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Electronic catch recordings for scientific and commercial use

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Short summary

For assessment and management of marine fish resources, representative data of statistically good quality describing the actual catch are lacking for many fisheries. Even for the most studied fisheries in the North Atlantic, the uncertainty regarding what is actually caught has implications for management. Fish stock assessments and sound advice in most cases rely on representative samples of catches. Distant and high sea fisheries often suffer from poor sampling due to sampling personal logistics. Consequently, stock assessment and management of marine fish resources exploited by those fisheries are based on poor or scarce catch data. Presently, sampling at sea is often random in time and place, and not necessarily representative with respect to the fleet metier. Biological sampling in distant waters is a challenge due to logistics and high costs. The use of electronic scales onboard commercial fishing vessels opens a new approach for data collection. In recent years electronic scales measuring individual fish weights on deck have been connected to GPS in combination with data on depth, fishing gear, logbook information etc. This approach will link detailed data to auxiliary information on the fishery, thereby meeting the challenges of obtaining representative fishery data, that is continuous and complete and willprovide sufficient data for fish stock assessments and, hence, subsequent fisheries management of species found in distant waters.

CONTENTS

1. INTRODUCTION

For the assessment and management of marine fish resources, representative data of the actual catch are lacking for many fisheries. Even for the most studied fisheries in the north Atlantic, the uncertainty regarding what is actually caught has profound implications for the management of a number of species. Estimation of commercial catch composition is most often based on port samplings or more rarely observations onboard fishing vessels. However, onboard sampling is often rare and scattered, and it may be questioned how representative these data are of the actual catches. The sampling onboard fishing vessels is often conducted by scientific personnel and the long trips to distant waters by some high sea fisheries make it a challenge to sample these fleets.

The waters off East Greenland and the Barents Sea are important fishing areas for commercial fishing fleets from several nations. These waters represent large as well as distant areas, which mean that science faces comprehensive challenges to obtain representative data from these fishing fleets (Helle & Pennington, 2004). The fishery is conducted far from shore in both East Greenland waters and the Barents Sea and the vessels operating in these areas are large factory vessels that process the catch on board. The trips are of long duration, and as the catch is processed on board, port sampling is usually impossible. A scientific crew will have to stay onboard for a long time, which not necessarily fulfills the needs for a representative sampling from the total catch. Presently, sampling of the fishery is limited, especially for the offshore fleet in East Greenland, and observer's data are often limited in time.

The logistic challenges of data sampling are related to all species caught in these waters (pelagic fisheries for redfish, herring and blue whiting, demersal fisheries for northern shrimp, cod and Greenland halibut). The catch is usually sorted at sea with respect to size, depending on market demands and production needs onboard. Related to this sorting procedure, many vessels now use electronic sorting machines – called "graders" that record the individual weights of the fish in the catch. This detailed information is now only used for sorting by size and to estimate total fish weight on board (Fossen 2003 a, b). Data modules are now being developed aiming to record individual fish weights and combine these weights with other

available data from the log-instruments on the vessels – such as GPS and echo sounder readings (Fossen, 2003 and b; Dyb & Bjørshol, 2005). This will provide a detailed and continuous record of the catch, combined with information on fishing depth position and effort.

This paper summarises the experiences of a pilot project on electronic catch registrations funded by NORA and the Norwegian Research Council. The overall aim of the pilot project was to evaluate the current possibility and suitability of using electronic scale data and to establish a basis for a larger, comprehensive project that will focus on the potential for combining and collecting data from automatic weight registrations (Grader measurements) as well as other data systems onboard fishing vessels employing existing or new software (*e.g.* Datafangst). Furthermore, there is the potential of streamlining the catch registration process onboard fishing vessels to improve fishing performance, as well as to increase data acquisition which will improve the scientific management of these stocks.

2. STATE OF THE ART

Graders and other electronic weight recording systems onboard fishing vessels often measure individual weights in order to sort the fish into weight groups (see illustration in Figure 1). These data are not used for other purposes, but it is possible to collect and store them systematically. This may be the foundation for collecting more detailed catch data, which will provide ship owners, fishermen, and fishing industry as well as research scientists with systematic information on fishing performance and catch composition. Combining such data with other electronic measurements from the fishing operation (depth, temperature, position, date, weather, etc), which are usually available on most fishing vessel, will provide data for stock assessments that are more precise and complete than the data available today.

