Possible reductions in Barents Sea surveys—a test of its influence on Northeast Arctic cod assessment quality

Yury Kovalev and Anatoly Chetyrkin

Abstract

The problem of funding could lead to fewer and less frequent surveys. This study evaluated how such a reduction may affect the quality of Northeast Arctic (NEA) cod stock assessment, which relies on the results of survey data. Based on data from the ICES Arctic Fisheries Working Group collected for the period from 1946 to 2010, VPA/XSA stock assessments were performed in FLR with different assumptions on possible reduction in surveys. For all explored cases of reduced frequency of surveys a serious deterioration of the NEA cod assessment quality was observed. Retrospective patterns of SSB estimates demonstrate possible deviation of up to 55% and the same effect is observed for total stock estimates. If such a situation becomes real, it may lead to serious under/overestimation of the stock and TAC. In addition, in current ICES practice the results of NEA cod assessment are used for NEA haddock assessment and capelin TAC prediction, for which cod consumption is taken into account. Thus a decrease in cod assessment quality will influence the quality of NEA haddock and capelin assessments and advice. It was also concluded that reductions in survey frequency may reduce the quality of assessments for other species as these surveys are multispecies.

Keywords: assessment quality, frequency of surveys, NEA cod.

Contact author: Yury Kovalev, Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 183038, 6 Knipovich Street, Murmansk, Russia [e-mail: kovalev@pinro.ru].

Methods

There are four surveys and commercial CPUE data series used for tuning VPA/XSA model for NEA cod:

XSA name	Name	Place	Season	Age	Years
Fleet 09	Russian trawl CPUE	Total area	All year	9-11	1985-2011
Fleet 15	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2012
Fleet 16	Joint acoustic survey	Barents Sea+Lofoten	Feb-Mar	3-9	1985-2012
Fleet 18	Russian bottom trawl survey	Total area	Oct-Dec	3-9	1994-2011

There is one more time series – Joint Ecosystem survey available for the period 2004-2011 but this survey was not used in assessment yet (ICES 2012).

The following cases of possible reductions in surveys number were tested:
- data from only one of Russian bottom surveys or Norwegian winter survey for each year and another national survey next year are available;
- data from simultaneous (Russian and Norwegian) surveys but only every 2nd year data are available;
- data from an extra survey are introduced into estimation for each of two above cases (joint ecosystem survey).
Each of the first two cases could be presented in two different combinations with a survey/surveys starting in even or odd year.

The following methods and criteria of comparison of the results from different assessments (with different surveys sets) were used:
- visual analysis of retrospective graphs;
- comparison of average distance (AD) between terminal points in retrospective run (SSB, R or F_{bar} values) and the "true" (AFWG-2011 assessment; (see Fig.1 for example).

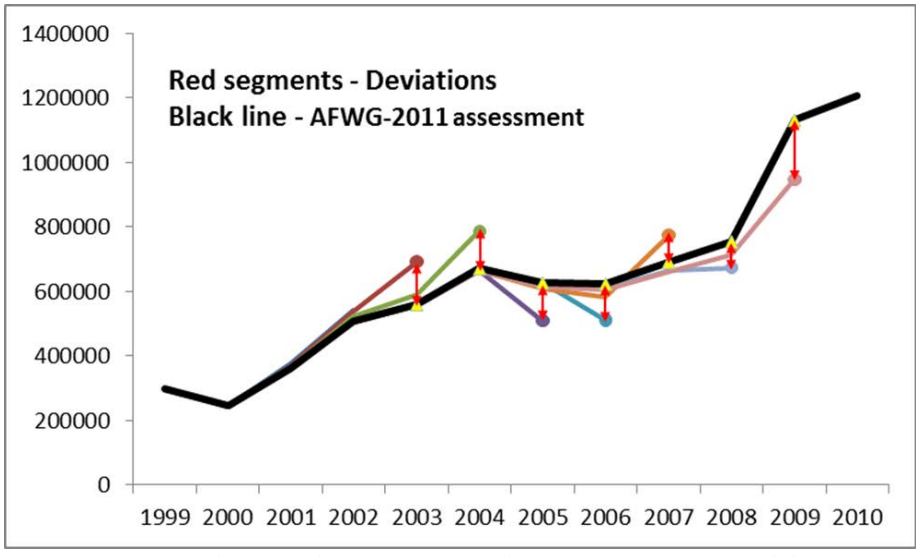

Fig. 1. Deviations/distances between terminal SSB estimates in a model retrospective run and the "true" SSB (AFWG-2011 assessment).

Additional problem associated with the surveys number reduction is the necessity to derive data on fish mean weights-at-age and maturity ogives. The attempt was made to derive the weight and maturity data for the first case of possible survey number reduction. An analysis of stability of coefficients of regression between the observed data and the data obtained from the model was made to test accuracy of deriving weight and maturity data.

The weights in stock and ogives were derived according to the following algorithm:

1. For the case with only one survey available:

X - weight/maturity from Russian surveys
Y - weight/maturity from Norwegian surveys
Z - AFWG-2011 data (mean of Norway and Russian)

$$Z = a1 * X + b1$$ (observed $R^2 = 0.5 - 0.93$)

a1, b1 - coefficients of regression.

$$Z = a2 * Y + b2$$ (observed R2 = 0.88 - 0.99)

a2, b2 - coefficients of regression.

2. For the case with data from simultaneous (Russian and Norwegian) surveys yet available for only every 2nd year the standard AFWG procedure was used with observed weights and maturity data. No attempts to model these data were made.

Results

"Stand alone" surveys cases
(in the XSA file "fleet" data for even years for one survey and odd years for another survey were eliminated)

Retrospective graphs for this case demonstrated considerable decrease in stock assessment stability as compared to AFWG-2011 retrospective run especially in the 1990s (Fig. 2-4).

Objective criteria of the assessment stability (AD) supports this visual observation (Fig. 8).

Using the data from ecosystem survey in these assessments generally slightly reduces terminal estimates deviations, but nevertheless stock assessments demonstrated lower stability as compared to AFWG-2011 (Fig. 8).

Analysis of performance of the model applied for assessment for the most resent years produces similar results. Average of distances between terminal points in retrospective runs and "the true" for 2006-2010 increased with surveys number reduction except when the Russian survey data was introduced first (Fig. 9). Using the data of ecosystem survey caused slight decrease of AD values, though AD of SSB on the opposite became much higher when the Russian survey data introduced first (Fig. 9).

Derived data on weights and maturity agree with the observed data reasonably well except for certain ages and years when big discrepancy in the observed data between countries was present (Fig. 10, 11). Therefore it may be stated that using data from both surveys produces results less sensitive to outliers in observations. Elimination of one of the surveys will increase such sensitivity. Parameters of regressions for both surveys are rather stable in the most recent years (Fig. 12, 13), except for the youngest and the oldest ages.

"Surveys at the same year" cases
(in the XSA file "fleet" data for both surveys deleted for even/odd years)

Retrospective graphs of these cases not only for the 1990s but also for the most recent years are indicative of considerably lower assessment stability (Fig. 5-7) as compared to AFWG-2011 and the cases of "Stand alone surveys".

