

This study used a similar calibration fishing design (two vessels towing on parallel tracks at the safest minimum distance from each other) with a goal of minimizing the effects of small-scale spatial heterogeneity on catches. This work assumes that both vessels are sampling from the same distribution and that effects of small-scale heterogeneity in distribution patterns will be captured in the residual error structure of the estimation model. The underlying assumptions may be violated if separation distance between vessels is too large and/or there is “patchiness” in the distribution of the target species. The study used georeferenced catch rates from Campelen trawls in Newfoundland (1995-present), along with georeferenced acoustic density estimates from spring and fall multi-species surveys since 2008. The survey stratified tow locations by bathymetry, abundance/biomass, seafloor type, region, season, and possibly other factors; one caveat being the presence of spatial variability at distances smaller than the sampling interval (i.e. which are included in the nugget effect of the model).

Geostatistical techniques are used to describe and model spatial patterns (spatial autocorrelation); predict values at unmeasured locations (extrapolation/interpolation); and assess the uncertainty associated with predicted values at unmeasured locations.

This analysis had two objectives:

1. To examine patterns of spatial consistency of catches using geostatistical techniques (e.g., using a variogram); and
2. Infer the safe minimum operating distance of vessels conducting calibration fishing tows.

An overview of the derivation of an empirical semivariogram was provided (Figure 10). It depicts the spatial autocorrelation and directional variation of the measured sample points. It is an anisotropic model (i.e., the range differs with direction), where the major range is the distance at which the sill is attained along the major axis and the minor range is an approximate indicator of the maximum distance apart the vessels should operate in calibration tow experiments. Figure 11 provides an example of a 3D semivariogram model.

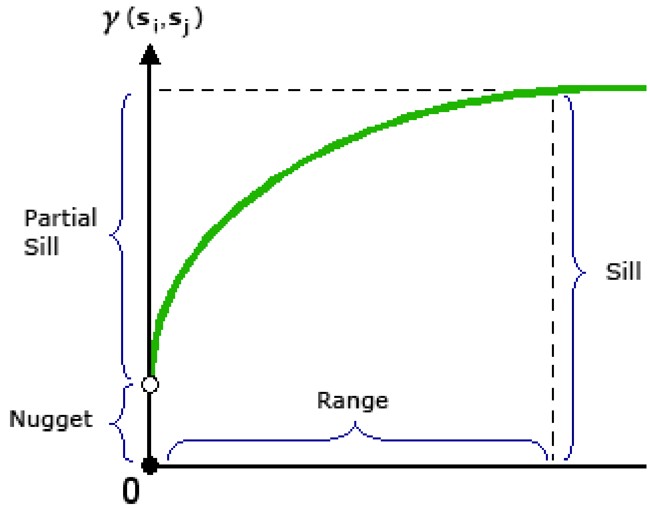

Figure 10. Basic illustration of range, sill and nugget components of a semivariogram model (which depicts the spatial autocorrelation of the measured sample points).

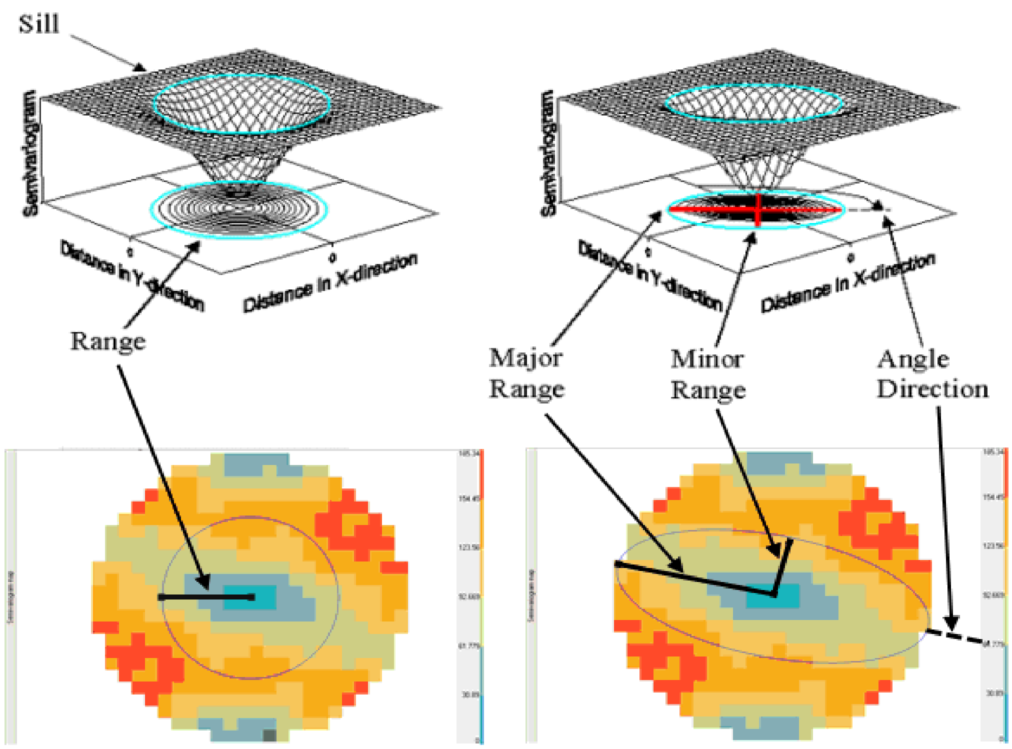

Figure 11. Visual representation of a 3D semivariogram model, depicting both major and minor ranges.