Many of the commercial fish species migrate over distances that are related to their life history (*e.g.* growing up, feeding, spawning, etc.). Fishermen use their fishing experiences to determine when and where to fish relative to these migrations. They adjust their fishing performance to the catch rates and the availability of fish species that they have experienced previously. The use of grader / electronic catch recordings combined with other available information will make this planning process easier. So far this information is often only

available for the captain of the ship, but recording these data electronically will make the information available for the entire company.

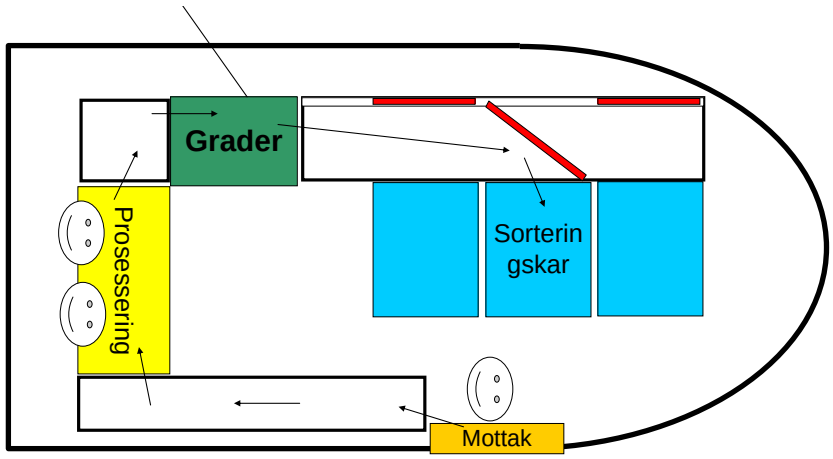

Figure 1. Typical installation of a grader on a high seas fishing vessel.

A research project conducted by Møreforsking in collaboration with Maritech developed a software program "Datafangst" to retrieve, store and exploit grader data and other data of interest from fishing operations. The program receives data from several data sources onboard fishing vessels (GPS, echo sounder, trawl data), and combines and stores the data automatically along with the individual weight and species recordings. Furthermore, it is possible to include information in the data record such as:

- Vessel type
- Name of the vessel
- Captain's name
- Gear type and specification
- Gear condition (after the haul or setting)
- Crew
- Wave height
- Other comments

Today, the software must be controlled by an operator, typically the captain who can easily replace his logbook with this electronic tool with no increase of effort. A picture of the operating panel with illustration of possible instruments to connect is shown in Figure 2.

Datafangst is designed for operating with passive fishing gear. It needs adjusting for use with active fishing gear, but this will require only minor changes in the program.

The catch is often stored before being processed in the onboard factory. Thus there is a lag betweenich the actual time the catch is taken and the time the catch is sorted by the grader. This is solved in the program by using a joint storage area for all the grader data. After the catch at a station is processed, the data is assigned to the correct station by the operator.

