Report of the working group on methods for averaging surveys

Background

For the 2012 assessment cycle, the Groundfish Plan Teams appointed a number of working groups. General terms of reference for the working groups were as follow:

> "Working groups are tasked with developing/collating and analyzing alternative policies/approaches for their respective topic. Analyses can be either quantitative or qualitative (i.e., listing likely pros and cons). Ideally, the working group reports will be substantial enough that the Teams can use them to make informed policy recommendations, which will then be forwarded to the SSC for comment."

This report describes the progress of the working group tasked with addressing issues pertaining to averaging of survey biomass estimates (Jon Heifetz, Jim Ianelli, Paul Spencer, and Grant Thompson). Specific topics assigned to the group included the following:

1. Methods for using survey time series to produce a "reliable" estimate of biomass for stocks/complexes managed under Tier 5, including an inventory of methods presently in use.
2. Methods for using survey time series to apportion ABC among areas.
3. Methods for filling in unsurveyed areas during years when survey funding was unavailable. For example, this applies to the groundfish bottom trawl survey in the GOA, and some periods for the sablefish longline survey (e.g., where the eastern Aleutian area is surveyed in alternate years with EBS slope areas).

The working group focused on topics #1 and #2. Further work on topic #2 is needed and work on topic #3 was initiated based on an extension of topic #1.

Simulation modeling

Two simulation models were developed in order to generate data sets for testing various methods for obtaining reliable biomass estimates and subarea proportions from survey time series. First, a single-area model was developed to evaluate estimation of biomass. Operational models were developed for "Pacific ocean perch" (POP) and "walleye pollock" life-history patterns. The group considered the following variables in conducting the simulations: coefficient of variation (CV) of survey biomass estimates, survey frequency/data availability, stock longevity/productivity, trend in fishing mortality/biomass, and recruitment variability. The single-area model simulations used the following parameter settings:

Survey CV:
This was approximated by the σ parameter of a lognormal distribution, and values of 0.15 and 0.35 were used.

Natural mortality (*M*):
Set to 0.06 and 0.30 for the POP and walleye pollock life history types, respectively.

Recruitment variability (σ_R):
Evaluated at 0.8 and 0.4.

Survey frequency:
We considered annual, biannual, and triannual survey schedules.

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Trend in fishing rate/biomass:
Trends in biomass were produced by varying the fishing rate over time. Three patterns were evaluated: 1) an increasing biomass trend (F_{spr} changes from $F_{20\%}$ to $F_{100\%}$ over the simulation); 2) a decreasing biomass trend (F_{spr} changes from $F_{100\%}$ to $F_{20\%}$ over the simulation); and 3) a constant trend (F_{spr} held at $F_{50\%}$ over the simulation).

The variables above result in 36 permutations for each life history type. For each permutation, 100 simulations of 54 years were conducted (this ensured that the end year had a survey for each of the three survey frequencies)

Simulations with movement

For analysis of estimation of area proportions, the single-area model was expanded to a three-area model, with the areas organized in a linear pattern (as along a coastline or island chain). At each time step, the total number of recruits was obtained from a Beverton-Holt recruitment function applied to the total level of spawning stock biomass. The total predicted recruits were distributed with 40% to the central area and 30% to each of the other two areas. Recruitment variability was then added to the predicted recruits in each subarea, and this variability incorporated global variability (identical for all subareas) and local variability (separate for each subarea). The variability was modeled with lognormal distributions, with the global values of σ evaluated at 0.8 and 0.4, and the local values of σ were set to one half the global value.

Adults were allowed to move between areas. The proportion of adults moving from a subarea was modeled as function of age with a logistic function. Two levels for maximum proportion of fish (by age) moving were used (0.1 and 0.3). The age at which the movement rate reached 50% of maximum was set to age 3 for pollock and age 8 for POP; these ages roughly correspond to the age at 50% maturity.

In the multiple-area model, estimates of survey biomass are modeled for each subarea. Because of this finer scale of resolution, the subarea survey CVs were increased from those used in the single area model. Values of 0.25 and 0.6 were evaluated.

Evaluation of the two values of maximum proportion of adult movement increased the number of permutations for each life-history type to 72. As with the single-area model, 100 simulations of 54 years were conducted for each permutation.

Estimation methods

Inventory of current methods

The first task completed was an inventory of methods used for averaging survey estimates for stock assessment and ABC considerations for the BSAI and GOA (Table 1). The methods used for different stocks vary and are listed in Table 2. This illustrates the variety of methods presently in use and also provided guidance on a range of methods to evaluate against the simulated data:

1. The most recent survey estimate
2. Simple recent N survey average (N= 3, 4)
3. Weighted versions of 2)
4. Simple Kalman filter, with trend assumed to be zero (i.e., random walk).

In the BSAI, methods for obtaining biomass for Tier 5 stocks include all of the methods listed above, with a simple average and the most recent survey biomass estimate being the most common. For GOA Tier 5 stocks, a simple average was the most common method, being used in 7 of 11 cases. In the BSAI, weighted averages were used to produce area proportions in 4 of the

6 cases where they were used to estimate overall biomass. In contrast, area proportions were used in 19 cases in the GOA, with the most common methods being weighted average (7 cases) and most recent survey (7 cases).

The Kalman Filter (KF) approach applied here partitions the variability due to underlying processes (i.e., changes in population "state" from one year to the next) from the observation errors due to sampling. The KF model will estimate high values for process errors when the population appears to fluctuate broadly and observations are highly precise. In situations where observation errors are high, the ability to detect population fluctuations will decrease and the overall uncertainty may remain high. In addition to applying the KF to the simulated datasets, we also provide a graphical presentation of a similar approach (a random-walk model in which the process errors are treated as random effects) applied to actual survey estimates from the GOA and Aleutian Islands.

Performance statistics selected include the mean relative error of biomass (relative error is defined here as estimate/true-1) and variability in relative errors.

Results

Estimation of survey biomass

For the pollock stock, Tables 3 and 4 show the mean relative error (averaged across runs for each scenario) while Tables 5 and 6 show the standard deviation of the relative errors for the different simulation cases and estimation methods. Analogous results for the POP stock are provided in Tables 7-10. Column labels for the "weighted average" methods represent exponential weighting terms applied to the entire time series. Column labels for the "unweighted average" methods represent the number of years included in the average (note that weighted and unweighted averages with parameter 1 are identical).

Over all the scenarios, some weighted average methods performed well in terms of low bias, as did the Kalman filter. However, the variability was higher for these and hence the Kalman filter would be preferred.

Between species, the Kalman filter performed better (over all scenarios) for pollock than POP relative to the alternatives tested (Table 11).

Estimation of area proportions

"Relative proportion error (individual areas, pollock).xlsx[1]" and "Relative proportion error (individual areas, POP).xlsx" show statistics pertaining to the relative errors in estimates of ending biomass *proportions* among areas for each species, scenario, and method. Two groups of three sheets are included in each file, with each group being analogous to the tables described above. The first set of three sheets bases the calculations on the proportions of the averages, whereas the second set of three sheets bases the calculations on the averages of the proportions.

Two conclusions are especially apparent: First, the mean relative errors are *extremely* small for all methods (rarely exceeding 1%). Second, the methods which come closest to taking an arithmetic average of the entire time series tend to produce the smallest standard deviations, which was not at all the case in the first set of simulations (see preceding subsection). Both of these results are likely explained by the fact that, because recruitment was distributed in constant proportion to all three areas (albeit with some additional local variability) and because fishing

[1] Available at www.afsc.noaa.gov/refm/stock/Plan_Team/working_groups/simulations.htm

mortality trends were identical across all three areas, the proportion of biomass in each of the three areas was fairly stable over time.

Application of the Kalman Filter approach to example datasets

An approximation to the Kalman Filter can be written as a random effects (RE) model where the process errors (step changes) from one year to the next are the random effects to be integrated over and the process error variance is a free parameter. The observations can be irregularly spaced. The box below shows the contents of a typical data file:

```
# Aleutian Islands Kamchatka flounder
# Year range
1991 2013
#Number of observations
8
#Years of observations
 1991  1994  1997  2000  2002  2004  2006  2010
#Biomass estimates
16255 49156 37664 28535 49035 39219 45369 53962
#Std Errors of biomass estimates
4458  18522  9588  6601 13634  9219 11058 20567
```

Results from this model for selected Aleutian Islands stocks are shown in Fig. 1. Note the interplay between the magnitude of the observation errors and that predicted by the model and how this can provide a way to naturally weight observations going forward.

This model can also be applied to situations where there are missing regions in some years as is the case with the GOA. Figures 2 and 3 show two stocks where the model is fit to each region independently, noting that the values for 2001 are missing due to lack of funding to complete a GOA-wide survey. Given that the performance of the KF method tested well for individual time series, it may follow that applying it to regional time series to "fill in" missing years of data may be appropriate (and it should be feasible to compute uncertainties for application in *P**-based ACLs).

Discussion

Webster (2011) conducted an evaluation (without simulations) using a Kalman filter approach with alternative models including the trendless random walk used here along with 3 other forms that allowed for underlying trends to be estimated. He concluded that the trendless model performed adequately and based on evaluations of halibut longline survey data from a variety of different areas that a general historical weighting scheme was a suitable approximation to the results from the Kalman Filter application (with the 3-most recent surveys being weighted 70:25:5 (with 70 being the most recent). The KF method applied here could be used to develop similar "rules of thumb" but this may likely vary by species.

Our workgroup was tasked with three topics:

1) obtaining a reliable" estimate of biomass for Tier 5 stocks
2) Methods for using survey time series to apportion ABC among areas and
3) Methods for covering unsurveyed areas.

For tier 5) stocks the KF or RE model could be used to address all three topics simultaneously. The KF or RE model could be applied to each area separately which would enable calculation of apportionments and filling in for unsurveyed areas. The overall ABC could then be based on the sums of the individual areas.

Recommendations

The Kalman Filter approach was simple to apply and performed well in the simulations, and the RE model gave very similar results in limited testing. A next step would be to apply the methods

described here to a range of species and compare ABC values and apportionments to that currently used. The KF has the added benefit of providing estimates of biomass variances which combine the process errors and observation errors. This approach could prove useful for application to risk-averse ACL specifications. In particular, it provides insight on the loss of information as surveys become more or less infrequent.

We recommend that the Kalman filter or RE model be applied to obtain the "reliable biomass" estimate required for Tier 5 stocks. Depending upon how quickly a generic and user-friendly computer program can be developed, we recommend that this change be instituted for the 2012 assessments if possible, but no later than the 2013 assessments.

Regarding apportionment, while further work is needed, the KF and RE methods also hold promise since they naturally weight the time series of information by region according to the level of sampling (e.g., if an area is missed in a survey year or less well covered).

Future work

As mentioned above, the ability of the methods to estimate relative proportions could reflect the strongly coupled dynamics between the subareas assumed in the simulation, which resulted in the true proportions not varying extensively over time. This modeling approach was consistent with viewing the three subareas as components of a single stock, as strongly different population trends between the subareas would suggest relatively isolated population units. Nonetheless, further work involving greater variability in biomass proportions over time (from some combination of spatial variation in fishing pressure and recruitment dynamics) will be needed to further evaluate the various methods' usefulness in making area apportionments.

Another method that the working group hopes to pursue in the coming year is a vector autoregressive model in which the two elements of the state vector are survey biomass (scaled relative to the time series mean) and the ratio of catch to survey biomass. The only data required are the time series of survey biomass and catch, plus standard errors for each. The model is cast in state-space form and estimated via the Kalman filter. The correlation between observations of the two state variables is accounted for in the observation error covariance matrix. In addition to producing estimates of the biomass time series and projections of future biomass, the model also estimates MSY, the MSY exploitation rate (MSY divided by survey biomass at MSY), and OFL; and is capable of estimating a probability-based ABC. Preliminary testing of the approach has been very limited but also very promising, with performance so far being equal to or better than a full age-structured assessment.

Tables

Table 1. Summary of methods used for different stocks by tiers for the BSAI and GOA.

Bering Sea Aleutian Islands

Tier:	1	2	3	4	5	6
Number of stocks	3	0	12	0	7	3
Biomass estimation method						
NA	3		11			3
Average			1		3	
Weighted average					1	
Kalman filter					1	
Most recent					2	
Proportion estimation method						
NA	3		7		6	3
Average			1			
Weighted average			4		1	

Gulf of Alaska

Tier	1	2	3	4	5	6
Number of stocks	0	0	9	2	11	5
Biomass estimation method						
NA			9			5
Average				1	7	
Most recent				1	3	
Mature biomass from model					1	
Proportion estimation method						
NA				1	3	4
Average			2		2	
Weighted average			4	1	2	
Most recent			3		4	
Proportion of historical catch						1

Table 2. Inventory of methods used for different stocks which involved some form of survey averaging (unless otherwise specified).