This work is still in progress and will be updated at future meetings.

Comparative Fishing Power, Alex Hanke, Maritimes

As an initial analytic assessment, it is necessary to determine if the fishing power of the two vessels being compared is similar when using the same gear. All things being equal, catches by each vessel should look like samples drawn from the same distribution. If not, it may be necessary to estimate inter-vessel calibration factors (also called the “catchability coefficient” or “q”. A summary of factors that can affect the “q” is provided in Figure 12.

A calibration fishing study was conducted between the CCGS Teleost and CCGS Alfred Needler on the Scotian Shelf and Georges Bank in 2005. Both vessels used the same net design, towed roughly 0.5nm apart for 30 minutes at 3.5knots, alternating their port-starboard order. For shelf-edge tows, the vessels used non-overlapping tracks with one vessel leading. The tows targeted a range of species including cod, haddock, pollock, white hake, silver hake, herring, dogfish, plaice, and redfish. In the end, 66 paired tows were obtained.

Four statistical tests were applied to the resulting data: Parametric bootstrap, Permutation test, Bootstrap Kolmogorov-Smirnov, and Kernel approach. The analyses retained all zero catches and large values, but did not consider catch at size (though methods could be adapted to include it). Further, these methods assume catches are independent samples from the same underlying distribution, but they do not account for the paired nature of the calibration fishing data.

Parametric Bootstrap: A Tweedie model was fit to the catch data from the CCGS Teleost. The Tweedie distribution has a point mass at zero followed by exponential growth. Five hundred bootstrap samples of 66 were drawn with replacement from the fitted cumulative density function (cdf). A 95% distribution-free prediction interval was estimated using nonlinear quantile regression, and this was compared with the empirical cdf (ecdf) of each of the vessels.

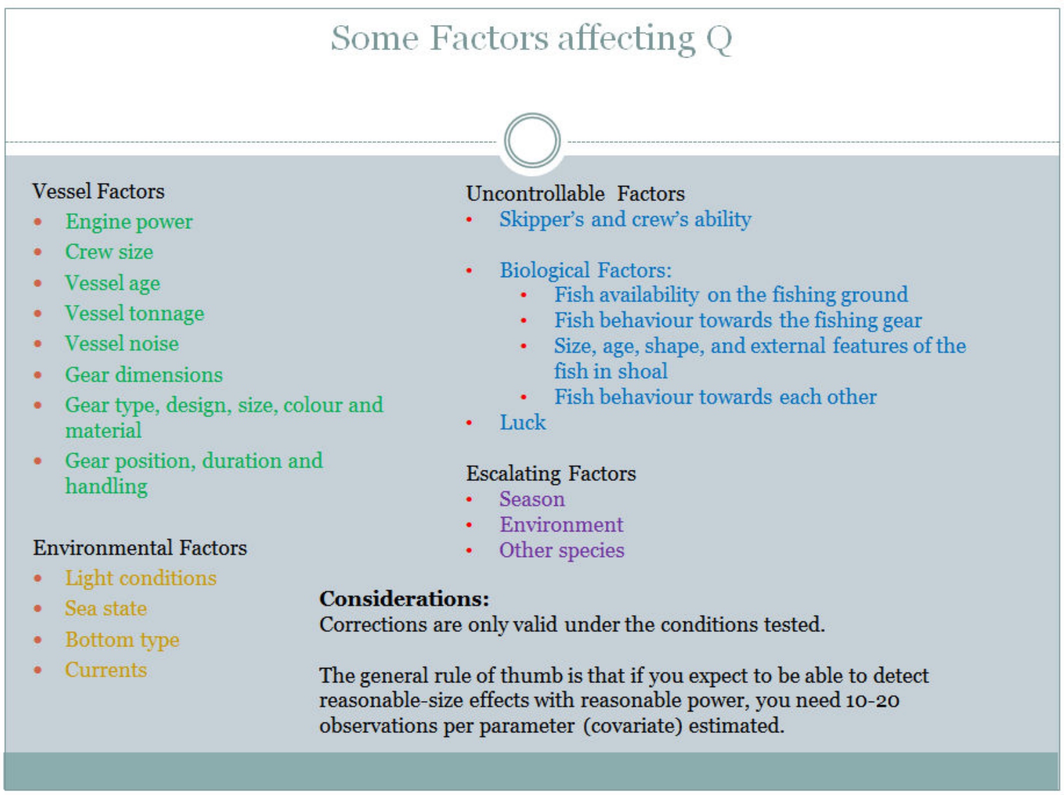

Figure 12. Overview of factors that can affect relative catchability, denoted by the coefficient "q".

Permutation Test: Tests whether the observed total difference in catch is significantly different than zero? Compare the observed difference to a permutation distribution by Resampling without replacement from the combined data and recalculating the sum of the differences.

Bootstrap Kolmogorov-Smirnov: Are the catch probability densities for both the CCGS Needler and CCGS Teleost the same? Two thousand bootstrap samples taken. This sampling provides correct coverage even when the distributions being compared are not entirely continuous. This test is sensitive to differences in both location and shape of the ecdf of the two samples.

Kernel Approach: Are the catch samples drawn from the same distribution? The difference between the mean function values on the two samples was calculated (i.e., the maximum mean discrepancy; MMD). When MMD is large, the samples are likely from different distributions.