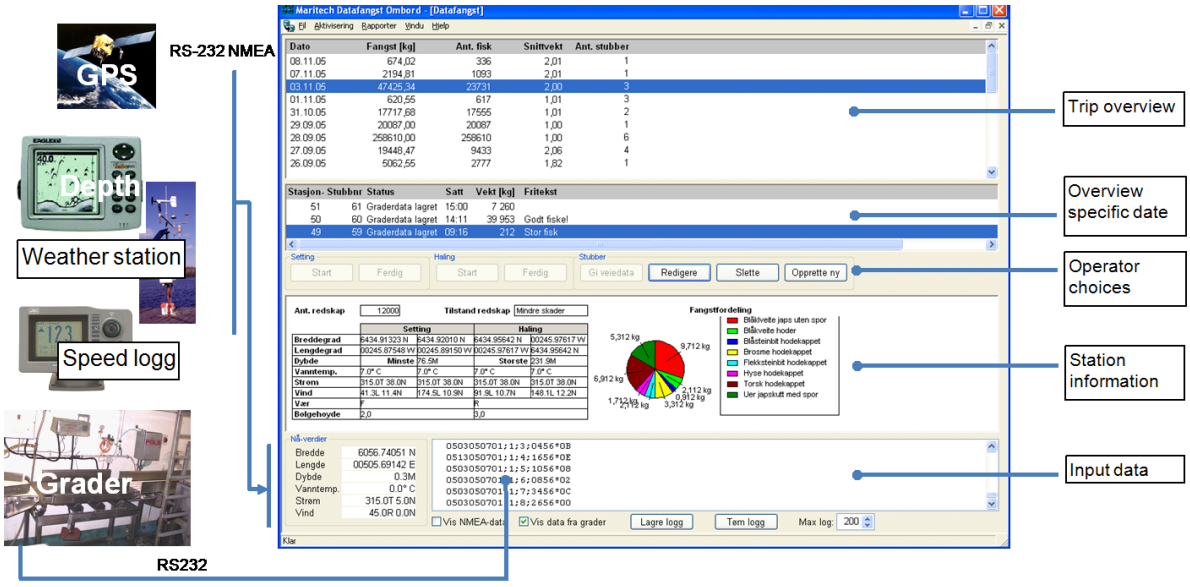

Figure 2. Operating panel from the programme Datafangst, with illustration of possible instruments that could be connected.

The basic platform for the program is now finished, but to reach the full potential of the program, additional modules are needed for generating reports as well as for exporting data. The present program is basically a data collecting platform, and particular analysis of the data can be implemented using added program modules. This provides flexibility and the possibility to serve several users. The program was developed to take into account the needs of the fishing industry as well as scientific requirements. It has been constructed to correspond with established sampling routines, making it easy to export data in a familiar format to researchers. The data protocol of the Institute of Marine Research, Norway, was used as a model for the content and format of the database. The data can be exported at present and

combined with existing data sets with only minor adjustments. It would beneficial to create an export module that would provide an exact format match with one or more management databases.

The fishing industry can use the data in many ways. For example, detailed information can follow the fish to the buyers at the market, providing good tracking possibilities and detailed description of the catch. Today the tracking starts at the processing plants, but in the future it will be necessary to track the fish back to its origin, or fishing area. This is because the market will demand a fish product that is captured from a stock that is within safe biological limits, with environmental friendly fishing gear and that is fished in a healthy environment. Many markets black lists certain species because of poor stock sizes or the fish are from a non-reported fishery. Generated reports from Datafangst will work like a certificate documenting the origin of the fish. Furthermore, the vessels will have detailed a history of their catches. Maybe this can even be used to predict catch rates, and where and when to fish next year?

Historical documentation will give the fishermen objective observations of what they experienced at sea, a huge advantage in discussions when they disagree with the government or scientists. For example, today discussions concerning the possible negative effect from seismic activity on fish stocks might have been solved if historical documentation at the detailed level of "Datafangst" had been available. For larger companies with several boats, information can more easily be exchanged among the vessels and priceless information will not disappear with the captain.

"Datafangst" is presently installed on two fishing vessels operating in the North Atlantic; "Leinebris", a Norwegian longliner and "Sisimiut", a Greenland trawler. Both installations were successful, but were halted because of a lack of funds for their continued development. Maritech AS has also decided not to develop Datafangst further, but Marel, who are the main installers of grader systems on fishing vessels, may be interested to adapt either Datafangst or a similar program to the needs of management and fishermen.

So far a few projects have studied the potential of using grader data. Møreforsking Marin and the Institute of Marine Research, Bergen have during the last 7 years worked with several small projects directed especially towards the collection and use of grader data together with the company Maritech AS (Fossen, 2003 a, b; Dyb & Bjørshol, 2005). Today individual recordings of the entire catch can be collected from a number of vessels. This has been made

possible by several projects supported by the Research Council of Norway (Fossen, 2003 a and b; Dyb & Bjørshol, 2005). The projects have focused on the general characteristics of this type of data as well as evolving solutions for how to store data from grader systems combined with information regarding the specific station (position, date, time, depth, weather conditions, etc). The latest project (NFR nr. 162410/110) developed software from Maritech AS called "Datafangst" which has been installed on fishing vessels.