Average distance between terminal points in retrospective runs and the "true" during two periods 1990-2010 and 2006-2010 increased significantly as compared to the AFWG-2011 run (Fig. 8, 9).

Introduction of ecosystem survey data increases AD values in cases where survey starts in 1986, and slightly decreases AD when they start in 1985 (Fig. 8, 9).

In general, every case of reducing surveys number demonstrates decreased assessment quality (retrospective stability) at least by 50 % (table 1). Situation is especially grave for SSB estimates and same effect is well expected for total stock estimates. The minimum loss of SSB estimates quality is observed for the case of "stand alone surveys" where Russian 1985 survey data was introduced first.

Introduction of Ecosystem survey in tuning most often reduces assessment stability in any case even for "standard" AFWG run (table 1).

Table 1. The difference (%) between AD criteria estimated for NEA stock parameters assessed for all cases of survey number reduction and AD estimated for the AFWG-2011 final run.

Runs without Ecosystem survey					
	AFWG-2011	Nor1st	Rus1st	1985NA	1986NA
SSB	100	245	155	208	216
R	100	170	152	148	179
F	100	209	182	209	236
Runs with Ecosystem survey					
	AFWG-2011	Nor1st	Rus1st	1985NA	1986NA
SSB	111	234	177	216	201
R	101	167	150	150	174
F	109	200	164	218	227

Changes in data used for XSA tuning cause changes in estimates of survivors and terminal SSB (table 2). For different cases of survey SSB reduction could be 2-10 % lower or higher as compared to AFWG-2011 assessment. The difference may appear not so big yet with the view to the results of analyses of retrospective runs (Fig. 2-7) one may come to conclusion that such a difference could be really big.

Table 2. NEA cod SSB in terminal year (2010) from XSA assessments done with different data sets (all variants of surveys reductions and final AFWG-2011).

	AFWG-2011	Nor1st	Rus1st	1985NA	1986NA
without Eco survey	1 141 291	1 080 859	1 185 915	1 023 794	1 198 696
with Eco survey	1 204 326	1 167 542	1 249 177	1 079 542	1 234 250

Conclusion

For all the cases reduction of survey number seriously corrupts the NEA cod assessment quality. Stability of retrospective SSB estimates demonstrates possible deviation of up to 55 % and same effect is well expected for total stock estimates. If such a situation appears in the future it may lead to serious under/overestimation of the stock and TAC.

Comparing different cases of surveys number reduction one may conclude that:

- In all cases reduction in number of surveys increases assessment uncertainty (reduced assessment stability in retrospective pattern) especially when stock dynamics passes the turning point from positive to negative trend and vice versa;
- Another problem of decreasing quality of weight and maturity data and their predictions emerges;

- Based on the last 5 years retrospective, the case with surveys alternation is more preferable as compared to conducting both surveys at the same year;
- Introduction of the Ecosystem survey into the assessment produces rather negative effect than improves the situation significantly.

The best option to reduce surveys costs without compromising the NEA cod assessment quality is to have the Ecosystem survey not every year whereas continuing the practice of annual Russian bottom and Norwegian/Joint winter surveys.

There are other problems with unknown consequences in situation of surveys reduction:

- there could be decrease in the quality of NEA haddock assessment and prediction;
- decreased quality of Greenland halibut indexes;
- decreased quality of predictions for all stocks (differences in predictions should be bigger than in assessments);
- lack of data on young fish abundance (ages 1-3) required for NEA cod and haddock recruitment predictions;
- the probability of decrease in the quality of the cod consumption estimates with the reduced number of surveys (impacts cod and haddock assessments quality);
- decrease in NEA cod assessment quality affects the quality of capelin TAC estimation.

References

ICES. 2011. Report of the Arctic Fisheries Working Group (AFWG), 28 April - 4 May 2011, Hamburg, Germany. ICES CM 2011/ACOM:05. 659 pp.

ICES. 2012. Report of the Arctic Fisheries Working Group 2012 (AFWG), 20 - 26 April 2012, ICES Headquarters, Copenhagen. ICES CM 2012/ACOM:05. 633 pp.

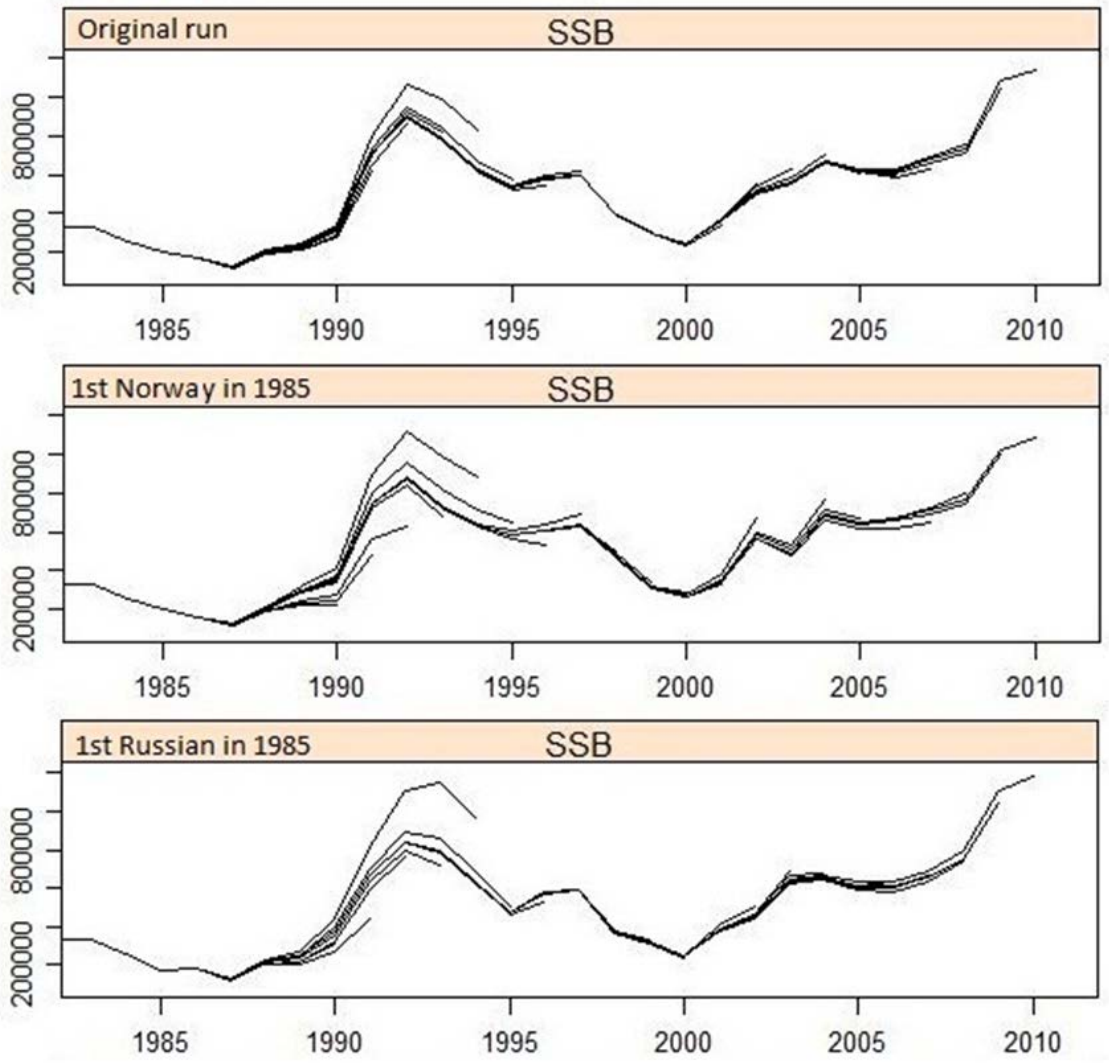

Fig. 2. VPA retrospective graphs for NEA cod SSB estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 1 - one national survey in odd years, another in even years).

