

Session 1 summary

Current status of mobile and static sampling gears used in resource surveys

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Survey sampling tools: challenges, themes and questions

Introduction

The conference proceedings included a session on the "Current status of mobile and static sampling gears used in resource surveys". The session had invited papers on the following types of study:

- (i) Survey gear design and use, including innovations to meeting ecosystem survey requirements.
- (ii) Fish behaviour, gear rigging, and fishing strategies that affect survey trawl catchability, including vertical and horizontal herding and escapees, bridle angles, effect of tow duration, groundgear choice, bottom contact, and speed over ground and through water.
- (iii) Effectiveness of standardization and quality control programmes that focus on survey gear construction, rigging and repairs, and minimizing variation in catchability.
- (iv) Use of fish behaviour, and performance and geometry/stability data from instrumentation, in estimating catchability; raising catch per unit effort (cpue) to abundance estimation.
- (v) Requirements for intercalibration of survey gears and survey vessels. The focus should be on experimental design and statistical analysis of data, including precision of intercalibration factors.
- (iii) How to deal with all the factors that give bias and variance in gear catches;
- (iv) Why we can make some changes easily and not others;
- (v) Can we, should we, develop more software tools and laboratory studies to explore what happens with our gears in the sea?
- (vi) Gear mensuration and behavioural observations: minimum standards for data collection on surveys for gear.

Choice and integration of survey tools

In the 21st century, the range of capture tools for surveying resource abundance in the ocean is continually widening. They include the traditional methods, such as trawls (otter trawls, beam trawls, etc.), seines and purse-seines, gillnets and trammel-nets, and longlines, and now extend to new methods (or at least novel for survey scientists) such as pots, traps, and cameras on ROVs, and baited lander systems. Ichthyoplankton and acoustic surveys were beyond the scope of this conference, so we restrict this discussion to surveys that depend on capture methods.

Often, the gear used in a survey will have been the same for many years. This is particularly true where the survey outputs are used in analytical stock assessments, because consistency in the time-series is a major requirement. However, as surveys are increasingly required to deliver information on non-commercial species, the make-up of fish assemblages, and biodiversity issues, the original gears used for these tasks may not be appropriate. Often, survey gears were derived from commercial gear to target specific species, which may not be efficient at capturing other non-target species, fish, or invertebrates. Many of our traditional gears, particularly towed gears, can only be operated in limited areas, e.g. soft ground, restricting their ability to sample representatively. In some cases, it may even affect our ability to sample our target species. Additionally, reductions in data from fishing sources caused by effort reduction give survey data increased value.

One solution to this problem is to develop a survey trawl that is non-selective, or at least as unselective as possible. Valdemarsen

Our summary is based on the papers presented in the session and on the extended plenary discussion that followed. It does not attempt to summarize any of the presentations, but rather tries to capture the key emerging issues and challenges for the survey community, based on a number of themes presented by the moderator for discussion. The opinions of the delegates were recorded and included here. The themes were:

- (i) Choice and integration of survey tools;
- (ii) Fish behaviour in relation to survey gears and modifications;

et al. presented one project that endeavoured to achieve this. Another approach is to utilize the range of different sampling tools available. However, the challenge is in integrating these other tools to provide the wider view that we seek. Several papers illustrated this search for integration. Jones *et al.* considered how to relate baited camera observations with catches in trawls, whereas Castro and Gibson looked at lobster capture in trawls and pots. Fraser *et al.* used different trawl methods to provide a wider view of fish community. These studies found that using two different methods in the same area can provide complementary perspectives. For instance, information from the different gears can confirm or modify our view of a particular ecosystem or fish assemblage. Alternate methods can also be used to ground-truth older time-series, and not simply to replace them. We can also learn more about how to interpret the data from these time-series more appropriately.