Several authors have suggested describing size and species composition through using weight registrations from commercial catches (Berntsen et al., 1999, Anon, 2000, Fossen, 2003 a, b). The main gain related to using such data in assessment and advice, is that uncertainty in fish stock assessments will be reduced by using weight data from fishing vessels directly. Today weight at age data for stock assessments are often obtained using relations derived from a few samples or obtained from scientific surveys with other gear than used in the fishery. Furthermore, grader data will provide large amounts of objective data that will allow a continuous online description of fishing operations, a new evaluation of present sampling strategies as the variation in catch composition is made available, and, finally, will increase our biological understanding of the fishery. It is also obvious that individual fish weights can be sampled in a cost-effective way as most electronic graders can be connected to a PC for continuously storing of weight records in a simple manner. The data are particularly useful for fisheries where no or little data are available, and will optimise scientific sampling regimes through a full description of catch compositions onboard vessels. The data will provide information on catch composition over time and reveal if there is variability in catch composition over time or geographical areas. Weight measurements from electronic scales are objective, which will provide an international standard with respect to sampling.

Established fish stock models are today based on a relatively small amount of data. The gain from an enormous amount of data on nearly the total catch will provide for assessments is unknown. Because of the detailed description of the catches over time, it may be possible to track changes in the stock. For example, it may be possible to calculate the age structure of the stock based on weights, and therefore reduce the need for reading age structures. This will help to provide non-prioritised species a more complete stock assessment.

Previous studies have pointed to the possible gains with storing electronic data automatically, both with respect to science and for the fishers. There is no indication of anyone using such detailed information, as suggested in our study, for the management of fish stocks at present.

The only known onboard set-up is the one onboard the Norwegian longliner MS Leinebris and the proposed implementation onboard the Greenlandic trawler "Sisimiut". Both the Danish and Canadian management programs have electronic systems to control the catches on some vessels. This is based on a system with cameras, and dedicated people need to go through the films to calculate the characteristics of the catch.

There are other software programs that seek to obtain and store information from the onboard fishery operations for better planning of coming operations and for reporting using electronic logbooks. These are, however, not aimed at storing information of individual fish but rather summed over per-day or by station (catch rates). A South African company has delivered a software program called "olfish" (www.olrac.com), an Icelandic company "Trackwell" (www.trackwell.com) is developing an electronic logbook in association with the Icelandic Directorate of Fisheries, NAFO, NEAFC, and the Faroese Directorate of Fisheries. Both include many of the same ideas as presented in our project reports. Generally, it is easy to see the potential for using electronically stored data for describing the catches. This is the case, *e.g.*, through electronic logbook systems, traceability information, description and availability of previous operations, and for assessment purposes. There are also likely a number of other uses of the data which is not yet obvious (migration patterns, biology etc.) (Fossen 2003 a, b).

3. EVALUATION OF "SISIMIUT" AND "LEINEBRIS" TRIALS

The installation of "Datafangst" onboard "Sisimiut" was done in the Faroe Islands and in Denmark. A dedicated computer was installed on the bridge and connected to GPS and to an echo sounder using serial ports. The computer was also connected to the data network onboard. The grader had to be modified to send out the measurements from a print port. This port is preinstalled on the grader, but it had to be made suitable for a cable from the outside. A communication cable was also installed from the grader to the office in the factory, where the data network onboard was connected. The grader transmits the weights as text strings to a serial port. These data were made available to the computer on the bridge through a serial to LAN converter (Moxa box), which creates virtual serial ports on the data network. The weights from the grader were successfully sent to "Datafangst", but the new setup blocked the possibility to manually program the grader in the factory. This is essential for the production

process, and the grader had to be returned to its original setup. This problem was solved with a new Eprom. After the upgrade it was possible to both send weights to the “Datafangst” and to manually program the grader.

Datafangst was originally programmed to conform with the operation of fishing vessels that use passive fishing gears, but it needed a set-up modification for use in a trawl fishery. Because of several problems, this modification process went rather slowly, but was finally successful. Even if “Datafangst” is intuitively easy to use, training is needed. On board Sisimiut, the software is installed, but there is a need for more training to get the system operational. This must be completed during fishing. It is further planned to collect data from the trawl monitoring system to provide better effort data.