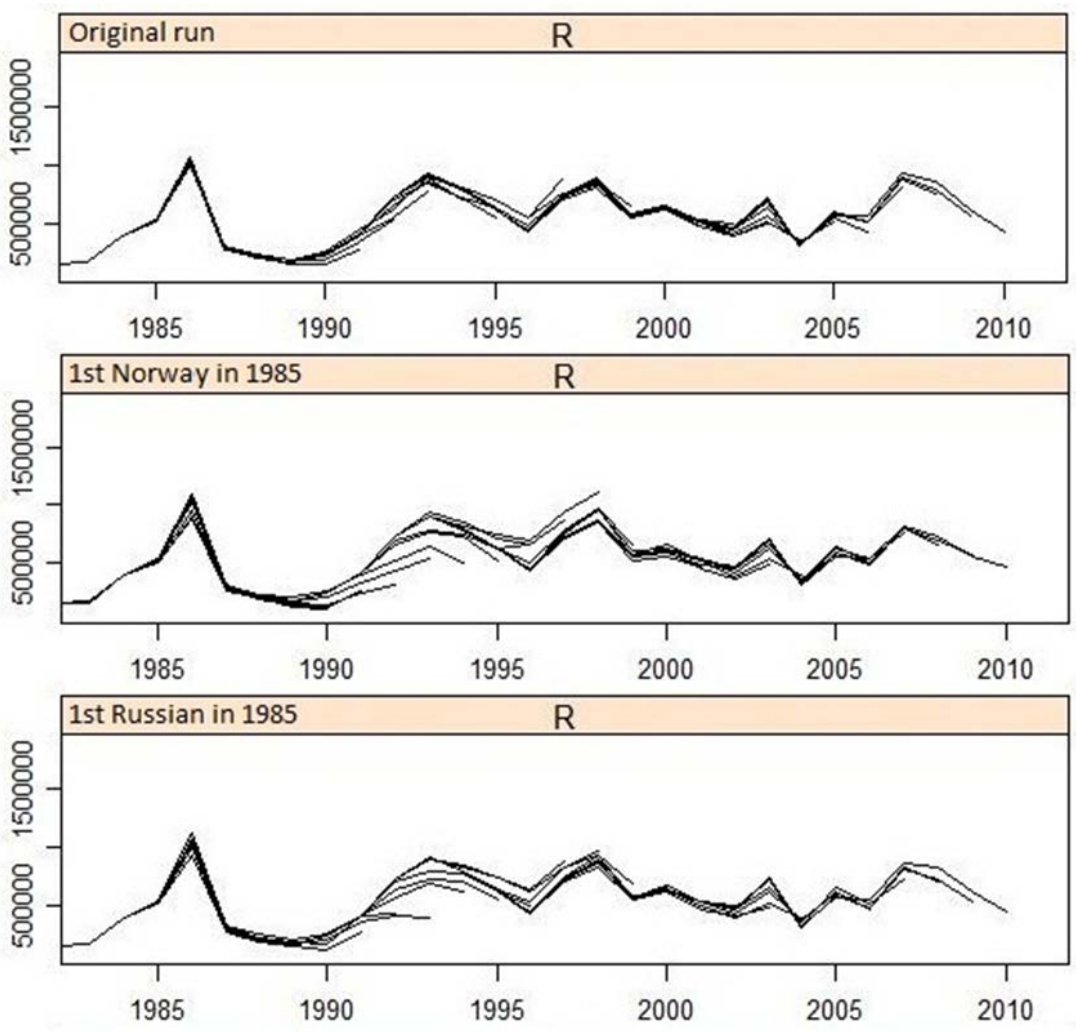

Fig. 3. VPA retrospective graphs for NEA cod R (age 3) estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 1 - one national survey in odd years, another in even years).

