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The Norwegian Reference fleet : co-operation between fishermen and scientists for multiple objectives.

by

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Abstract

In Norway, port sampling of landings, sea sampling by the coastguard and by inspectors from the Directorate of Fisheries are used for collecting biological samples from commercial catches for research and assessment purpose.

In order to obtain better and continuous samples from the fishing fleet, knowledge about fleet behaviour and technical developments influencing efficiency and effort, 14 high seas- and 18 coastal fishing vessels (the Reference fleet) are contracted, some of them since 2001. The vessels may be equipped with electronic length measuring board, electronic scales and PC with necessary software including satellite communication. Crewmembers are trained to conduct self-sampling. Biological samples (length, otoliths, genetic samples, stomachs etc) and logbook data are delivered according to contract, which secure a proper statistical coverage for a defined number of species in time and area. A minor extra catch quota mainly finances the program.

In addition to improved biological sampling, the Reference fleet provides better insight for optimised sampling, it updates the scientists on technological developments, it is a useful platform for testing official catch statistics and data collecting systems and procedures (e.g., electronic logbooks), provides the scientist with continuous information about species that are hardly accessible by research vessels (e.g., deep water species, near coast fish populations) and do also provide observations of sea mammals, sea birds, crabs etc. Further, such trust based co-operation between fishermen and scientist seems to reduce controversies and rather build a common understanding and ownership of improved stock assessments and fisheries management.

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Background

In Norway different platforms are used for collecting biological samples from commercial catches, including port sampling of landings and at sea sampling by the coastguard during inspections, and by inspectors from the Directorate of Fisheries.
In order to obtain better and continuous biological samples from the fishing fleet, knowledge about fleet behaviour and technical developments influencing fishing efficiency and effort, 14 high seas- and 18 coastal fishing vessels are currently contracted (Tables 1 and 2) , some of them since 2001. See photos of the vessels in Figures 1 and 2.

This **Reference Fleet** is a small group of Norwegian fishing vessels that are paid to provide the Institute of Marine Research (IMR) with detailed information about their fishing activity and catches on a regular basis. Their sampling and data management procedures are similar to the system used on board IMR's research vessels.

Table 1. **The high seas Reference fleet**. Vessel name, vessel owner and gear types.

Vessel Name	Company Name	Boat-length (m)	Callsign	Gear(s)
Atlantic	Atlantic Longline A/S	44.9	LIYX	Longline
Geir	H.P.Holmeset A/S	45.6	LJPZ	Longline
Hargun	K/S Hargun	68.1	LJVB	Purse seine, pelagic trawl
Hauge Senior	Hauge & Hauge A/S	43.2	LJQG	Longline
K. Arctander	Nordland Havfiske	53.1	LHMF	Trawl
Kato	Partrederiet Kato ANS	38.2	LLJC	Gillnet
Leinebris	Leinebris A/S	44.8	LIWR	Longline, gillnet
Libas	Libas AS v/Liegruppen A/S	94,0	LMQI	Purse seine, pelagic trawl
Nesejenta	Partsrederiet Fjeldskår DA	23.9	LJCS	Gillnet
Nybo	Nybo Holding A/S	69.5	LJBD	Purse seine
Prestfjord	Prestfjord A/S	56.9	JXNA	Trawl
Skjongholm	Skjongholm A/S	26.6	JWZZ	Gillnet
Utflesa	Utflesa Kystfiske A/S	21.3	LLQX	Purse seine
Varegg	A/S Varegg c/o Vartdal Fiskeriselskap AS	62.9	LAOW	Trawl

Table 2. **The coastal Reference fleet**. Vessel name, vessel owner and gear types.

