

Effect of station depth distribution on survey CPUE

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Abstract

IPHC setline surveys stations are set on a 10 nmi grid in depths from 20 to 275 fm, so the depth distribution of the survey stations should approximate the depth distribution of the bottom in each regulatory area, and the simple mean CPUE should be the same as the depth-stratified mean CPUE. This is true in all areas except Area 2A, where the depth-stratified mean is consistently higher than the simple mean, by an amount averaging 40%.

Background

In the 2006 assessment (Clark and Hare 2007) the staff estimated coastwide abundance by fitting the standard assessment model to a coastwide data set, and then estimated exploitable biomass in each regulatory area by apportioning the total in proportion to an estimate of stock distribution derived from the setline survey. Specifically, an index of abundance in each area was calculated by multiplying setline CPUE (running 3-year average) by total bottom area between 0 and 300 fm. The logic of this index is that survey CPUE can be regarded as an index of density, so multiplying it by bottom area gives a quantity proportional to total abundance. The estimated proportion in each area is then the index value for that area divided by the sum of the index values.

The survey CPUE value used for each area in each year is the simple mean of the CPUE values recorded at all stations fished in that area. The stations are set on a 10 nmi grid between 20 and 275 fm so they provide a uniform coverage of every area. As a result, the various conditions that could affect CPUE—such as depth, substrate type, temperature, dissolved oxygen—should be represented in the stations in approximately the same proportions as in the area as a whole. The simple mean of all the station values should therefore be close to the mean that would be obtained by stratifying the stations by e.g. depth, computing a mean CPUE for each depth stratum, and then computing an overall CPUE by weighting the stratum means by the actual proportion of bottom in each depth stratum.

At the 2007 annual meeting there was some concern expressed that the simple mean CPUE failed to account for the variation in CPUE with depth. This paper addresses that concern. The depth distribution of survey stations is compared with the depth distribution of the bottom in each area, and the depth-stratified mean CPUE is compared with the simple mean CPUE. They are the same in all areas except Area 2A, where the depth-stratified mean is 40% higher.

Depth distribution of survey stations, bottom, and commercial catch

Figure 1 shows the cumulative depth distribution of survey stations and bottom in each regulatory area. As expected they are quite similar but there are some differences. There is a small excess of shallow stations in Area 2A, a small excess of deep stations in Area 2C, and a substantial excess of shallow stations in Area 4B. The comparison is not shown for Area 4C because it is not surveyed, nor for Area 4D which is partially surveyed.

For information, Figure 2 shows the depth distribution of commercial catch in each area as a check on whether the maximum survey depth of 275 fm is deep enough. It is. More than 98% of the commercial catch is taken at depths less than 280 fm in all areas except Area 4A, where the proportion is 94%.

Variation of survey CPUE with depth

The effect of any mismatch between survey station depth distribution and bottom depth distribution in a given area will depend on how survey CPUE varies with depth in that area. The effect of depth was estimated by fitting a generalized additive model to survey CPUE from 2001-2006 in which year entered as factor to account for changes over time and depth entered as a smooth function. Set time and soak time were also included in initial fits but neither was significant so they were dropped. The smooth functions estimated for the depth effect are plotted in Figure 3.

In most areas the variation with depth while highly significant is not very large. The exceptions are Area 2A and to a lesser extent Area 2C. In Area 2A catch rates are low in shallow water, so the excess of shallow stations in Area 2A can be expected to have an important effect.

Unstratified and depth-stratified survey CPUE series

Figure 4 shows the bottom line: a comparison of simple mean CPUE series and depth-stratified CPUE series for each area. The two are very close in all areas except Area 2A, where the depth-stratified CPUE is consistently higher, by an amount averaging 40%.

Discussion

Except for Area 2A, the results presented here show that there is no need to calculate a depth-stratified survey CPUE. Because of the uniform station distribution, the simple mean CPUE accounts for the depth effect in all areas except Area 2A. This is a good outcome, because computing a depth-stratified estimate would complicate the assessment and possibly raise some statistical problems. In Area 2A some adjustment may be appropriate, but it is difficult to choose a number. The Area 2A survey CPUE has a high sampling variance either way it is computed. The depth-stratified CPUE exceeds the simple mean by an average of 40%, but that excess has a standard deviation of 10%, so an approximate 95% confidence interval for the adjustment is 20-60%.