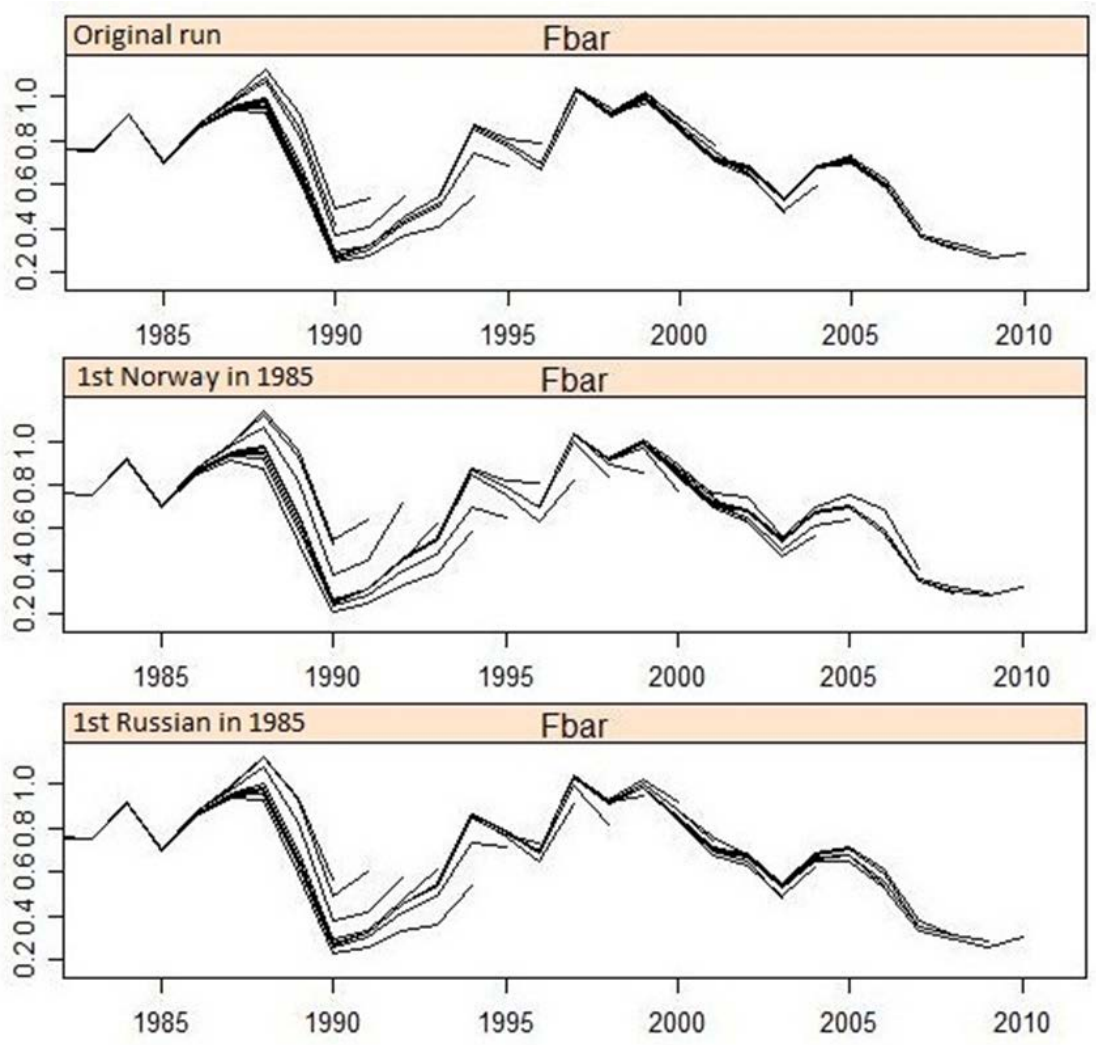

Fig. 4. VPA retrospective graphs for NEA cod Fbar (5-10) estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 1 - one national survey in odd years, another in even years).

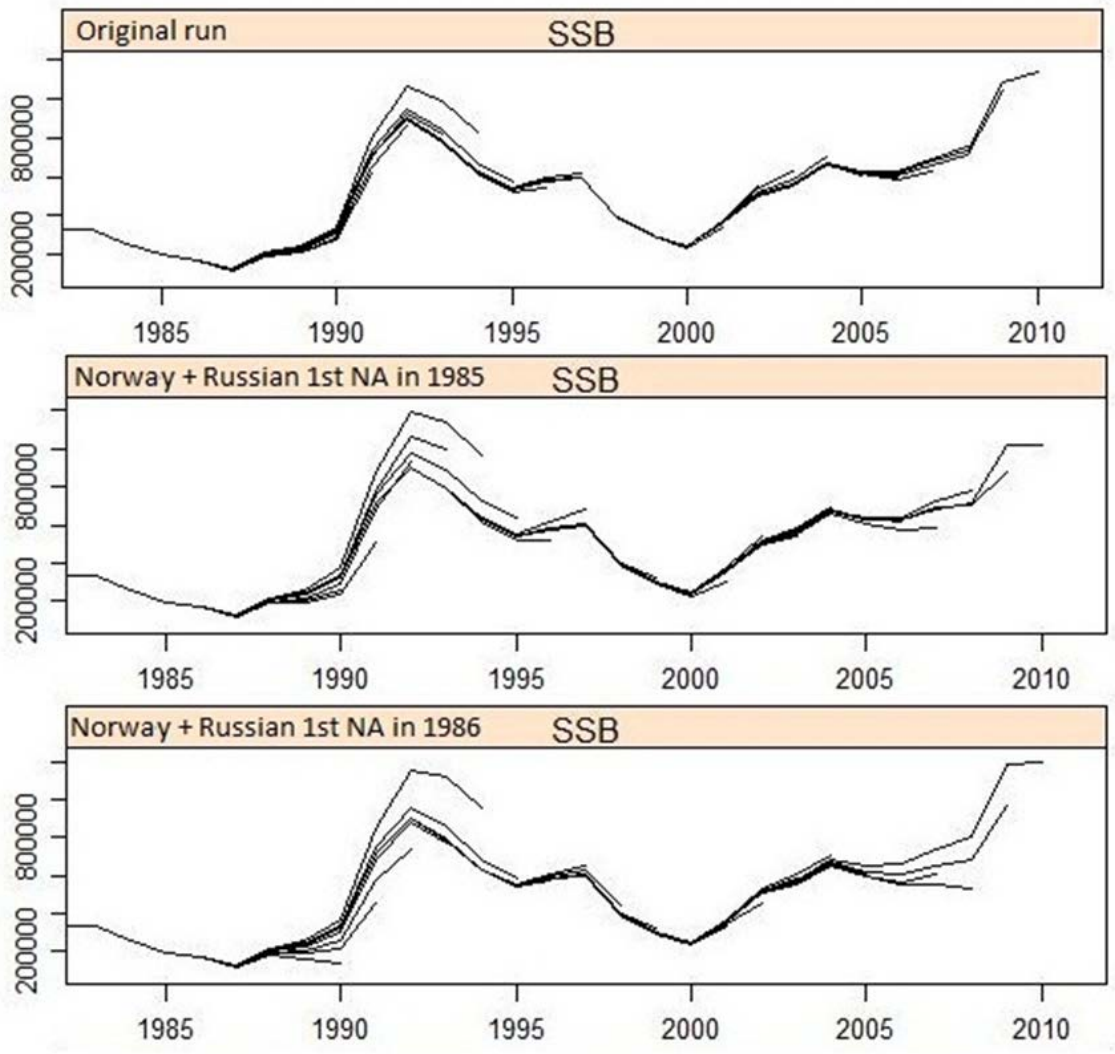

Fig. 5. VPA retrospective graphs for NEA cod SSB estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 2 - both national surveys in odd/even years).