A set-wise comparison plot (CCGS Needler catch on the x-axis and CCGS Teleost catch on the y-axis) was also shown for each species caught.

In conclusion, differences in the catch ecdfs were too small to reject the null hypothesis (i.e., there was no evidence to support a difference between vessels). Large discrepancies in catch were rare and occurred when fish density was high (though it is unclear why this was the case). Ultimately, in this study it was determined that the CCGS Teleost and CCGS Needler sampled the available biomass similarly. However, this conclusion may have resulted from a lack of statistical power given that the analyses did not account for the paired nature of the data. Methods that explicitly account for such data also account for an important source of catch variability resulting from mid to large scale variation in fish densities. Such methods are very likely to have greater statistical power.

Analytical models for paired gear data at the Northeast Fisheries Science Center (NEFSC), Timothy J. Miller, NOAA

The proposed methods to analyze the paired tow data from this study evolved over time. Initially, beta-binomial models were proposed for the analysis. These models were applied to aggregate catches (numbers) and a subsequent independent peer-review of the proposed method determined this approach was suitable if there were greater than 30 stations with catches by both vessels; otherwise, a designed-based ratio estimator was to be used. Based on this approach, estimates were generated for over 300 species captured in the paired tow stations (Miller et al. 2010). Some species had estimates by season (spring, fall) and biomass calibration factors also estimated. Preliminary investigations of changes with size were also conducted. These investigations showed that size effects seemed to be important for many species, and as such, size effects were incorporated into some benchmark assessments and Transboundary Resource Assessment Committee (TRAC) assessments (i.e., for species such as Cod, haddock, and yellowtail flounder stocks in the Atlantic jointly managed by Canada and US).

The analysis has now moved to using Generalized Additive Mixed-effects models (GAMMs) to estimate calibration factors. This approach compares the fit of a set of models with different assumptions about the effects on calibration factors and the nature of the underlying variability within and between pairs. Miller (2013) applied this method to 16 assessed species, and it is also being used for some other NEFSC assessed stocks. Currently, the analysis is being expanded for an ongoing Canadian dogfish benchmark assessment (using NEFSC bottom trawl survey data). It is also being used for an analysis to compare commercial scallop dredge gears (Virginia Institute of Marine Science) and most recently, to analyze size and diel effects on relative efficiency of the R/V Henry B. Bigelow with rockhopper gear and chain sweeps. Data required for this analysis includes: the swept areas (or volumes) of the two gears; the subsampling fractions of the two gears for measurements/counts; recorded numbers- at-size in subsamples of the two gears; and, any other covariates that may be thought to affect relative catch efficiency.

SUMMARY OF DISCUSSIONS

For the last part of Day 1, participants were divided into 5 discussion groups and tasked with an agenda building exercise to help shape discussions on Day 2:

Part A. Analytics Sub-Group Agenda

1. Identify a key issue for consideration.
2. Identify probing questions to guide discussions on that issue.
3. Repeat for other key issues.
4. Identify out-of-scope issues.

Part B. Logistics Sub-Group Agenda

1. Identify a scenario to explore.
2. Identify probing questions to guide discussions on that scenario.
3. Repeat for other scenarios.
4. Identify out-of-scope issues.

On Day 2, participants divided into the two sub-groups (logistics and analytics) to discuss the main points identified at the end of Day 1 (and summarized by the facilitator prior to the start of the second day) in more detail. Their findings were then reported at the start of Day 3.

LOGISTICS SUB-GROUP SUMMARY

1. Scheduling scenarios for all three vessels were established based on windows of acceptance as of November 29, 2017 (Table 3).

Table 3. Windows of vessel acceptance, based on current delivery schedule (November 29, 2017).

Vessel	Windows of Vessel Acceptance
OFSV#1 (CCGS Sir John Franklin)	“Fall 2018” (Aug 31 – Dec 3, 2018)
OFSV#2	April 30 – Sep 2, 2019
OFSV#3	“Fall 2019” (Aug 30 – Dec 3, 2019)

2. Key challenges with each of the scenarios were identified along with possible mitigating steps (Table 4).

Table 4. Challenges identified by the Logistics Group on workshop Day 2, along with possible mitigating steps.

	Challenge	Mitigating Steps/Considerations
1.	Synchronizing survey schedules with CCG crew change dates.	
2.	Shifting survey timing to avoid overlaps between regions.	Consider increasing survey duration to obtain required number of calibration tows.
3.	Ensure sufficient and qualified CCG crew.	- 3 vessels = 6 crews - 24h/day ops; contingency: 12h/day fishing ops - CG recruitment strategy
4.	Ensure sufficient and qualified Science staff.	- Region-dependent - Draw staff from other regions and programs - Use students and casual term appointments (observers)

	Challenge	Mitigating Steps/Considerations
5.	Keeping 3 vessels operational for 12 months of calibration fishing.	- Complete a condition survey of the CCGS Needler to determine what is needed to sustain it through to Aug 1/2020 - CCGS Needler dry-dock Jan-Mar/2018 - Ensure winter 2019/2020 prepares CCGS Needler for 2020 calibration work (Feb-Aug/2020)
6.	Ensure sufficient gear.	Carry out an inventory to identify gaps with respect to program needs.
7.	Costs	- Keeping the CCGS Needler operational to Aug 2020 - Increased operating costs of new vessels - Additional Science staff and CCG crew - Overtime for Science staff - Possible gear costs

ANALYTICS SUB-GROUP SUMMARY

This sub-group began their session with presentations from 4 analytics specialists. These presentations are summarized in a previous section of this report. The group then addressed the 9 calibration fishing topics relating to analytic requirements in further detail.