References

- Clark, W.G., and Hare, S.R. 2007. Assessment of the Pacific halibut stock at the end of 2006. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2006:97-128.

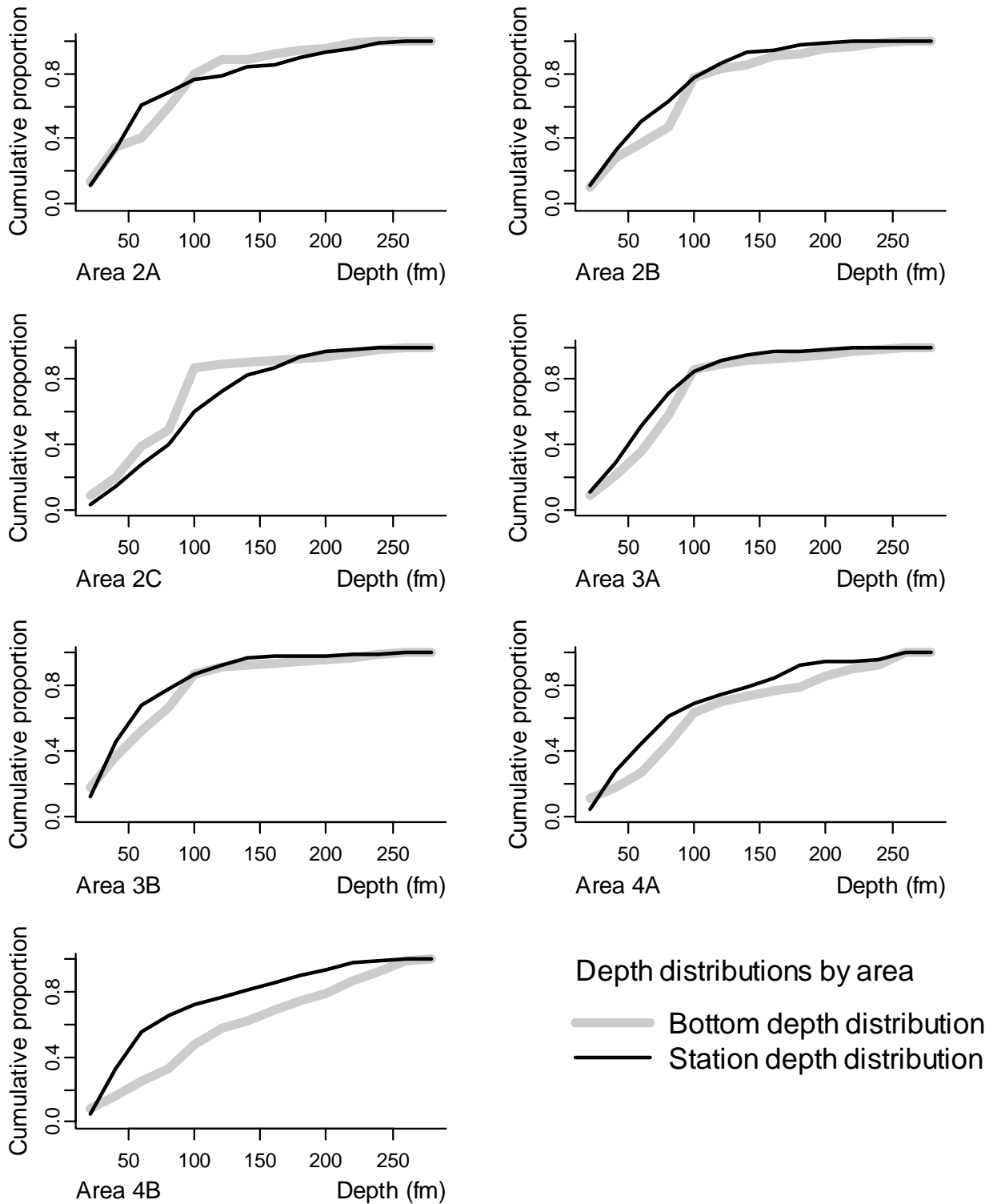


Figure 1. Cumulative distribution of bottom depth and survey station depth in each area.