Vessel Name	Company Name	Boat-length (m)	Callsign	Gear(s)
Elias	Johannes Røttingen	10.66	LK6828	Gillnet, purse seine
Gullholmen	Gullholmen AS	14.09	LK5775	Gillnet
Haldorson	Svein Tore Olsen	12.44	LK3175	Gillnet, pot
Heimdal	Helge Husevåg	11.80	LK4399	Gillnet, pot, trap
Haaværbuen	Haaværbuen DA	10.60	LM5498	Gillnet
Leirvåg Junior	Pr. Br. Olsen Da	14.15	LM7612	Gillnet
Nimrod	P/R Brødrene Hansen ANS	12.34	LM8020	Gillnet
Odd Yngve	P/R Fagertun DA	14.97	LM2864	Gillnet
Oddson	Odd Lam	13.15	LK3860	Gillnet, longline, pot
Repsøy	Repsøy AS	13.72	LM6877	Gillnet, trolling
Rånes-Viking	Rolf Rånes	12.32	LK5016	Gillnet
Stein Jimmy	Partsrederiet Thevik jr. ANS	14.95	LK3697	Gillnet, longline
Thema	Gunvald Aanensen	10.60	LK5874	Gillnet, trolling
Thor-Arild	Skarsvåg Kystfiske AS	14.87	LK2234	Gillnet, Danish seine, pot
Tom-Robert	Jan Ove Larsen	9.10	LM7949	Gillnet, pot
Tramsegg	P/R Gjetøyfisk	12.98	LK7141	Gillnet
Vesleper	Anders Paulsen	9.65	LM7915	Gillnet, pot
Vågøybuen	Tore Vågø	10.66	LK8734	Gillnet, pot

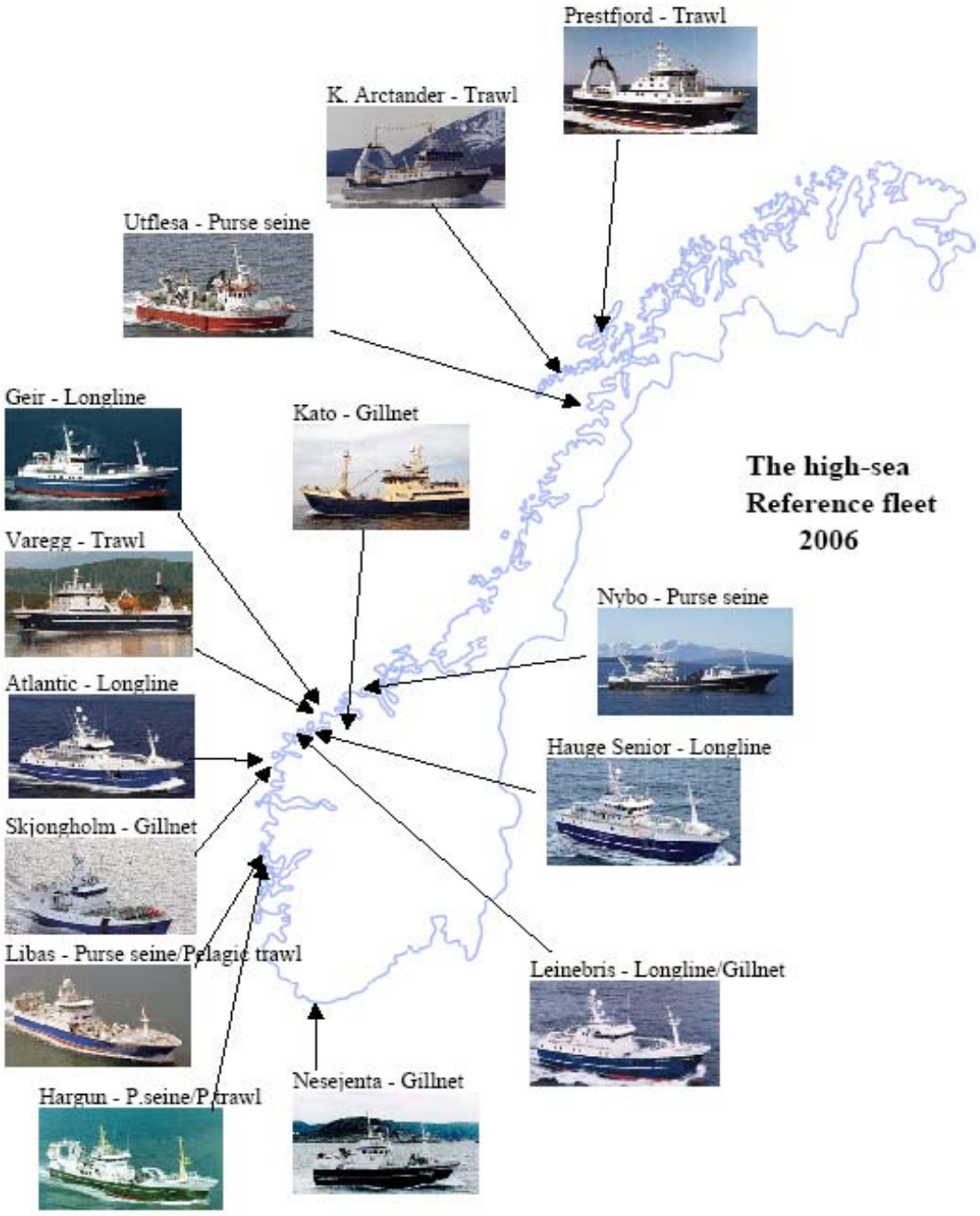

Figure 1. The high seas Reference fleet. The arrows are pointing to the vessels' home ports in Norway.