Area	Stock	Tier	Biomass	Proportions
BSAI	Pacific cod	3	Scaled to BSAI using Kalman filter	NA
AK	Sablefish	3	NA	5 year weighted average of survey and fishery indices
BSAI	Greenland Turbot	3	NA	Most recent three
BSAI	POP	3	NA	4-6-9 weighting by subarea
BSAI	Rougheye/BS	3	NA	4-6-9 weighting by subarea
BSAI	Alaska skate	3	NA	NA
BSAI	Atka mackerel	3	NA	8-12-18-27 weighting
BSAI	Kamchatka	5	7-year average	NA
Bogo	Pollock	5	Most recent	NA
BSAI	Other flatfish	5	Most recent	NA
BSAI	Shortraker rockfish	5	Kalman filter	NA
BSAI	other rockfish	5	4-6-9 weighting	4-6-9 weighting
BSAI	other skates	5	Most recent three	NA
BSAI	sculpins	5	Most recent three	NA
GOA	pollock	3	NA	4 most recent average
GOA	Pacific cod	3	NA	3 most recent average
GOA	Arrowtooth	3	NA	Most recent
GOA	flathead sole	3	NA	Most recent
GOA	northern rockfish	3	NA	4-6-9 weighting
GOA	Pel. shelf rockfish (dusky)	3	NA	4-6-9 weighting
GOA	POP	3	NA	4-6-9 weighting
GOA	RE/BS rockfish	3	NA	4-6-9 weighting
GOA	Shallow flats N, S rock sole	3	NA	Most recent
GOA	Demersal shelf	4	Most recent	NA
GOA	Other rockfish - sharpchin	4	Most recent three	4-6-9 weighting
GOA	Big skate	5	Most recent three	Most recent three
GOA	deep flats Dover sole	5	most recent	Most recent (dover)
GOA	longnose skate	5	Most recent three	Most recent three
GOA	Oher rockfish - other	5	Most recent three	4-6-9 weighting
GOA	Other skates	5	Most recent three	NA
GOA	rex sole	5	Mature biomass from model	Most recent
GOA	Sculpins	5	Most recent four	NA
GOA	shallow flats - others	5	Most recent	Most recent
GOA	Sharks - spiny dogfish	5	Most recent three	NA
GOA	shortraker rockfish	5	Most recent three	4-6-9 weighting
GOA	Thornyhead	5	Most recent	Most recent
GOA	Atka mackerel	6	NA	NA
GOA	deep flats others	6	NA	Proportion of historical catch
GOA	octopus	6	NA	NA
GOA	Sharks - others	6	NA	NA
GOA	squids	6	NA	NA

Table 3. Mean relative biomass error for combined areas "pollock" like simulations comparing weighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Weighted average methods									Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	filter
up	0.8	0.25	1	0.1	-0.15	-0.06	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	-0.06
up	0.4	0.25	1	0.1	-0.19	-0.09	-0.06	-0.04	-0.03	-0.02	-0.02	-0.01	-0.01	-0.08
up	0.8	0.6	1	0.1	-0.14	-0.06	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.14
up	0.4	0.6	1	0.1	-0.18	-0.10	-0.07	-0.06	-0.06	-0.05	-0.04	-0.03	-0.02	-0.15
down	0.8	0.25	1	0.1	1.34	0.57	0.33	0.21	0.14	0.10	0.06	0.04	0.02	0.02
down	0.4	0.25	1	0.1	1.13	0.48	0.27	0.17	0.11	0.07	0.04	0.02	0.01	0.01
down	0.8	0.6	1	0.1	1.54	0.68	0.38	0.23	0.13	0.06	0.02	-0.02	-0.04	-0.02
down	0.4	0.6	1	0.1	1.17	0.51	0.29	0.18	0.12	0.08	0.05	0.03	0.01	0.06
flat	0.8	0.25	1	0.1	0.13	0.10	0.07	0.05	0.04	0.03	0.03	0.03	0.03	0.02
flat	0.4	0.25	1	0.1	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
flat	0.8	0.6	1	0.1	0.08	0.02	-0.01	-0.03	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06
flat	0.4	0.6	1	0.1	0.01	-0.01	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.02
up	0.8	0.25	2	0.1	-0.30	-0.14	-0.08	-0.05	-0.03	-0.02	0.00	0.01	0.02	-0.06
up	0.4	0.25	2	0.1	-0.33	-0.17	-0.10	-0.07	-0.05	-0.04	-0.03	-0.02	-0.01	-0.09
up	0.8	0.6	2	0.1	-0.30	-0.13	-0.07	-0.03	-0.01	0.00	0.01	0.02	0.03	-0.18
up	0.4	0.6	2	0.1	-0.32	-0.16	-0.10	-0.07	-0.04	-0.02	0.00	0.02	0.04	-0.18
down	0.8	0.25	2	0.1	2.83	1.28	0.71	0.44	0.29	0.19	0.12	0.08	0.04	0.02
down	0.4	0.25	2	0.1	2.31	1.08	0.61	0.38	0.24	0.16	0.09	0.05	0.02	0.01
down	0.8	0.6	2	0.1	2.64	1.24	0.70	0.45	0.30	0.21	0.15	0.11	0.07	0.08
down	0.4	0.6	2	0.1	2.16	0.99	0.57	0.36	0.24	0.16	0.11	0.07	0.03	0.08
flat	0.8	0.25	2	0.1	0.07	0.05	0.04	0.03	0.02	0.01	0.01	0.00	0.00	-0.03
flat	0.4	0.25	2	0.1	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03
flat	0.8	0.6	2	0.1	0.12	0.07	0.05	0.03	0.02	0.02	0.01	0.00	0.00	-0.03
flat	0.4	0.6	2	0.1	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	-0.01
up	0.8	0.25	3	0.1	-0.38	-0.18	-0.10	-0.07	-0.05	-0.04	-0.04	-0.04	-0.03	-0.08
up	0.4	0.25	3	0.1	-0.42	-0.23	-0.14	-0.09	-0.06	-0.04	-0.03	-0.02	-0.01	-0.08
up	0.8	0.6	3	0.1	-0.39	-0.20	-0.11	-0.07	-0.05	-0.03	-0.03	-0.02	-0.01	-0.21
up	0.4	0.6	3	0.1	-0.42	-0.22	-0.13	-0.08	-0.05	-0.03	-0.01	0.00	0.00	-0.19
down	0.8	0.25	3	0.1	3.27	1.71	1.01	0.64	0.41	0.27	0.16	0.08	0.02	-0.01
down	0.4	0.25	3	0.1	2.86	1.48	0.87	0.55	0.37	0.24	0.16	0.10	0.05	0.03
down	0.8	0.6	3	0.1	3.98	2.12	1.26	0.80	0.53	0.34	0.21	0.11	0.03	0.02
down	0.4	0.6	3	0.1	3.10	1.56	0.90	0.56	0.37	0.24	0.15	0.08	0.03	0.05
flat	0.8	0.25	3	0.1	0.17	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.01
flat	0.4	0.25	3	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.01
flat	0.8	0.6	3	0.1	0.14	0.10	0.07	0.04	0.01	0.00	-0.02	-0.03	-0.03	-0.08
flat	0.4	0.6	3	0.1	0.07	0.06	0.05	0.04	0.02	0.01	-0.01	-0.02	-0.03	0.02
up	0.8	0.25	1	0.3	-0.17	-0.08	-0.05	-0.03	-0.02	-0.01	-0.01	-0.01	0.00	-0.06
up	0.4	0.25	1	0.3	-0.18	-0.08	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02	-0.07
up	0.8	0.6	1	0.3	-0.11	-0.05	-0.03	-0.02	-0.01	0.00	0.02	0.03	0.05	-0.12
up	0.4	0.6	1	0.3	-0.16	-0.06	-0.03	-0.01	0.00	0.01	0.01	0.02	0.02	-0.12
down	0.8	0.25	1	0.3	1.39	0.58	0.33	0.21	0.14	0.09	0.06	0.04	0.02	0.01
down	0.4	0.25	1	0.3	1.10	0.47	0.27	0.16	0.10	0.06	0.03	0.01	-0.01	-0.01
down	0.8	0.6	1	0.3	1.43	0.62	0.34	0.19	0.09	0.03	-0.01	-0.05	-0.07	-0.04
down	0.4	0.6	1	0.3	1.20	0.52	0.30	0.19	0.12	0.08	0.05	0.03	0.01	0.06
flat	0.8	0.25	1	0.3	0.09	0.05	0.03	0.01	0.01	0.00	0.00	0.00	0.00	-0.02
flat	0.4	0.25	1	0.3	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
flat	0.8	0.6	1	0.3	0.07	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.06	-0.01
flat	0.4	0.6	1	0.3	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
up	0.8	0.25	2	0.3	-0.30	-0.14	-0.08	-0.06	-0.04	-0.04	-0.03	-0.03	-0.03	-0.08
up	0.4	0.25	2	0.3	-0.32	-0.16	-0.09	-0.06	-0.03	-0.02	-0.01	0.00	0.01	-0.07
up	0.8	0.6	2	0.3	-0.28	-0.12	-0.07	-0.05	-0.04	-0.03	-0.04	-0.04	-0.04	-0.15
up	0.4	0.6	2	0.3	-0.32	-0.15	-0.08	-0.05	-0.03	-0.01	0.00	0.00	0.01	-0.17
down	0.8	0.25	2	0.3	2.81	1.33	0.78	0.50	0.34	0.23	0.15	0.09	0.04	0.02
down	0.4	0.25	2	0.3	2.09	0.96	0.54	0.34	0.22	0.14	0.09	0.05	0.02	0.01
down	0.8	0.6	2	0.3	2.59	1.23	0.72	0.47	0.31	0.21	0.13	0.08	0.03	0.04
down	0.4	0.6	2	0.3	2.30	1.08	0.62	0.39	0.25	0.16	0.09	0.03	-0.01	0.04
flat	0.8	0.25	2	0.3	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.00	-0.03
flat	0.4	0.25	2	0.3	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
flat	0.8	0.6	2	0.3	0.05	0.02	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.10
flat	0.4	0.6	2	0.3	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03
up	0.8	0.25	3	0.3	-0.40	-0.20	-0.12	-0.07	-0.05	-0.03	-0.02	-0.02	-0.01	-0.07
up	0.4	0.25	3	0.3	-0.42	-0.23	-0.14	-0.09	-0.06	-0.04	-0.03	-0.02	-0.01	-0.08
up	0.8	0.6	3	0.3	-0.40	-0.21	-0.13	-0.09	-0.07	-0.06	-0.05	-0.04	-0.04	-0.21
up	0.4	0.6	3	0.3	-0.41	-0.21	-0.12	-0.07	-0.03	-0.01	0.00	0.01	0.02	-0.17
down	0.8	0.25	3	0.3	3.58	1.86	1.10	0.71	0.48	0.32	0.21	0.12	0.04	0.00
down	0.4	0.25	3	0.3	3.02	1.60	0.96	0.62	0.41	0.27	0.18	0.10	0.05	0.02
down	0.8	0.6	3	0.3	3.51	1.90	1.16	0.76	0.52	0.35	0.22	0.13	0.06	0.05
down	0.4	0.6	3	0.3	3.02	1.57	0.91	0.58	0.38	0.25	0.16	0.09	0.04	0.06
flat	0.8	0.25	3	0.3	0.09	0.08	0.06	0.04	0.03	0.02	0.01	0.00	-0.01	-0.03
flat	0.4	0.25	3	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02
flat	0.8	0.6	3	0.3	0.11	0.09	0.08	0.07	0.07	0.06	0.06	0.05	0.05	-0.04
flat	0.4	0.6	3	0.3	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01
					0.70	0.35	0.20	0.13	0.08	0.05	0.03	0.02	0.00	-0.04