Table 5. Findings of the analytics sub-group. Shaded rows were discussed in greater detail.

Component – Description	Risk Profile [Likely impact of failing to provide accurate and precise calibration factors]	Risk Mitigation
1. How many sets? - Survey-specific; determined by relative catchability of target species.	A data set with 20-50 paired sets presents a moderate risk of not being able to derive an aggregated, species-specific conversion factor. If additional factors must be considered for stratification (e.g. age, length, diel impacts), the number of required sets increases, with 20 – 50 sets required for each age/length strata, etc.	ACTION ITEM: regional programs to work together to prioritize surveys. No upper limit on the number of sets. Need to get “as many as possible” to ensure conversion factors can be derived. ACTION ITEM: conduct a meta-analysis using data from existing calibration studies; vary sample sizes (n= 10 to 100) to see how results change Impact of vessel noise is not clear-cut (vessel noise vs. size vs. pressure wave, etc.); the group considered focusing calibration fishing activities on larger bodied species, but this was determined not advisable.

Component – Description	Risk Profile [Likely impact of failing to provide accurate and precise calibration factors]	Risk Mitigation
2. Targeted vs. Paired sets - For which species do you optimize the design? - What are the trade-offs? - [FOR FUTURE CONSIDERATION: How far apart/close together do TARGETED pairs need to be to ensure contrasts in catch + independence?]	The group identified paired fishing sets according to the regular survey design as the preferred option for calibration experiments. This approach was termed 'shadow surveys'[1] and was considered advantageous because the design accounts for factors that are known to affect catchability such as depth, habitat and time or day. Resulting calibration coefficients account for this variability and will therefore most accurately reflect the overall differences in relative catchability between vessels. Higher risk species (i.e., rare species) will require more targeted sets (i.e., may not be sufficiently sampled by random 'shadow survey'[1] tows) ASSUMPTIONS: - Due to logistic constraints of operating 2 vessels, "shadow survey" effort may be reduced, (e.g., survey timing –if sampling is reduced to daytime only (from 24h), or due to crewing issues, etc. - may not get regular catch indices from shadow surveys if effort is <50% of regular survey effort (ways to be mitigated are region-specific) - min. 1 set per strata (rather than usual min. of 2); aggregate strata, if needed? Risk: not getting sufficient samples to give reliable estimates of relative catchability. Will need to determine degree to which realized survey matches designed survey. Use as rationale for 2nd year of calibration fishing, if necessary.	Baseline: 'shadow survey'[1] is the preferred approach Enhanced survey design/time permitting: targeted paired fishing for specific species is anticipated for spatially-restricted species ACTION ITEM: need to identify which species would need targeted sampling – known species assemblages can inform this work; <u>retrospective analysis</u>: anticipated sample size based on average results from recent surveys, used to develop risk prioritization matrix. Identifying priority species for targeted paired fishing will be a challenge given that the relative value of information for different species can be difficult to assess. It is not clear how one choses, for example, between commercially important, ecologically important, depleted and at-risk species.

[1] "Shadow surveys" are comparative paired-tow fishing experiments that are conducted following the survey stratified-random designs for the selection of sampling sites. The tow pairs can include side-by-side and follow-the-leader configurations, where port-starboard orientation or lead vessel is selected randomly.

Component – Description	Risk Profile [Likely impact of failing to provide accurate and precise calibration factors]	Risk Mitigation
3. Optimal distance between paired vessels	[NOT DISCUSSED]	[NOT DISCUSSED]
4. Spatial pairing: site vs. strata [Related to Item 2]	Accounting for spatial variation in fish densities is critical for ensuring the accuracy and high precision of calibration factors. This accounting can be accomplished via the survey/experimental design and/or during analysis. Spatially paired sets best account for spatial variation in density, though there is also some accounting at the stratum level. The question is, should the design be strictly restricted to paired sets?	With 100% coverage, use a combination of “pairs” and “random w/in strata” (RWIS) sampling to test for differences. In some instances there will be a need to break off calibration fishing (e.g., SAR call or vessel break-down). ACTION ITEM: Need strategy for dealing with vessel break-down. Vessel to re-join survey vessel directly to continue paired tows? Or complete missed tows (to contribute to RWIS analysis)? Need objective methods to validate “good” paired tows with respect to performance (e.g. use of acoustics?); Use of random mixed effects modeling approaches (as per Cadigan et al.); Future Work: Consider how uncertainties are propagated through time series (more work required, may not be important).
5. Data resolution: sampling design consideration - Different needs for data-rich vs. data-poor species? - Will impact number of sets	Vessels that sub-sample differently may introduce errors that are confounded with vessel differences.	Both vessels must use same catch sampling protocol (particularly sub-sampling). End goal: biological samples are as comparable between vessels as possible (through standardization and randomization)
6. Estimates of relative catchability (‘q’ coefficients) are robust to nuisance factors (season, environmental, technical)	The more the survey deviates from the original survey design, the higher the risk of not being robust to nuisance factors.	In principle, the shadow survey design is robust to these factors; it will be important to quantify as many factors as possible (design considerations – relative vessel position, bottom type, weather, use of auto-trawl, etc.)