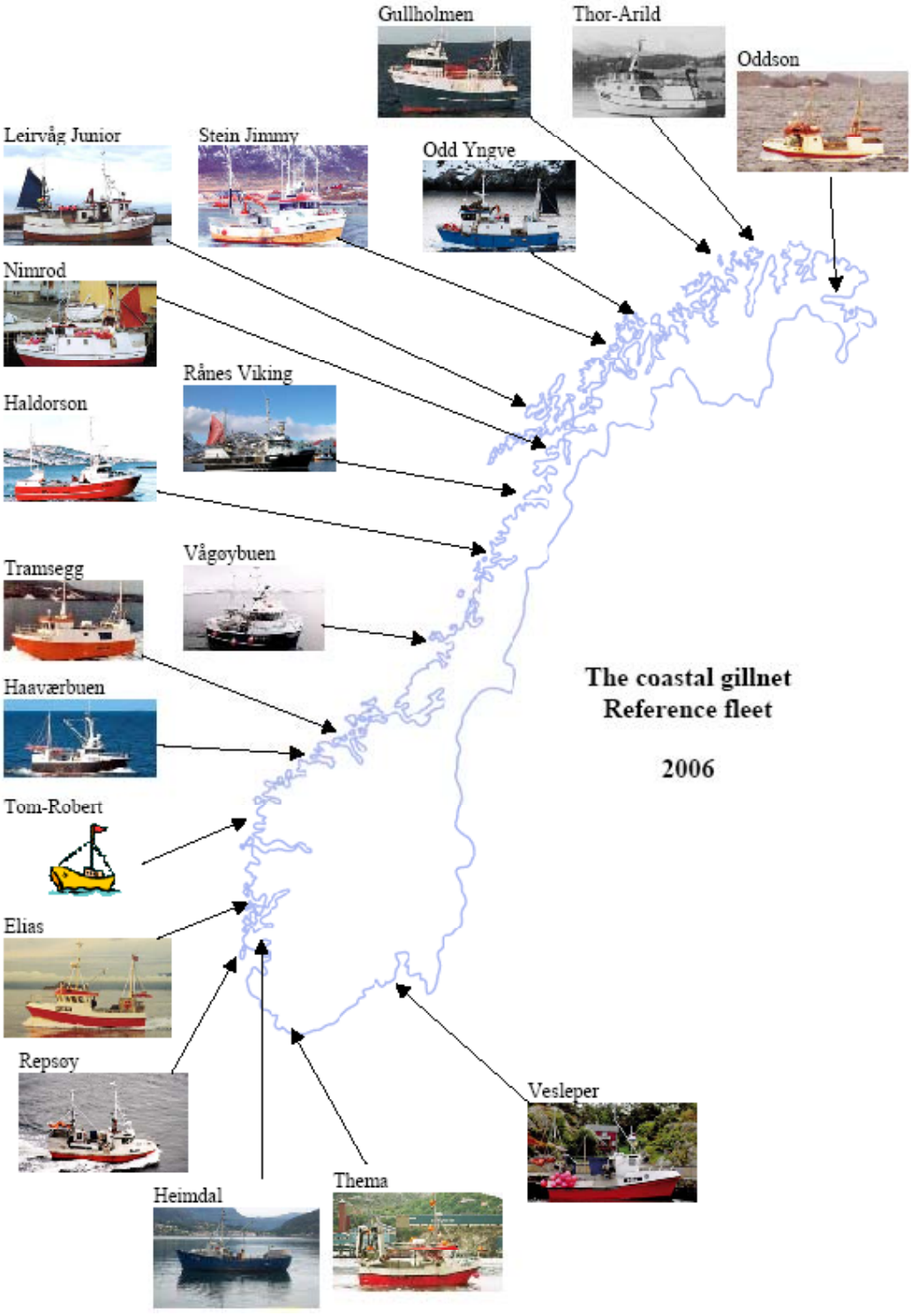

Figure 2. The coastal Reference fleet. The arrows are pointing to the vessels' home ports in Norway.