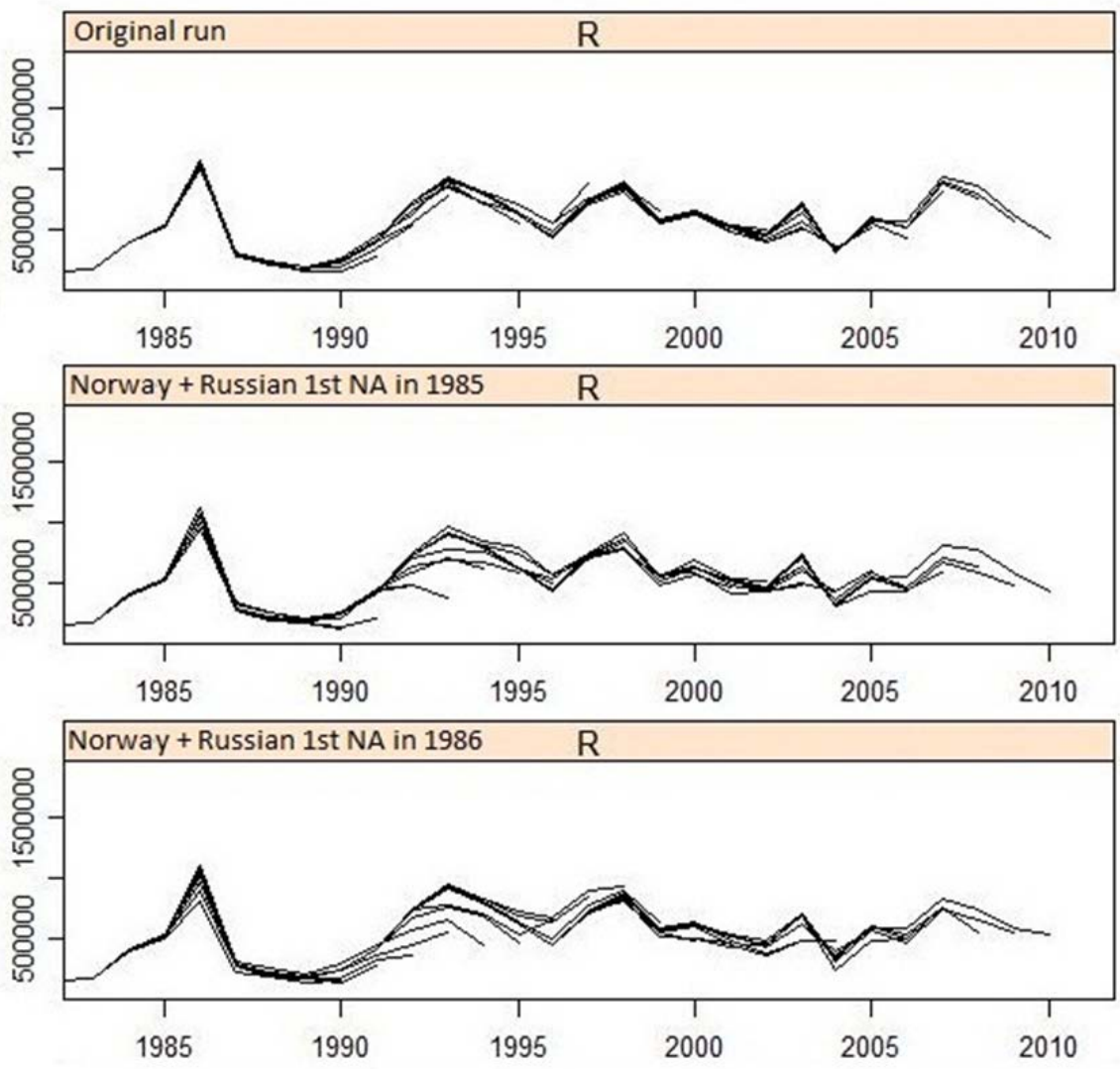

Fig. 6. VPA retrospective graphs for NEA cod R (age 3) estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 2 - both national surveys in odd/even years).

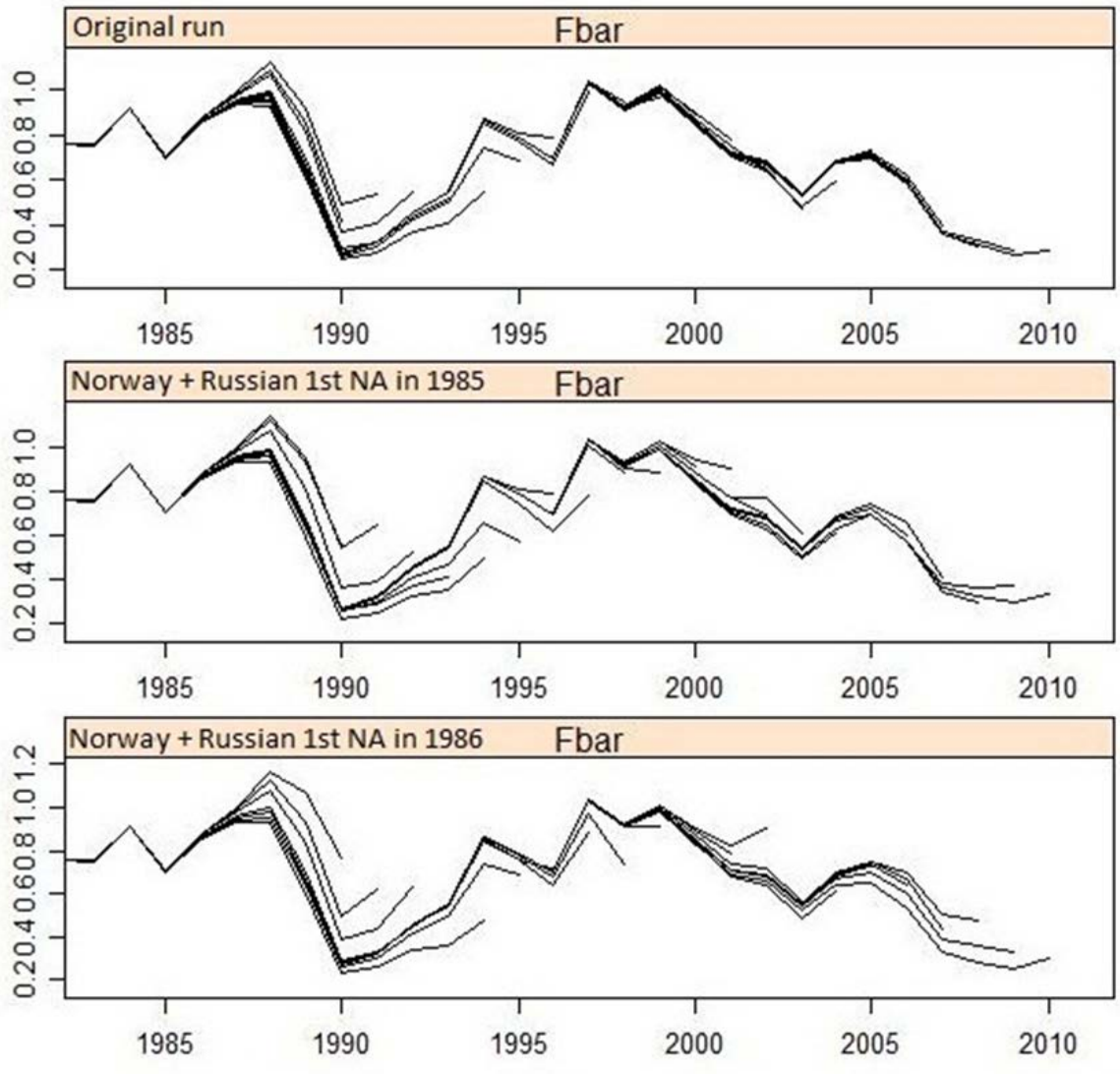

Fig. 7. VPA retrospective graphs for NEA cod Fbar (5-10) estimates by AFWG-2011 and results of exploratory runs with surveys reduction (case 2 - both national surveys in odd/even years).

