

Proceedings of the Technical Expertise in Stock Assessment (TESA) National Workshop on ‘Survey design and analysis’, 10-12 March 2026, Nanaimo, BC

Chris Rooper, Hugues P. Benoît, Sean C. Anderson, Paul Van Dam-Bates, Meghan Burton, Jean-Martin Chamberland, Jillian Dunic, Chelsey Lumb, Marianne Marcoux, Théa Rachinski, Rick M. Rideout, Laura Wheeland

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ABSTRACT

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The Technical Expertise in Stock Assessment (TESA) group of Fisheries and Oceans Canada (DFO) held a national workshop on 'Survey design and analysis', in Nanaimo, British Columbia (BC) from March 10th to 12th, 2026. The workshop was chaired by Chris Rooper (DFO Pacific Region) and Hugues Benoît (DFO Quebec Region). It was attended by 27 DFO participants and three external participants, two from the United States and one from Italy. The objectives for the workshop were to motivate a more concerted national approach to survey design, evaluation and analysis, and to identify priority areas related to survey design and analysis that could be addressed through TESA in the coming years.

The first day and a quarter were devoted to talks by participants, with 16 contributed by DFO scientists, an invited talk by an external expert and two keynote seminars by the other invited external experts. The talks were broadcast nationally by videoconferencing, with keynote seminars constituting part of a 2025-2026 national seminar series on an ecosystem approach to fisheries management. The remainder of the workshop involved short plenary discussions and longer discussions within breakout groups. Topics discussed during the breakout sessions included: 1) the strengths, weaknesses, and limits of model-based approaches to survey data standardization and data integration, 2) navigating changes in survey design, 3) changing survey designs on the fly and maintaining comparability, 4) considerations related to low catchability for some target species, and 5) combining multiple surveys covering portions of a stock.

Discussions during the workshop, combined with a post-workshop questionnaire to participants, resulted in a prioritized list of eight proposed activities for improving survey design, implementation, and data analysis within DFO nationally. The first two activities, possibly involving a working group, followed by a larger workshop, concerned 1) undertaking a broad range of simulations to evaluate consequences of survey changes, and 2) identifying best practices for spatiotemporal modelling. The next two activities were proposed courses related to 3) using simulations for evaluating survey and sampling designs, and 4) principles in survey design. Proposed collaborative research ideas included: 5) developing methods for model-based estimation of survey catch composition and 6) evaluating the consequences of choices in sampling composition data. Remaining activities included: 7) evaluating the utility of forming an in-house expert oversight and consultancy committee and 8) the development of a multi-regional survey database. Many of these proposed activities likely fall within TESA's remit, thereby constituting options for future TESA activities related to surveys.

RÉSUMÉ

Rooper, C., Benoît, H.P., Anderson, S.C., Van Dam-Bates, P., Burton, M., Chamberland, J-M., Dunic, J., Lumb, C., Marcoux, M., Rachinski, T., Rideout, R.M., Wheeland, L. 2026. Proceedings of the Technical Expertise in Stock Assessment (TESA) National Workshop on 'Survey design and analysis', 10-12 March 2026, Nanaimo, BC. Can. Tech. Rep. Fish. Aquat. Sci. 3800: v + 36 p. <https://doi.org/10.60825/b44d-rv85>

Le groupe d'Expertise technique en évaluation des stocks (ETÉS) de Pêches et Océans Canada (MPO) a tenu un atelier national sur la conception et l'analyse des relevés, à Nanaimo Colombie-Britannique, du 10 au 12 mars 2026. L'atelier était présidé par Chris Rooper (Région du Pacifique du MPO) et Hugues Benoît (Région du Québec du MPO). Vingt-sept participants du MPO et trois participants externes, deux des États-Unis et un d'Italie, y ont assisté. L'atelier visait à promouvoir une approche nationale plus concertée en matière de conception, d'évaluation et d'analyse des relevés, et à cerner les domaines prioritaires liés à ces aspects qui pourraient être abordés par le groupe ETÉS au cours des prochaines années.

La première journée et le premier quart de la deuxième ont été consacrés aux présentations des participants, dont seize par des scientifiques du MPO, une conférence d'une experte externe et deux séminaires d'ouverture animés par d'autres experts externes invités. Les conférences ont été diffusées à l'échelle nationale par vidéoconférence, les séminaires principaux s'inscrivant dans le cadre d'une série de séminaires nationaux 2025-2026 sur une approche écosystémique de la gestion des pêches. Le reste de l'atelier comprenait de brèves séances plénières et des discussions plus approfondies en petits groupes. Les sujets abordés lors des séances en petits groupes incluaient les suivants : 1) les forces, les faiblesses et les limites des approches fondées sur des modèles pour la normalisation et l'intégration des données des relevés, 2) la gestion des changements dans la conception et la mise en œuvre des relevés tout en maintenant la comparabilité, 3) les considérations liées à la faible capturabilité de certaines espèces cibles et 4) la combinaison de plusieurs relevés couvrant des portions d'un stock.

Les discussions menées lors de l'atelier, combinées à un questionnaire post-atelier destiné aux participants, ont permis d'établir une liste priorisée d'activités proposées pour améliorer la conception, la mise en œuvre et l'analyse des données des relevés au sein du MPO à l'échelle nationale. Les deux premières activités, qui pourraient impliquer un groupe de travail, suivi d'un atelier plus important, visaient à : 1) réaliser une vaste gamme de simulations pour évaluer les conséquences des modifications apportées aux relevés, et 2) identifier les meilleures pratiques en matière de modélisation spatio-temporelle. Les deux activités suivantes étaient des formations proposées portant sur : 3) l'utilisation de simulations pour évaluer les plans de relevés et d'échantillonnage, et 4) les principes de conception de relevés. Les activités restantes comprenaient deux idées de recherche collaborative, 5) l'élaboration de méthodes d'estimation de la composition des captures de relevés à partir de modèles, et 6) l'évaluation des conséquences des choix relatifs aux données de composition de l'échantillonnage. Ont aussi été identifiés : 7) l'utilité potentielle de la création d'un comité interne de consultation d'experts, et 8) la création d'une base de données multirégionale des relevés. Bon nombre de ces activités proposées relèvent vraisemblablement du mandat du groupe d'ETÉS, ce qui constitue des options pour les activités futures de ce groupe liées aux relevés.

1. INTRODUCTION

Fisheries and Oceans Canada (DFO) undertakes or coordinates a large number and diversity of fishery-independent surveys in Canada's three oceans. For instance, a 2018 review of all ongoing bottom-contacting surveys undertaken in marine coastal, shelf and slope waters off Canada identified 58 surveys across DFO's administrative regions: Pacific (10), Central & Arctic (8), Quebec (10), Gulf (7), Maritimes (12), and Newfoundland and Labrador (11) (Benoît et al. 2020). That inventory does not include the many surveys that do not employ bottom-contacting gear (e.g., acoustic, pelagic trawl, pelagic gillnet, pelagic longline, intertidal or diver), as well as irregularly-occurring surveys. The results from all of these surveys provide key inputs to stock assessments, and in the case of large-scale multi-species surveys and others, for broader ecological assessments, in addition to supporting research. Ensuring that surveys can provide statistically reliable estimates of absolute or relative abundance, and of the demographic composition of marine species populations, is key to the production of reliable science-based advice.

Constraints on resources (e.g., vessel time, personnel, funding), combined with increasing demands for surveys of non-traditional fishery resources (e.g. new or protected species), changes in survey domains or areas (e.g., for marine protected areas or offshore wind energy), environmentally driven changes in fishery availability to surveys (e.g. changes in fish distributions), along with innovations in sampling methods, all motivate a need to regularly (re)evaluate survey objectives, designs, methods and protocols. Meanwhile, state-of-the-art model-based inferences are now able to compensate for some data-collection deficiencies that were previously problematic for design-based inference, although the limits to which this can be done reliably are still being evaluated. Other countries and international working groups, such as the ICES Workshops on Unavoidable Survey Effort Reduction (ICES 2020, ICES 2023, ICES 2026), have undertaken concerted efforts aimed at evaluating and modernizing their surveys. Meanwhile, Canada's national approach to date has been more focused on prioritizing surveys in light of limited resources, and choices about survey design and analysis have been largely regional or limited to specific research units (e.g. DFO 2025).

DFO's national committee on Technical Expertise in Stock Assessment (TESA) has been mandated since 2009 to provide national activities that strengthen DFO's expertise and capacity to conduct stock assessments. TESA has hosted a number of workshops and courses covering a diversity of topics over the years. While many of these touched upon survey analysis, at least indirectly, only two past events have been focussed specifically on survey design and analysis. A course on Modelling and Data Analysis for Complex Surveys, taught by Jay Breidt and Jean Opsomer, both from the Department of Statistics, Colorado State University, was held in Moncton, NB, in March 2012. In 2013, TESA held a national workshop on Evaluating the Effects of Changes in Monitoring and Assessment Frequency on Management Advice for Canadian Fisheries. The workshop was chaired by Stephen Smith and Garry Stenson, respectively, with DFO in the Maritimes and NL regions at the time. No proceedings for the workshop or other documents related to changes in monitoring frequency were published, although two research documents were produced concerning assessment frequency (Bourdages and Desgagnés 2014; Hammill and Stenson 2014). More generally, there have been very few concerted

multiregional workshops within DFO on survey design and evaluation (e.g., Doubleday and Rivard 1981; Thiess et al. 2018).

To motivate a more concerted national approach to survey design, evaluation and analysis, TESA held a national workshop on 'Survey design and analysis', in Nanaimo, British Columbia (BC), from March 10th to 12th, 2026. The workshop was chaired by Chris Rooper (DFO Pacific Region) and Hugues Benoît (DFO Quebec Region). The main objectives for the workshop were for participants to share practical technical knowledge across DFO regions (and from external sources) and identify priority areas related to survey design and analysis that could be addressed through TESA in the coming years. More specifically, expected outcomes for the workshop were:

- Gap analysis/evaluation for surveys in Canada (design, implementation, needs)
- Knowledge transfer among participants and regions
- Possible development of collaborations (proposals, research, manuscripts)
- Identification of training and further workshop needs (TESA) around surveys

27 scientists from DFO and three invited experts, two from the United States and one from Italy, participated in the workshop (Figure 1). The first day and the beginning of the second were largely devoted to plenary talks by participants, with three invited seminars by external experts and 16 contributed talks by DFO scientists. The remainder of the workshop involved a mix of breakout group and plenary discussion sessions for in-person participants. The agenda for the workshop and the list of participants are provided in Appendix A. Workshop agenda and list of participants.