Component – Description	Risk Profile **[Likely impact of failing to provide accurate and precise calibration factors]**	Risk Mitigation
		Documentation is key. It is important to note that differences in fishing efficiency are not limited to differences between vessels. Ultimately the calibration experiments are comparing survey protocols, which includes the vessels, the crew and how they operate the gear, etc.
7. Borrowing info from other surveys - Meta-analysis of relative change/magnitude of change among vessels - Use as priors in modelling analyses	In the absence of CF data, some information is better than no information. However these approaches are associated with high risk and high uncertainty. In the absence of CF, there is a real risk of needing to re-start the time series from the beginning.	NEED (ALL REGIONS): **Increased analytical capacity** (Meta-analysis, quantifying uncertainty, retrospective analyses) Coordination/standardization of effort across regions/ surveys; data/methods sharing agreements (Working Group/National Peer Review) Analysis of CF data will require human, financial and material resources (and time).
8. In the absence of direct CF, other surveys or commercial fishery catch rates could be used as calibration "standard" in an indirect estimation of relative catchability.	High risk, high uncertainty Fishery dependent data cannot be used for some species because of constraints on fisher behaviour (note, maybe suitable for shrimp trawl data?) Historical data for hake can be used for retrospective analyses. Greater variability in past two years (Pacific region) is confounded with vessel/ environment factors.	Use common charter vessel to provide indirect calibration. This work is critical for linking Ricker – Franklin time series. (Assumes that Ricker/charter data is comparable → this needs to be tested); likely limited to small number of commercially important species (another risk) Methods have been developed for calibrating surveys in the absence of direct CF, e.g., VAST R-package (J. Thorson): https://github.com/James-Thorson/VAST
9. Modelling approaches for calibration in the absence of direct CF; (time series approaches) Example: with long-lived species (e.g., some	Moderate risk, moderate uncertainty: assumes age-related mortality does not change over time. Likely need 20-30 cohorts per species for the approach to work	Need (PAC): increased capacity for ageing data (samples collected but not processed)

Component – Description	Risk Profile [Likely impact of failing to provide accurate and precise calibration factors]	Risk Mitigation
groundfish species), can track age cohorts (to calibrate charter to Ricker, then calibrate charter to Franklyn)	(Ricker cohorts vs. charter cohorts).	

CONCLUSIONS

The workshop concluded with participants agreeing to a set of key principles to guide calibration trawl studies in both Atlantic and Pacific regions:

1. Calibration fishing presents an acute, complex and expensive challenge for fisheries scientists on both coasts. However, if properly resourced and executed, it is a sound investment over the 30-40-year lifespan of the OFSVs. For example, uncalibrated survey time series that appear to show a dramatic decline in abundance have led in the past to ill-informed SARA listings and missed harvest-- the costs which quickly outweigh the direct costs of calibration fishing. Further, in the face of increasing environmental variability due to climate change, it is even more important to assess and attempt to understand variability associated with changes in survey design and/or execution.
2. All species which are currently being recorded during the surveys will need conversion factors. The number of sets to allocate by stratum during calibration fishing should be planned to ensure sufficient data are available for as broad a range of taxa as possible.
3. Calibration fishing is the international standard in developed countries for calibrating catches and integrating pre-existing/current time-series with new time series. Calibration work must be conducted throughout the standard range of the survey to ensure conversion factors are applicable over the range of conditions where they will be applied. The "Shadow survey"[2] design is the preferred experimental design option for calibration fishing.
4. Trawl catch rates vary significantly among research vessels. These differences result from two main sources: vessel specific noise signatures which impact vessel avoidance by fish and vessel specific trawl performance differences due to differences in vessel power, winch power and trawling systems. The OFSVs incorporate significant changes in both of these areas. Unlike the current vessels, they are designed as noise reduced vessels, they are also more powerful than the CCGS Alfred Needler and they will utilise an Autotrawl system (versus a fixed-length trawl warp system), which is currently only employed on the CCGS Teleost.
5. Methods for calibrating some Pacific region time series exist, but all are associated with higher uncertainty, and will be limited to a few commercially important species. Notwithstanding, calibration fishing is critical and will be required to ensure scientific validity of the combined data time series (i.e., in order to ensure Science can continue to use the many long-standing data time-series collected over many decades and to preserve the significant investments of departmental resources that went into acquiring these data).

[2] "Shadow surveys" are comparative paired-tow fishing experiments that are conducted following the survey stratified-random designs for the selection of sampling sites. The tow pairs can include side-by-side and follow-the-leader configurations, where port-starboard orientation or lead vessel is selected randomly.