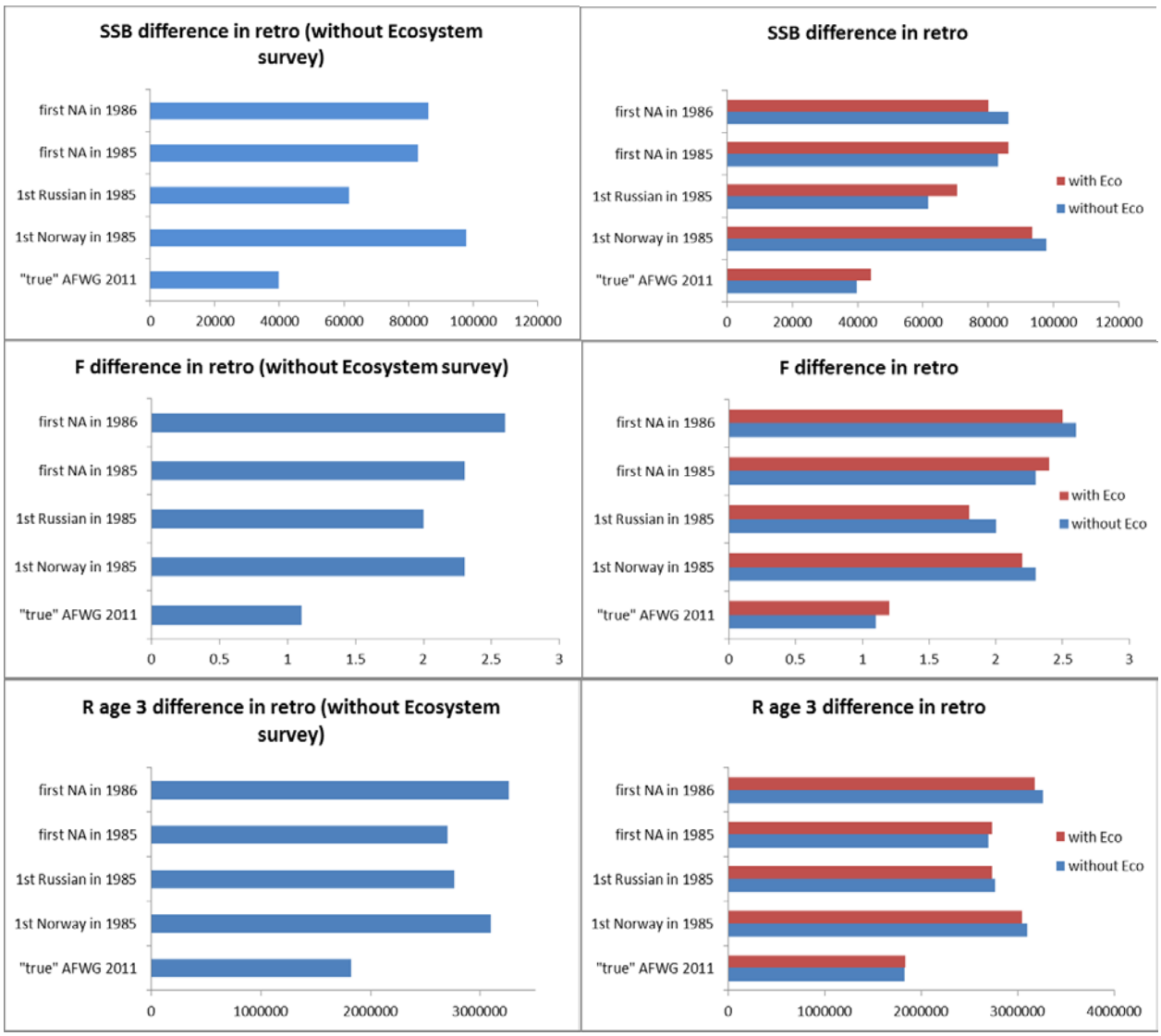

Fig. 8. The comparison of average distance (AD) between terminal points (SSB, R or Fbar values) in retrospective runs for all variants of possible survey number reduction and the "true" (AFWG-2011 final run), calculated for period 1990-2010. ("first NA in 1985/1986" - "Surveys at the same year" cases)

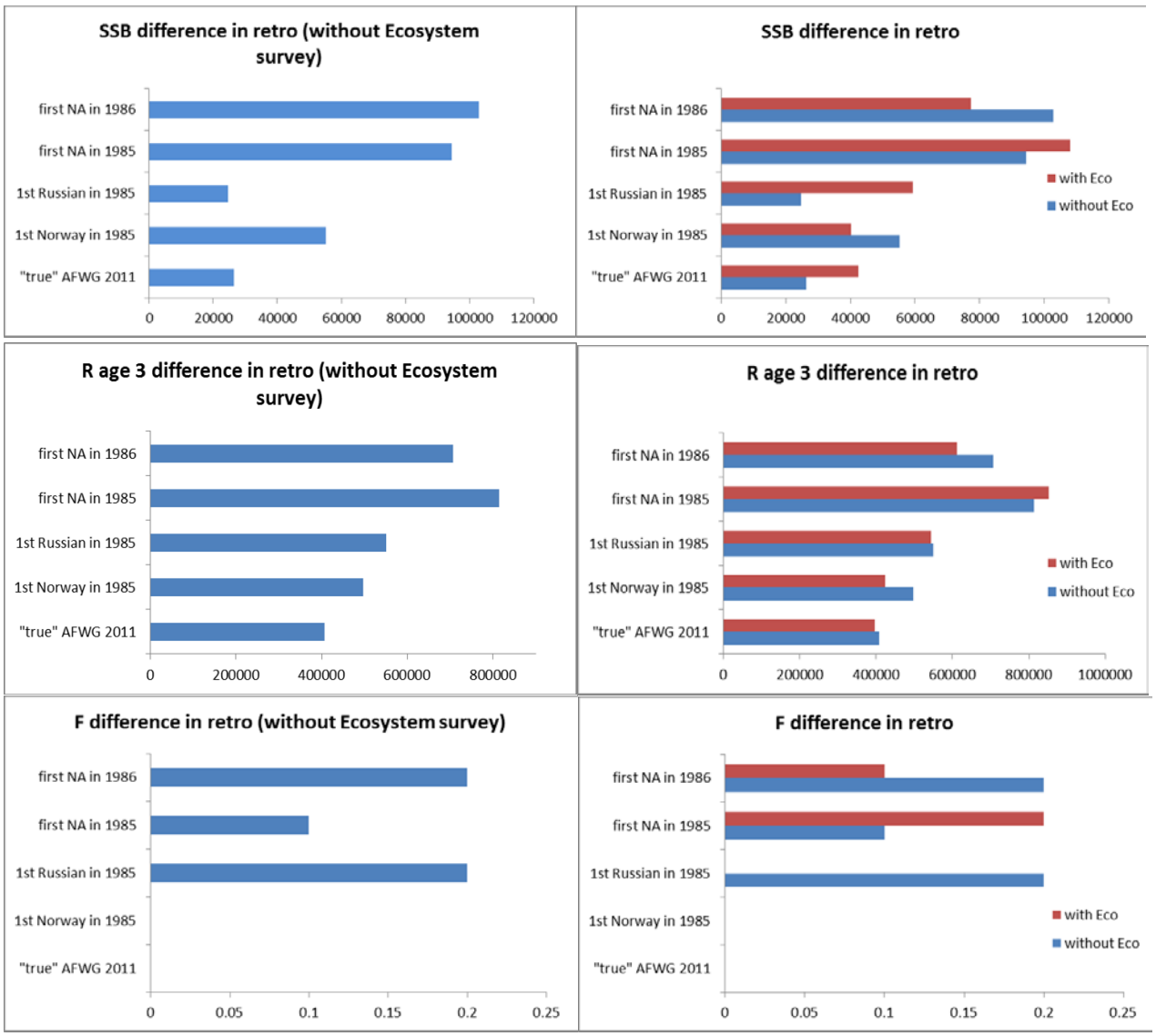

Fig. 9. The comparison of average distance (AD) between terminal points (SSB, R or Fbar values) in retrospective runs for all variants of possible survey reduction and the "true" (AFWG-2011 final run), calculated for period 2006-2010. ("first NA in 1985/1986" - "Surveys at the same year" cases)