The biological sampling program

Biological samples (length, otoliths, stomachs, genetic and environmental samples etc.) and logbook data are delivered according to contract, which secure a proper statistical coverage for a defined number of species in time and area.

The program is mainly financed by a minor extra catch quota which is part of the national TAC set aside for this purpose. The extra quota is mainly composed of cod, and some herring, mackerel and Greenland halibut. The fishermen, however, collect material from all the species they catch. The value of the quota is currently shared 60/40 between vessel and IMR, respectively. The fishermen, in the name of IMR, sell all the fish. IMR's 40% share is used for paying the fishermen according to priced deliveries, and for running costs.

Such trust-based co-operation between fishermen and scientist seems to reduce controversies and rather builds a common understanding and ownership of data from the fisheries, improved stock assessments and fisheries management.

Each vessel in the high seas Reference Fleet is equipped with an electronic fish sampling board (Scantrol), scales, otolith sampling device and PC with specialised software. The smaller vessels in the coastal Reference Fleet have to begin with only been equipped with conventional fish length measuring boards.
IMR teaches the responsible contact persons on each vessel, provides training support, visits the vessels, and updates the scientific equipment when necessary. The agreement between IMR and the Reference Fleet includes an obligation for the vessels to record their catch logbooks electronically.

Once a day, maximum 60 individuals of each species (300 shrimp) are length measured. In addition, and upon request, otoliths may be collected for age determination. Altogether, up to seven samples per species per week are collected dependent on the fishery.
The collected data are recorded electronically and transmitted to IMR via a satellite link together with the electronic logbooks. This information is after a standard quality check continuously added to IMR's research database. Also, there is a direct e-mail connection between vessel and IMR. IMR has access to data from the vessel monitoring system (satellite tracking) operated by the Norwegian Directorate of Fisheries. The Reference Fleet may also be requested to conduct specific observations and urgent data collection. The Reference Fleet makes it thus possible for the institute to be at the right place at the right time.

Utilization of the information from the Reference fleet

Sampling protocols are designed and results are used mainly for assessment purpose, i.e., for distributing the total catch on length- and/or age groups, and also monitoring where the various fleets operate at any time, and as well their catch composition during the season. This enables the Institute of Marine Research, e.g., to decide how to allocate commercial catch sampling resources in time and space. Important biological information is obtained from the fleets' observations of sea mammals, sea birds, red king crabs and by-catch (i.e., discards) in e.g., the shrimp fishery.

The Reference Fleet may be used as a testing platform of new technology such as electronic logbooks, and observation/understanding of technology creeping.

Through this relationship of trust with the Reference Fleet, it is possible for IMR to discuss controversial issues with the vessel-owner, skipper and the crew, in order to obtain a common understanding between fishermen and scientists.

The Reference Fleet seems to deliver reliable data on by-catch, but has so far only indirectly shown to be useful for estimating discards. More validation studies should be conducted, however, to statistically prove how representative the Reference Fleet is for the whole Norwegian fleet regarding different aspects in order to establish correct raising procedures.

The geographical distribution of biological samples collected by the high seas Reference fleet in 2005 as well as the movement of the fleet during its fishery in 2005 (as registered by satellite tracking) is shown in Figure 3. Figure 4 shows which species and how many of them that was length measured by the high seas Reference fleet from its catches in 2005.