Table 4. Mean relative biomass error for combined areas "pollock" like simulations comparing unweighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Unweighted average methods										Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	1	2	3	4	5	6	7	8	9	10	filter
up	0.8	0.25	1	0.1	0.00	0.00	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06	-0.07	-0.06
up	0.4	0.25	1	0.1	-0.01	-0.02	-0.02	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09	-0.10	-0.08
up	0.8	0.6	1	0.1	-0.03	-0.02	-0.03	-0.03	-0.04	-0.03	-0.04	-0.05	-0.06	-0.06	-0.14
up	0.4	0.6	1	0.1	-0.01	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08	-0.09	-0.09	-0.10	-0.15
down	0.8	0.25	1	0.1	0.00	0.08	0.14	0.20	0.27	0.33	0.41	0.48	0.56	0.63	0.02
down	0.4	0.25	1	0.1	-0.01	0.06	0.10	0.15	0.22	0.28	0.34	0.41	0.48	0.55	0.01
down	0.8	0.6	1	0.1	-0.06	0.02	0.12	0.25	0.36	0.43	0.52	0.59	0.68	0.75	-0.02
down	0.4	0.6	1	0.1	0.00	0.06	0.12	0.18	0.25	0.31	0.38	0.44	0.51	0.56	0.06
flat	0.8	0.25	1	0.1	0.03	0.02	0.02	0.04	0.06	0.08	0.10	0.11	0.12	0.12	0.02
flat	0.4	0.25	1	0.1	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
flat	0.8	0.6	1	0.1	-0.06	-0.05	-0.06	-0.04	-0.02	0.00	0.01	0.02	0.03	0.04	-0.06
flat	0.4	0.6	1	0.1	-0.05	-0.06	-0.03	-0.04	-0.02	-0.02	-0.01	-0.01	0.00	0.00	-0.02
up	0.8	0.25	2	0.1	0.03	-0.02	-0.04	-0.05	-0.07	-0.07	-0.09	-0.11	-0.13	-0.15	-0.06
up	0.4	0.25	2	0.1	-0.01	-0.03	-0.05	-0.07	-0.09	-0.11	-0.13	-0.15	-0.17	-0.19	-0.09
up	0.8	0.6	2	0.1	0.04	0.00	-0.01	-0.04	-0.05	-0.07	-0.09	-0.11	-0.13	-0.15	-0.18
up	0.4	0.6	2	0.1	0.06	-0.04	-0.07	-0.09	-0.10	-0.12	-0.13	-0.15	-0.16	-0.18	-0.18
down	0.8	0.25	2	0.1	0.02	0.13	0.26	0.42	0.56	0.72	0.88	1.05	1.21	1.40	0.02
down	0.4	0.25	2	0.1	-0.01	0.10	0.23	0.37	0.51	0.65	0.79	0.93	1.07	1.21	0.01
down	0.8	0.6	2	0.1	0.05	0.15	0.30	0.42	0.55	0.69	0.86	1.04	1.22	1.40	0.08
down	0.4	0.6	2	0.1	0.01	0.12	0.25	0.34	0.47	0.57	0.69	0.83	0.97	1.11	0.08
flat	0.8	0.25	2	0.1	0.01	-0.01	0.01	0.03	0.05	0.06	0.06	0.06	0.06	0.07	-0.03
flat	0.4	0.25	2	0.1	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.01	0.01	0.02	-0.03
flat	0.8	0.6	2	0.1	-0.01	0.03	0.02	0.02	0.05	0.06	0.08	0.08	0.08	0.09	-0.03
flat	0.4	0.6	2	0.1	0.01	0.01	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-0.01
up	0.8	0.25	3	0.1	-0.03	-0.04	-0.05	-0.06	-0.07	-0.09	-0.11	-0.14	-0.17	-0.20	-0.08
up	0.4	0.25	3	0.1	0.00	-0.03	-0.06	-0.09	-0.12	-0.15	-0.18	-0.21	-0.24	-0.27	-0.08
up	0.8	0.6	3	0.1	-0.01	-0.02	-0.05	-0.07	-0.08	-0.10	-0.12	-0.15	-0.19	-0.22	-0.21
up	0.4	0.6	3	0.1	0.00	0.00	-0.04	-0.08	-0.12	-0.15	-0.18	-0.20	-0.23	-0.27	-0.19
down	0.8	0.25	3	0.1	-0.02	0.18	0.43	0.63	0.85	1.04	1.28	1.53	1.77	2.00	-0.01
down	0.4	0.25	3	0.1	0.01	0.18	0.36	0.54	0.72	0.91	1.10	1.29	1.50	1.70	0.03
down	0.8	0.6	3	0.1	-0.04	0.25	0.56	0.79	1.03	1.39	1.63	1.90	2.16	2.45	0.02
down	0.4	0.6	3	0.1	-0.01	0.18	0.38	0.54	0.73	0.91	1.11	1.35	1.54	1.76	0.05
flat	0.8	0.25	3	0.1	0.02	0.04	0.06	0.09	0.11	0.13	0.13	0.13	0.13	0.13	0.01
flat	0.4	0.25	3	0.1	0.01	0.03	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01
flat	0.8	0.6	3	0.1	-0.04	-0.03	0.02	0.05	0.08	0.10	0.12	0.13	0.12	0.13	-0.08
flat	0.4	0.6	3	0.1	-0.04	0.01	0.04	0.07	0.06	0.06	0.06	0.08	0.09	0.09	0.02
up	0.8	0.25	1	0.3	0.00	-0.01	-0.02	-0.03	-0.04	-0.06	-0.06	-0.08	-0.09	-0.09	-0.06
up	0.4	0.25	1	0.3	-0.02	-0.03	-0.03	-0.03	-0.04	-0.05	-0.07	-0.08	-0.09	-0.09	-0.07
up	0.8	0.6	1	0.3	0.06	-0.03	-0.03	-0.03	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.12
up	0.4	0.6	1	0.3	0.03	0.00	-0.01	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.07	-0.12
down	0.8	0.25	1	0.3	0.01	0.07	0.13	0.21	0.27	0.33	0.40	0.47	0.55	0.63	0.01
down	0.4	0.25	1	0.3	-0.03	0.04	0.11	0.17	0.23	0.29	0.35	0.41	0.47	0.53	-0.01
down	0.8	0.6	1	0.3	-0.10	0.02	0.09	0.17	0.30	0.39	0.46	0.57	0.64	0.70	-0.04
down	0.4	0.6	1	0.3	0.00	0.05	0.11	0.18	0.26	0.32	0.38	0.46	0.51	0.57	0.06
flat	0.8	0.25	1	0.3	0.00	0.00	0.01	0.01	0.01	0.03	0.04	0.05	0.06	0.06	-0.02
flat	0.4	0.25	1	0.3	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	-0.01
flat	0.8	0.6	1	0.3	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	-0.01
flat	0.4	0.6	1	0.3	0.00	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
up	0.8	0.25	2	0.3	-0.02	-0.03	-0.04	-0.06	-0.06	-0.07	-0.09	-0.11	-0.12	-0.14	-0.08
up	0.4	0.25	2	0.3	0.02	-0.01	-0.03	-0.06	-0.08	-0.10	-0.12	-0.14	-0.16	-0.18	-0.07
up	0.8	0.6	2	0.3	-0.05	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.09	-0.10	-0.12	-0.15
up	0.4	0.6	2	0.3	0.01	0.00	-0.03	-0.04	-0.07	-0.09	-0.11	-0.13	-0.15	-0.17	-0.17
down	0.8	0.25	2	0.3	0.01	0.16	0.34	0.50	0.66	0.84	1.03	1.19	1.34	1.50	0.02
down	0.4	0.25	2	0.3	-0.01	0.11	0.22	0.33	0.44	0.57	0.70	0.82	0.94	1.07	0.01
down	0.8	0.6	2	0.3	0.00	0.16	0.31	0.50	0.64	0.77	0.91	1.07	1.22	1.39	0.04
down	0.4	0.6	2	0.3	-0.05	0.13	0.26	0.39	0.53	0.65	0.82	0.96	1.08	1.21	0.04
flat	0.8	0.25	2	0.3	0.00	0.01	0.02	0.04	0.06	0.06	0.06	0.06	0.05	0.05	-0.03
flat	0.4	0.25	2	0.3	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.02
flat	0.8	0.6	2	0.3	-0.06	-0.04	-0.02	-0.01	0.01	0.04	0.04	0.03	0.02	0.03	-0.10
flat	0.4	0.6	2	0.3	-0.01	0.01	0.00	-0.01	0.00	-0.01	0.00	0.00	0.01	0.01	-0.03
up	0.8	0.25	3	0.3	-0.01	-0.02	-0.04	-0.06	-0.10	-0.12	-0.15	-0.17	-0.20	-0.24	-0.07
up	0.4	0.25	3	0.3	-0.01	-0.02	-0.06	-0.10	-0.12	-0.15	-0.18	-0.21	-0.24	-0.27	-0.08
up	0.8	0.6	3	0.3	-0.03	-0.05	-0.07	-0.08	-0.10	-0.12	-0.14	-0.18	-0.21	-0.24	-0.21
up	0.4	0.6	3	0.3	0.03	0.00	-0.03	-0.07	-0.10	-0.13	-0.16	-0.20	-0.23	-0.26	-0.17
down	0.8	0.25	3	0.3	-0.01	0.25	0.53	0.74	0.92	1.12	1.34	1.60	1.87	2.13	0.00
down	0.4	0.25	3	0.3	0.00	0.20	0.41	0.61	0.81	1.03	1.24	1.44	1.64	1.86	0.02
down	0.8	0.6	3	0.3	0.00	0.26	0.53	0.79	1.05	1.25	1.49	1.73	2.00	2.18	0.05
down	0.4	0.6	3	0.3	0.00	0.18	0.35	0.57	0.78	0.97	1.15	1.33	1.59	1.79	0.06
flat	0.8	0.25	3	0.3	-0.01	0.01	0.02	0.05	0.07	0.09	0.11	0.11	0.11	0.10	-0.03
flat	0.4	0.25	3	0.3	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
flat	0.8	0.6	3	0.3	0.04	0.06	0.09	0.07	0.06	0.07	0.08	0.09	0.08	0.09	-0.04
flat	0.4	0.6	3	0.3	0.01	-0.02	-0.02	0.00	0.00	0.00	0.00	0.01	0.02	0.03	-0.01
					0.00	0.04	0.08	0.13	0.17	0.22	0.26	0.31	0.35	0.39	-0.04