Figure 1. Group picture of the TESA workshop participants (invited experts: Sven Kupschus and Stan Kotwicki not shown)

2. CONTRIBUTED TALKS AND INVITED SEMINARS (DAYS 1 AND 2)

The workshop began with a short welcome and introductions session. This was followed by two invited keynote seminars, and a shorter invited talk. The keynote seminars were broadcast nationally, within DFO and to external partners via Zoom as part of the 2025-2026 Stéphane Plourde Memorial National Ecosystem Approach to Fisheries Management seminar series. There were over 80 online participants during the keynote seminars, in addition to the workshop attendees.

In his keynote presentation, Sven Kupschus (European Commission) reviewed the work undertaken by the ICES workshops on Unavoidable Survey Effort Reduction (WKUSER), which brought together survey practitioners and assessment scientists to address how changes in survey design, implementation, or effort affect the reliability of long-term survey indices and assessment-derived advice. He then discussed the relative merits and challenges of design-

and model-based survey estimates under different realized sampling schemes and other constraints. Overall, he argued for more robust decision-making frameworks that better account for uncertainty throughout the survey-assessment-advice chain and competing management goals when designing surveys and when survey designs inevitably change.

The second keynote presentation by Stan Kotwicki (NOAA) summarized considerable multi-year research efforts by his team at the Alaska Fisheries Centre, to modernize fisheries-independent surveys to address shifting species distributions and environmental conditions, new technologies, and evolving management goals. Importantly, he emphasized that modernization should focus on maintaining the consistency of information rather than strict methodological adherence, utilizing calibration and simulations to ensure new data remains comparable to historical records. He also noted that successful implementation requires balancing innovation with stable long-term monitoring through strategic planning, stakeholder engagement, and optimized sampling designs. In response to questions from the audience, Stan underlined the need to employ survey designs that can accommodate both design and model-based estimations, particularly when surveys target multiple species. This is because there are inevitably many species in a survey for which model-based estimators may not presently be reliable, and because there are often too few analysts available to produce well-validated model-based estimates for a majority of species.

The final keynote speaker, Kimberley Fitzpatrick (NOAA and University of Washington), presented results of simulations aimed at determining whether effects of a systematic transition in survey design or procedure on a stock's survey catchability can be estimated in age-structured stock assessment models, and whether different transition strategies—such as instantaneous versus gradual changes— affect this estimation. Her study found that the cohort structure within these models can help mitigate the effects of survey changes, particularly when new methodologies are implemented rapidly. An audience member asked whether the reliability of estimates from the assessment would be affected by non-stationarity in parameters affecting population dynamics. Kimberley answered that while changes in recruitment patterns are not expected to have an impact, changes in other parameters (e.g., natural mortality) certainly could and that requires further investigation.

The invited seminars were followed by contributed talks by DFO Scientists from across Canada. There were 16 contributed talks, covering a diversity of topics including descriptions of existing surveys, often with an emphasis on associated challenges, proposals for new or modified survey designs, and model-based analysis of survey data (Appendix B). The contributed talks were broadcast nationally within DFO via MS Teams.

Abstracts for the contributed talks and invited seminars are provided in Appendix B.

3. PLENARY DISCUSSIONS

3.1 PLENARY DAYS 1 AND 2

Short plenary discussions occurred on Day 1 and Day 2 focussed on themes and questions brought up by the invited speakers and contributed talks, and on establishing topics for breakout

group discussions to follow. The meeting co-chairs also presented a list of possible topics for the plenary or breakout group discussions that had been developed ahead of the meeting in consultation with a small number of DFO scientists or proposed by some meeting participants (Appendix C).

A number of common issues were identified through these discussions. Notably:

- Surveys that are plagued by frequent/repeated major survey coverage issues
- Designing effective and efficient surveys for the long term (e.g., climate change impacts, reduced ice coverage)
- “Catch” subsampling: how much, how, and what are the needs to support assessment? What are the advantages and disadvantages of using length-stratified or random sampling of the catch?
- Analytical and numerical (simulation) methods for survey design and evaluation of survey effectiveness.
- Transitioning from one design to another (e.g., an index site survey to a random stratified survey)
- How to deal with unavoidable changes in survey domain, such as exclusion zones due to MPAs and windfarms? How can existing surveys contribute to monitoring needs in MPAs, thereby reducing the degree of exclusion?
- Survey data analysis: what are the pros and cons of model-based and design-based estimation

Based on those discussions, the group separated into two breakout groups starting late morning on Day 2 (see section 4.0 below).

3.2 PLENARY DAY 3

At the beginning of Day 3, Rick Rideout presented a summary and led a discussion of one of the common themes identified in the contributed presentations from DFO participants and Stan Kotwicki: perennial survey coverage issues. This is an issue that has affected all DFO surveys to some degree, particularly in recent years. The most common causes include interruptions due to adverse weather, vessel or equipment breakdowns, implementation of regulations prohibiting survey activity over part of survey areas, changes in vessel/personnel availability, prioritizing non-survey activities, and gear conflicts.

Surveys that are plagued by frequent/repeated major survey coverage issues could consider operational or survey design modifications. Modifications discussed in detail during the plenary session that could offer solutions included:

1. Change (reduce) survey allocation

If the number of planned survey stations is not attainable on a regular basis, it might be advisable to reduce the number of planned sets to a manageable number. Consideration will be needed with respect to how the reduced number of sets might influence survey estimates and variability, and how it might influence other biological sampling, for instance. Simulation testing could be used to evaluate the consequences of reduced sampling density.

2. Remove 'high risk' (difficult to sample) sampling areas from the survey

Not all areas within a survey domain are necessarily suitable for the deployment of various sampling gears. For example, in research vessel (RV) bottom-trawl surveys there are areas that frequently result in gear tears and invalid survey tows. To avoid such incidents and the necessary gear repairs, there is often excess time spent evaluating the bottom and/or searching for suitable bottom. Various approaches can be taken to avoid these 'high risk' areas and to potentially improve survey efficiency by reducing downtime. However, consideration should be given to impact on survey interpretation (e.g. biasing sampling away from certain habitats).

3. Reduce biological sampling

Excessive biological sampling at each station might contribute to individual sets taking too long to process, and reducing the total number of sets that can be completed. Reducing sampling could help efficiency. Simulation studies could determine levels of sampling needed to attain survey objectives. Furthermore, the time required for different survey sampling activities can be measured to evaluate the marginal cost of taking particular measurements (e.g., Link et al. 2008). The latter can probably be undertaken presently using the time stamps automatically recorded along with individual data by the existing data collection software used at sea (e.g. Andes, Access). Another possibility is to shorten survey tows to reduce catch and therefore processing and sampling time, although this needs to be carefully considered given the non-proportional relationship between tow duration and catch for some species (e.g., Berg et al. 2024). Yet another option is to freeze samples for later processing in the lab, though this requires dedicated resources on shore, and not all samples can be obtained from frozen specimen. Despite the many options, the experience of the workshop participants is that such changes may not greatly enhance efficiency, and importantly, reduced biological sampling can reduce the value of data collected for stock assessment (e.g., Link et al. 2008).

4. Alternate priority areas interannually

If survey spatial coverage is a repeated issue, it might be possible to prioritize different areas of the survey domain (e.g., strata) each year to ensure that the same areas are not missed repeatedly. Such an approach might better support modelling exercises to estimate (i.e. 'fill in' or interpolate) the missed areas. However, this approach can be problematic in prolonged surveys during which different areas were sampled at different times historically, and when the availability of fish to the survey varies over time because of migration. Changing the timing at which particular areas are visited as part of a new multi-annual scheme could result in an uncalibrated change in catchability. A possible compromise solution is to employ a two-pass sampling scheme involving a light pass sampling a minimum number of stations per strata, followed by a second pass completing the remaining stations in each strata. This design helps ensure that at least a minimal complete coverage of the survey domain is achieved, but at a higher cost. Experience in the southern Gulf of St. Lawrence during the late 2000s showed that this design was achieved with an additional cost of about 20% in fuel and total survey time (unpublished data). There will be larger logistical issues employing this approach for much larger survey domains, so the trade-off between better areal coverage and higher cost must be fully considered.

5. Perform survey on lower frequency (e.g. annual to biannual)

When resources are insufficient to attain full survey coverage, it might be possible to get sufficient resources to complete a full survey every second year. Indices resulting from reduced survey frequency may be fine for longer-lived species with low frequency population dynamics, but may cause problems for shorter-lived, more temporally variable species. More generally, a change in survey frequency can be said to result in a trade-off between accuracy and precision.

Life history also needs to be considered for a lower frequency change, particularly for taxa for which time-varying natural mortality is estimated in their assessment, given that estimation could become difficult with data collected at a frequency less than annual. If spatial extent is the main concern, then a lower frequency may work. For long-lived species (e.g., marine mammals) with low reproductive rates, less frequent but spatially complete surveys may be preferable.

In instances where vessels are shared among regions (e.g., Atlantic Canada), it would probably be necessary for two regions to agree to perform surveys in alternating years. However, this could end up with time/space confounding the survey estimates, such has been observed in the West Coast synoptic bottom trawl surveys (Anderson and Dunic 2025 and dive surveys for Northern Abalone (*Haliotis kamtschatkana*, Obradovich et al. 2021). This can lead to uncertainty about the source of biomass changes over time and the need for more complex data analysis.

6. Switch from design-based to model-based estimation

Model-based estimation approaches are better able to handle some survey coverage issues. Although model-based estimates can help resolve some of the issues listed above (e.g., reduced survey stations or intermittent sampling of some survey areas), they do not replace the need to conduct surveys with proper design and implementation. For all surveys, we should be able to produce a design-based estimate, but may choose to produce a model-based estimate.