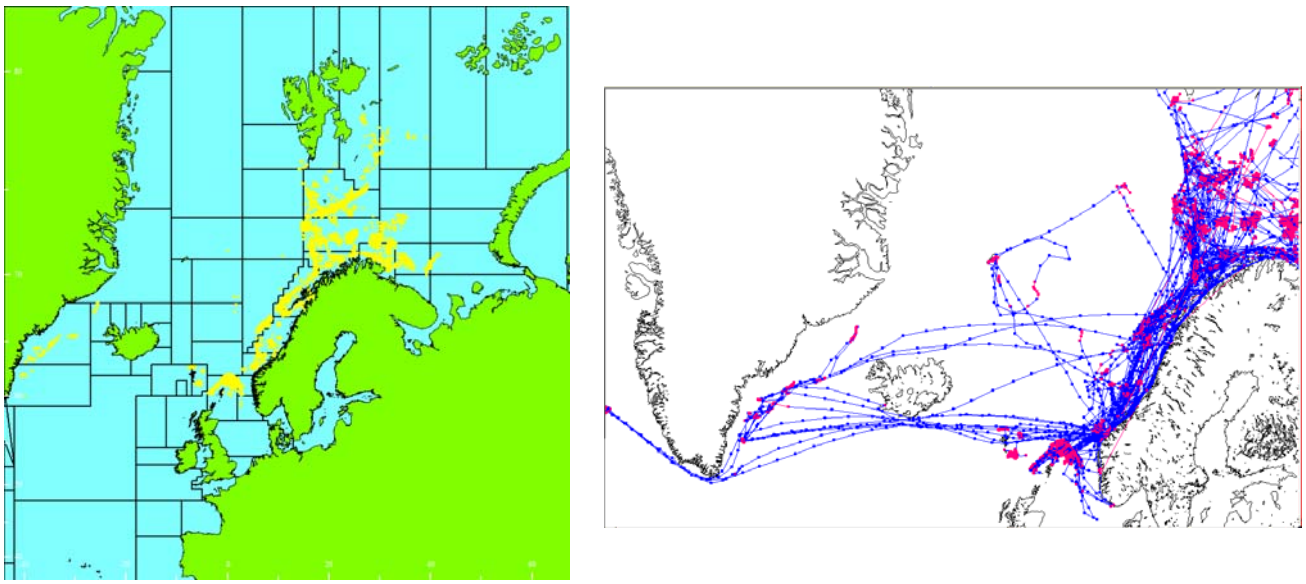

Figure 3. Maps showing the geographical distribution of samples collected (left) and satellite tracking (right) of the high seas Reference Fleet in 2005.

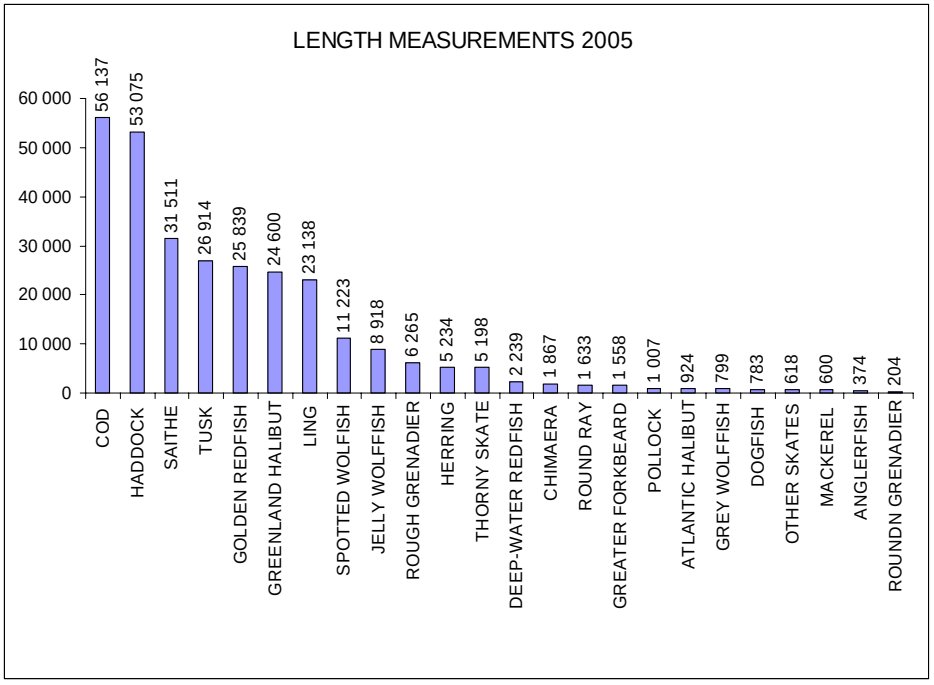

Figure 4. An account of the number of specimens that were length measured by the high seas Reference fleet in 2005.

Sources of variability and determination of an efficient sampling plan

The fish sampled are not a random sample of individuals from the entire commercial catch, but in statistical terms they are selected from a number of clusters (all the fish caught during a day by a boat form a 'cluster' of fish). A variance component analysis is used to quantify the sources of variability, and based on these estimates an efficient sampling scheme can be selected. The example from tusk (*Brosme brosme*) shown in Figure 5 clearly shows that it is first of all a greater number of vessels (c) from which samples (length measurements) are collected that will contribute to less standard error and thus higher precision. The number of fish sampled per day (a), and the number of days each boat collects samples (b) seems already to be acceptable/ sufficient for this particular species.