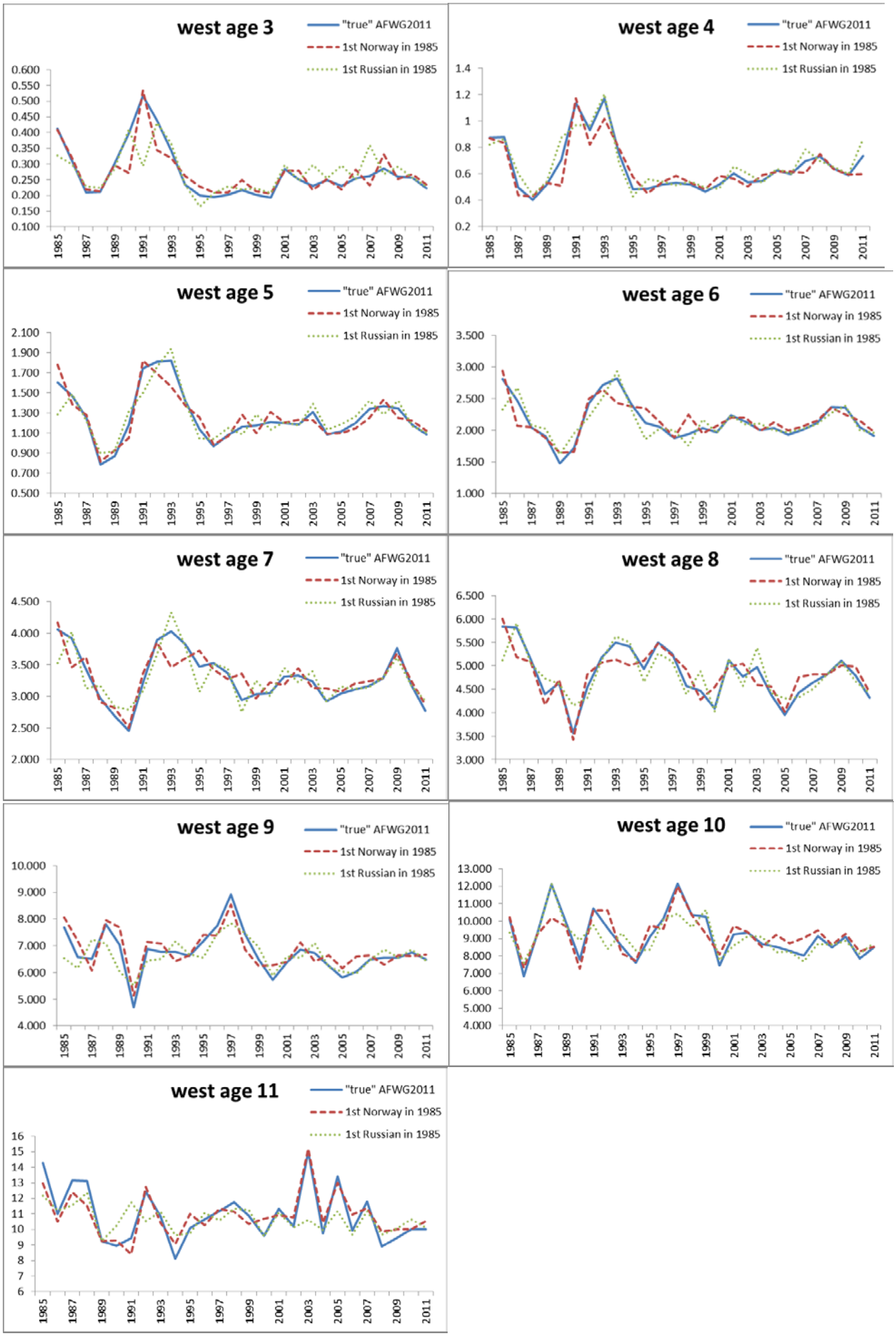

Fig. 10. The comparison between modeled (in case of survey reduction "Stand alone surveys") and observed weight-in-stock data.