The main challenge is to understand the different catchabilities of different gears and to determine how to relate them to each other and integrate the observations. We have some understanding of selectivity for trawls, but very little for other approaches. For instance, the understanding of fish behaviour in relation to bait is still fairly rudimentary, and this will affect pots and baited cameras. Clearly, there is a major role for fishers in this wider range of survey tools, many of which will have been used commercially, e.g. pots and traps. As scientists, we have much to learn about their use.

Finally, it is important to consider the purpose of our surveys. Often, we are now being asked to provide biomass data, distributions, and biodiversity and ecosystem data from surveys not originally designed to provide these types of information. In many instances, the surveys are being modified to achieve these goals, but these modifications may not actually work well for either the original purposes or the new ones. Perhaps, we should consider carefully what we want from our surveys, both in terms of data and maintaining time-series, then design surveys and choose tools that fit the identified purpose. Also, we should not oversell our surveys, and make it clear to managers what these can and cannot deliver, and in what detail and precision.

Fish behaviour in relation to survey gear and modifications

To achieve much of what is discussed earlier, we need to understand better how fish and other organisms behave in relation to survey gear. This understanding is essential to selectivity estimation and to the integration of different gears in more holistic surveys.

Many papers presented in this session made suggestions about fish behaviour in relation to the gear, without actually observing that behaviour directly; for example, Walsh on tow duration and Langeland *et al.* on groundgear and escapes. The presentation by Reid *et al.* illustrated how direct observation of fish behaviour could be applied to direct evaluation of catchability.

The main problem is that direct observation of fish behaviour in the field is expensive and time-consuming, and it is difficult to control for external factors, such as light, weather, water movements, fish condition, and abundance. At the same time, it is also difficult to carry out appropriate fish behaviour studies in the laboratory, where natural reactions are unlikely and maintenance of fish is often difficult. The challenge is to gather data in either approach that is applicable across a broad range of conditions. This challenge is as true for mobile gears as it is for

static gears, and it is arguable that understanding fish behaviour is even more important to evaluating static gear than it is for mobile gear.

One possibility that should be explored further is the use of computer-based simulation methods, such as that presented by Takagi *et al.* Such models can be used to simulate the physical aspects of the gear, but the key is to include the fish in the model. Examples of this were demonstrated for commercial gears by O'Neill *et al.* and Eayrs *et al.* in the other conference sessions. The combination of individual-based modelling of fish behaviour from observations and the physical modelling of the gear represents a powerful research tool. Such models could be used to predict the effect of different gear components on catchability, but perhaps most important, they allow us to understand that capture systems are most sensitive to fish behaviour. This understanding could be used to target our fieldwork more appropriately and make the best use of our limited resources and field time.

How do you deal with all the factors that give bias and variance in gear catches?

Implicit in the two sections above is the need to continue examining the performance of our sampling gears, old and new, in relation to our aims, whatever they may be. Five papers (Somerton *et al.*, Langeland *et al.*, Walsh, Kynoch *et al.*, and Reid *et al.*) looked at the performance of survey gears and factors that might affect the results. These factors ranged from the performance of the groundgear to tow duration and weather. Other factors identified during the discussion included density-dependent catchability and the presence of other species affecting catchability.

Clearly, it is important to understand how our gears perform in relation to both intrinsic (construction, ground contact, etc.) and extrinsic (substratum, weather, fish abundance, etc.) factors. What is less clear is what we should do when we have identified sources of bias and variance.

One route would be to identify changes to the gear that would remove bias or reduce variance, e.g. reduce escapes under ground-gear, but changing gear might affect our time-series. Alternatively, we could quantify the effect, and then develop model approaches to “correct” for the effect. This correction would require analyses to prove that variance was actually reduced and that we were not simply introducing more variance from our measures of an external effect. A simpler alternative would be to carry out sampling under a restricted range of conditions. Therefore instead of modelling a weather effect, we could restrict fishing to weather conditions where its effect was small, but this would reduce the number of trawl stations we could complete in a given time, potentially increasing variance.

One approach proposed in discussion, which has not been attempted so far, is to document all these factors and provide them to stock modellers, who could use the information to address changes in time-series or bias–variance issues, as they would with factors such as changes in fishing pattern, fish growth/maturity, or index performance. This issue led neatly into the next question discussed.