Table 5. Standard deviation for relative biomass error for combined areas "pollock" like simulations comparing weighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Weighted average methods									Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	filter
up	0.8	0.25	1	0.1	0.16	0.13	0.11	0.10	0.10	0.10	0.11	0.12	0.13	0.12
up	0.4	0.25	1	0.1	0.08	0.07	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.07
up	0.8	0.6	1	0.1	0.18	0.16	0.16	0.18	0.21	0.25	0.28	0.31	0.35	0.20
up	0.4	0.6	1	0.1	0.12	0.16	0.18	0.20	0.23	0.26	0.29	0.32	0.35	0.16
down	0.8	0.25	1	0.1	0.88	0.47	0.32	0.24	0.18	0.14	0.12	0.12	0.12	0.13
down	0.4	0.25	1	0.1	0.39	0.24	0.17	0.13	0.11	0.10	0.10	0.10	0.11	0.11
down	0.8	0.6	1	0.1	0.95	0.50	0.36	0.31	0.29	0.29	0.30	0.33	0.36	0.32
down	0.4	0.6	1	0.1	0.38	0.24	0.21	0.21	0.23	0.25	0.27	0.30	0.34	0.26
flat	0.8	0.25	1	0.1	0.29	0.22	0.17	0.14	0.12	0.12	0.12	0.13	0.14	0.13
flat	0.4	0.25	1	0.1	0.13	0.10	0.09	0.08	0.08	0.08	0.08	0.09	0.10	0.08
flat	0.8	0.6	1	0.1	0.34	0.27	0.23	0.21	0.21	0.22	0.24	0.26	0.29	0.24
flat	0.4	0.6	1	0.1	0.15	0.15	0.15	0.16	0.18	0.19	0.21	0.23	0.26	0.16
up	0.8	0.25	2	0.1	0.16	0.16	0.15	0.13	0.12	0.12	0.12	0.12	0.13	0.14
up	0.4	0.25	2	0.1	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.13	0.10
up	0.8	0.6	2	0.1	0.16	0.19	0.20	0.21	0.23	0.25	0.28	0.31	0.34	0.21
up	0.4	0.6	2	0.1	0.11	0.15	0.19	0.23	0.27	0.31	0.35	0.39	0.44	0.24
down	0.8	0.25	2	0.1	1.73	0.87	0.54	0.38	0.29	0.23	0.19	0.17	0.17	0.17
down	0.4	0.25	2	0.1	0.57	0.35	0.25	0.19	0.15	0.13	0.12	0.13	0.14	0.14
down	0.8	0.6	2	0.1	1.29	0.73	0.51	0.41	0.36	0.34	0.33	0.35	0.37	0.35
down	0.4	0.6	2	0.1	0.80	0.46	0.34	0.30	0.28	0.29	0.30	0.31	0.33	0.31
flat	0.8	0.25	2	0.1	0.33	0.29	0.25	0.20	0.16	0.13	0.12	0.11	0.11	0.12
flat	0.4	0.25	2	0.1	0.15	0.12	0.11	0.10	0.10	0.10	0.10	0.11	0.12	0.11
flat	0.8	0.6	2	0.1	0.39	0.32	0.28	0.26	0.26	0.27	0.29	0.31	0.34	0.30
flat	0.4	0.6	2	0.1	0.16	0.17	0.19	0.21	0.23	0.26	0.29	0.31	0.34	0.18
up	0.8	0.25	3	0.1	0.14	0.16	0.16	0.14	0.13	0.12	0.11	0.11	0.12	0.12
up	0.4	0.25	3	0.1	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.14	0.09
up	0.8	0.6	3	0.1	0.18	0.21	0.22	0.23	0.24	0.26	0.29	0.31	0.34	0.26
up	0.4	0.6	3	0.1	0.08	0.12	0.15	0.17	0.19	0.21	0.23	0.25	0.28	0.16
down	0.8	0.25	3	0.1	1.64	0.95	0.62	0.45	0.33	0.25	0.19	0.15	0.13	0.13
down	0.4	0.25	3	0.1	0.79	0.45	0.30	0.22	0.17	0.15	0.14	0.14	0.14	0.14
down	0.8	0.6	3	0.1	2.15	1.16	0.78	0.60	0.50	0.42	0.36	0.33	0.33	0.32
down	0.4	0.6	3	0.1	1.05	0.60	0.43	0.35	0.31	0.29	0.30	0.32	0.35	0.32
flat	0.8	0.25	3	0.1	0.41	0.33	0.27	0.23	0.19	0.17	0.15	0.14	0.14	0.15
flat	0.4	0.25	3	0.1	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.13	0.13	0.12
flat	0.8	0.6	3	0.1	0.44	0.37	0.32	0.28	0.26	0.26	0.27	0.29	0.32	0.27
flat	0.4	0.6	3	0.1	0.23	0.22	0.21	0.21	0.22	0.23	0.25	0.27	0.30	0.21
up	0.8	0.25	1	0.3	0.15	0.12	0.10	0.09	0.09	0.09	0.10	0.11	0.12	0.11
up	0.4	0.25	1	0.3	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.11	0.12	0.08
up	0.8	0.6	1	0.3	0.20	0.17	0.18	0.21	0.24	0.27	0.31	0.34	0.38	0.19
up	0.4	0.6	1	0.3	0.11	0.14	0.17	0.19	0.21	0.23	0.25	0.28	0.31	0.14
down	0.8	0.25	1	0.3	0.72	0.38	0.26	0.20	0.16	0.13	0.11	0.11	0.12	0.12
down	0.4	0.25	1	0.3	0.33	0.20	0.15	0.13	0.12	0.12	0.12	0.13	0.14	0.14
down	0.8	0.6	1	0.3	0.90	0.54	0.38	0.29	0.26	0.25	0.26	0.28	0.30	0.28
down	0.4	0.6	1	0.3	0.37	0.24	0.22	0.22	0.24	0.26	0.29	0.32	0.35	0.29
flat	0.8	0.25	1	0.3	0.29	0.21	0.16	0.13	0.11	0.11	0.11	0.11	0.12	0.11
flat	0.4	0.25	1	0.3	0.13	0.11	0.10	0.10	0.10	0.10	0.11	0.12	0.13	0.10
flat	0.8	0.6	1	0.3	0.27	0.23	0.23	0.24	0.26	0.29	0.32	0.36	0.41	0.23
flat	0.4	0.6	1	0.3	0.14	0.17	0.21	0.24	0.28	0.32	0.36	0.40	0.44	0.19
up	0.8	0.25	2	0.3	0.16	0.16	0.14	0.12	0.11	0.11	0.11	0.11	0.13	0.13
up	0.4	0.25	2	0.3	0.07	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.08
up	0.8	0.6	2	0.3	0.19	0.23	0.24	0.25	0.27	0.29	0.31	0.34	0.37	0.25
up	0.4	0.6	2	0.3	0.11	0.16	0.19	0.23	0.26	0.29	0.32	0.34	0.37	0.20
down	0.8	0.25	2	0.3	1.39	0.75	0.49	0.34	0.25	0.19	0.16	0.14	0.13	0.14
down	0.4	0.25	2	0.3	0.61	0.34	0.24	0.18	0.14	0.12	0.12	0.12	0.13	0.14
down	0.8	0.6	2	0.3	1.62	0.92	0.64	0.48	0.38	0.33	0.31	0.32	0.35	0.33
down	0.4	0.6	2	0.3	0.71	0.41	0.31	0.27	0.26	0.27	0.29	0.31	0.34	0.31
flat	0.8	0.25	2	0.3	0.34	0.27	0.22	0.18	0.15	0.13	0.12	0.11	0.12	0.13
flat	0.4	0.25	2	0.3	0.15	0.13	0.11	0.11	0.10	0.11	0.11	0.12	0.13	0.11
flat	0.8	0.6	2	0.3	0.35	0.31	0.28	0.26	0.25	0.25	0.26	0.28	0.31	0.26
flat	0.4	0.6	2	0.3	0.16	0.17	0.19	0.22	0.24	0.27	0.30	0.33	0.37	0.19
up	0.8	0.25	3	0.3	0.14	0.17	0.17	0.16	0.15	0.14	0.13	0.13	0.14	0.16
up	0.4	0.25	3	0.3	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.10
up	0.8	0.6	3	0.3	0.13	0.16	0.17	0.18	0.20	0.21	0.24	0.26	0.29	0.20
up	0.4	0.6	3	0.3	0.10	0.15	0.18	0.22	0.26	0.29	0.33	0.37	0.42	0.22
down	0.8	0.25	3	0.3	1.69	0.98	0.64	0.46	0.35	0.27	0.21	0.17	0.15	0.15
down	0.4	0.25	3	0.3	0.78	0.46	0.31	0.23	0.18	0.15	0.14	0.13	0.14	0.15
down	0.8	0.6	3	0.3	1.89	1.18	0.87	0.68	0.55	0.45	0.39	0.37	0.37	0.36
down	0.4	0.6	3	0.3	1.10	0.56	0.39	0.32	0.28	0.26	0.26	0.27	0.30	0.29
flat	0.8	0.25	3	0.3	0.37	0.31	0.26	0.22	0.19	0.16	0.14	0.13	0.13	0.15
flat	0.4	0.25	3	0.3	0.14	0.12	0.11	0.11	0.11	0.11	0.12	0.13	0.14	0.12
flat	0.8	0.6	3	0.3	0.33	0.29	0.27	0.27	0.28	0.29	0.31	0.33	0.36	0.29
flat	0.4	0.6	3	0.3	0.20	0.18	0.18	0.20	0.22	0.25	0.27	0.30	0.34	0.21
					0.47	0.31	0.25	0.22	0.21	0.20	0.21	0.22	0.24	0.18

Table 6. Standard deviation for relative biomass error for combined areas "pollock" like simulations comparing unweighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Unweighted average methods										Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	1	2	3	4	5	6	7	8	9	10	filter
up	0.8	0.25	1	0.1	0.14	0.11	0.11	0.11	0.12	0.13	0.14	0.16	0.17	0.18	0.12
up	0.4	0.25	1	0.1	0.14	0.10	0.09	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.07
up	0.8	0.6	1	0.1	0.39	0.28	0.22	0.17	0.16	0.19	0.20	0.20	0.20	0.21	0.20
up	0.4	0.6	1	0.1	0.39	0.25	0.22	0.20	0.19	0.18	0.17	0.17	0.16	0.16	0.16
down	0.8	0.25	1	0.1	0.14	0.15	0.21	0.29	0.36	0.43	0.48	0.52	0.56	0.60	0.13
down	0.4	0.25	1	0.1	0.12	0.11	0.13	0.16	0.19	0.22	0.24	0.26	0.28	0.30	0.11
down	0.8	0.6	1	0.1	0.39	0.30	0.32	0.38	0.45	0.47	0.50	0.53	0.59	0.63	0.32
down	0.4	0.6	1	0.1	0.38	0.28	0.24	0.24	0.27	0.27	0.28	0.29	0.28	0.29	0.26
flat	0.8	0.25	1	0.1	0.16	0.12	0.13	0.17	0.20	0.24	0.26	0.29	0.29	0.30	0.13
flat	0.4	0.25	1	0.1	0.11	0.09	0.10	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.08
flat	0.8	0.6	1	0.1	0.32	0.26	0.23	0.25	0.27	0.30	0.33	0.35	0.36	0.36	0.24
flat	0.4	0.6	1	0.1	0.29	0.21	0.20	0.19	0.19	0.19	0.18	0.17	0.17	0.17	0.16
up	0.8	0.25	2	0.1	0.14	0.11	0.14	0.17	0.19	0.20	0.21	0.21	0.21	0.21	0.14
up	0.4	0.25	2	0.1	0.14	0.11	0.11	0.10	0.11	0.11	0.11	0.10	0.10	0.10	0.10
up	0.8	0.6	2	0.1	0.37	0.26	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.22	0.21
up	0.4	0.6	2	0.1	0.49	0.28	0.24	0.21	0.19	0.18	0.17	0.16	0.15	0.15	0.24
down	0.8	0.25	2	0.1	0.18	0.24	0.34	0.47	0.56	0.63	0.72	0.83	0.96	1.14	0.17
down	0.4	0.25	2	0.1	0.16	0.13	0.18	0.22	0.27	0.32	0.37	0.40	0.41	0.44	0.14
down	0.8	0.6	2	0.1	0.41	0.38	0.44	0.48	0.55	0.63	0.72	0.76	0.86	0.91	0.35
down	0.4	0.6	2	0.1	0.35	0.36	0.31	0.34	0.36	0.40	0.42	0.48	0.54	0.61	0.31
flat	0.8	0.25	2	0.1	0.12	0.14	0.20	0.27	0.33	0.37	0.38	0.38	0.38	0.38	0.12
flat	0.4	0.25	2	0.1	0.13	0.11	0.12	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.11
flat	0.8	0.6	2	0.1	0.37	0.30	0.27	0.29	0.32	0.34	0.37	0.38	0.39	0.39	0.30
flat	0.4	0.6	2	0.1	0.38	0.29	0.26	0.23	0.21	0.20	0.19	0.18	0.18	0.18	0.18
up	0.8	0.25	3	0.1	0.12	0.13	0.15	0.19	0.20	0.22	0.22	0.22	0.21	0.20	0.12
up	0.4	0.25	3	0.1	0.15	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.08	0.09
up	0.8	0.6	3	0.1	0.37	0.30	0.25	0.25	0.25	0.27	0.28	0.28	0.27	0.26	0.26
up	0.4	0.6	3	0.1	0.31	0.24	0.20	0.18	0.16	0.14	0.13	0.13	0.12	0.11	0.16
down	0.8	0.25	3	0.1	0.13	0.23	0.45	0.57	0.71	0.76	0.84	0.95	1.06	1.19	0.13
down	0.4	0.25	3	0.1	0.15	0.19	0.22	0.26	0.31	0.34	0.40	0.45	0.51	0.56	0.14
down	0.8	0.6	3	0.1	0.36	0.50	0.71	0.84	0.85	1.04	1.07	1.20	1.29	1.44	0.32
down	0.4	0.6	3	0.1	0.39	0.33	0.41	0.44	0.50	0.54	0.57	0.65	0.68	0.73	0.32
flat	0.8	0.25	3	0.1	0.15	0.20	0.24	0.29	0.33	0.38	0.38	0.39	0.40	0.41	0.15
flat	0.4	0.25	3	0.1	0.15	0.14	0.13	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.12
flat	0.8	0.6	3	0.1	0.35	0.27	0.30	0.36	0.40	0.42	0.45	0.44	0.44	0.45	0.27
flat	0.4	0.6	3	0.1	0.33	0.28	0.25	0.24	0.24	0.24	0.25	0.26	0.27	0.27	0.21
up	0.8	0.25	1	0.3	0.14	0.10	0.09	0.10	0.10	0.12	0.14	0.14	0.15	0.16	0.11
up	0.4	0.25	1	0.3	0.14	0.09	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.08
up	0.8	0.6	1	0.3	0.42	0.26	0.22	0.19	0.18	0.18	0.17	0.19	0.19	0.20	0.19
up	0.4	0.6	1	0.3	0.34	0.24	0.21	0.21	0.19	0.17	0.15	0.14	0.15	0.14	0.14
down	0.8	0.25	1	0.3	0.13	0.12	0.20	0.27	0.32	0.36	0.37	0.40	0.44	0.47	0.12
down	0.4	0.25	1	0.3	0.15	0.13	0.14	0.15	0.17	0.19	0.21	0.23	0.25	0.26	0.14
down	0.8	0.6	1	0.3	0.34	0.27	0.30	0.32	0.41	0.51	0.58	0.68	0.71	0.71	0.28
down	0.4	0.6	1	0.3	0.39	0.28	0.26	0.26	0.24	0.25	0.26	0.28	0.30	0.31	0.29
flat	0.8	0.25	1	0.3	0.13	0.11	0.14	0.16	0.18	0.22	0.24	0.26	0.28	0.28	0.11
flat	0.4	0.25	1	0.3	0.14	0.11	0.10	0.11	0.12	0.13	0.14	0.14	0.14	0.14	0.10
flat	0.8	0.6	1	0.3	0.45	0.27	0.24	0.26	0.25	0.26	0.26	0.26	0.27	0.29	0.23
flat	0.4	0.6	1	0.3	0.49	0.30	0.26	0.24	0.21	0.22	0.20	0.19	0.18	0.17	0.19
up	0.8	0.25	2	0.3	0.14	0.12	0.14	0.16	0.18	0.19	0.21	0.21	0.22	0.22	0.13
up	0.4	0.25	2	0.3	0.15	0.11	0.10	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.08
up	0.8	0.6	2	0.3	0.40	0.33	0.29	0.27	0.27	0.27	0.27	0.27	0.27	0.26	0.25
up	0.4	0.6	2	0.3	0.40	0.36	0.27	0.22	0.18	0.18	0.17	0.17	0.16	0.15	0.20
down	0.8	0.25	2	0.3	0.14	0.21	0.33	0.40	0.52	0.65	0.76	0.86	0.90	0.95	0.14
down	0.4	0.25	2	0.3	0.15	0.13	0.18	0.22	0.26	0.30	0.35	0.38	0.39	0.40	0.14
down	0.8	0.6	2	0.3	0.40	0.34	0.40	0.63	0.71	0.87	0.98	1.02	1.07	1.17	0.33
down	0.4	0.6	2	0.3	0.37	0.32	0.28	0.32	0.39	0.36	0.42	0.45	0.51	0.53	0.31
flat	0.8	0.25	2	0.3	0.13	0.14	0.19	0.24	0.28	0.31	0.32	0.33	0.34	0.35	0.13
flat	0.4	0.25	2	0.3	0.14	0.12	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.16	0.11
flat	0.8	0.6	2	0.3	0.34	0.27	0.31	0.33	0.34	0.40	0.40	0.38	0.37	0.38	0.26
flat	0.4	0.6	2	0.3	0.41	0.27	0.25	0.25	0.23	0.21	0.20	0.19	0.19	0.19	0.19
up	0.8	0.25	3	0.3	0.15	0.15	0.19	0.21	0.21	0.21	0.22	0.21	0.21	0.21	0.16
up	0.4	0.25	3	0.3	0.15	0.12	0.10	0.09	0.08	0.08	0.08	0.08	0.09	0.08	0.10
up	0.8	0.6	3	0.3	0.33	0.24	0.22	0.22	0.22	0.22	0.21	0.20	0.19	0.19	0.20
up	0.4	0.6	3	0.3	0.46	0.29	0.24	0.21	0.18	0.17	0.16	0.15	0.14	0.13	0.22
down	0.8	0.25	3	0.3	0.16	0.29	0.48	0.58	0.67	0.75	0.83	0.98	1.09	1.22	0.15
down	0.4	0.25	3	0.3	0.15	0.19	0.23	0.28	0.33	0.38	0.46	0.50	0.54	0.59	0.15
down	0.8	0.6	3	0.3	0.39	0.53	0.63	0.93	1.15	1.19	1.23	1.28	1.37	1.41	0.36
down	0.4	0.6	3	0.3	0.33	0.30	0.39	0.41	0.47	0.54	0.55	0.58	0.62	0.66	0.29
flat	0.8	0.25	3	0.3	0.14	0.18	0.24	0.30	0.32	0.35	0.37	0.38	0.41	0.41	0.15
flat	0.4	0.25	3	0.3	0.15	0.12	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.12
flat	0.8	0.6	3	0.3	0.40	0.34	0.33	0.32	0.31	0.32	0.33	0.34	0.34	0.35	0.29
flat	0.4	0.6	3	0.3	0.37	0.26	0.22	0.20	0.19	0.20	0.20	0.21	0.21	0.22	0.21
					0.26	0.22	0.23	0.26	0.29	0.31	0.33	0.35	0.37	0.39	0.18