Model-based estimation shifts the burden from proper sampling design and implementation to the analyst with a specialized skill set and expertise in model construction and validation (e.g. Hatefi 2021). Models will perform better if the underlying sampling design is appropriate, and model estimates should be similar to design-based estimates (although potentially with improved accuracy and precision). However, model-based estimation may not be reliable if major coverage issues are persistent, model-based estimation cannot fully replace missed sampling, and model-based estimation may not be suitable for some species (e.g., highly contiguous/clustered or variable distributions). There are still many limitations and unknowns about the capacity and behaviour of models. In particular, the question of how best to model composition data (e.g., age and length composition) still requires additional research.

7. Permanently reduce survey domain (drop part of survey) to a manageable size

In some instances, removing part of the survey area or domain might ensure completion of the remaining part of the survey domain. This might be an option if there is a separate survey that also covers the dropped portion of the survey domain (i.e. two seasonal surveys that partially overlap). It might also work if the range of the species of interest contracts and the survey area can contract as well. In general, sampling a smaller domain results in higher risk of incomplete

coverage of a species total distribution. This is compounded if there is time-varying availability to the survey if a species distribution changes over time. In a multi-species survey context, it seems likely that this concern would be relevant for at least some species of interest. Participants felt that on balance the risks associated with this option appear to outweigh possible benefit.

8. Restratify the survey

In many instances, surveys may be overstratified and the unnecessarily complex design can contribute to spatial coverage issues and potentially reduce accuracy and precision (e.g., Gavaris and Smith 1987). In multi-species surveys, this may be true for the majority of species, where an increased sampling probability does not necessarily coincide with a higher variance in that stratum. This can lead to lower precision for abundance or biomass estimates. In the past, stratification was used, in part, as a method to spread sampling effort out over space, which is not the original intent of stratification (Cochran 1977, Hilborn and Walters 1992, Doubleday 1981). Newer sampling allocation theory can provide the same spatial spread of stations without the need to stratify for that explicit purpose (e.g., Balanced Acceptance Sampling (BAS); Robertson et al. 2013). Strata can still be beneficial in heterogeneous areas where spatial variability in habitat features influences variation in catch rates. In general, survey designs should strive for fewer, larger strata, with more sampling per stratum. Stratification should be based on a habitat variable that does not change much over time (e.g., depth), which may not necessarily align with management areas. Workshop participants agreed that based on the experience of participants (e.g. the presentation by Stan Kotwicki) a good rule of thumb is that simpler survey designs are often more robust than complex or highly stratified designs.

9. Redesign survey (e.g., unequal probability sampling)

If the current survey is completely insufficient for the current objectives or data needs, then a complete redesign of a survey may be needed (see also section 4.1.2 and 4.1.3 for the breakout discussions on this topic). Changing the design of an existing survey does not necessarily require some sort of calibration or a break in the existing series. The time series can be maintained, provided that the historical and new designs each produce an unbiased estimate. However, if the change in survey design involves one or more factors that can affect the catchability of species (e.g., a change from day to nighttime sampling), then this needs to be accounted for through calibration or estimated analytically using model-based estimation. There are also methods that will allow transitioning from one design to another (e.g., systematic to stratified random) over time. One example discussed in the workshop was for the West Coast Small Mesh Multi-species Survey, which was designed to systematically sample small areas of past high shrimp abundance, but could be redesigned to a stratified random survey with the old survey areas becoming strata within a new and expanded survey area that would cover the full range of the shrimp population (DFO 2025).

4. BREAKOUT GROUPS

4.0 GENERAL OVERVIEW

Following the plenary discussion that took place once the contributed talks were completed, the meeting participants separated into two breakout groups, one focussed on model-based approaches to survey data standardization, while the other discussed the challenges and possible solutions for navigating changes in survey design. Discussions within the model-based approaches group continued during the third day of the workshop, albeit with some changes in participants. Meanwhile, three new breakout groups were formed during the third day, addressing different operational and analytical issues.

The sub-section that follows includes summaries of the breakout group discussions as reported by each group. Note that the summaries below have not been edited for content, length, or to achieve a common style.

4.1 BREAKOUT GROUP SUMMARIES

4.1.1 Breakout group 1 - Exploring the strengths, weaknesses, and limits of model-based approaches to survey data standardization and data integration.

Lead: Sean Anderson, Rapporteur: Marianne Marcoux, Members (day 2): Sean Anderson, Kimberly Fitzpatrick, Jill Campbell, David Poissant, Natalie Asselin, Brendan Aulhouse, Cameron Freshwater, Hugues Benoît, and Marianne Marcoux. Members (day 3): Sean Anderson, Mackenzie Mazur, Meghan Burton, Kimberly Fitzpatrick, Hugues Benoît, Jackie King, Amy Tabata, Cameron Freshwater, Brendan Aulhouse, Natalie Asselin, and Marianne Marcoux.

This breakout group explored the strengths, weaknesses, and limitations of model-based approaches to survey data standardization and data integration, including accounting for loss of survey domain, integrating data across surveys or gear types, and extending these methods to catch composition data. Discussions addressed when these approaches are warranted, how to assess and communicate their limits, and how the field can progress toward a principled set of best practices. The group discussed these topics on Day 2 and developed a set of recommendations on Day 3.

Discussion topics from Day 2

Composition data and standardization approaches

The group discussed the application of spatiotemporal models to survey data standardization, focussing on both abundance indices and composition data. While these models are widely used for index standardization, their use for age and length composition remains limited, creating a mismatch in how different data types are treated. Given that spatiotemporal approaches already support data integration across surveys and can account for gaps in survey

effort, the group saw extending them to composition data as a logical next step. Although this is feasible with existing tools such as ‘sdmTMB’ (Anderson et al. 2025), practical challenges remain, including sparse observations for some age-year combinations, frequent zeros, and estimation challenges when many age classes are included. These issues may be less severe for short-lived species. Length-stratified sampling introduces additional complexity, requiring expansion of subsampled biological data to represent the full catch at the tow level (referred to as “first-stage expansion” at NOAA’s Alaska Fisheries Science Center), prior to any further scaling to the survey-domain level.

Evaluating model performance and limitations

The group discussed how to assess and communicate the limits of spatiotemporal models, identifying four complementary approaches:

1. Posterior predictive checking (self-simulation) compares observed data to data simulated from the fitted model; one practical interpretation is a “Turing test,” for data where model adequacy is supported if simulated data are visually indistinguishable from real observations (Turing 1950).
2. Data degradation uses high-quality datasets that are deliberately reduced to mimic real-world survey effort reductions or survey area loss, allowing evaluation under realistic constraints, albeit without knowledge of the true state.
3. Custom simulation (e.g., via the ‘SimSurvey’ R package, Regular et al. 2020) enables comparison to a known truth but is limited to processes specified by the analyst and can be time-consuming to design.
4. Sensitivity analyses can explore alternative model structures and mesh configurations and therefore provide insight into robustness to modelling decisions (Commander et al. 2022; Ward and Anderson 2025).

The group highlighted several practical considerations. Spatiotemporal models are often challenged in areas with strong environmental gradients, where models may oversmooth important variation. As a result, the random effects in spatiotemporal models are generally better suited to broad-scale patterns than fine-scale prediction. The group also emphasized the distinction between model-based and design-based estimators: while model-based approaches relax assumptions such as within-stratum homogeneity, they shift the burden from optimizing survey design implementation to model specification and choice, making sensitivity analyses, model-checking, and established best practice guidelines essential.

Data integration across surveys

The integration of data across surveys was considered in several contexts, including adjacent surveys, overlapping surveys, and surveys covering different depth ranges, as well as the increasing use of industry data. While integration can improve coverage, participants emphasized the need to first understand each dataset independently through separate modelling exercises. Furthermore, it was acknowledged that we do not yet understand how

some of the more complex modelling options, such as spatially varying catchability, will behave under complex data integration exercises.

Preferential sampling—where sampling locations depend on prior knowledge of fish distribution—was identified as a concern because it violates core geostatistical assumptions. A participant noted that in practice, its effects often appear modest and can be reduced by including relevant covariates that drive the preferential sampling.

Differences in survey timing (e.g., across seasons) present an additional challenge: without overlap in space or time, integration requires strong assumptions about fish behaviour and distribution. Targeted sampling to estimate differences in catchability or selectivity may be needed to support such data integration.

Alternatives to survey data integration

Alternatives to data integration via spatiotemporal models were also discussed. One option is to include multiple indices separately in an assessment model, allowing the model to reconcile them; however, most assessment models do not make use of spatial information and assume each index is proportional to the entire stock abundance. Assessment models are thus left to reconcile this through estimating separate selectivity curves. Spatial assessment models provide another option by partitioning populations into internal “boxes” and modelling movement between boxes, but, in practice, movement is rarely known and is difficult to estimate.

Recommendations from Day 3

On the third day, the group developed a set of recommended potential activities to advance survey data standardization and integration at DFO that emerged from the previous two days of discussion.

Best practices for spatiotemporal modelling (TESA working group and/or workshop)

The group recommended a two-phase approach to developing best practices for spatiotemporal model-based survey standardization. The first phase would be a blind simulation and modelling exercise, structured as a TESA working group, in which multiple regional teams independently fit the same simulated dataset without knowledge of the underlying data-generating process. This exercise would reveal how modelling choices differ across analysts and regions, providing insight into the sensitivity of results to analyst decisions. The simulated data would be generated using tools such as ‘SimSurvey’ or bespoke code and would aim to be broadly representative, encompassing different survey types (e.g., trawl, dive, trap) and species ecologies, and including covariates that modellers would need to select from. The data would also include challenges such as gear changes within the time series. Each region would assemble a small team including analysts at different levels of expertise, and the primary output would be a standardized index of abundance.

The results of the blind exercise would then kick off the second phase: a TESA workshop to develop a best practices paper. The results would be revealed, and participants would contrast

and compare their modelling decisions at the workshop. The insights would motivate and inform a best practices publication.

Simulations to evaluate survey changes (TESA working group and/or workshop)

The group recommended establishing a working group focused on the evaluation of the consequences of changes to existing surveys. Two complementary approaches were proposed: (1) data resampling and degradation exercises, in which historically rich datasets are deliberately reduced to mimic current or projected data-poor conditions, and (2) simulations from a model with known truth.