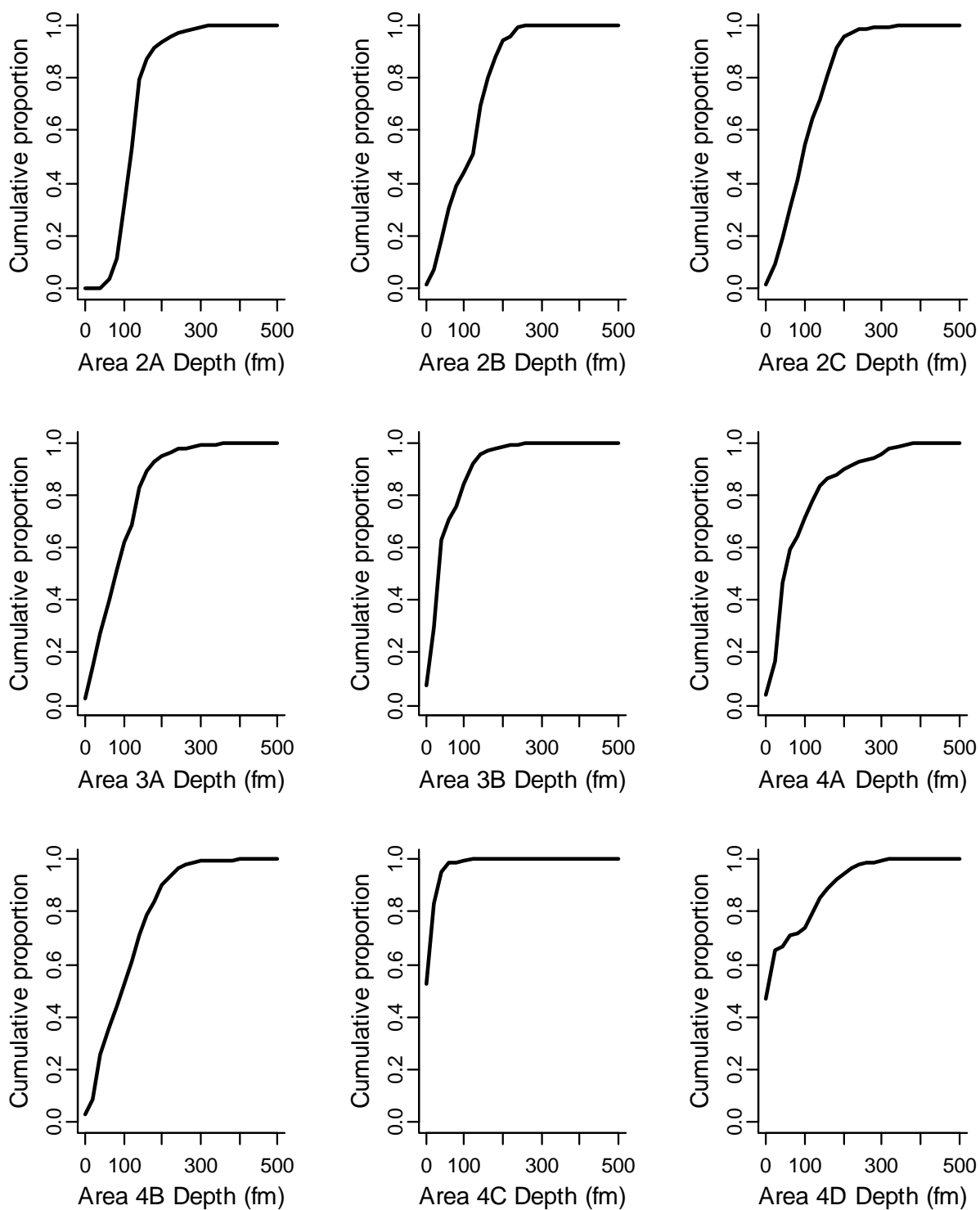


Figure 2. Cumulative depth distribution of commercial catch (2004-2006) in each area.