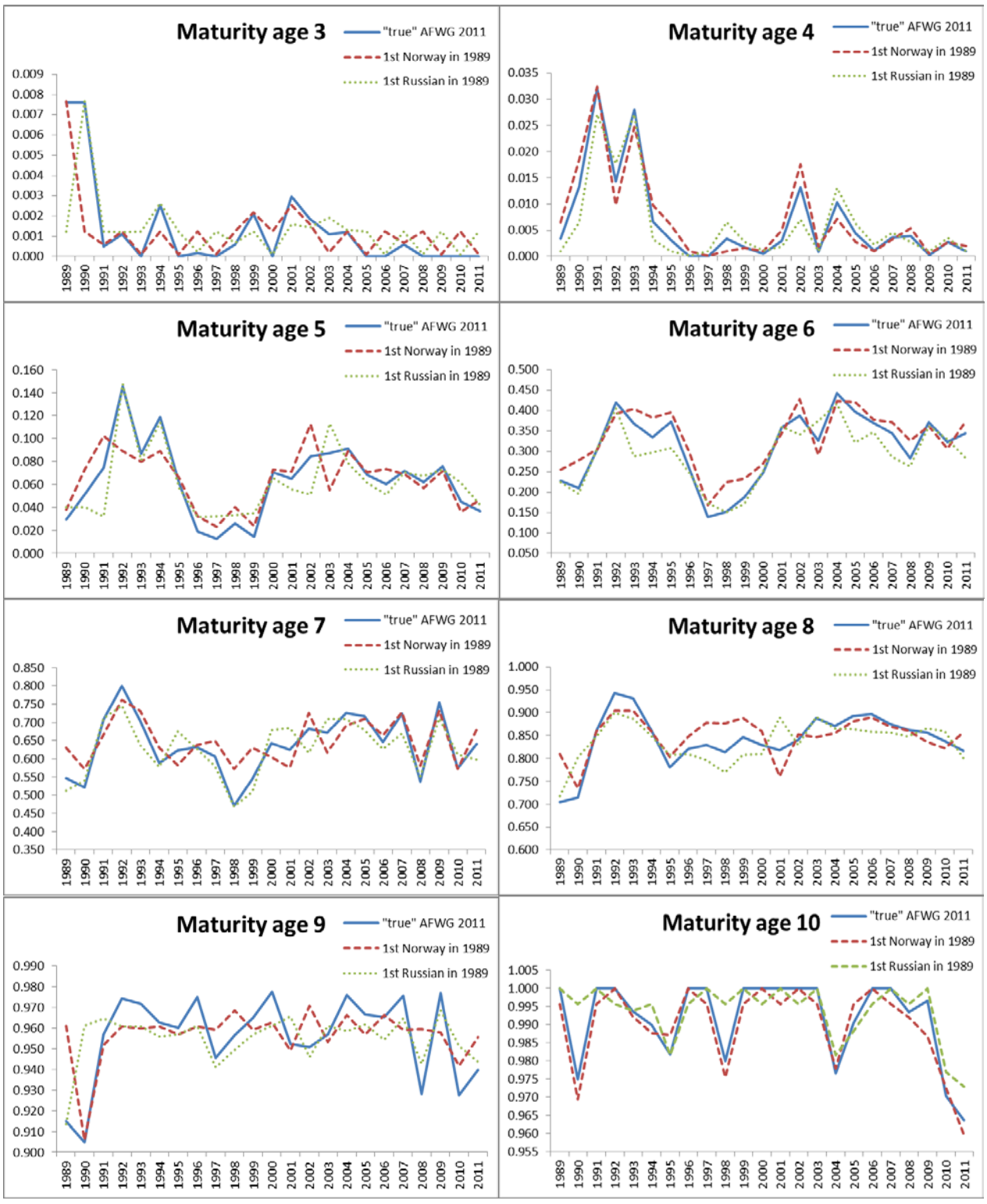

Fig. 11. The comparison between modeled (in case of survey reduction "Stand alone surveys") and observed maturity data.

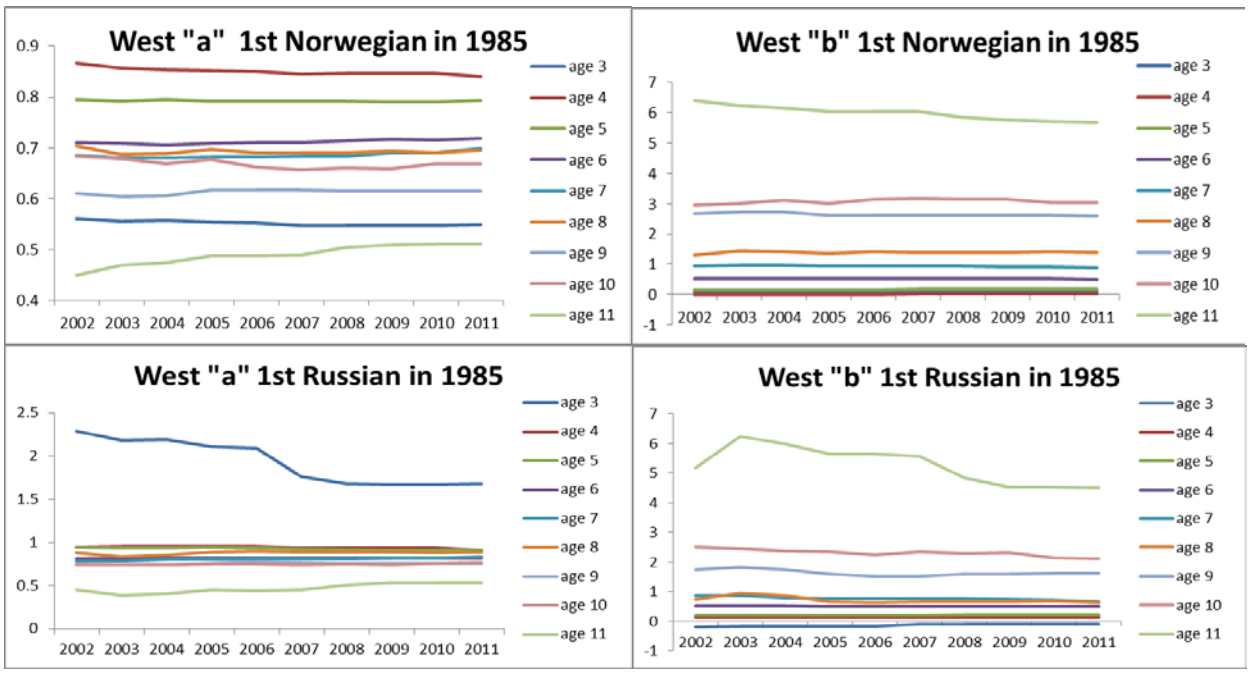

Fig. 12. Values of regression (between Russian/Norwegian survey weight in stock (WEST) data and AFWG-2011 data) coefficients fitted on data for period 1985 – specified year.

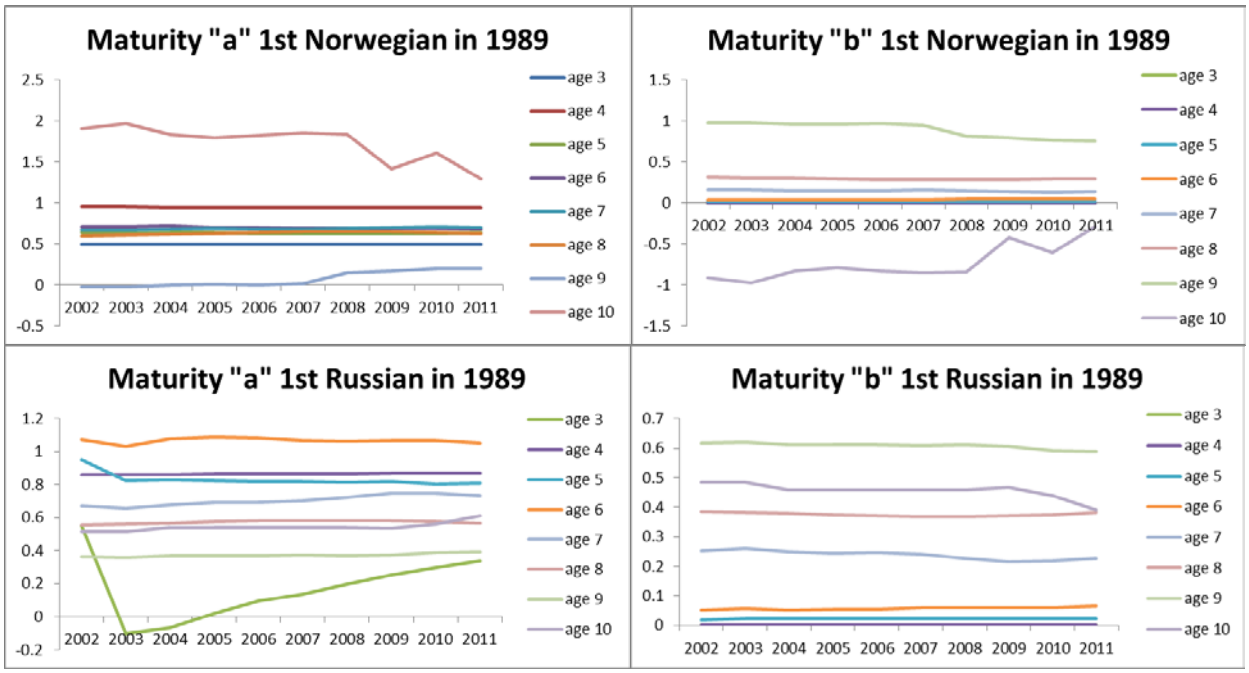

Fig. 13. Values of regression (between Russian/Norwegian survey maturity data and AFWG-2011 data) coefficients fitted on data for period 1989 – specified year.