6. Detailed and standardized sampling protocols are required to minimize potential impacts of bias and controllable sources of variability (particularly for surveys spanning multiple regions and crews). Historical fishing protocols must remain unchanged on existing platforms for the duration of calibration fishing surveys (otherwise, these changes will be confounded with the change in vessel).
7. Comparison of noise signatures between OFSV#2 and OFSV#3 must be conducted as soon as possible to determine whether they can be used interchangeably during calibration fishing studies.
8. Retrospective analyses of existing survey data are required immediately to identify instances where there are risks of obtaining insufficient calibration fishing data for particular species across regular surveys. In cases where insufficient data exists, directed calibration fishing protocols may be required.
9. Timeliness and robustness of analyses will require dedicated (additional) analytics staff to provide consistency across zones, both in advance of and following calibration fishing activities. For post-calibration fishing analytical work, additional resources will be required (i.e. staff, money for increased sample and data analyses, and time).
10. Communication of the risks associated with the transition to new vessels to client groups must occur, including the likelihood that data may not be available for some assessments and regular Fisheries Management deadlines, given the time required for analyses and review. Calibration fishing studies cannot begin until sufficient prior trial tows have been carried out to ensure vessel, gear, CG crew, and Science staff are fully operational, coordinated, and prepared to conduct the required calibration fishing studies (i.e. the “shake-down” period is complete).
11. All East coast vessels (OFSV #2 and #3, CCGS Needler, and the CCGS Teleost) need to be operational through 2020. Based on the current delivery schedule for the new vessels, the CCGS Needler, which conducts the bulk of the Atlantic Zone trawling, must remain operational until August 2020. Further delays in the delivery of OFSV #2 and #3 or delays in their preparation for operation once delivered, will require revisiting this requirement.
12. The East coast Science programs will need three fully-staffed vessels (two with fishing capacity, one for the Atlantic Zone Monitoring Program oceanographic survey), plus one vessel in warm lay-up (for the first six months of 2020), based on the current delivery schedule for OFSV #2 and #3.
13. DFO Science – Pacific Region will require a fully operational OFSV, as well as necessary resources and staff for chartering former Ricker replacement vessels as needed.
14. Additional resources are required to ensure sufficient and qualified CCG crew and Science staff to carry out the calibration fishing surveys. This will likely require innovative recruitment strategies (e.g. inter-change programs, international resources, other regions, and retired staff) to fulfill this need.
15. Additional financial and material resources are required to complete calibration fishing-related work (e.g., hydrophones, Scanmar sensors, fishing gear). In particular, consideration should be given to making improvements/changes to the survey trawl design to remedy problem areas (e.g. differences to net or footgear that contribute to frequency of tear-ups and repairs) on the new vessel prior to initiating calibration work (i.e., so that any effect from these changes is included in the “calibration” effect). Also, it is important that both vessels (old and new) use bottom contact sensors during calibration tows.

16. A national working group and additional financial and material resources to establish and maintain its operations are imperative to adhere to these Key Principles, and to provide ongoing calibration fishing guidance through 2022.

ACTION ITEMS

The following action items were identified at the end of the workshop. These items were provided to the Regional Directors of Science after the workshop for discussion at their next joint meeting.

1. Establish Calibration Fishing Working Group (CFWG) and schedule first meeting in Feb 2018.
    - CCG/Science to identify members for CFWG.
    - Establish budget for CFWG to cover FY2017/18 – FY2021/22. Assume monthly virtual meetings, and up to three times per year in-person (as needed).
    - Initial draft of CFWG membership, governance and objectives were agreed upon at the workshop (see Appendix D).
2. Prepare high level overview of Scenarios for presentation to Science Executive Committee (SEC) Operations Meeting [Dec 6, 2017; Don Clark]
3. Prepare briefing note from Science to CG regarding plans for calibration fishing and support needed for the CCGS Needler and CCGS Teleost, in light of further OFSV delivery delays. [Dec 6, 2017; Jennifer Vollrath, informed by Don Clark's high-level overview and Mary Thiess' draft of the workshop proceedings]
4. Draft and circulate Workshop Proceedings to participants. [Dec 31, 2017; Mary Thiess] To be finalized and published by Jan 31, 2018. This will provide the basis for building first agenda of CFWG.
5. Compile and summarize workshop participant evaluations for inclusion in workshop proceedings. [Dec 1; Peter Abrams]

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APPENDICES

APPENDIX A. AGENDA

November 28

Time	Agenda Item
8:30 am	Arrival and informal greetings
Introductions and overview	
9:00	Welcome and overview of our workshop
Context setting	
9:45	Overview of trawl vessel comparison studies Don Clark, Chief Scientist, Atlantic Region
10:00	History of trawl vessel comparison studies, and key issues for the current vessel transition: Atlantic region perspective Don Clark, Chief Scientist, Atlantic Region
10:15	History of trawl vessel comparison studies, and key issues for the current vessel transition: Pacific region perspective Ken Fong, Chief Scientist, Pacific Region
10:30	**Break**
10:45	Previous trawl vessel comparison studies: lessons learned and applications Tim Miller, Research Fishery Biologist, Northeast Fisheries Science Center, NOAA Noel Cadigan, Research Scientist, Marine Institute of Memorial University of Newfoundland
11:30	Coast Guard logistics support: scheduling and crewing parameters, and possible contingencies Cyndi Byatt, CCG Superintendent – Operations, Maritimes Darcene Thirkell, CCG Superintendent – Operations, Pacific
11:45	Discussion and scoping of issues
12:15pm	**Lunch (nearby restaurants or cafés)**
Overview of two factors influencing vessel comparison studies	
1:15	Introduction to gear performance analysis Truong Nguyen, Research Biologist/Analyst, Newfoundland
1:45	Introduction to vessel noise signature issues Fran Mowbray (for Jinshan Xu), Research Biologist/Chief Scientist, Newfoundland
2:15	**Break**
Identifying analytics and logistics scenarios	
2:35	Identify analytics and logistics scenarios to be examined on Day 2 (table groups)
3:30	Confirm scenarios (large group)
4:15	Announcements and check-out
4:45	**Adjourn**