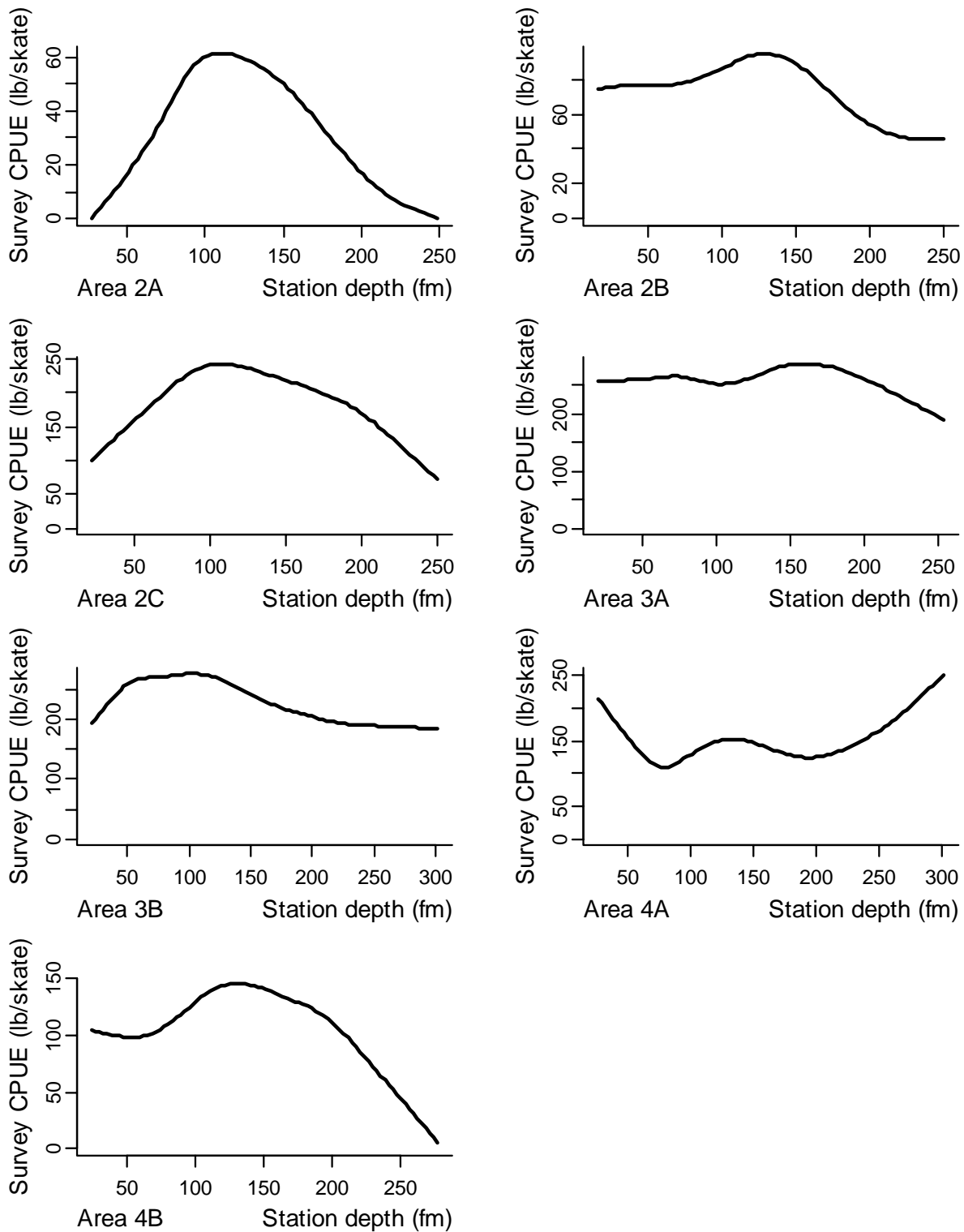


Figure 3. Variation of survey CPUE (2001-2006) with depth in each area. The plotted line is the depth term from a fitted generalized additive model with year as a factor and depth as a smooth function.