Two example case studies were discussed: a large-scale survey with a long time series, suitable for data degradation and restratification experiments, and an invertebrate species that requires borrowing information from external data sources. Because survey performance is species-specific, simulations should consider species with multi-year life cycles and situations where surveys must serve multiple species simultaneously. Data degradation experiments were seen as particularly valuable for evaluating the consequences of reduced sampling effort, changed survey designs, or loss of biological sampling (e.g., length and age data) on management advice. Such exercises would also help communicate to managers the costs of reducing survey coverage. Additional simulation priorities include evaluating the effects of preferential sampling and assessing trade-offs in the spatial allocation of survey effort across strata.

Survey design course (TESA course)

The group identified a need for a foundational TESA course on survey design principles, targeting personnel who conduct surveys in the field. An existing course external to DFO on survey design could serve as the basis or springboard, with emphasis adapted to the practicalities of DFO surveys, including implementation constraints. Topics would include basic survey design concepts, the distinction between design-based and model-based estimators, practical limitations of surveys, and decision-making during survey operations. The course should be offered remotely and recorded to maximize accessibility. The goal would be to ensure that all staff involved in survey execution have a shared baseline understanding of survey design principles.

Model-based estimation of survey catch composition (collaborative research)

Developing workable solutions for model-based estimation of survey catch composition was identified as a research priority, building on the challenges discussed on Day 2. The group recommended this be pursued as a focused collaborative research effort rather than a TESA activity, likely resulting in a publication.

Consequences of choices in sampling composition data (collaborative research)

A related but distinct priority is understanding the consequences of choices in the sampling of composition data and other biological samples, and making efficient use of available sampling resources. This would involve closed-loop simulations examining consequences on quantities of

management interest. Like the model-based composition work above, this was recommended as a collaborative research effort rather than a TESA activity.

Multi-regional survey database (TESA workshop and working group)

A TESA workshop or working group focused on creating a multi-regional survey database was recommended. Initial brainstorming for this effort could potentially be added to the terms of reference of the TESA stock assessment output database workshop planned for 2026/27. It would build on existing initiatives, such as the ‘surveyjoin’ project (Pacific Region DFO and NOAA; Ward et al. 2025), and could contribute to broader datasets, such as [FISHGLOB](#). Key elements include assembling regional expertise, standardizing data entry and metadata (including both raw and converted data), linking open data portals to improve accessibility, and exploring potential integration with NOAA datasets. The emphasis would be on creating multi-regional datasets that are practical and useful for analysts conducting stock assessments and other analyses.

Expert oversight and consultancy (TESA committee or workshop)

The group noted the potential utility of a formal expert oversight or consultancy committee to support DFO programs with survey-related questions, similar in spirit to the DFO “4S” committee (sampling, surveys, statistics, and stock assessment) of the 1970s and 1980s. This group could provide consultation on survey design and model-based standardization, functioning as an in-house statistical resource for DFO science programs. An alternative or complementary approach would be a consultancy workshop focused on survey design problems.

Overarching consideration: non-stationarity

The impacts of non-stationarity—arising from climate change and shifting species distributions—were identified as an overarching consideration that cuts across all of the above activities. Simulation exercises, best practices guidance, and survey design evaluations should all account for scenarios in which historical patterns of species distribution and abundance may not hold into the future.

4.1.2 Breakout group 2 - Navigating changes in survey design.

Lead: Chris Rooper, Rapporteur: Meghan Burton, Members (Day 2): Diana McHugh, Shannon Obradovich, Amy Tabata, Eric Brunsdon, Jackie King, Thea Rachinski, Mackenzie Mazur, Francois-Etienne Sylvain, Rick Rideout, Laura Wheeland, Sheila Atchinson, Fatemeh Hatefi, Paul Van Dam-Bates, Jean-Martin Chamberland, Jillian Dunic, and Chelsey Lumb

This breakout group discussed the challenges and some possible solutions to deal with navigating changes in survey design. Of particular concern was how to design and adapt surveys to remain robust under current and future environmentally-driven change, such as shifting species distributions and availability. A central question was whether existing approaches, such as index-site based surveys commonly used for invertebrates, can remain effective under nonstationary conditions, or whether more flexible designs are required.

Participants emphasized the need for analytical and simulation-based methods to evaluate survey effectiveness and to guide transitions between survey designs, including transitions from single-species surveys to multispecies or ecosystem surveys, such as the Integrated Pelagic Ecosystem Survey (IPES; King et al. 2019) or multispecies invertebrate dive surveys (Lochead et al. 2023).

A recurring challenge discussed was the difficulty of changing survey objectives in the face of existing commitments, legal requirements, and limited resources. Examples included surveys that expanded from a single-species focus (e.g., Chinook salmon) to multiple species (e.g., Chinook and coho), often without an accompanying increase in funding or effort. Difficulties resulting from differences in coastwide monitoring objectives and local monitoring needs were highlighted, as were the complications introduced by marine protected areas (MPAs). While MPAs pose logistical challenges, participants also noted potential opportunities to leverage MPA monitoring data for broader species monitoring. As dedicated monitoring plans are being developed for numerous new Canadian MPAs, there might be opportunities to include stock assessment survey needs when MPA monitoring programs are being considered. The requirements of the *Fisheries Act* to manage species at a stock level have introduced complications when there is a mismatch in scale between the stock level and the management level. In particular, on the West Coast there are cases where local or regional surveys that set catch levels for local fishing grounds do not provide the necessary data to evaluate the entire stock. Several participants stressed the importance of planning for future uncertainty by developing “backup plans” in anticipation of changing priorities or reduced funding.

Much of the discussion centered on mismatches between survey objectives and available resources, particularly when annual surveys cannot be completed as designed. Inflexible survey designs were identified as especially vulnerable under constrained resources, leading to questions about whether better methods exist for reducing effort without entirely redesigning surveys. Spatially balanced sampling, panel designs, and mixed designs were suggested as possible solutions, with participants emphasizing that mixed designs are not inherently problematic from a statistical perspective. However, systematic designs that must be scaled back pose particular challenges, especially when reductions are unplanned. Participants emphasized the need for structured decision frameworks and practical tools (e.g. “flow charts”) to guide decisions on how to reduce effort while maintaining time-series integrity and quantifying the impacts of those reductions.

The issue of bridging between survey designs arose repeatedly, with participants noting that bridging often assumes deliberate overlap between old and new designs, which is frequently not the case. Some types of transitions, such as between index site surveys and depth- or habitat-stratified random designs, offer few clear bridging options. Panel approaches where some fixed sites continue to be sampled, while the transition to a randomized approach is implemented (e.g., McDonald 2003), were frequently discussed as a potential way to manage transitions, particularly for index-site-based surveys and cases where partial overlap can be maintained. Re-stratification and post-stratification were also noted as practical tools for addressing changes in survey design that occur during fieldwork (e.g., when new sampling stations have to be chosen during sampling).

Participants also emphasized that multispecies surveys add another layer of complexity, as a single design rarely performs well for all species. This leads to unavoidable trade-offs between data quantity and data quality. For example, a change from a less precise (lower sample density) annual survey to a more precise (higher sample density) biennial survey will have different implications for a short-lived groundfish species relative to a long-lived groundfish species. The less precise, but more frequent sampling might be better at tracking a species with large interannual variability in abundance than a less frequent sampling that might miss recruitment failure. Climate-driven distribution shifts further complicate these decisions, increasing the importance of broad spatial coverage and sometimes necessitating expansion or relocation of survey areas. Changing focal species, such as in multi-mesh gillnet surveys in boreal lakes, can result in incomplete representation of both species composition and size structure, weakening CPUE-based indices.

Catch sampling was highlighted as a concern that is less commonly examined than the overall effect of change on survey design. In particular, much of the focus for multispecies surveys is on the sampling needed to produce design-based biomass estimates or feeding into spatiotemporal models like sdmTMB to produce biomass estimates. However, catch sampling (e.g. maturity, condition) of multiple species is a critical source of data for modern stock assessment and is impacted by any changes to overall survey design.

The group discussed the broader trade-offs inherent in survey design, noting that designs fall along a spectrum from those optimized for temporal inference (revisiting the same sites annually) to those optimized for spatial inference (rarely revisiting sites). Surveys with no overlap in space or time were acknowledged as especially challenging to model, but participants emphasized that, in practice, analysts are constrained by the data that already exist. Hierarchical ordering of sampling locations was identified as a promising way to coordinate surveys and share resources across programs, so that multiple programs using the same gear can prioritize sampling and share data. Centralized data systems and increased data sharing were widely viewed as essential for improving efficiency and inference particularly across regions using similar gear.

Simulation and analytical tools featured prominently as ways to evaluate survey designs and guide decisions. Topics included power analysis to determine appropriate sampling intensity, simulation of alternative designs to understand the consequences of reduced effort, and testing whether spatiotemporal models produce unrealistically smooth estimates. Participants discussed ongoing work exploring how much overlap is needed when transitioning surveys and noted that species with strong interannual variability may benefit more from sparse annual sampling than from higher-intensity but less frequent surveys. The ability of models like sdmTMB to improve precision was seen as an opportunity to make better use of imperfect or historically unusable indices.

Finally, several participants noted that when systems are changing rapidly, increased sampling intensity may be required to maintain data quality.

The guidance suggested by the group for managing changes in survey design emphasized:

- the importance of built-in flexibility in survey design (e.g., hierarchical sampling frameworks);
- institutional support for change (both in terms of time and funding);
- use of calibration or panel designs during transitions from one survey design to another;
- ecosystem surveys that can provide more data per unit effort than single-species surveys and can address multiple species and multiple objectives;
- using simulation tools (e.g., SimSurvey) to evaluate sampling strategies and catch subsampling decisions; and
- integrating emerging technologies—such as acoustics, cameras, and AI—to help improve efficiency, attract funding, and supplement traditional surveys.

Key to these conclusions was recognition of the importance of working toward cross-regional collaborations, centralized data formats, national-scale coordination, and training initiatives such as TESA to enable evidence-based decisions to be made regarding survey changes.