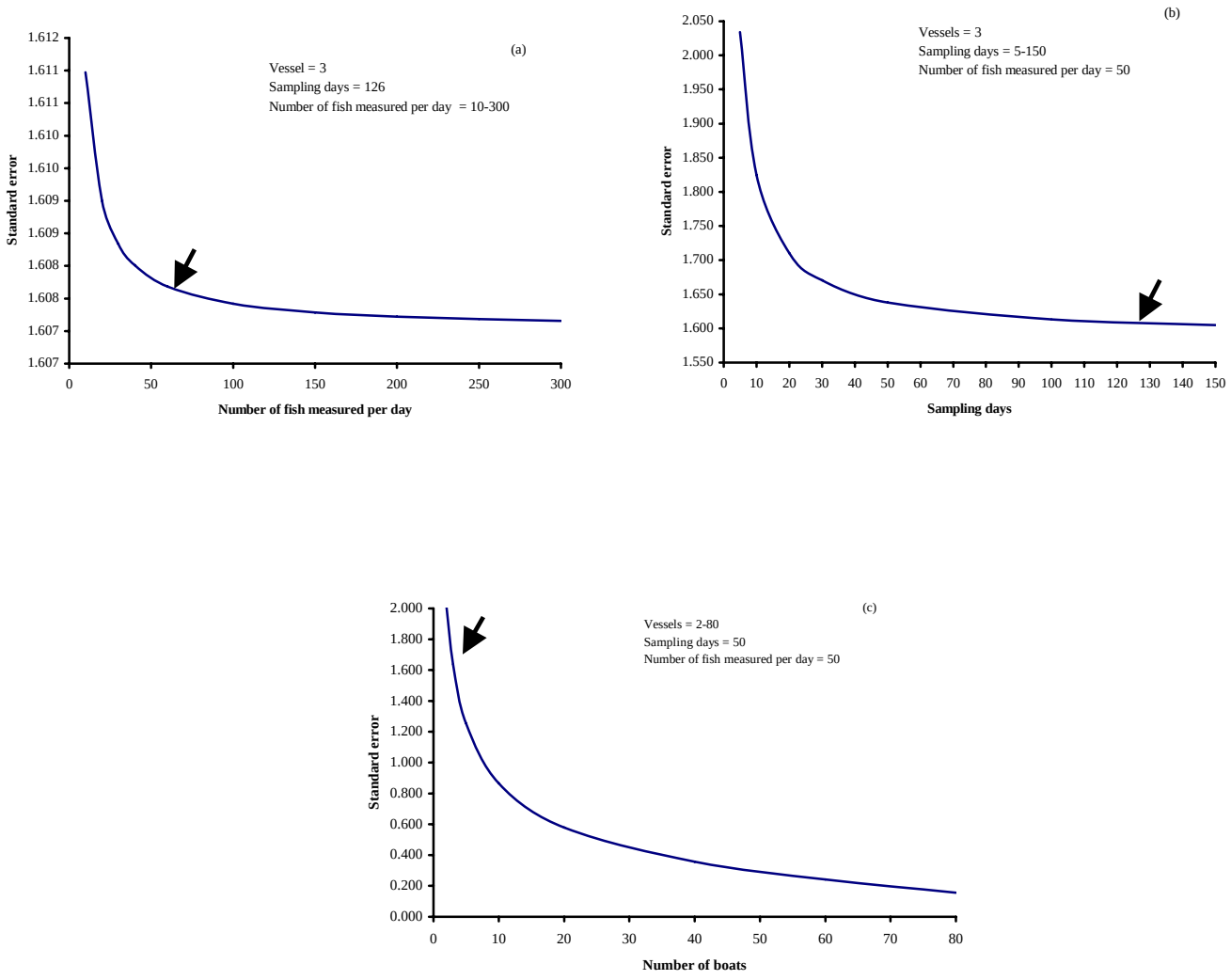

Figure 5. Precision of the estimate of the mean length of tusk (*Brosme brosme*) as a function of (a) the number of fish sampled per day, (b) the number of days each boat collects samples, and (c) the number of boats in the reference fleet. The arrows denote the precision of the 2003 data (from Helle and Pennington 2004).

Impact on stock assessment

A model (Bayesian hierarchical model) and software have been developed to estimate catch-at-age by combining data from different sources (Hirst *et al*. 2004 and 2005), and e.g., to estimate the level of precision with and without data from the Reference Fleet. As an example for Northeast Arctic cod (*Gadus morhua*), Figures 6-8 show the impact on estimates of catch-, weight- and length-at-age, respectively, by including/excluding the data collected by the Reference fleet. These two different data sets, i.e., with and without Reference fleet data, may

further be used as input to e.g., the XSA-assessment to show consequences on the stock size estimates and prognoses.