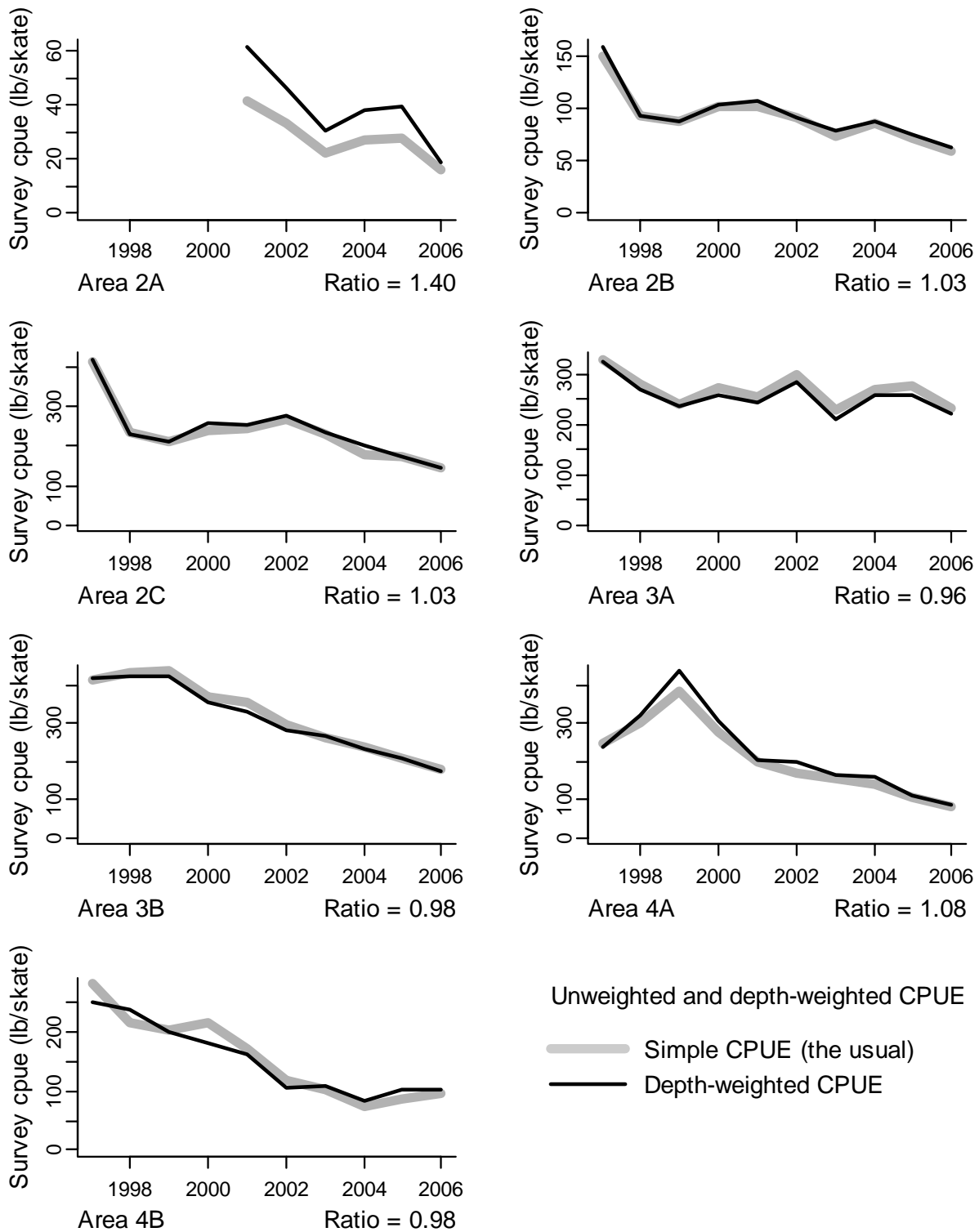


Figure 4. Comparison of simple and depth-stratified survey CPUE series in each area. The ratio shown at the lower right of each graph is the sum of the stratified estimates divide by the sum of the simple means.