Table 7. Mean relative biomass error for combined areas "rockfish" like simulations comparing weighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Weighted average methods									Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	filter
up	0.8	0.25	1	0.1	-0.18	-0.09	-0.06	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02	-0.08
up	0.4	0.25	1	0.1	-0.18	-0.08	-0.05	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.07
up	0.8	0.6	1	0.1	-0.20	-0.11	-0.08	-0.07	-0.06	-0.06	-0.05	-0.05	-0.05	-0.17
up	0.4	0.6	1	0.1	-0.18	-0.09	-0.06	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.15
down	0.8	0.25	1	0.1	0.47	0.22	0.13	0.08	0.05	0.03	0.01	0.00	0.00	0.03
down	0.4	0.25	1	0.1	0.43	0.20	0.11	0.07	0.04	0.03	0.01	0.01	0.00	0.04
down	0.8	0.6	1	0.1	0.43	0.18	0.09	0.04	0.01	-0.01	-0.02	-0.03	-0.05	0.06
down	0.4	0.6	1	0.1	0.42	0.18	0.10	0.05	0.03	0.01	0.00	-0.01	-0.01	0.08
flat	0.8	0.25	1	0.1	0.01	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	0.00
flat	0.4	0.25	1	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flat	0.8	0.6	1	0.1	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flat	0.4	0.6	1	0.1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	0.00
up	0.8	0.25	2	0.1	-0.31	-0.16	-0.10	-0.06	-0.04	-0.03	-0.02	-0.02	-0.01	-0.08
up	0.4	0.25	2	0.1	-0.31	-0.16	-0.10	-0.07	-0.05	-0.04	-0.03	-0.03	-0.02	-0.09
up	0.8	0.6	2	0.1	-0.30	-0.15	-0.09	-0.05	-0.02	0.00	0.01	0.03	0.04	-0.17
up	0.4	0.6	2	0.1	-0.32	-0.17	-0.10	-0.07	-0.05	-0.03	-0.02	-0.01	-0.01	-0.18
down	0.8	0.25	2	0.1	0.78	0.41	0.25	0.16	0.11	0.07	0.05	0.03	0.01	0.05
down	0.4	0.25	2	0.1	0.74	0.38	0.23	0.15	0.10	0.06	0.04	0.02	0.00	0.04
down	0.8	0.6	2	0.1	0.74	0.38	0.22	0.13	0.07	0.03	-0.01	-0.04	-0.07	0.11
down	0.4	0.6	2	0.1	0.74	0.38	0.22	0.14	0.09	0.06	0.04	0.03	0.01	0.13
flat	0.8	0.25	2	0.1	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
flat	0.4	0.25	2	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
flat	0.8	0.6	2	0.1	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01
flat	0.4	0.6	2	0.1	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00
up	0.8	0.25	3	0.1	-0.39	-0.22	-0.14	-0.09	-0.06	-0.04	-0.03	-0.02	-0.02	-0.08
up	0.4	0.25	3	0.1	-0.40	-0.23	-0.14	-0.09	-0.06	-0.04	-0.02	-0.01	0.00	-0.09
up	0.8	0.6	3	0.1	-0.38	-0.22	-0.14	-0.10	-0.08	-0.07	-0.06	-0.06	-0.06	-0.19
up	0.4	0.6	3	0.1	-0.40	-0.23	-0.15	-0.11	-0.09	-0.07	-0.07	-0.07	-0.07	-0.21
down	0.8	0.25	3	0.1	1.03	0.60	0.39	0.26	0.18	0.12	0.08	0.05	0.03	0.05
down	0.4	0.25	3	0.1	0.96	0.56	0.36	0.24	0.16	0.11	0.07	0.04	0.02	0.05
down	0.8	0.6	3	0.1	1.01	0.58	0.35	0.23	0.14	0.09	0.05	0.02	0.00	0.14
down	0.4	0.6	3	0.1	0.94	0.56	0.36	0.24	0.17	0.11	0.07	0.04	0.01	0.18
flat	0.8	0.25	3	0.1	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
flat	0.4	0.25	3	0.1	-0.01	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.00
flat	0.8	0.6	3	0.1	0.02	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
flat	0.4	0.6	3	0.1	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	-0.01
up	0.8	0.25	1	0.3	-0.17	-0.08	-0.05	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.06
up	0.4	0.25	1	0.3	-0.17	-0.07	-0.04	-0.02	-0.01	0.00	0.01	0.01	0.02	-0.06
up	0.8	0.6	1	0.3	-0.18	-0.07	-0.03	-0.01	0.00	0.00	0.01	0.01	0.02	-0.14
up	0.4	0.6	1	0.3	-0.19	-0.10	-0.06	-0.04	-0.02	-0.01	0.00	0.01	0.01	-0.16
down	0.8	0.25	1	0.3	0.44	0.21	0.12	0.08	0.06	0.04	0.03	0.02	0.02	0.04
down	0.4	0.25	1	0.3	0.45	0.21	0.12	0.07	0.04	0.02	0.00	-0.01	-0.02	0.03
down	0.8	0.6	1	0.3	0.46	0.22	0.13	0.08	0.05	0.03	0.01	0.00	-0.02	0.11
down	0.4	0.6	1	0.3	0.45	0.23	0.15	0.11	0.08	0.06	0.05	0.03	0.02	0.14
flat	0.8	0.25	1	0.3	0.00	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.02	-0.01
flat	0.4	0.25	1	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flat	0.8	0.6	1	0.3	-0.01	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03
flat	0.4	0.6	1	0.3	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.00
up	0.8	0.25	2	0.3	-0.32	-0.17	-0.12	-0.08	-0.07	-0.05	-0.05	-0.04	-0.04	-0.11
up	0.4	0.25	2	0.3	-0.31	-0.17	-0.11	-0.07	-0.05	-0.04	-0.03	-0.02	-0.02	-0.09
up	0.8	0.6	2	0.3	-0.31	-0.17	-0.11	-0.07	-0.05	-0.03	-0.02	-0.01	0.00	-0.20
up	0.4	0.6	2	0.3	-0.32	-0.16	-0.09	-0.06	-0.03	-0.01	0.00	0.01	0.02	-0.19
down	0.8	0.25	2	0.3	0.82	0.43	0.26	0.17	0.11	0.07	0.04	0.02	0.01	0.04
down	0.4	0.25	2	0.3	0.74	0.39	0.23	0.15	0.10	0.07	0.04	0.02	0.01	0.04
down	0.8	0.6	2	0.3	0.77	0.39	0.22	0.14	0.10	0.07	0.05	0.04	0.03	0.11
down	0.4	0.6	2	0.3	0.73	0.38	0.23	0.15	0.11	0.08	0.06	0.04	0.04	0.16
flat	0.8	0.25	2	0.3	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01
flat	0.4	0.25	2	0.3	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00
flat	0.8	0.6	2	0.3	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	-0.01
flat	0.4	0.6	2	0.3	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
up	0.8	0.25	3	0.3	-0.39	-0.22	-0.14	-0.09	-0.06	-0.05	-0.03	-0.02	-0.01	-0.09
up	0.4	0.25	3	0.3	-0.40	-0.23	-0.15	-0.10	-0.08	-0.06	-0.05	-0.04	-0.03	-0.10
up	0.8	0.6	3	0.3	-0.40	-0.24	-0.17	-0.13	-0.11	-0.09	-0.08	-0.07	-0.06	-0.22
up	0.4	0.6	3	0.3	-0.40	-0.23	-0.13	-0.07	-0.03	0.00	0.03	0.05	0.07	-0.20
down	0.8	0.25	3	0.3	0.98	0.57	0.36	0.24	0.16	0.11	0.07	0.04	0.02	0.05
down	0.4	0.25	3	0.3	0.97	0.56	0.36	0.24	0.16	0.11	0.07	0.04	0.01	0.04
down	0.8	0.6	3	0.3	1.00	0.60	0.39	0.27	0.19	0.14	0.10	0.07	0.05	0.19
down	0.4	0.6	3	0.3	0.94	0.56	0.36	0.25	0.17	0.12	0.07	0.04	0.02	0.19
flat	0.8	0.25	3	0.3	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.01
flat	0.4	0.25	3	0.3	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flat	0.8	0.6	3	0.3	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	-0.03
flat	0.4	0.6	3	0.3	0.02	0.01	0.01	0.01	0.00	-0.01	-0.02	-0.03	-0.04	0.01
					0.15	0.08	0.05	0.03	0.02	0.01	0.01	0.00	0.00	-0.02