4.1.3 Breakout group 3 - Changing survey designs on the fly and maintaining comparability.

Rapporteur: Laura Wheeland; Members: Rick Rideout, Sheila Atchison, Fatemeh Hatefi, Paul Van Dam-Bates

Discussions in this group focused on the need to change the spatial extent of surveys – either expanding (e.g., in response to changing priorities or distributions) or reducing (e.g., in response to changing resources). It was highlighted that survey objectives need to be the driver for changes; these objectives need to be clearly defined, and cannot change frequently if the integrity of the series is to be maintained. It was also noted that survey objectives may be defined by science questions, or by management priorities.

If a survey area is expanded, this will naturally start a new series, as we cannot infer past trends in areas not previously sampled. To aid in the interpretation of the transition between series, data from the expanded area can be subset to create a series on a smaller scale that links more directly to the previous series. Conversely, if a survey area is constricted, a “continuous” series may be created by resampling from the previous design to focus on the new restricted area.

Survey coverage can vary year over year, but this should be done in an intentional way. Panel designs (McDonald 2003) should be explored to inform methods to allocate effort, for example, in adjusting the area or density of sampling.

Survey flexibility can be built into initial designs to allow for programs to respond to changes, and this should be considered in advance whenever possible. An example was discussed around the trawl survey in NAFO Div. 0A (Treble 2022) where annual fluctuations in the distribution of sea-ice impact the available survey area and substrata are used to adjust sampling area and area-based estimates of biomass and abundance. Other approaches discussed included: hierarchical set allocations; actively rotating survey gaps when the whole

area cannot be completed; and developing alternate plans to maximize vessel use in poor weather (e.g., inshore sampling).

Discussion then focused on improving the design of existing trawl surveys that are challenged by limited resources. Having to meet “minimum” strata sampling requirements (two sets per strata) challenges the statistical reliability of the survey, leading surveys to over sample some areas and drastically under sample others. When full survey allocations cannot be sampled, the original design objectives are not being achieved. Additionally, over-stratification is likely inflating variance in some trawl surveys. The original strata designs incorporated a large number of relatively small strata, in part to spatially spread effort. A shift to larger strata and/or unequal probability sampling (e.g., BAS) is likely to improve estimation of indices, with more modern statistical tools able to achieve spatially balanced sampling using fewer or no strata.

If surveys are being changed in a major way, it is preferable to do a calibration experiment (e.g., comparative fishing) and simulation test changes before they occur (e.g., Pacific shrimp survey area). Depending on the structure of the assessment and/or design of the survey, a slow transition could be used in place of specific calibration data/experiments if they are not practically feasible; overlapping data may assist in modelling efforts to link series. However, a knife-edge change may work better where the data are being used for an age-structured assessment (as per Kimberley Fitzpatrick’s presentation at this workshop) if it maintains integrity of data series at that transition. It was noted that practically, most changes are likely a knife-edge rather than a slow transition due to limitations in funding, resources, and advanced notice of change.

4.1.4 Breakout group 4 - Low catchability for some target species in surveys

Lead: Chelsey Lumb, Rapporteur: Théa Rachinski, Members: Eric Brunsdon, Diana McHugh, Virginia Noble, François-Étienne Sylvain.

This group discussed ways to address low catchability for some target species in a survey, which can hamper the ability of a survey to estimate accurate abundance or detect trends for the species. Catchability can be low if species are rare, occupy a habitat that is not surveyed (e.g., untrawlable habitat), are unavailable (e.g., marine mammals below detectable depths during aerial surveys, patchy distribution of shrimp), or if the size or species of interest are not selected by the survey gear. The objective of the breakout group, to propose solutions to improve catchability, was different than the previous group that discussed changing survey designs on the fly and maintaining comparability. This difference highlights the importance of knowing the current objective(s) of the survey, to identify changes that need to be considered.

Catchability can be improved by modifying survey methods and gear. If there is a change in survey objectives, such as an additional target species, it may be possible to adjust the survey design to improve catchability for the new target species. Changes could include sampling different areas or habitats within the survey domain, as long as data quality and indices for other target species are not compromised. Calibration of new survey methods or gear may be needed to ensure compatibility between historical and newly implemented methods.

If the current survey gear is not effective for the target species, alternative capture methods could be used. Multiple gear types could be employed to sample different parts of a population or to improve spatial coverage (e.g., hydroacoustics and trawling). This may include comparative gear studies to evaluate and calibrate differences in catchability, or possibly a new survey design, if resources are available.

Some habitats or survey areas may not be sampled because of logistics or environmental conditions (e.g., shallow depths, rocky bottom, or areas in rivers with high flow or debris). Alternative ways to estimate abundance could include mark-recapture or close-kin mark-recapture, depending on the target species, population size, and capture rates. It may be possible to calibrate between survey methods, to use more reliable abundance estimates to apply to less reliable estimates due to survey constraints (e.g., visual surveys in turbid streams).

There may be size selectivity of target species based on habitat preference and areas that can be surveyed (e.g., smaller fish in shallower depths than larger fish, or smaller fish in slower-moving water than larger fish in streams). Sentinel or collaborative monitoring programs could be used to collect data from areas not included in standard surveys to provide some information about catches in different habitats (e.g., inshore versus offshore habitats). This could lead to redesigning an existing survey (see previous summary of breakout group 3 discussion about changing survey designs on the fly and maintaining comparability). Implementing a two-stage survey design or adaptive sampling are possible approaches that could be explored if redesigning an existing survey is necessary.

Catchability may change over time if species shift habitats or distributions due to environmental conditions, predation, or climate change (e.g., fish moving to deeper waters). Recent monitoring tools could be used to track spatial distribution over time (e.g., telemetry, video or imagery from underwater cameras or drones). Environmental DNA could be used to detect species presence and absence. Information from these tools could help better target survey locations for abundance or biomass estimation. Monitoring distribution changes can help interpret results and adjust survey design, if the survey domain does not include the full range of target species.

Supplementing fisheries-independent surveys with additional data sources could provide a more complete picture of stock status when a single survey has low catchability. Data sources could include other fisheries-independent surveys (from DFO, provinces, or collected by industry), fisheries-dependent data, community-based monitoring, Traditional Ecological Knowledge, and local area knowledge. Understanding differences in population demographics among data sources can help interpret biases.

4.1.5 Breakout group 5 - Combining multiple surveys covering portions of a stock

Lead: Jean-Martin Chamberland, Rapporteur: Jillian Dunic, Members: David Poissant, Stan Kotwicki, Chris Rooper, Jill Campbell

For some species, there may be existing time series that assess a portion of the stock. For example, multiple surveys in British Columbia sample Dungeness crab throughout their range, including nearshore dive surveys, offshore bottom trawl surveys and trap surveys in all habitats

(Nephin et al. 2023). However, no single one of these surveys samples all of the habitats in which Dungeness crab are found. In cases such as these, where multiple surveys may be occurring on different components of a stock, combining all available survey data to get a full picture of the stock would be beneficial. Below are some options for combining data that were suggested by the breakout group for consideration.

In cases where comparative tows are available, comparative fishing experiments can be used to convert catches into a standard vessel–gear unit. When multiple vessel–gear combinations have been used within and across surveys, conversion factors can be estimated to place all surveys on a common scale. For example, on the East Coast of Canada, where many vessel–gear pairs have been deployed across different surveys and time periods, it may be possible to harmonize all surveys if at least one common vessel–gear combination has been used historically across surveys. However, this approach has limited utility for rare species, as sparse catches reduce the reliability of estimated conversion factors.

In cases where there are no direct comparative tows, but surveys overlap spatially and are close in time, other methods can be used. Even though gear or protocol differences may exist, conversion factors can be estimated directly within a spatiotemporal modeling framework (such as sdmTMB), allowing uncertainty in the conversion to be propagated through to the resulting index. This approach leverages shared spatial and temporal structure but still struggles with rare species, which must occur frequently enough within the overlap area for reliable estimation.

In situations with no spatial overlap, a common data stream can be used as a bridge between surveys. When a common gear or observation method is used in both surveys—such as acoustic data—these measurements can link otherwise non-overlapping bottom trawl surveys. Acoustic data collected during trawl surveys can be used to jointly estimate catchability ratios and effective fishing height (the height of the net headrope above the seafloor), while explicitly accounting for vertical overlap between different gear types. This approach has worked well for some species, such as walleye pollock, but has proven more challenging for others due to differences in behavior and seabed association.

The most difficult case is when there is no spatial or temporal overlap, requiring the strongest assumptions. In these situations, commercial catch-per-unit-effort (CPUE) data could be used to bridge gaps if commercial gear overlaps spatially with research surveys at different times. Paired commercial and research data can be used to estimate gear selectivity and size-specific catchability ratios. However, this approach carries significant risks, including changes in commercial fishing practices over time and biases arising from preferential or density-dependent sampling.

Looking forward, simultaneous multi-method surveys offer a promising way to reduce reliance on post hoc calibration. Multiple observation methods can be deployed on the same platform and integrated within a single, possibly spatiotemporal, model. Examples include combining acoustic surveys with trawls and eDNA sampling, using cameras or baited remote underwater video (BRUV) in untrawlable areas, or conducting side-by-side commercial and research trawls. The goal of this approach is to maintain time-series consistency while reducing costs and minimizing dependence on e.g. traditional trawl surveys. Developing improved methods for integrating different survey datasets should be a key priority.

5. WORKSHOP WRAP-UP & RECOMMENDATIONS

A plenary session was held during the afternoon of Day 3. Representatives from each of the breakout groups presented a summary of the main outputs from their groups. Most of the discussion focussed on the list of recommended activities produced earlier on Day 3 by breakout group 1 (section 4.1.1). The meeting participants found the list particularly relevant and additionally suggested that an introductory TESA course on using simulations for survey design would be beneficial. In addition to the proposed foundational survey design course, this course would give analysts the tools to evaluate survey design options and understand the consequences of design changes through simulation.