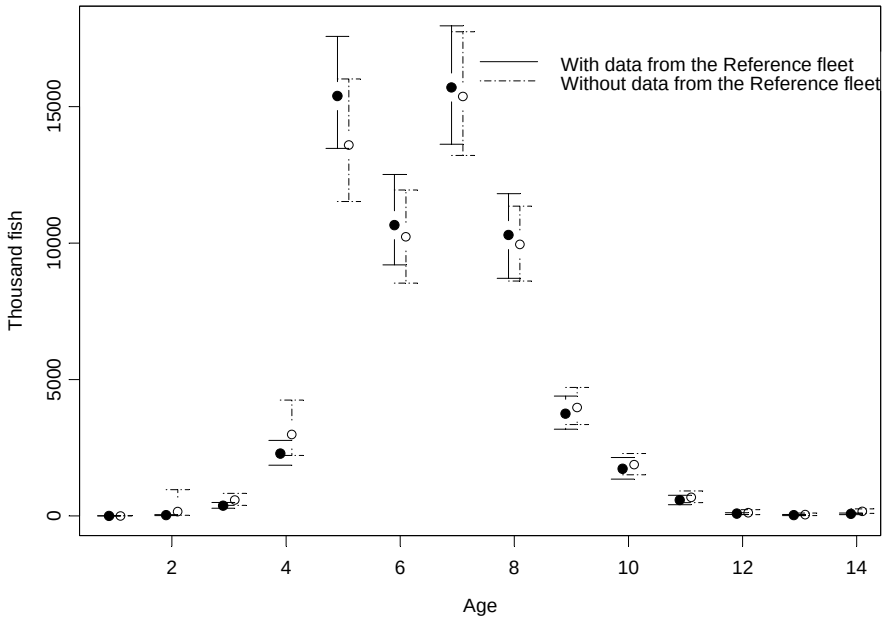

Figure 6. Norwegian catch-at age of Northeast Arctic cod (*Gadus morhua*) in 2005 with and without data from the Reference Fleet. Note that age 14 is a plus-group.

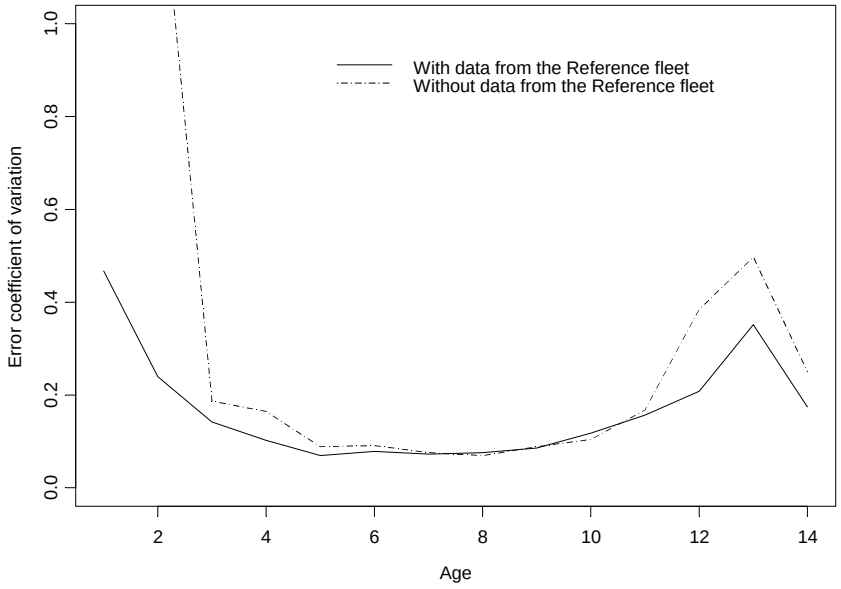

Figure 7. Error coefficient of variation (standard deviation/ mean) for the estimated numbers at age shown in Figure 6. Note that age 14 is a plus-group.