Onboard the longliner “Leinebris” “Datafangst” was installed in the same way as on “Sisimiut”, but some modifications were necessary. A serial cable was installed from the processing deck to the bridge of the boat. Depth and position was collected from the echo sounder and the GPS. “Leinebris” has used “Datafangst” for some time and has asked for further development of the equipment.

4. POTENTIAL APPLICATIONS TO RESEARCH AND FISHERIES ADVICE

Large vessels fish almost continuously throughout the year. They cover large geographical areas and target various species depending on the area and season. Scientific observers are usually necessary to collect detailed catch information from these fishing vessels. But there are fisheries where it is difficult or impossible to place observers on vessels, because, e.g., of the distance to the high sea fishing grounds and areas where there are no requirements for observers.

The detailed information which can be gathered from electronic catch recordings and related software such as “Datafangst” may provide us with new information on the catch process as

well as increase our understanding of fish stock dynamics. Like regular catch rate data (CPUE), the recordings from electronic catch recordings" give valuable information on catch rates but with much higher resolution (see Booth, 2000; Marrs *et al.*, 2002; Swartzman *et al*., 1992).

High sea and long distance fisheries are especially suitable candidates for implementation of the graders. The weight records obtained from graders can, with some minor additional effort in length sampling, provide the precise information on the size distributions of catches for input to stock assessments. An advantage of this system is the low cost in terms of manpower associated with data collection (software installation and data retrieval) and the unbiased measurements produced by graders (since all catches are recorded). Grader data along with additional information about the fishing operation, such as GPS data, echo sounder data and logbook data, would provide sample input for a CPUE analyses and for generic research on the spatial distribution of fishable resources.

To obtain better and continuous samples from the fishing fleet and to increase our knowledge about fleet behavior and technical developments influencing efficiency and effort, the Institute of Marine Research (IMR) began in 2001 a program to cooperate with fishing vessels in all the major gear categories. These cooperating vessels are called the "Reference Fleet". In 2009 there were 16 open sea- and 18 coastal-fishing vessels in the fleet. The gear types included are; gill nets, long lines, purse seines and several types of trawls. Crew members are trained to collect or record biological data such as; length, weight, otoliths, genetic material, stomachs, contaminants, tagging etc. The data are collected and delivered according to terms set in a contract between the fishers and the IMR, which secures a proper statistical coverage for various species over time and area. From the start of the reference fleet sampling program there has been a continuous effort to evolve the sampling design based on previous data, in order to increase the precision of the desired estimates and to optimize the precision with respect to sampling intensity.

Three of the reference vessels are equipped with a grader and three more vessels plan to install graders during 2010. These grader data will provide a means for evaluating the data collected and the sampling procedures employed. The present sampling strategy is that the fishers measure (length and weight) the fish in a sample of 40 fish per- species per-day. The grader measures individual weights for the entire catch and will provide a way to test how representative the subsamples are of the entire catch. In particular, we will evaluate whether

the estimated weight distribution of the entire catch of a species based on the fish in the subsample is unbiased and within the theoretical precision limits of the true weight distribution generated by the grader. Conversely, the sampled data will be employed to test the usefulness of the additional information provided by the grader data.

5. FUTURE BENEFITS

Electronic catch recordings will have several beneficial uses for fishermen. Firstly, the data will allow better documentation of previous fishing operations. Secondly, the data will easily provide a detailed and complete description of the catch which will be of benefit for a closer cooperation between the fishing industry and scientists which in turn will contribute to a better utilisation and exploitation of marine resources. A comprehensive overview of the actual catch may lead to better prices. Traceability of fish products with respect to when and where the fish were caught will be required in the future. Electronic catch registration has a great potential for meeting this requirement.