Table 8. Mean relative biomass error for combined areas "rockfish" like simulations comparing unweighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Unweighted average methods										Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	1	2	3	4	5	6	7	8	9	10	filter
up	0.8	0.25	1	0.1	-0.02	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.09	-0.10	-0.11	-0.08
up	0.4	0.25	1	0.1	0.00	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09	-0.07
up	0.8	0.6	1	0.1	-0.05	-0.05	-0.06	-0.08	-0.08	-0.08	-0.09	-0.10	-0.11	-0.12	-0.17
up	0.4	0.6	1	0.1	-0.07	-0.05	-0.03	-0.03	-0.04	-0.06	-0.07	-0.07	-0.08	-0.09	-0.15
down	0.8	0.25	1	0.1	-0.01	0.02	0.05	0.08	0.11	0.14	0.17	0.20	0.23	0.25	0.03
down	0.4	0.25	1	0.1	0.00	0.01	0.04	0.07	0.10	0.13	0.15	0.18	0.20	0.23	0.04
down	0.8	0.6	1	0.1	-0.06	-0.01	0.03	0.04	0.08	0.10	0.13	0.16	0.18	0.20	0.06
down	0.4	0.6	1	0.1	-0.01	-0.01	0.03	0.05	0.08	0.10	0.14	0.17	0.20	0.21	0.08
flat	0.8	0.25	1	0.1	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flat	0.4	0.25	1	0.1	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
flat	0.8	0.6	1	0.1	0.00	0.00	-0.02	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00
flat	0.4	0.6	1	0.1	-0.04	0.00	0.00	-0.01	-0.02	-0.01	0.00	-0.01	-0.01	0.00	0.00
up	0.8	0.25	2	0.1	-0.01	-0.02	-0.04	-0.06	-0.08	-0.10	-0.13	-0.15	-0.17	-0.19	-0.08
up	0.4	0.25	2	0.1	-0.02	-0.03	-0.04	-0.07	-0.09	-0.11	-0.13	-0.15	-0.17	-0.19	-0.09
up	0.8	0.6	2	0.1	0.05	0.00	-0.04	-0.06	-0.08	-0.10	-0.12	-0.14	-0.16	-0.18	-0.17
up	0.4	0.6	2	0.1	0.00	-0.02	-0.05	-0.08	-0.08	-0.11	-0.12	-0.15	-0.17	-0.20	-0.18
down	0.8	0.25	2	0.1	0.00	0.06	0.11	0.17	0.22	0.27	0.33	0.39	0.44	0.49	0.05
down	0.4	0.25	2	0.1	-0.01	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.46	0.04
down	0.8	0.6	2	0.1	-0.09	0.03	0.09	0.16	0.21	0.25	0.31	0.34	0.40	0.45	0.11
down	0.4	0.6	2	0.1	0.00	0.05	0.08	0.13	0.19	0.23	0.29	0.35	0.40	0.46	0.13
flat	0.8	0.25	2	0.1	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.00
flat	0.4	0.25	2	0.1	-0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.01
flat	0.8	0.6	2	0.1	-0.02	-0.02	-0.01	0.01	0.02	0.03	0.04	0.04	0.03	0.02	-0.01
flat	0.4	0.6	2	0.1	-0.01	0.00	-0.01	-0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00
up	0.8	0.25	3	0.1	-0.02	-0.03	-0.06	-0.09	-0.12	-0.15	-0.18	-0.21	-0.24	-0.27	-0.08
up	0.4	0.25	3	0.1	0.01	-0.03	-0.06	-0.10	-0.13	-0.16	-0.19	-0.22	-0.25	-0.28	-0.09
up	0.8	0.6	3	0.1	-0.06	-0.04	-0.06	-0.09	-0.12	-0.14	-0.17	-0.20	-0.23	-0.26	-0.19
up	0.4	0.6	3	0.1	-0.07	-0.06	-0.06	-0.10	-0.13	-0.16	-0.19	-0.22	-0.25	-0.28	-0.21
down	0.8	0.25	3	0.1	0.01	0.09	0.19	0.27	0.36	0.43	0.52	0.59	0.66	0.73	0.05
down	0.4	0.25	3	0.1	0.00	0.08	0.16	0.24	0.32	0.40	0.48	0.55	0.62	0.68	0.05
down	0.8	0.6	3	0.1	-0.02	0.06	0.13	0.24	0.32	0.40	0.48	0.55	0.64	0.70	0.14
down	0.4	0.6	3	0.1	-0.01	0.09	0.18	0.26	0.32	0.41	0.47	0.55	0.62	0.70	0.18
flat	0.8	0.25	3	0.1	-0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.04	0.00
flat	0.4	0.25	3	0.1	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
flat	0.8	0.6	3	0.1	-0.03	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	-0.01	-0.03
flat	0.4	0.6	3	0.1	0.05	0.00	-0.01	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01
up	0.8	0.25	1	0.3	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09	-0.06
up	0.4	0.25	1	0.3	0.02	0.00	-0.01	-0.02	-0.04	-0.04	-0.05	-0.06	-0.07	-0.09	-0.06
up	0.8	0.6	1	0.3	0.02	0.00	0.00	-0.01	-0.02	-0.03	-0.05	-0.06	-0.07	-0.09	-0.14
up	0.4	0.6	1	0.3	0.02	-0.01	-0.03	-0.05	-0.06	-0.07	-0.08	-0.09	-0.11	-0.12	-0.16
down	0.8	0.25	1	0.3	0.01	0.03	0.06	0.08	0.10	0.12	0.16	0.18	0.20	0.23	0.04
down	0.4	0.25	1	0.3	-0.03	0.01	0.04	0.07	0.10	0.13	0.16	0.19	0.22	0.25	0.03
down	0.8	0.6	1	0.3	-0.03	0.04	0.07	0.08	0.11	0.14	0.17	0.22	0.23	0.25	0.11
down	0.4	0.6	1	0.3	0.02	0.05	0.09	0.11	0.15	0.17	0.18	0.20	0.22	0.24	0.14
flat	0.8	0.25	1	0.3	0.02	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
flat	0.4	0.25	1	0.3	0.00	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00
flat	0.8	0.6	1	0.3	-0.03	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.03
flat	0.4	0.6	1	0.3	0.03	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00
up	0.8	0.25	2	0.3	-0.03	-0.05	-0.06	-0.08	-0.10	-0.12	-0.14	-0.16	-0.18	-0.20	-0.11
up	0.4	0.25	2	0.3	-0.02	-0.03	-0.05	-0.08	-0.09	-0.11	-0.13	-0.15	-0.17	-0.19	-0.09
up	0.8	0.6	2	0.3	0.00	-0.02	-0.05	-0.08	-0.10	-0.12	-0.14	-0.16	-0.18	-0.20	-0.20
up	0.4	0.6	2	0.3	0.03	0.00	-0.05	-0.06	-0.08	-0.10	-0.13	-0.15	-0.17	-0.19	-0.19
down	0.8	0.25	2	0.3	-0.01	0.05	0.11	0.17	0.23	0.29	0.35	0.40	0.45	0.50	0.04
down	0.4	0.25	2	0.3	0.00	0.06	0.10	0.15	0.20	0.26	0.30	0.35	0.40	0.45	0.04
down	0.8	0.6	2	0.3	0.02	0.05	0.08	0.15	0.17	0.23	0.29	0.33	0.39	0.44	0.11
down	0.4	0.6	2	0.3	0.03	0.05	0.09	0.16	0.20	0.24	0.29	0.36	0.40	0.44	0.16
flat	0.8	0.25	2	0.3	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
flat	0.4	0.25	2	0.3	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
flat	0.8	0.6	2	0.3	0.03	0.00	0.00	0.02	0.02	0.02	0.01	0.02	0.01	0.02	-0.01
flat	0.4	0.6	2	0.3	0.01	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
up	0.8	0.25	3	0.3	-0.01	-0.04	-0.06	-0.09	-0.12	-0.15	-0.18	-0.21	-0.24	-0.27	-0.09
up	0.4	0.25	3	0.3	-0.03	-0.04	-0.07	-0.10	-0.13	-0.16	-0.19	-0.22	-0.25	-0.28	-0.10
up	0.8	0.6	3	0.3	-0.06	-0.09	-0.11	-0.13	-0.15	-0.17	-0.20	-0.22	-0.25	-0.27	-0.22
up	0.4	0.6	3	0.3	0.10	-0.02	-0.05	-0.08	-0.12	-0.16	-0.19	-0.22	-0.25	-0.28	-0.20
down	0.8	0.25	3	0.3	0.00	0.08	0.16	0.24	0.33	0.40	0.48	0.56	0.62	0.69	0.05
down	0.4	0.25	3	0.3	-0.01	0.09	0.17	0.24	0.32	0.39	0.47	0.55	0.61	0.68	0.04
down	0.8	0.6	3	0.3	0.03	0.11	0.19	0.26	0.35	0.44	0.53	0.61	0.68	0.73	0.19
down	0.4	0.6	3	0.3	0.00	0.08	0.18	0.26	0.35	0.42	0.49	0.55	0.61	0.68	0.19
flat	0.8	0.25	3	0.3	0.01	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.01
flat	0.4	0.25	3	0.3	0.00	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00
flat	0.8	0.6	3	0.3	-0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.03	0.03	0.02	-0.03
flat	0.4	0.6	3	0.3	-0.05	-0.01	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
					-0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.09	-0.02

Table 9. Standard deviation for relative biomass error for combined areas "rockfish" like simulations comparing weighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Weighted average methods									Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	filter
up	0.8	0.25	1	0.1	0.08	0.07	0.07	0.08	0.08	0.09	0.10	0.12	0.13	0.07
up	0.4	0.25	1	0.1	0.04	0.05	0.05	0.06	0.07	0.09	0.10	0.11	0.13	0.05
up	0.8	0.6	1	0.1	0.10	0.12	0.16	0.19	0.22	0.26	0.29	0.33	0.37	0.12
up	0.4	0.6	1	0.1	0.08	0.12	0.15	0.18	0.20	0.22	0.25	0.27	0.30	0.10
down	0.8	0.25	1	0.1	0.17	0.11	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.11
down	0.4	0.25	1	0.1	0.09	0.07	0.07	0.08	0.09	0.10	0.11	0.11	0.12	0.09
down	0.8	0.6	1	0.1	0.20	0.14	0.15	0.17	0.19	0.21	0.24	0.26	0.30	0.16
down	0.4	0.6	1	0.1	0.15	0.15	0.17	0.19	0.22	0.24	0.26	0.28	0.31	0.18
flat	0.8	0.25	1	0.1	0.09	0.07	0.07	0.07	0.08	0.09	0.10	0.11	0.13	0.08
flat	0.4	0.25	1	0.1	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.06
flat	0.8	0.6	1	0.1	0.12	0.13	0.16	0.19	0.22	0.25	0.27	0.30	0.32	0.14
flat	0.4	0.6	1	0.1	0.09	0.12	0.15	0.18	0.21	0.23	0.26	0.29	0.32	0.09
up	0.8	0.25	2	0.1	0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.15	0.08
up	0.4	0.25	2	0.1	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.07
up	0.8	0.6	2	0.1	0.11	0.15	0.18	0.21	0.25	0.28	0.30	0.33	0.36	0.18
up	0.4	0.6	2	0.1	0.09	0.12	0.16	0.19	0.23	0.26	0.30	0.34	0.38	0.18
down	0.8	0.25	2	0.1	0.26	0.17	0.12	0.10	0.10	0.10	0.11	0.12	0.14	0.12
down	0.4	0.25	2	0.1	0.11	0.08	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.11
down	0.8	0.6	2	0.1	0.28	0.21	0.19	0.20	0.21	0.23	0.25	0.27	0.30	0.25
down	0.4	0.6	2	0.1	0.17	0.13	0.14	0.16	0.18	0.21	0.24	0.27	0.30	0.20
flat	0.8	0.25	2	0.1	0.12	0.10	0.09	0.08	0.09	0.10	0.11	0.12	0.13	0.10
flat	0.4	0.25	2	0.1	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.08
flat	0.8	0.6	2	0.1	0.13	0.12	0.14	0.16	0.19	0.22	0.25	0.27	0.30	0.14
flat	0.4	0.6	2	0.1	0.10	0.13	0.16	0.19	0.21	0.24	0.26	0.29	0.31	0.12
up	0.8	0.25	3	0.1	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.10
up	0.4	0.25	3	0.1	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13	0.08
up	0.8	0.6	3	0.1	0.10	0.14	0.17	0.20	0.24	0.27	0.31	0.34	0.38	0.23
up	0.4	0.6	3	0.1	0.08	0.12	0.15	0.17	0.20	0.22	0.24	0.27	0.29	0.17
down	0.8	0.25	3	0.1	0.32	0.22	0.17	0.14	0.13	0.12	0.12	0.13	0.14	0.14
down	0.4	0.25	3	0.1	0.15	0.10	0.09	0.09	0.09	0.10	0.10	0.12	0.13	0.12
down	0.8	0.6	3	0.1	0.43	0.27	0.22	0.21	0.22	0.25	0.27	0.30	0.34	0.29
down	0.4	0.6	3	0.1	0.27	0.19	0.19	0.20	0.22	0.23	0.25	0.28	0.30	0.27
flat	0.8	0.25	3	0.1	0.13	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.13	0.11
flat	0.4	0.25	3	0.1	0.07	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.16	0.08
flat	0.8	0.6	3	0.1	0.18	0.18	0.19	0.21	0.23	0.25	0.27	0.29	0.32	0.19
flat	0.4	0.6	3	0.1	0.12	0.13	0.15	0.18	0.22	0.25	0.28	0.31	0.35	0.12
up	0.8	0.25	1	0.3	0.06	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.06
up	0.4	0.25	1	0.3	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.06
up	0.8	0.6	1	0.3	0.10	0.12	0.15	0.17	0.20	0.22	0.25	0.27	0.30	0.13
up	0.4	0.6	1	0.3	0.08	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.11
down	0.8	0.25	1	0.3	0.17	0.11	0.09	0.09	0.09	0.10	0.11	0.11	0.13	0.10
down	0.4	0.25	1	0.3	0.08	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.09
down	0.8	0.6	1	0.3	0.22	0.18	0.20	0.22	0.24	0.27	0.29	0.32	0.34	0.23
down	0.4	0.6	1	0.3	0.13	0.15	0.19	0.21	0.24	0.25	0.27	0.28	0.30	0.19
flat	0.8	0.25	1	0.3	0.11	0.09	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.09
flat	0.4	0.25	1	0.3	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.06
flat	0.8	0.6	1	0.3	0.13	0.12	0.14	0.16	0.19	0.22	0.25	0.28	0.31	0.13
flat	0.4	0.6	1	0.3	0.09	0.12	0.15	0.17	0.19	0.22	0.24	0.27	0.30	0.10
up	0.8	0.25	2	0.3	0.06	0.06	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.07
up	0.4	0.25	2	0.3	0.04	0.05	0.06	0.07	0.08	0.09	0.11	0.12	0.13	0.07
up	0.8	0.6	2	0.3	0.11	0.14	0.17	0.20	0.22	0.25	0.28	0.31	0.34	0.17
up	0.4	0.6	2	0.3	0.09	0.13	0.16	0.19	0.23	0.26	0.30	0.33	0.37	0.15
down	0.8	0.25	2	0.3	0.26	0.16	0.13	0.11	0.11	0.11	0.11	0.12	0.13	0.12
down	0.4	0.25	2	0.3	0.13	0.09	0.08	0.08	0.09	0.10	0.11	0.12	0.14	0.11
down	0.8	0.6	2	0.3	0.29	0.20	0.19	0.19	0.21	0.23	0.26	0.28	0.31	0.22
down	0.4	0.6	2	0.3	0.17	0.17	0.18	0.20	0.23	0.26	0.29	0.32	0.36	0.24
flat	0.8	0.25	2	0.3	0.14	0.12	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.11
flat	0.4	0.25	2	0.3	0.06	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.07
flat	0.8	0.6	2	0.3	0.16	0.15	0.16	0.18	0.20	0.23	0.26	0.30	0.33	0.16
flat	0.4	0.6	2	0.3	0.11	0.13	0.15	0.17	0.19	0.22	0.25	0.29	0.33	0.12
up	0.8	0.25	3	0.3	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.09
up	0.4	0.25	3	0.3	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.08
up	0.8	0.6	3	0.3	0.09	0.12	0.15	0.17	0.20	0.23	0.25	0.28	0.32	0.18
up	0.4	0.6	3	0.3	0.08	0.14	0.18	0.22	0.26	0.30	0.34	0.38	0.42	0.23
down	0.8	0.25	3	0.3	0.27	0.19	0.15	0.12	0.11	0.11	0.11	0.12	0.14	0.13
down	0.4	0.25	3	0.3	0.17	0.11	0.10	0.10	0.10	0.10	0.11	0.12	0.13	0.12
down	0.8	0.6	3	0.3	0.35	0.24	0.21	0.22	0.23	0.25	0.27	0.30	0.33	0.28
down	0.4	0.6	3	0.3	0.22	0.16	0.17	0.19	0.21	0.23	0.26	0.30	0.34	0.27
flat	0.8	0.25	3	0.3	0.16	0.12	0.09	0.09	0.09	0.10	0.10	0.12	0.13	0.11
flat	0.4	0.25	3	0.3	0.06	0.06	0.07	0.07	0.08	0.09	0.11	0.12	0.13	0.07
flat	0.8	0.6	3	0.3	0.18	0.16	0.17	0.20	0.22	0.25	0.28	0.31	0.33	0.17
flat	0.4	0.6	3	0.3	0.16	0.15	0.18	0.20	0.23	0.25	0.28	0.31	0.33	0.14
					0.13	0.12	0.12	0.14	0.15	0.17	0.19	0.21	0.23	0.13