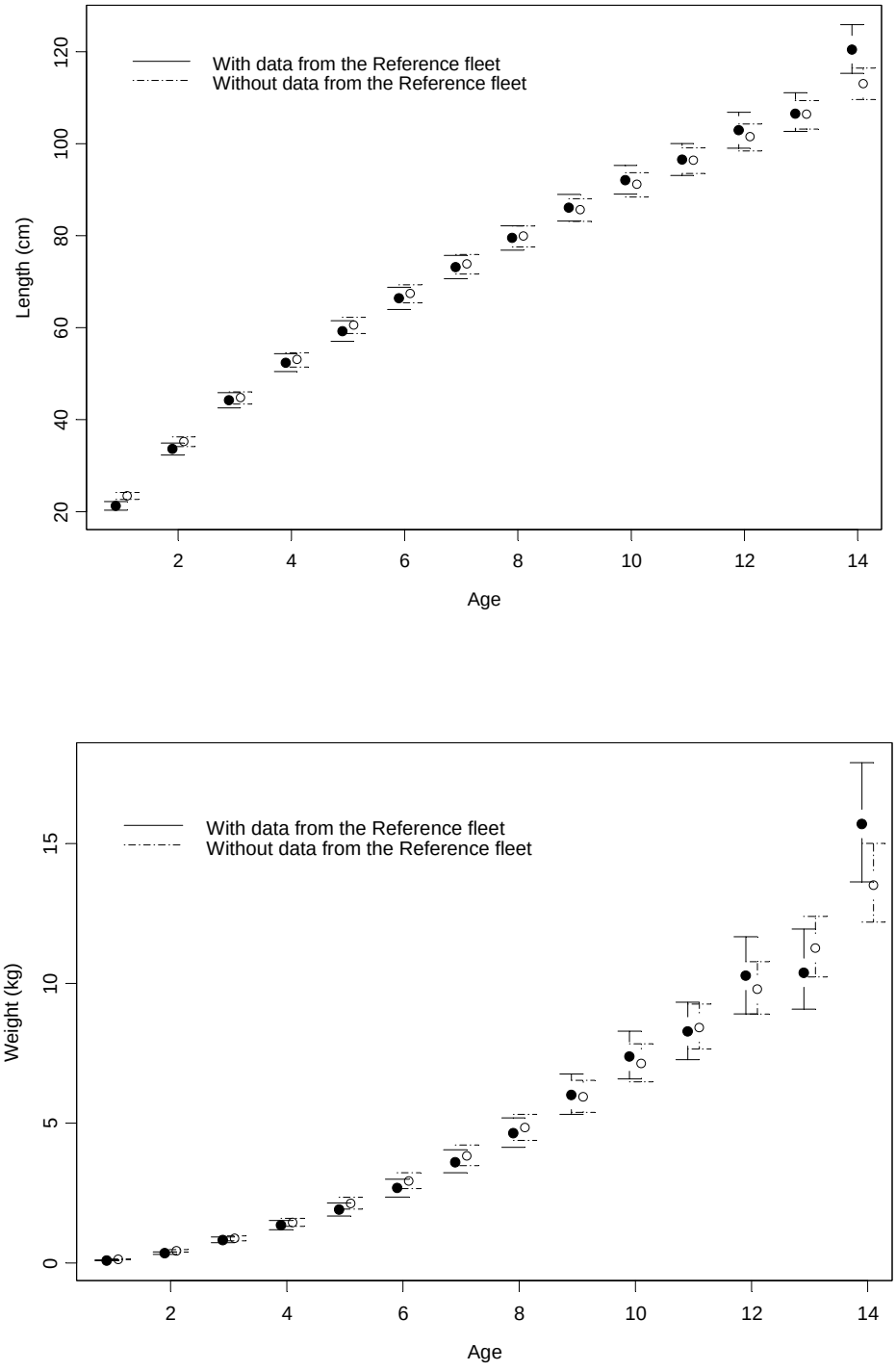

Figure 8. Differences in length- (upper) and weight-at-age (lower panel) of the Northeast Arctic cod (*Gadus morhua*) caught by Norwegian fishermen in 2005 dependent on using data from the Reference Fleet or not. Note that age 14 is a plus-group.

References

Helle, K., and M. Pennington. 2004. Survey design considerations for estimating the length composition of the commercial catch of some deep-water species in the Northeast Atlantic. Fisheries Research 70:55-60.

Hirst, D., Aanes, S., Storvik, G. and Tvete, I.F. 2004. Estimating catch at age from market sampling data using a Bayesian hierarchical model. Journal of the Royal Statistical Society. Series C, Applied statistics, 53: 1-14.

Hirst, D., Storvik, G., Aldrin, M., Aanes, S., and Huseby, R.B. 2005. Estimating catch-at-age by combining data from different sources. Canadian Journal of Fisheries and Aquatic Sciences, 62: 1377-1385.