A list of recommendations for future activities was developed during discussions in the concluding plenary session. These recommendations were then prioritized using a post-workshop questionnaire sent to participants (n = 10 responses). The resulting prioritized list of recommended activities was as follows (with the average rank of each from the questionnaire responses indicated in parentheses with lower numbers indicating higher priorities):

1. Simulations to evaluate survey changes - TESA working group and/or workshop (1.6)
2. Best practices for spatiotemporal modelling - TESA working group and/or workshop (2.8)
3. Introduction to using simulations for survey design - TESA course (4.4)
4. Survey design course - TESA course (4.8)
5. Model-based estimation of survey catch composition - Collaborative research (5.6)
6. Consequences of choices in sampling composition data - Collaborative research (6.1)
7. Expert oversight and consultancy - TESA committee or workshop (6.8)
8. Multi-regional survey database - TESA workshop and working group (7.9)

The meeting co-chairs committed to working with the national TESA planning committee in communicating this list to senior management and to seek support for the activities in the coming years.

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APPENDIX A. WORKSHOP AGENDA AND LIST OF PARTICIPANTS

Note: This is the agenda as proposed at the start of the workshop, noting it would remain fluid depending on the direction of discussions.

TESA Workshop on survey design and analysis, March 10-12, 2026

Chairs: Chris Rooper (PAC) and Hugues Benoît (QUE).

Coast Bastion Hotel, Nanaimo, B.C.

Agenda

Tuesday March 10, 2026	
830	Introduction - goals, purpose of meeting, participant introductions
Invited seminars	
900	Considerations for fisheries-independent survey designs: lessons from the ICES workshops on unavoidable survey effort reduction (WKUSER) (Sven Kupschus)
1030	Pathways towards modernizing fisheries-independent surveys (Stan Kotwicki)
1130	Lunch (not provided)
1230	Simulation Analyses In Support of Eastern Bering Sea Survey Modernization (Kimberly Fitzpatrick)
Contributed talks by DFO participants	
1245	Southern Gulf Multispecies Bottom-Trawl Survey Design and Challenges (François-Étienne Sylvain)
1300	Integrating three bottom trawl surveys to estimate the biomass and distribution of American lobster in the southern Gulf of St. Lawrence (Natalie Asselin)
1315	Title Assessment of existing DFO monitoring programs to support the Great Bear Sea MPA Network Monitoring Strategy (Jillian Dunic)
1330	Recommendations on the Design of the Shrimp Survey For Stock Monitoring in British Columbia (Mackenzie Mazur & Virginia Noble)
1345	Integrating fisheries survey data: theory, practice, and open questions (Sean Anderson)
1400	Ecosystem surveys in the Maritimes region: past, present and future challenges. (Eric Brunson)
1415	Cetacean surveys in the Canadian Arctic (Marianne Marcoux)
1430	Catch Sampling for Pelagic Survey (Chris Rooper)
1445	Model-based indices of juvenile Pacific salmon abundance highlight species-specific seasonal distributions and impacts of changes to survey design (Cam Freshwater)
1500	Coffee Break (not provided)
1530	Discussion
1630	Summary and outline of tomorrow's tasks
1700	End for the day
Wednesday March 11, 2026	
900	Introduction to Day 2

915	Challenges with variability in survey design for assessing Dungeness Crab in BC (Brendan Aulthouse)
930	Laurentian Channel Survey (David Poissant)
945	The Northern Gulf of St Lawrence Ecosystemic Survey: improving efficiency and analytical methods (Jean-Martin Chamberland)
1000	Overview of methods for the annual multispecies survey in Baffin Bay and Davis Strait (NAFO subarea 0) (Sheila Atchison)
1015	Overview of current challenges in the Newfoundland & Labrador multispecies trawl surveys (Laura Wheeland)
1030	Spatially Balanced Sampling Methods (Paul van Dam-Bates)
1045	Discussion
1200	Lunch (not provided)
Plenary & Breakout group discussions	
1315	Plenary discussion & instructions to Breakout groups
1330	Breakout groups 1 & 2
1530	Coffee Break (not provided)
1545	Breakout groups 1 & 2 (cont.)
1630	Plenary summary of breakout groups & Discussion
1700	End for the day
1830	Group Dinner - Asteras Greek Restaurant

Thursday March 12, 2026	
900	Breakout group instructions
915	Breakout groups 1 & 3-5
1030	Coffee Break (not provided)
1100	Breakout groups 1 & 3-5
1130	Plenary summary of breakout groups & Discussion
1230	Lunch (not provided)
1330	Plenary discussion of steps to move forward/gaps/what can TESA do? (Breakout group 1)
1430	Coffee Break (not provided)
1500	Plenary discussion of breakout group results (groups 2-5)
1630	Summary, recommendations, words of wisdom & Proceedings document tasks
1700	End of the workshop

List of workshop participants

Participant	Affiliation
Anderson, Sean	DFO, Pacific Region
Asselin, Natalie	DFO, Gulf Region
Atchison, Sheila	DFO, Arctic Region
Aulthouse, Brendan	DFO, Pacific Region
Benoît, Hugues	DFO, Quebec Region
Brunsdon, Eric	DFO, Maritimes Region
Burton, Meghan	DFO, Pacific Region
Campbell, Jill	DFO, Pacific Region
Chamberland, Jean-Martin	DFO, Quebec Region
Davidson, Katie	DFO, Pacific Region
Dunic, Jillian	DFO, Pacific Region
Fitzpatrick, Kimberly	U.S. NOAA, Alaska Fisheries Science Center
Freshwater, Cameron	DFO, Pacific Region
Hatefi, Fatemeh	DFO, NL Region
King, Jackie	DFO, Pacific Region
Kotwicki, Stan	U.S. NOAA, Alaska Fisheries Science Center (remote participation)
Kupschus, Sven	European Commission JRC, Italy (remote participation)
Lumb, Chelsey	DFO, Arctic Region
Marcoux, Marianne	DFO, Arctic Region
Mazur, Mackenzie	DFO, Pacific Region
McHugh, Diana	DFO, Pacific Region
Noble, Virginia	DFO, Pacific Region
Obradovich, Shannon	DFO, Pacific Region
Poissant, David	DFO, Quebec Region
Pourfaraj, Vahab	DFO, Pacific Region
Rachinski, Théa	DFO, Pacific Region
Rideout, Rick	DFO, NL Region
Rooper, Chris	DFO, Pacific Region
Sylvain, François-Étienne	DFO, Gulf Region
Tabata, Amy	DFO, Pacific Region
van Dam-Bates, Paul	DFO, Pacific Region
Wheeland, Laura	DFO, NL Region

APPENDIX B. ABSTRACTS FOR CONTRIBUTED AND INVITED PRESENTATIONS

(ordered according to the Agenda)

INVITED SEMINARS

Considerations for fisheries-independent survey designs: lessons from the ICES workshops on unavoidable survey effort reduction (WKUSER). Sven Kupschus, European Commission - Joint Research Centre, Italy.

This presentation reviews the history and evolution of the ICES WKUSER (Workshop on Unavoidable Survey Effort Reduction) initiative and discusses broader challenges in integrating fisheries survey data into stock assessments. WKUSER was established to bring together survey practitioners and assessment scientists to address how changes in survey design, implementation, or effort affect the reliability of long-term abundance indices and the advice derived from them. The talk highlights key considerations in linking survey design with assessment requirements, including trade-offs among fixed, systematic, and random sampling strategies, the role of design-based versus model-based indices, and the increasing use of spatiotemporal models such as VAST to account for environmental variability and spatial structure in survey data. Emphasis is placed on understanding the assumptions embedded in models and how these should be related to the true underlying biological processes affecting distribution, the interpretation of survey indices relative to catchability and selectivity processes, and the often-underappreciated role of compositional data and clustered sampling in fisheries surveys. Examples from recent literature illustrate how sampling design, environmental change, and survey implementation can influence abundance estimation and assessment outcomes. The presentation argues that while WKUSER has provided a valuable set of analytical tools and best-practice guidance for handling survey changes, future progress requires stronger frameworks for decision-making that explicitly consider uncertainty, competing management objectives, and the distribution of variance across survey, compositional, and assessment processes.

Pathways towards modernizing fisheries-independent surveys. Stan Kotwicki. NOAA National Marine Fisheries Service, Alaska Fisheries Science Centre, U.S.A.

Fisheries-independent surveys provide the foundational data used in stock assessments, ecosystem research, and fisheries management, yet the environmental, technological, and institutional contexts in which these surveys operate are rapidly changing. This presentation outlines pathways for modernizing fisheries-independent surveys while maintaining the continuity of long-term data series that underpin management advice. Drivers of change include shifting species distributions, evolving management objectives (e.g., ecosystem-based fisheries

management), emerging survey technologies, constraints on traditional sampling, and advances in statistical modeling and artificial intelligence. Future survey programs will need to transition from rigid, highly standardized designs toward flexible, platform-agnostic approaches that integrate multiple sampling methods (e.g., trawls, acoustics, cameras, and eDNA) and emphasize model-based estimation. Modernization must prioritize the consistency of information content rather than strict methodological continuity, often requiring incremental implementation, calibration between old and new methods, and rigorous evaluation through simulations and field experiments. Case studies from Alaska Fisheries Science Center survey redesign efforts illustrate how optimized sampling designs and adaptive approaches can improve survey performance while preserving comparability with historical time series. Ultimately, successful modernization will require careful planning, stakeholder engagement, adequate resources, and transparent evaluation to balance innovation with the need for reliable long-term monitoring of marine ecosystems.

Simulation Analyses In Support of Eastern Bering Sea Survey Modernization. Kimberley Fitzpatrick. NOAA National Marine Fisheries Service, Alaska Fisheries Science Centre, U.S.A.

Fishery-independent surveys provide critical data to inform fishery stock assessments and support sustainable fisheries management. These surveys rely on standardized and consistent sampling procedures applied across the survey area and timeseries to relate abundance indices to population biomass and to detect changes in stock dynamics. However, changes to survey design are occasionally necessary to continue to provide high quality data for informing management due to changes in equipment, dynamics of targeted populations, reductions in survey resources, or in the best available science. Switching between two survey methodologies can cause changes in catchability (i.e., the relationship between actual abundance and estimated survey abundance) and, by extension, influence the perception of stock trends. To better understand the effect changes in survey catchability may have on stock assessment results, we used simulation experiments to explore the transition between two methodologies for a fishery-independent survey and their impact on an integrated age-structured assessment model. We investigated different approaches to implementing changes in survey methodologies (e.g. instantaneous vs. gradual change) and ways of handling the change in survey methodology within the assessment model. We found that the cohort structure within age-structured stock assessment models could mitigate some of the impact of catchability changes on assessment results. This was particularly true when changes in survey methodologies were rapidly implemented, while changes in catchability tended to be harder to accurately estimate when new survey methodologies were gradually implemented. Greater understanding of the relationship between changes in survey methodologies and stock assessments may better prepare practitioners for accommodating future changes in fishery-independent surveys while maintaining high quality stock assessments.