Table 10. Standard deviation for relative biomass error for combined areas "rockfish" like simulations comparing unweighted average methods with Kalman filter based on 100 simulations for each row.

Factors					Unweighted average methods										Kalman
trend	sigmaR	survey CV	survey freq.	max. move.	1	2	3	4	5	6	7	8	9	10	filter
up	0.8	0.25	1	0.1	0.14	0.10	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07
up	0.4	0.25	1	0.1	0.14	0.09	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05
up	0.8	0.6	1	0.1	0.42	0.25	0.21	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.12
up	0.4	0.6	1	0.1	0.34	0.26	0.21	0.19	0.16	0.14	0.13	0.11	0.11	0.10	0.10
down	0.8	0.25	1	0.1	0.15	0.12	0.10	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.11
down	0.4	0.25	1	0.1	0.13	0.11	0.09	0.09	0.08	0.08	0.07	0.08	0.08	0.08	0.09
down	0.8	0.6	1	0.1	0.33	0.22	0.22	0.18	0.17	0.16	0.17	0.18	0.17	0.18	0.16
down	0.4	0.6	1	0.1	0.33	0.27	0.23	0.20	0.20	0.19	0.17	0.17	0.16	0.16	0.18
flat	0.8	0.25	1	0.1	0.14	0.10	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
flat	0.4	0.25	1	0.1	0.15	0.11	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
flat	0.8	0.6	1	0.1	0.35	0.27	0.22	0.19	0.16	0.13	0.14	0.14	0.13	0.13	0.14
flat	0.4	0.6	1	0.1	0.35	0.26	0.21	0.17	0.16	0.15	0.13	0.13	0.12	0.12	0.09
up	0.8	0.25	2	0.1	0.17	0.12	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
up	0.4	0.25	2	0.1	0.14	0.09	0.08	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.07
up	0.8	0.6	2	0.1	0.39	0.29	0.24	0.20	0.18	0.17	0.16	0.14	0.14	0.14	0.18
up	0.4	0.6	2	0.1	0.43	0.26	0.22	0.16	0.14	0.14	0.13	0.12	0.12	0.11	0.18
down	0.8	0.25	2	0.1	0.15	0.10	0.11	0.11	0.13	0.15	0.17	0.19	0.20	0.22	0.12
down	0.4	0.25	2	0.1	0.15	0.11	0.09	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11
down	0.8	0.6	2	0.1	0.33	0.26	0.24	0.24	0.23	0.22	0.23	0.24	0.25	0.26	0.25
down	0.4	0.6	2	0.1	0.33	0.24	0.20	0.17	0.17	0.16	0.17	0.17	0.18	0.17	0.20
flat	0.8	0.25	2	0.1	0.14	0.10	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.10
flat	0.4	0.25	2	0.1	0.13	0.10	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.08
flat	0.8	0.6	2	0.1	0.33	0.25	0.19	0.18	0.17	0.15	0.16	0.15	0.15	0.15	0.14
flat	0.4	0.6	2	0.1	0.34	0.26	0.24	0.19	0.16	0.16	0.16	0.14	0.13	0.13	0.12
up	0.8	0.25	3	0.1	0.15	0.11	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.10
up	0.4	0.25	3	0.1	0.15	0.09	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.08
up	0.8	0.6	3	0.1	0.41	0.30	0.21	0.17	0.16	0.16	0.16	0.15	0.14	0.13	0.23
up	0.4	0.6	3	0.1	0.32	0.24	0.22	0.17	0.15	0.14	0.13	0.12	0.11	0.10	0.17
down	0.8	0.25	3	0.1	0.15	0.13	0.14	0.17	0.19	0.21	0.24	0.26	0.27	0.29	0.14
down	0.4	0.25	3	0.1	0.14	0.10	0.11	0.10	0.11	0.11	0.11	0.12	0.13	0.13	0.12
down	0.8	0.6	3	0.1	0.37	0.27	0.24	0.26	0.26	0.27	0.29	0.31	0.35	0.36	0.29
down	0.4	0.6	3	0.1	0.33	0.26	0.26	0.24	0.22	0.23	0.21	0.22	0.24	0.24	0.27
flat	0.8	0.25	3	0.1	0.14	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.11
flat	0.4	0.25	3	0.1	0.17	0.12	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.08
flat	0.8	0.6	3	0.1	0.35	0.31	0.26	0.22	0.21	0.21	0.20	0.20	0.20	0.20	0.19
flat	0.4	0.6	3	0.1	0.38	0.26	0.20	0.16	0.15	0.15	0.14	0.13	0.13	0.13	0.12
up	0.8	0.25	1	0.3	0.14	0.10	0.08	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.06
up	0.4	0.25	1	0.3	0.14	0.10	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06
up	0.8	0.6	1	0.3	0.32	0.26	0.20	0.18	0.16	0.14	0.13	0.13	0.12	0.12	0.13
up	0.4	0.6	1	0.3	0.37	0.23	0.20	0.18	0.15	0.13	0.13	0.12	0.11	0.10	0.11
down	0.8	0.25	1	0.3	0.14	0.10	0.11	0.11	0.10	0.11	0.11	0.12	0.13	0.14	0.10
down	0.4	0.25	1	0.3	0.13	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.09
down	0.8	0.6	1	0.3	0.38	0.30	0.26	0.22	0.22	0.21	0.21	0.22	0.20	0.20	0.23
down	0.4	0.6	1	0.3	0.32	0.34	0.29	0.22	0.20	0.18	0.18	0.17	0.16	0.16	0.19
flat	0.8	0.25	1	0.3	0.15	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.09
flat	0.4	0.25	1	0.3	0.15	0.10	0.08	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.06
flat	0.8	0.6	1	0.3	0.35	0.23	0.18	0.18	0.16	0.15	0.14	0.13	0.13	0.13	0.13
flat	0.4	0.6	1	0.3	0.34	0.22	0.20	0.17	0.17	0.17	0.14	0.13	0.13	0.12	0.10
up	0.8	0.25	2	0.3	0.12	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.07
up	0.4	0.25	2	0.3	0.15	0.10	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.07
up	0.8	0.6	2	0.3	0.38	0.26	0.22	0.18	0.17	0.16	0.15	0.14	0.14	0.13	0.17
up	0.4	0.6	2	0.3	0.41	0.27	0.20	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.15
down	0.8	0.25	2	0.3	0.14	0.12	0.11	0.11	0.13	0.15	0.16	0.18	0.20	0.21	0.12
down	0.4	0.25	2	0.3	0.15	0.12	0.09	0.09	0.09	0.09	0.09	0.10	0.11	0.12	0.11
down	0.8	0.6	2	0.3	0.34	0.27	0.22	0.24	0.23	0.21	0.23	0.24	0.25	0.27	0.22
down	0.4	0.6	2	0.3	0.40	0.26	0.24	0.23	0.20	0.19	0.19	0.20	0.20	0.21	0.24
flat	0.8	0.25	2	0.3	0.13	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.11
flat	0.4	0.25	2	0.3	0.15	0.10	0.08	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07
flat	0.8	0.6	2	0.3	0.37	0.26	0.21	0.19	0.18	0.19	0.18	0.17	0.17	0.17	0.16
flat	0.4	0.6	2	0.3	0.37	0.23	0.18	0.20	0.18	0.17	0.17	0.15	0.14	0.14	0.12
up	0.8	0.25	3	0.3	0.14	0.10	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
up	0.4	0.25	3	0.3	0.13	0.10	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.08
up	0.8	0.6	3	0.3	0.35	0.24	0.20	0.16	0.16	0.15	0.14	0.13	0.12	0.12	0.18
up	0.4	0.6	3	0.3	0.47	0.30	0.24	0.20	0.16	0.15	0.14	0.13	0.11	0.10	0.23
down	0.8	0.25	3	0.3	0.16	0.11	0.12	0.15	0.17	0.19	0.21	0.22	0.23	0.25	0.13
down	0.4	0.25	3	0.3	0.14	0.13	0.11	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.12
down	0.8	0.6	3	0.3	0.37	0.29	0.26	0.26	0.25	0.29	0.30	0.32	0.31	0.33	0.28
down	0.4	0.6	3	0.3	0.38	0.26	0.25	0.24	0.22	0.21	0.20	0.21	0.22	0.22	0.27
flat	0.8	0.25	3	0.3	0.15	0.11	0.10	0.10	0.11	0.11	0.13	0.14	0.15	0.15	0.11
flat	0.4	0.25	3	0.3	0.15	0.10	0.09	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.07
flat	0.8	0.6	3	0.3	0.36	0.28	0.23	0.19	0.19	0.19	0.19	0.19	0.20	0.19	0.17
flat	0.4	0.6	3	0.3	0.36	0.31	0.24	0.20	0.18	0.17	0.16	0.16	0.15	0.15	0.14
					0.25	0.18	0.16	0.14	0.14	0.13	0.13	0.13	0.13	0.14	0.13

Table 11. Summary over the 36 different population/survey scenarios showing the minimum and maximum mean relative error (and the range) along with the mean standard deviation between the different stocks. Shadings are relative to the values within the row (darker being worse).