November 29

Time	Agenda Item
8:30 am	Arrival and informal greetings
Overview	
9:00	Welcome and overview of day
Analytics and logistics scenarios	
9:30	Overview of process for analytics and logistics discussions Hugues Benoit, Chief Scientist/Analyst, Gulf Mary Thiess, Comparative Studies Coordinator, Pacific
9:45	Group A discussions: Analytics issues Group B discussions: Logistics scenarios
11:30	Group A: continue Analytics discussion Group B: Prepare logistics summary presentation for Day 3
12:00pm	**Lunch (nearby restaurants or cafés)**
1:00	Group A discussions: Analytic issues
3:30	Prepare analytics summary presentation for Day 3
4:00	**Adjourn**

November 30

Time	Agenda Item
8:30 am	Arrival and informal greetings
Overview	
9:00	Welcome and overview of our day
Refine Analytic and Logistic results	
9:30	Summary Day 2 Analytics results Summary Day 2 Logistics results
10:00	Refine analytics and logistics results, and clarifying linkages among them
12:00pm	**Lunch (nearby restaurants or cafés)**
Next steps	
1:00	Workshop summary report preparation and timeline Additional follow-up items
2:00	Wrap up, checkout, and evaluations
3:00	**Adjourn**

APPENDIX B. PARTICIPANTS

First Name	Last Name	Region/Affiliation
Peter	Abrams	Facilitator
Irene	Andrushchenko	MAR, Science/Analyst
Keith	Bartlett	MAR, CCG/FM
Hugues	Benoit	GULF, Science/CS/Analyst
Doug	Bliss	GULF, RDS
Jennifer	Boldt	PAC, Science/CS/Analyst
Hugo	Bourdages	GULF, Science/CS/Analyst
Paul	Burton	NHQ, CCG/Ops
Cyndi	Byatt	MAR, CCG/Ops
Noel	Cadigan	SME, Fisheries & Marine Institute, Memorial University of Nfld
Donald	Clark	MAR, Science/CS/Analyst
Andrew	Edwards	PAC, Science/Analyst
Tim	Fleming	NHQ, CCG/Vessel Procurement
Linnea	Flostrand	PAC, Science/CS/Analyst
Ken	Fong	PAC, Science/CS/Analyst
Stephane	Gauthier	PAC, Science/CS/Analyst
Chris	Grandin	PAC, Science/CS/Analyst
Alex	Hanke	MAR, SME
Jackie	King	PAC, Science/CS/Analyst
Keith	Levesque	NHQ, Science/Planning
Bennett	Light	PAC, CCG/Ops
Carmel	Lowe	PAC, RDS
Barry	McCallum	NFLD, RDS
Joanne	McNish	PAC, Regional Fleet Director
Luiz	Mello	NFLD, Science/CS
Tim	Miller	SME, NOAA - Northeast Fisheries Science Center
Alan	Mohr	PAC, CCG/Ops
Fran	Mowbray	NFLD, Science/CS
Chrys	Neville	PAC, Science/CS
Truong	Nguyen	NFLD, Science/Analyst
Glenn	Ormiston	PAC, CCG/CO
Pierre	Pepin	NFLD, Science/CS
Catriona	Regnier-McKellar	MAR, Science/CS
Manuel	Rowswell	MAR, CCG/CO
Carolyn	Self	NHQ, CCG/Ops
Katherine	Skanes	NFLD, Science/CS/Analyst
Doug	Swain	GULF, Science/Analyst
Mary	Thiess	PAC, Science/Workshop Coordinator
Darcene	Thirkell	PAC, CCG/Ops
Strahan	Tucker	PAC, Science/CS/Analyst

First Name	Last Name	Region/Affiliation
Jennifer	Vollrath	NHQ, Science/Planning
Steve	Walsh	NFLD, Science/Analyst (Scientist emeritus, NAFC)
Brian	West	PAC, CCG/FM
Laura	Wheeland	NFLD, Science/CS
Malcolm	Wyeth	PAC, Science/CS
Al	Young	PAC, CCG/CO
Tyler	Zubkowski	PAC, Science/CS

Regions	Affiliations
GULF = Gulf Regions, North & South	CCG = Canadian Coast Guard
MAR = Maritimes Region	CO = Chief Officer
NFLD = Newfoundland & Labrador Region	CS = Chief Scientist
NHQ = National Headquarters	FM = Fishing Master
PAC = Pacific Region	Ops = Operations
	RDS = Regional Director, Science
	SME = Subject Matter Expert

APPENDIX C. PARTICIPANT EVALUATION RESULTS

Participant Evaluation results

OFSV Trawl Vessel Comparison Study Design Workshop - Nov 28 - 30, 2017

Evaluation response rate and average overall rating of Workshop

Number of evaluations	% of average # of participants	Average overall rating of Workshop *1 (poor) – 5 (excellent)*	Range
26	75% (26 out of 35)	4.5	4 - 5

Comments on the Workshop overall

- Top marks for organization, staying on track, and prioritizing (3)
- Great leadership: kept us on topic to make effective use of time (2)
- Very productive, well-structured, and informative (2)
- Well organized – great to have a professional facilitator
- A highlight was frank but positive discussion between Coast Guard and Science
- Team spirit took little time to develop
- Great variety of experience in the group
- Looks like we're pointed in the right direction.

Responses to remaining questions

Following are the remaining evaluation questions and participants' responses. Similar responses are grouped and their total number indicated in brackets. Comments are ordered by number of similar responses, where applicable.

2. Do you think we achieved our goal and objectives?

Yes: 26 people: 100%

Comments:

- We've created a great framework with meaningful, new objectives moving forward (4)
- The workshop did a great job of solidifying the important objectives and work to be done going forward (3)
- Framework is well-structured, and the need is well-rationalized (2)
- Buy-in achieved (2)
- We have both operational plans and plans to brief senior management to gain support
- Alternate comparative fishing scenarios were developed by Science and Coast Guard
- Exceeded my expectations.