CONTRIBUTED TALKS (DFO PARTICIPANTS)

Southern Gulf Multispecies Bottom-Trawl Survey Design and Challenges. François-Étienne Sylvain (Gulf Region)

The Southern Gulf of St. Lawrence Multispecies Bottom Trawl Survey has been conducted annually since 1971 and remains the primary source of fishery independent information for this region. Its random stratified design, comprising 27 strata defined by depth and substrate type, provides long term data on the abundance and distribution of numerous fish and invertebrate species, including Atlantic Cod, Yellowtail Flounder, Winter Flounder, Witch Flounder, and White Hake. The survey also generates key oceanographic observations—temperature, salinity, oxygen levels—that support ecosystem modelling and environmental assessments. Despite its central role in stock assessment and ecosystem monitoring, the survey faces operational and design challenges. Spatial coverage is limited in some strata due to the presence of fixed fishing gear, and catchability is reduced for species whose distributions extend into shallow coastal waters (<25 m) not currently included in the survey domain. Station selection is also inherently biased toward trawlable soft bottom habitats, while harder or shallower areas are sampled less frequently. In addition, inter-annual variations in the survey timeframe, operational constraints and effective time at sea can impact the survey's potential to detect representative changes in the ecosystem. Long term planning of survey structure and schedule requires a clear understanding of how operational and methodological constraints may affect the program's capacity to detect ecosystem change and support management needs.

Integrating three bottom trawl surveys to estimate the biomass and distribution of American lobster in the southern Gulf of St. Lawrence Natalie Asselin (Gulf Region)

Scientific trawl surveys are consistently used in fisheries stock assessment and are generally assumed to provide unbiased indices of key stock features including commercial biomass and species distribution. Due to a combination of factors, including costs and vessel operational depths, individual surveys do not always cover the full distribution of a fished stock, which can result in biased estimates. Spatiotemporal generalized linear mixed effects models (GLMMs) allow for the inclusion of a survey effect that serves as a calibration for differences in selectivity between data series. GLMMs were developed to integrate data from three scientific trawl surveys in the southern Gulf of St. Lawrence (2001-2024) and estimate standardized stock-wide indices of the biomass and distribution of commercial lobsters (i.e. lobsters at or above the minimum legal size, excluding berried females). The standardized index of commercial biomass could be used to develop a fisheries-independent limit reference point for the southern Gulf of St. Lawrence American lobster stock.

Evaluating hard bottom longline surveys for Marine Protected Area Network monitoring using simulation-based power analysis. Jillian Dunic (Pacific Region)

Monitoring of Marine Protected Areas is necessary to evaluate the effectiveness of conservation interventions. The Great Bear Sea MPA Network is a collection of MPA sites in the Northern Shelf Bioregion of British Columbia, Canada. Since 2003, Fisheries and Oceans Canada has

conducted hard bottom longline surveys to monitor groundfish abundance and distribution in waters that overlap with this MPA network. There is interest in understanding how this existing long-running survey could support MPA monitoring while also continuing to support stock assessment and other conservation monitoring. Here, we used a simulation-based power analysis to assess the ability of existing monitoring programs to detect changes in population indices of groundfish across the MPA network. Our approach consisted of four steps: (1) fit conditioning models to empirical data, (2) simulate population recovery trends inside and outside of the MPAs under the assumption of fishing cessation within MPAs, (3) apply different sampling strategies to the simulated population, and (4) test the power of these sampling strategies to detect trends across the MPA network. Using a spatiotemporal modelling approach, we applied this power analysis to five conservation priority species well sampled by this survey (Yelloweye Rockfish, Quillback Rockfish, Lingcod, Pacific Halibut, and Pacific Spiny Dogfish). We evaluated power at four-year intervals over a 25-year duration of MPA implementation. Statistical power to detect MPA recovery trends varied across species and effect sizes. For species with faster recovery rates, $\geq 80\%$ power could be reached within the first 10-15 years of MPA implementation using status quo sampling, while for species with slower recovery it may take 20-25 years of monitoring. Reducing MPA sampling frequency generally delayed when $\geq 80\%$ power was reached.

Recommendations on the Design of the Shrimp Survey For Stock Monitoring in British Columbia. Mackenzie Mazur & Virginia Noble (Pacific Region)

British Columbia's shrimp by trawl fishery primarily targets Smooth Pink (*Pandalus jordani*), Spiny Pink (*Pandalus eous*), and Sideshripe Shrimp (*Pandalopsis dispar*), with stock status estimated from fixed station trawl surveys that only partially cover their coastwide distribution. To evaluate the survey design, we tested alternative spatial sampling schemes using simulated data from a spatiotemporal operating model fit with sdmTMB. Systematic, simple random, and stratified random sampling designs with varying sample sizes (70–130 tows) were compared against the current survey. The current survey design was consistently less accurate and more biased than all candidate sampling schemes, with systematic sampling performing slightly better among feasible options. A new coastwide survey area of 70,421 km² was defined using habitat predicted from species encounter models, implying ~200 tows spaced ~19 km apart with current resources. We recommended adopting a systematic sampling scheme across the new coastwide survey area. Although with this recommendation, we face a challenge implementing the recommended survey design when it focuses on monitoring coastwide stock status and fisheries management requires indices at small spatial scales.

Integrating fisheries survey data: theory, practice, and open questions. Sean Anderson (Pacific Region)

Analysts are increasingly turning to model-based approaches to join datasets from neighbouring surveys, combine data across different gear types, or account for gear changes within a single survey. When applied carefully, these methods can improve precision and accuracy in index estimation and distribution modelling. In this talk, I will cover the theory behind data integration—including same- versus expanded-domain integration, accounting for catchability vs. length selectivity, spatially varying catchability, and combining different data types—along

with the practical implications of the various approaches. I will briefly demonstrate how to implement these methods using sdmTMB. I will close by discussing what we should consider before integrating survey data, along with open questions about the limitations of these approaches.

Ecosystem surveys in the Maritimes region: past, present and future challenges. Eric Brunson (Maritimes Region)

The Maritimes region RV survey has been occurring for over 50 years covering the Scotian Shelf, Bay of Fundy and Georges Bank. Although originally designed as a groundfish survey to support stock assessments, more recently it has taken an ecosystem approach contributing data to a variety of groups with different goals from monitoring physical oceanography to species at risk. As a random stratified survey, it is crucial to the time series to maintain consistent sampling protocols both spatially and temporally. However, changes in vessels and gears, vessel availability and new exclusion zones from protected areas and wind farms pose unique challenges in maintaining a comparable time series. The goal of this presentation is to discuss some of the challenges occurring within the Maritimes region in order to collaborate and contribute to potential solutions.

Cetacean surveys in the Canadian Arctic. Marianne Marcoux (Arctic Region)

Most abundance estimates for Arctic whales are derived from aerial surveys, which typically follow a distance sampling design. Survey areas are divided into strata based on existing knowledge of species distribution and relative abundance. Transect lines are flown using a systematic design with a random starting point. Key challenges include correcting surface counts for animals that are submerged and therefore unavailable for detection during the survey. In addition, the aggregated distribution of most whale species further complicates survey design and the interpretation of resulting estimates. For this presentation, I will give examples of beluga and narwhal aerial surveys.

Spatially balanced sampling methods (Paul van Dam-Bates)

Over the last twenty years, modern statistical sampling methods have proposed alternatives to simple random samples and systematic when selecting a spatial sample. These methods balance the improvement in precision from well spread samples given by grid-based samples, with flexibility of random samples by randomly generating spatial samples that are well spread in space, as well as in other dimensions, such as the covariate space (e.g. depth). I'll present some details about different spatial sampling methods and the R package 'spbal'.

Model-based indices of juvenile Pacific salmon abundance highlight species-specific seasonal distributions and impacts of changes to survey design. Cam Freshwater (Pacific Region)

Changes in survey implementation can bias traditional design-based indices of abundance, particularly for migratory species where local abundance can vary at short temporal scales. Spatiotemporal model-based estimators provide a flexible alternative that can better account for changes in the timing and location of surveys. Here we develop a geostatistical model, a generalized linear mixed effects model with Gaussian Markov random fields, that is sufficiently flexible to account for changes in survey design, as well as seasonal and interannual variability in abundance and spatial distribution. We then apply this model to a suite of migratory species—juvenile Pacific salmon—with survey data collected from southern British Columbia’s continental shelf over the previous 25 years. Juvenile Pacific salmon showed species-specific spatial distributions with considerable seasonal variability. While the location of species-specific hot spots varied among years, seasonal variation in distributions were greater than interannual variation. We found that a shift from standard transects and opportunistic sampling to a random stratified survey design resulted in lower estimates of abundance for four of five juvenile Pacific salmon species; however, these differences were not significant after accounting for other sampling attributes. Trends in abundance for several species shifted when models included survey and diel effects. Our approach provides a means of deriving indices of abundance for migratory species from surveys with variable effort in time and space. Ultimately such indices can be used to better understand the ecological mechanisms regulating productivity by linking distribution and abundance to environmental drivers.

Challenges with variability in survey design for assessing Dungeness Crab in BC.

Brendan Aulthouse (Pacific Region)

The British Columbia Dungeness Crab fishery is assessed through a number of surveys, which vary in methodology across the seven Crab Management Areas. Two southern areas are assessed via a DFO pre- and post-fishery survey, with approximately 60 fixed station sites. Another four areas throughout the coast are assessed via fewer index sites, but at a higher temporal frequency (1-2 sites, sampled every month). These sites are sampled such that a minimum number of crabs is sampled in each area. One final management area is assessed only during the approximate timing of the major male moult, to determine if the fishery should open or close. The time series of these survey programs ranges from 15-30 years. As DFO looks to implement stock assessments and reference points for the Dungeness Crab fishery, the variability in data collection throughout the coast represents a challenge.