The electronic recording of catches will provide scientists with a continuous record of catch characteristics for the entire fishery, not just parts of it, which is the case when scientific personnel collect data during selected fishing trips. The method will mean a substantial improvement for obtaining data from the long distant fishing areas where logistics more or less makes sampling impossible because of its high costs and the long trip duration. East Greenland, Norwegian Sea, Barents Sea, and Mid Atlantic Ridge are some examples of such distant fishing areas. In addition, electronic catch registrations give the possibility of obtaining data from fisheries where the fish are processed on board. Finally, data that are sampled automatically using electronic catch registration systems will generate unbiased measurements, since the process is free of personal/subjective factors. An extended software program may also have the potential for dividing catches into more desirable size-groups (and thereby increasing revenue). For example, using grader data a more optimal separation of weights might be determined (for instance, dependent on swell height) to meet specific requests from buyers which would increase the value of the catch. For scientists, the

equipment may provide better fisheries dependent data for assessments and allow the analyses of factors affecting various fisheries, including, e.g., the effect of changes in size distribution.

From an **assessment perspective** there are several gains by having data from electronic catch recordings:

- Sampling from the fishery is now limited, especially offshore fleet East Greenland.
- Observer data often are limited to a few seasons.
- Observer data are not always reliable
- Port samplings of offshore fisheries catches is often impossible
- Use of weight recordings in assessments will decrease uncertainty by reducing the number of recalculations between W, TL, N and back
- Cost effective sampling
- Weight measures from electronic scales are an objective measure.
- Large amounts of objective data which allows
    - A continuous online description of fishing operations
    - An "unbiased" description of a vessel's catch composition, of both size and species composition.
    - Allow optimizing of scientific sampling regimes through a full description of catch composition onboard vessels.

Expected gains related to **fishing operations** are:

- Allow better documentation of fishing activity, easier access to previous activity, and thus improved and more efficient planning of future fishing operations.
- Detailed description of catches which will lead to a better and closer cooperation with research scientists. In turn this will mean better and more secure utilization of marine resources.
- More detailed information on catches which in turn will increase the value of the catches.
    - Particular benefits of grader data include: Provides better fisheries dependent data for assessments and hence better utilization of resources.
    - Allows analyses of which factors affect various fisheries and in what way. Optimal limits for separation weights might be determined (for instance dependent on swell height) to meet requests from buyers and thus increase the value of the catch.

- Electronic sorting by weight improves efficiency:
    - Processing of the individual haul.
    - Planning the next haul.
    - Planning the strategy for the remaining fishing trip.
    - ”Historical information” available for long-term planning.
- Data recording/flow to scientists ensure the fishermen’s contributions to documentation of the sustainability of the fishery. Improves dialog between fishers and scientists.

6. SUMMARY

For the assessment and management of marine fish resources, representative data of statistically good quality describing the actual catch are lacking for many fisheries. Even for the most studied fisheries in the north Atlantic, the uncertainty regarding what is actually caught has implications for management. Fish stock assessments and sound advice in most cases rely on representative sampling of catches. Distant and high sea fisheries often suffer from poor sampling due to sampling logistics. Consequently, stock assessments and management of marine fish resources exploited by these fisheries are based on poor or scarce catch data. Presently, sampling at sea is often random in time and place, and not necessarily representative with respect to the fleet metier. Biological sampling in distant waters is a challenge due to logistics and high costs. The use of electronic scales onboard commercial fishing vessels provides a new approach for data collection. In recent years electronic scales measuring individual fish weights on deck have been connected to GPS measurements and combined with data on depth, fishing gear, logbook information etc. This approach links detailed catch data to auxiliary information on the fishery, thereby meeting the challenges of obtaining representative fishery data that will generate sufficient data for fish stock assessments and hence provide a sound basis for fisheries management of species found in distant waters.

7. ACKNOWLEDGEMENTS

This project “Elektronisk fangstregistrering” was initiated in spring 2007 aiming to establish a Nordic network to summarize the state of the art regarding electronic sorting systems, discuss how to meet new challenges and possibilities in using catch registrations as well as use of these data in assessments. The idea was based on a previous project conducted by Møreforsking in collaboration with industrial partners Maritech AS, and a Norwegian longliner Leinebris as well as Institute of Marine Research in Bergen. The project was financed by NORA, the Norwegian Research Council and all the participating partners; Møreforsking Marin (Project leader), Greenland Institute of Natural Resources, DTU Aqua/National Institute of Aquatic Resources, Marine Research Institute, Iceland, Institute of Marine Research, Bergen, Maritech AS and Royal Greenland.

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