3. Please give your assessment of these elements of our session:

(1) Poor (2) Satisfactory (3) Very good (4) Excellent

Organization of session	3.7	3 - 4
Effectiveness of Large group facilitator in guiding discussions and our workshop process	3.6	3 - 4
Quality of venue	3.5	3 - 4

Comments

- I dislike round tables/did not like the seating arrangements (3)
- Providing coffee/tea would have created enhanced opportunities for discussions (2)
- The set up of the analytics group didn't always permit input from everyone
- Structure and coaching were good; sometimes there wasn't enough time for discussion.
- Overall well facilitated, but some areas could have been improved in terms of keeping people on task to improve efficiency
- The facilitator did a good job in keeping us on track
- Especially pleased with the last-minute reorganization of the 2nd day: very productive work
- Acoustics bad at times during group discussions
- The room temperature was variable.

4. What was the most valuable part of our workshop; what made this worthwhile for you?

- Both Coast Guard and Science working together to achieve workshop objectives (8)
- Organized and focused on deliverables (2)
- Separate groups/sessions for analytics and logistics (2)
- Overall value: general understanding of how Science and Coast Guard can work together
- Gathering engaged people for Coast Guard and Science sectors, with a diversity of experience, knowledge, and responsibility
- Hearing difference perspectives, and creative problem solving
- Having Science management present
- Day 3: great and amazed to see this all come together
- The summary session was great in making sure everyone left with the same conclusions
- Day 1 overview of all necessary elements
- Well guided discussions; effort was made to say on topic
- Coming up with potentially realistic solutions to challenges ahead
- Logistical issues, e.g. from Coast Guard perspective
- Group discussion to fill in prepared table of concepts
- Comparative Fishing role for future
- Possibility of work after retirement.

5. What was the least valuable part, and how might we improve upon this?

- Morning of Day 3: Sum up of break-out groups (3)
- Instead of Day 3 breakout group summaries, distribute key points from groups at end of Day 2 to inform other groups
- Not all participants needed to be involved in all segments. Sub-committees work well
- The presentations on Day 2 did not support the agenda
- Some presentations did not seem as relevant
- Too often some discussions got caught in the weeds
- Sometimes presentations were rushed with not enough time for questions
- The Day 1 table groups to build Day 2 agenda was a bit redundant. I think we could have come up with lists without breaking out.
- Listening to other regions issues.

6. What did we miss that still needs to be addressed?

- More in-depth analytical discussion, but probably premature, and would take longer (2)
- Representatives from management
- Sub-group structure of the Working Group
- We have a good Plan A, but we may want to think of possible contingencies
- Chocolate.

7. Additional comments and observations

- Great workshop. Much appreciate your hard work and effort in helping the group achieve its objectives
- Thanks for the effort put in by organizing committee for great job: Mary, Don, Doug, Hugues, and Peter
- Huge undertaking. Great start to the road ahead. Need to continue to work together (Coast Guard and EOS)
- Excellent facilitation and organization. Thanks!
- Raising hands would have allowed more people to participate: the same 3 or 4 people dominated discussions
- Do not allow the pressure of keeping vessels operational ever become more of a focus than safety of vessel, crew, science, environment
- Hoping there are dollars to carry out the surveys
- Well done, thanks!

APPENDIX D. CALIBRATION FISHING WORKING GROUP (CFWG)

Governance:
1. ACTION ITEM: Establish reporting structure to clarify oversight of CFWG and to effectively communicate CFWG products to management of Science, Coast Guard and client groups (e.g., Fisheries Management). This item was identified for discussion at the December 2017 National SEC Operations meeting.

2. ACTION ITEM: Draft Terms of Reference (TOR) for the CFWG at the first meeting (Feb 2018). The TOR needs to include roles, responsibilities, scope of decision-making, and accountabilities.

Membership:
Membership of the CFWG is to be comprised of:

1. Science – two members per region (MAR, NFLD, GULF, QUE, PAC)
    - NHQ [Jennifer Vollrath, plus one alternate]
    - external advisors and reviewers
    - internal SMEs as needed (e.g., analysts, IT support)
2. Coast Guard – to cover scheduling, crewing, etc. (2 members Atlantic, 2 members Pacific); 1 NHQ [John Armstrong, Manager of Ship Operational Service Delivery]
3. “For information” group: EMB/EOS – NHQ; regional FAM.

Proposed CFWG Objectives:
1. Finalize design of calibration fishing studies (logistics/operational aspects/scheduling/standardizing protocols –fishing and sampling, e.g., use of trawl mensuration sensors/contingencies for dealing with changes to established plans).
2. Provide a range of analytical approaches for resulting calibration fishing data and calibrating surveys in general, for both coasts.
3. Provide costing of calibration fishing scenarios (ship time, overtime, additional staffing).
4. Provide oversight of preparation for and follow up from calibration fishing studies (acquiring gear, testing, training, all logistics and analytic needs).
5. Provide mechanism for communication between Science, CCG, regions, sectors, clients, management.
6. Identify and communicate the risks associated with different calibration fishing scenarios to key stakeholders (e.g. Fisheries Management).
7. Provide recommendations for securing sufficient and qualified ship’s crew and science staff.
8. Establish protocols for data and code sharing, storage, and preservation [IT management].

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