Laurentian Channel Survey. David Poissant (Quebec Region)

Since DFO stopped monitoring Redfish in Unit 2 (NAFO 3Ps4Vs4Wfgj) in 2002, the industry has led a biennial Redfish survey with scientific support from DFO. In 2024, a comparative experiment between the NGCC John Cabot and the industry vessel revealed methodological issues resulting in the invalidation of data collected since 2020. DFO is now moving forward to lead the survey in 2026, broadening its scope from a Redfish focus to a more comprehensive ecosystemic survey. This presentation aims to 1-introduce this new Laurentian Channel Survey to DFO personnel across regions, and 2- present and discuss methodological questions to integrate best practices in survey design.

The Northern Gulf of St Lawrence Ecosystemic Survey: improving efficiency and analytical methods. Jean-Martin Chamberland (Quebec Region)

Northern Gulf of St Lawrence (nGSL) Ecosystemic Survey is random stratified bottom trawl survey covering 118,587 km² with 33 calendar days of boat time. Time spent for searching trawlable grounds and increasing complexity of wetlab and oceanography protocols have contributed among other things to a decrease in number of stations fished since the mid 2000s. Consequently a number of strata are not fished each year. A few of solutions to ensure a better spatial coverage have been implemented and others are going to be presented. Also, the actual analytical method to impute values in missed year-strata is going to be presented. New imputation methods as well as alternatives to the design based estimator will also be discussed.

Overview of methods for the annual multispecies survey in Baffin Bay and Davis Strait (NAFO subarea 0). Sheila Atchison (Arctic Region)

Since 1999, DFO has conducted multi-species, stratified random, bottom trawl survey to assess stocks of Greenland Halibut (*Reinhardtius hippoglossoides*) in Baffin Bay and Davis Strait (specifically Northwest Atlantic Fisheries Organization Subarea 0, Divs. 0A and 0B). The survey has undergone changes over the years with regards to survey area (e.g., removing area due to closures), gear, platform, and depths surveyed. The objectives of this presentation are to 1) provide an overview of methodology, 2) review changes and how they've been implemented, and 3) discuss potential improvements and refinements.

Overview of current challenges in the Newfoundland & Labrador multispecies trawl surveys. Laura Wheeland (NL Region)

The Newfoundland and Labrador multispecies trawl survey is the largest science program in the Region. The current survey designs cover an expansive spatial area, spanning six NAFO Divisions (2HJ3KLNO) and 515,000 km² in the autumn and four NAFO Divisions (3LNOP) and 324,000 km² in the spring. Although there have been changes in coverage, vessels, and gear over the timeseries, these survey provide information over a >50 year period, informing stock assessments and associated scientific advice for fisheries management, ecosystem assessments, monitoring of species at risk, marine conservation monitoring, and a variety of research programs. Plagued by issues of vessel availability and efficiency, and increasingly hostile weather conditions, the fall and spring surveys have not been fully completed as designed since 2010 and 2019, respectively. Gaps in coverage are most evident in deep water and northern areas, and set density throughout the area has been reduced by 20-30% in recent surveys. Many analyses face compounded challenges due to an incomplete comparative fishing program associated with the introduction of the CCGS Capt Jacques Cartier and CCGS John Cabot. We present an overview of the current NL multispecies trawl surveys, their challenges, and ongoing efforts to continue the provision of robust scientific advice in the face of incomplete survey data.

Finding good sample sizes for length, weight and age in pelagic trawl surveys of the west coast of Vancouver Island. Chris Rooper and Jennifer Boldt (Pacific Region)

The IPES survey is conducted using a stratified random sampling design off the west coast of Vancouver Island in the summers since 2017. The survey samples pelagic fishes including Pacific salmon and Pacific herring. The objective of this analysis is to determine the sample sizes needed to accurately represent the size (length and weight) and age distributions for Pacific herring captured in the survey. The sample sizes needed for each metric were generated using statistical theory and the characteristics of historical data prior to the survey in 2022 and then data were collected using this protocol in July-August 2022 and in July-August 2023 implementing the sampling plan. Pennington et al. 2001 analyzed bottom trawl data across a number of surveys and found that taking fewer samples from more tows is better for quantifying the age, length, weight characteristics of a population and that taking more samples within a tow is not effective past a certain point. So randomly sampling every tow for herring was used as an overarching principle. Gerritsen and McGrath (2007) multinomial sampling method found that as a rule of thumb that if you sampled $10 \times$ the number of length bins, you get reasonably good CV's. This rule of thumb could also be applied to weight and age bins. Hulson et al (2017) simulated the effect of age and length sampling to determine the impact on stock assessments. It basically used a simulation study (operating model) to test what different types of sampling did for stock assessment. It concluded that proportional allocation or simple random sampling (this would be taking a random age sample from the length sample) was the best method (in that it requires least number of samples) for determining age distributions. For roundfish (although there were no herring included in the analyses) it showed that taking age structures from a random 10% of the length samples roughly achieved the sampling goals (based on a CV of 15%). They also found that for species with higher growth rates (this would include herring), the sample size could be decreased. Based on the variability in length in the historical data, for each tow there were roughly 11 samples taken per 0.5 cm size bin. To achieve a multinomial CV of 25% would take 11 length samples per 0.5 cm size class or 178 total samples assuming the average number of 0.5 cm size bins. The average multinomial CV in the historical data was 0.292 and the average number of weight bins was 18. In this case the size classes were 5 g bins. In an average tow there were roughly 10.2 samples taken per 5 g size bin. To achieve a multinomial CV of 25% would take 11 length samples per 5 g size class or 199 total samples. The historical average multinomial CV was 0.171 and the average number of age classes in a tow was 4.8. In an average tow there were roughly 20.3 samples taken per age class. To achieve a multinomial CV of 25% would take 9 age samples per age class or 43 total samples assuming the average number of ages per tow. So based on the literature and the preliminary analysis, a target sample size of up to 150 lengths and weights from each tow was used, and measuring and weighing all individuals where less than 150 are caught. The specific age collection process implemented in the 2022 IPES survey was to collect 5 scales from randomly selected fish in tows with ≤ 25 fish, 10 scales from tows with ≤ 50 fish, 15 scales from tows with < 150 fish, and 20 scales from tows with > 150 fish. The mean weighted multivariate CV for 2023 was 0.363. The mean weighted multivariate CV for 2023 was 0.386 for herring weight. The mean weighted multivariate CV for 2023 was 0.309 for herring age.

APPENDIX C. PLENARY AND BREAKOUT GROUP TOPICS IDENTIFIED PRIOR TO THE WORKSHOP

CHAIR-PROPOSED GENERAL THEMES

1. Scoping surveys for stock assessment: what data are needed from surveys to support stock assessments?

- a. What are the main existing gaps (multispecies, seasonal, regions, etc.)?
- b. Are we doing the types of surveys and using the best approaches to support modern stock assessment?
- c. Are there alternative designs and approaches being contemplated or applied elsewhere and worth considering here?
- d. Evaluating surveys – Maximizing value for effort/cost, optimizing across different data needs.
 - Survey frequency: seasonal, annual, biannual, etc.
 - How many samples are needed (oversampling/undersampling) for survey variance.
 - “Catch” subsampling: how much, how and what are the needs to support assessment? Length stratified v. random?
 - Multispecies concerns - optimizing for multispecies?

2. Designing effective and efficient surveys for the long term

- a. How to make surveys robust to current and future environmentally-driven changes, e.g., changes in species availability? Is there a solution for index-site based surveys used for a number of invertebrates, for example?
- b. Analytical and numerical (simulation) methods for survey design and to evaluate survey effectiveness.
- c. Transitioning from one design to another
- d. How to deal with unavoidable changes in survey domain such as exclusion zones due to MPAs and windfarms? How can existing surveys contribute to monitoring needs in MPAs, thereby reducing the degree of exclusion?

3. Survey data analysis:

- a. Standardization and calibration.
- b. The relative merits of design versus model-based estimation.
- c. Models to fill in gaps, join surveys: possibilities, validation and limitations

4. Workshop and training needs with respect to survey planning, design and analysis .

PARTICIPANT PROPOSED BREAKOUT GROUP TOPICS

- Navigating changes in survey design (Host: Meghan Burton and/or Chris Rooper)
 - This breakout group would provide participants the opportunity to share successes or lessons-learned when transitioning between surveys (such as managing changes in survey coverage, frequency, design, subsampling protocols etc), and to brainstorm some "best practices" or practical approaches to dealing with survey changes. Some ideas for topics of discussion include analytical methods for dealing with different survey designs over time, how to deal with competing survey objectives or changing survey objectives, ways to bridge old and new survey methods, or practical recommendations for communicating changes and timelines of changes to management, or anything else that is of interest to participants
- Exploring the strengths, weaknesses, and limits of model-based approaches to survey data standardization and data integration (Host: Sean Anderson)
 - Topics could include accounting for episodic or systematic loss of survey domain, integrating data across surveys or gear types, and related challenges. When are these approaches warranted? How do we as a field determine their limits? And how do we progress towards a principled set of best practices?
- Current uses (across regions), limitations for advice provision (e.g., reference points, stock status), and future research needed or training for staff for (1) Passive survey gear surveys (e.g., traps, longlines) and (2) Visual surveys. (Host: Shannon Obradovich)
- How to use modern tools to redesign an existing long time series survey for more efficiency while maintaining comparability.
- Dealing with unavoidable changes in survey domain: How to deal with unavoidable changes in survey domain such as exclusion zones due to MPAs and windfarms? How can existing surveys contribute to monitoring needs in MPAs, thereby reducing the degree of exclusion?
- Survey design under increasing constraints to vessel time
- Use of models (spatio-temporal or other) for survey design modification (e.g. reduction in number of tows, periodic surveys in less surveyed areas) to help address increased demand for broader spatial coverage but a decrease in vessel days or staff available.
- Methods to correct for preferential sampling when using data from small-scale targeted projects (e.g., SCUBA surveys) and/or fisheries-dependent data (e.g., at-sea sampling of commercial catch).