	Weighted average methods									Unweighted average methods										Kalman
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	2	3	4	5	6	7	8	9	10	filter
Rockfish-like																				
Min	-0.40	-0.24	-0.17	-0.13	-0.11	-0.09	-0.08	-0.07	-0.07	-0.09	-0.09	-0.11	-0.13	-0.15	-0.17	-0.20	-0.22	-0.25	-0.28	-0.22
Max	1.03	0.60	0.39	0.27	0.19	0.14	0.10	0.07	0.07	0.10	0.11	0.19	0.27	0.36	0.44	0.53	0.61	0.68	0.73	0.19
Range	1.43	0.85	0.56	0.40	0.30	0.23	0.18	0.14	0.14	0.18	0.20	0.31	0.40	0.50	0.62	0.73	0.83	0.93	1.01	0.41
Std Dev	0.13	0.12	0.12	0.14	0.15	0.17	0.19	0.21	0.23	0.25	0.18	0.16	0.14	0.14	0.13	0.13	0.13	0.13	0.14	0.13
Pollock-like																				
Min	-0.42	-0.23	-0.14	-0.09	-0.07	-0.06	-0.06	-0.06	-0.07	-0.10	-0.07	-0.07	-0.10	-0.12	-0.15	-0.18	-0.21	-0.24	-0.27	-0.21
Max	3.98	2.12	1.26	0.80	0.53	0.35	0.22	0.13	0.07	0.07	0.26	0.56	0.79	1.05	1.39	1.63	1.90	2.16	2.45	0.08
Range	4.40	2.35	1.40	0.89	0.60	0.40	0.28	0.19	0.15	0.17	0.33	0.64	0.89	1.18	1.54	1.81	2.11	2.40	2.72	0.29
Std Dev	0.47	0.31	0.25	0.22	0.21	0.20	0.21	0.22	0.24	0.26	0.22	0.23	0.26	0.29	0.31	0.33	0.35	0.37	0.39	0.18

Figures

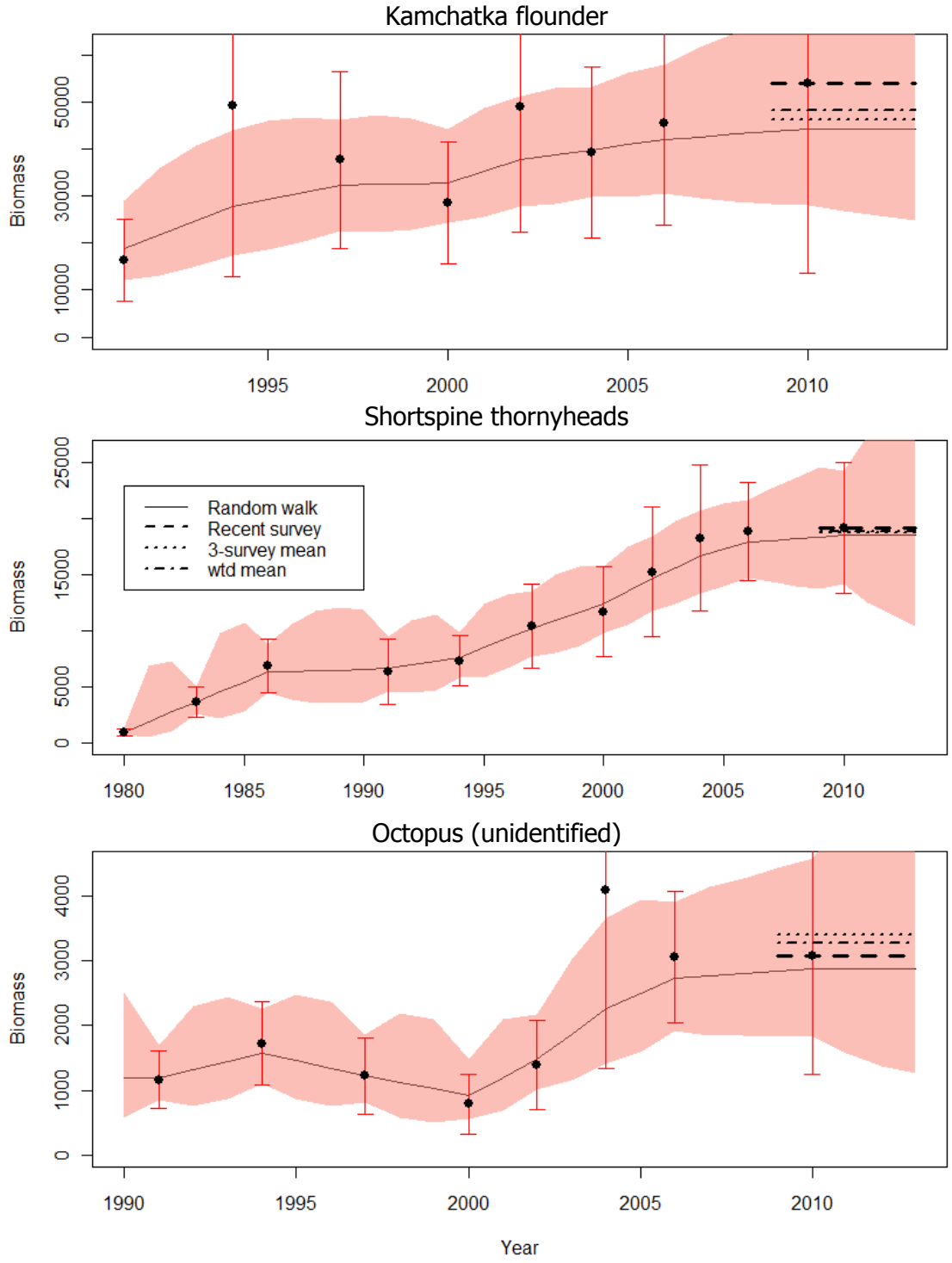

Figure 1. Aleutian Islands survey biomass fits for the random-walk model for some selected stocks. Shaded region represents ± 2 standard deviations from biomass estimates and error bars on points represents survey (observation) errors.

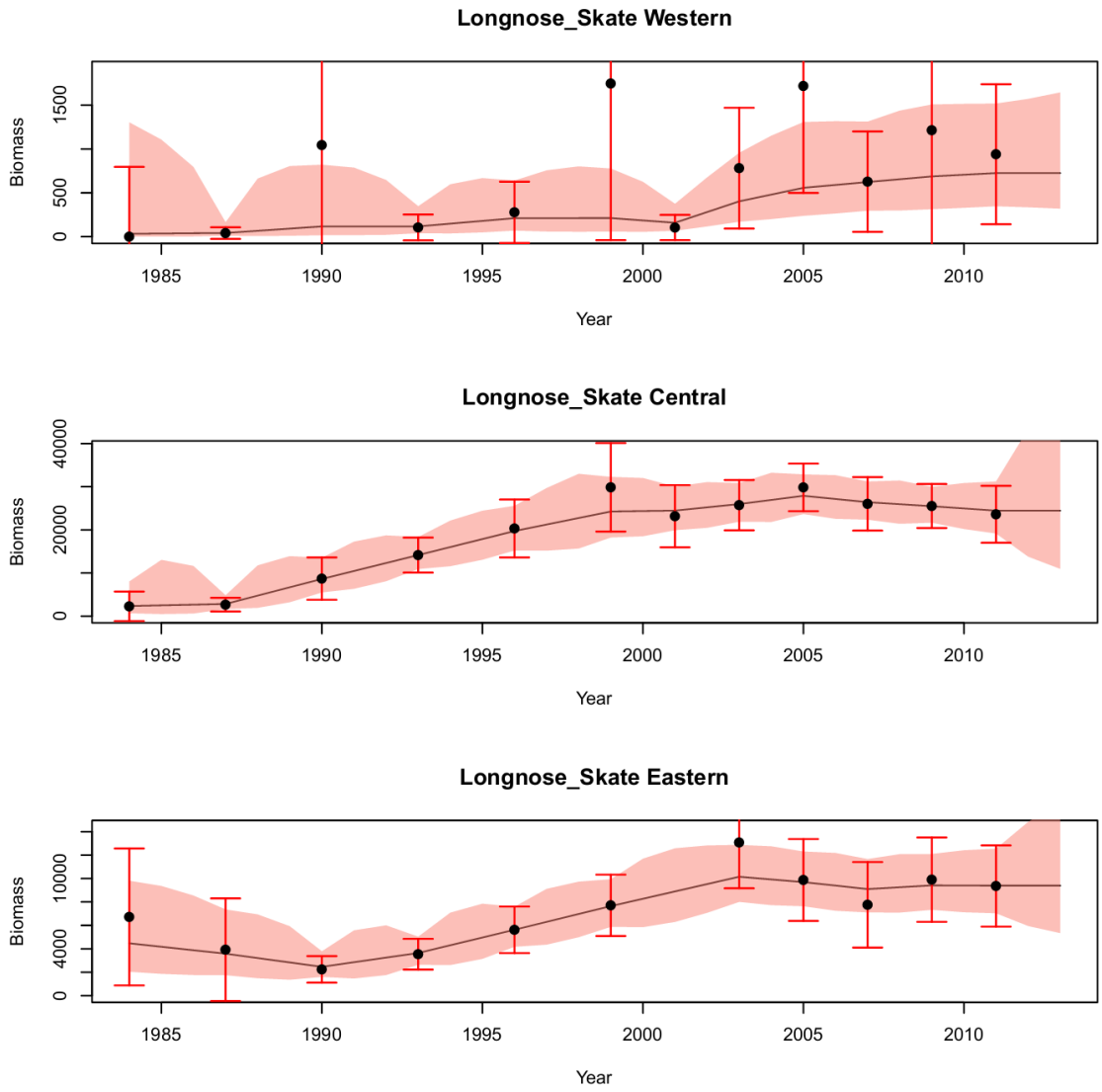

Figure 2. Gulf of Alaska survey biomass fits for the random-walk model for longnose skate showing how 2001 is missing in the eastern region (bottom panel). Shaded region represents ± 2 standard deviations from biomass estimates and error bars on points represents survey (observation) errors. Note that the vertical scales differ between regions.

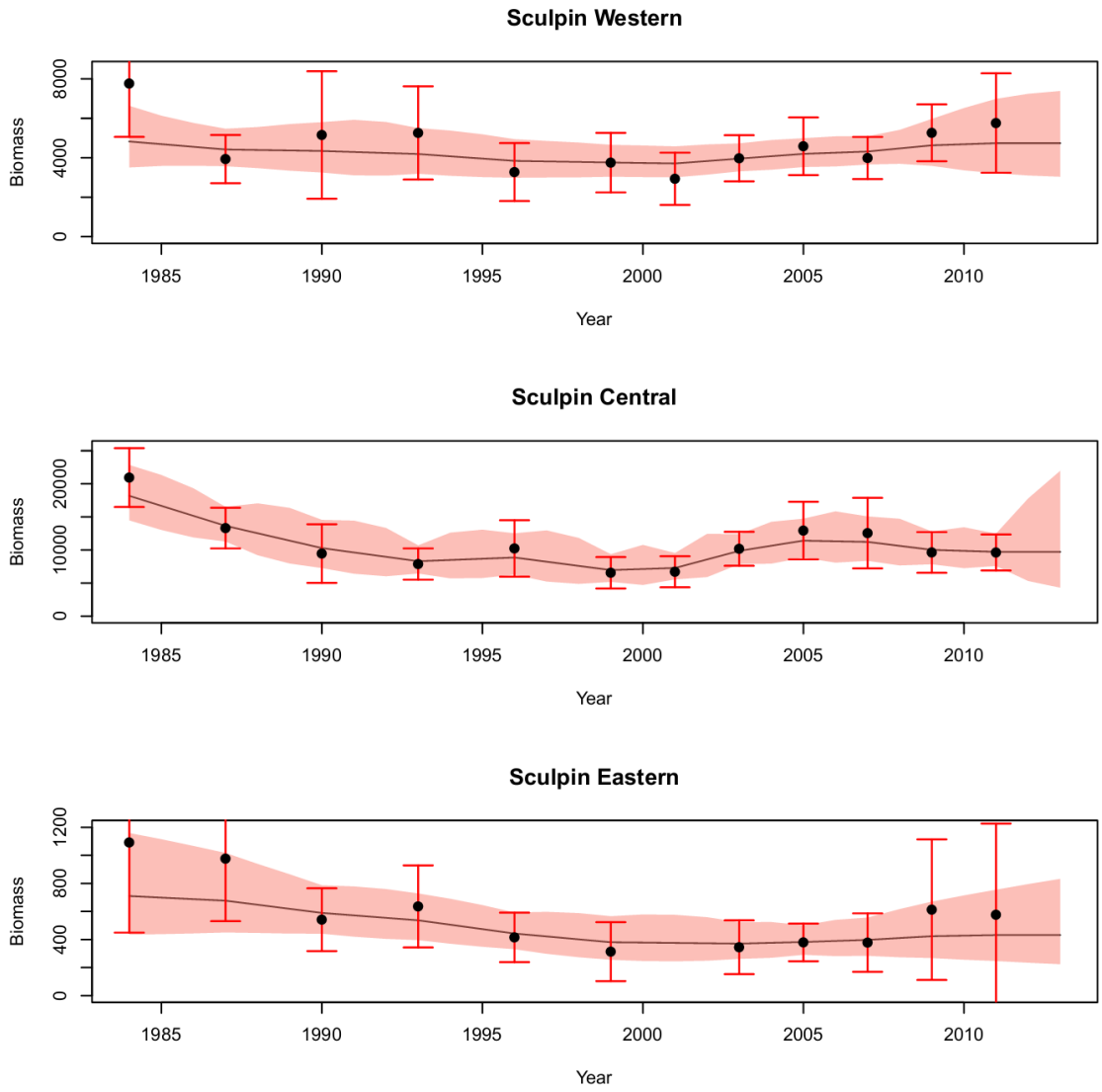

Figure 3. Gulf of Alaska survey biomass fits for the random-walk model for the sculpin complex showing how 2001 is missing in the eastern region (bottom panel). Shaded region represents ± 2 standard deviations from biomass estimates and error bars on points represents survey (observation) errors. Note that the vertical scales differ between regions.