Why we can make some changes to surveys easily and not others

Most survey operatives will have encountered the request from assessment scientists that no changes be made to survey gears or

practices to maintain consistency in the time-series. At the same time, we see other changes being made with little or no consideration, e.g. haul duration and survey vessel. Sometimes changes are made and intercalibration exercises carried out to quantify the effects of different variables. However, these are very expensive and often inconclusive. On the other hand, sometimes we will continue to use a “bad” net or survey practice, simply to maintain consistency.

How “bad” do our surveys have to be before we change or remove them? Use of tools such as trawl performance monitoring gear or symmetry sensors can bring us closer to optimal trawl performance. However, if we started out without these, our surveys have likely become more “efficient” with them. If efficient means that we get a better cpue, then we need to understand and control for these effects on the longer time-series.

An immediate need is the ability to catalogue “all” changes that have been made in a survey across its life. These metadata should include gear and gear-use changes, as well as vessel and survey methodology changes. This catalogue should allow the investigation of the impact that these might have had on the survey performance. A second possibility is to allow changes, but to introduce a group of changes at one time. Then if we have a new vessel, we could also introduce shorter tows and better instrumentation at the same time. Probably the worst scenario would be the regular introduction of small changes that are not documented. Most important, there needs to be a consistent approach that is agreed by all parties involved in the use of the survey and gear.

Can we, should we, develop more software tools and laboratory studies to explore what happens with our gears in the sea?

The simple answer to this question from the discussion was yes. As described earlier, software modelling can be used to identify gear components or rigging that is most likely to affect performance. Models already exist that incorporate both the mechanical aspects of gear and some behavioural elements (O'Neill *et al.*), and these can be developed further. The predictions from the models can then be tested in field experiments. This should result in targeted and cost-effective field observations. This advance should lead to an iterative improvement in both the models and our understanding of gear and fish behaviour.

Laboratory-based studies also have a role in this process. We should be able to test aspects of fish behaviour, identified as important in the models, or where the model is very sensitive to assumptions of fish behaviour, e.g. response to twine colour or in dark–light environments. Again, laboratory-based studies should help make predictions that can be tested in the field.

Gear mensuration and behavioural observations: minimum standards for data collection on surveys for gear

To follow up on all the types of research described earlier, we will need to collect and analyse a wide range of data describing our gear. This range will cover both the intrinsic aspects (wing spread, bottom contact, etc.) and the extrinsic aspects (weather, substratum, fish community, light levels, etc.). The delegates considered that it was important that there should be consistency in what is collected, and that standards for this consistency should be established. For example, standards could be established for where sensors are mounted to measure wing spread, sensor calibration, and so on, so that we are able to relate data from one situation to another. Advice on this is being provided to ICES by the Study Groups on Survey Trawl Standardization and on Mesh Measurement Methodology. A more difficult task is to set standards for behavioural observations. The interpretation of behaviour is quite subjective. However, standards have been developed for behaviour research in terrestrial situations, and these standards could be consulted to start the same process in our research.

Conclusions

The broad conclusion of this session on survey gears was that much work remains to be done, but that we are developing the tools and methodologies to address the key issues. Survey planners are being asked to answer an increasingly wider range of questions, and this expansion of responsibilities will affect our choice of gears and our analysis of the data. In particular, we need to:

- (i) Understand the priorities for these surveys; abundance estimation, biodiversity, ecosystem monitoring, etc.;
- (ii) Understand the factors that affect our gear performance and how to deal with these effects, either by improving the gear or dealing with the variance analytically;
- (iii) Have a good understanding of how fish (and other species) behaviour affects our results;
- (iv) Make better use of models and laboratory-based research to focus our limited potential for field studies;
- (v) Continue to develop alternative gears to provide a wider perspective than trawling alone can provide; and
- (vi) Have common standards for data collection and analyses.

doi:10.1093/icesjms/fsm141