## Questions and Significant issues arising at BAW II

1. **Could there be a larger than believed component of older fish in the exploitable biomass in Area 2A, as evidenced by reports of catches of large fish by trollers late in the year?**

Without sample information on these fish caught late in the year, it is not possible to place the reports into the context of the size distribution of the landings from the commercial or recreational fisheries halibut. There may well be larger fish but the question is whether they are larger or older than fish seen in the commercial fisheries. It is common for many regulatory areas to encounter larger fish during the fall. However, these fish are not any larger than the larger fish encountered during other periods of the fishery, there are simply more of the larger-sized fish moving among areas during spawning migrations than at other times of year. It is significant that smaller fish are not generally moving with these larger migrating fish, so the average size is larger.

However, even if we assume that there is a different size composition in the Area 2A troll fisheries as noted, then the question can still be addressed. The key point is not whether larger fish may occur but rather, what is their relationship to the exploitable biomass. If the fish were the same size as larger fish encountered during the regular commercial fisheries then their contribution would be reflected in the sampling and estimation normally conducted. If the fish are of a substantially different size than those encountered in the commercial fishery, then they are not part of the exploitable biomass. That is, since they are not encountered by the fishery, they are not included in the exploitable stock. The trends and differences in average age and percentage of older fish that we note of concern are for the exploitable stock.

2. **What is the effect of variation in the timing of the survey in a given area on the CPUE of the survey?**

The amount of commercial catch taken prior to the IPHC setline survey varies with both regulatory area and time (Webster and Clark, 2008, Webster 2009). It is plausible that survey catch per unit effort (CPUE) is affected by the proportion of removals taken prior to the survey: in areas and years where harvest is greater early in the season, we might expect survey CPUE to be lower on average than in areas where fishing is spread evenly across the fishing season. Webster (2009) looked at the relationship between survey CPUE and proportion of commercial catch taken prior to the median survey date, but found no obvious patterns. The data, however, were highly variable, and it was not possible to conclude that no relationships exist. Concern about the effect of commercial catch on survey CPUE is particularly strong in Area 2A, where typically over 80% of the catch is taken prior to the median survey date, much higher than in all other areas (Webster 2009).

We are working on an adjustment to survey CPUE to account for variation in the proportion of removals taken prior to the survey. Some preliminary results of applying this adjustment were presented at BAW II, and we saw that such an adjustment would lead to increases in Area 2A CPUE, and decreases in CPUE in Area 4. The values we presented adjusted for commercial catch only. In some areas, sport catch and bycatch are significant sources of removals, and we will incorporate estimates of these removals into revised survey adjustments before presenting these for further discussion.

It is also important to consider that these adjustments address potentially lower survey CPUE resulting from removals prior to the survey. They do not address other factors such as growth of fish through the summer or migration of fish throughout the year, which may have different effects on biomass (and therefore CPUE) at the time of the survey in different areas.

Webster, R.A. Further examination of fishery-survey interactions. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2008: 203-211.

Webster, R.A. and Clark, W.G. 2008. Questions about fishery-survey interactions. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2007: 229-243.

**3. Was the absence of declining catches in the removal study due to the use of low CPUE stations? Wouldn't groups of fish passing through have a greater effect in areas of low CPUE than in areas of high CPUE?**

The removal study took place in the Yakutat and Prince William Sound survey regions of Area 3A, although some eastern stations in the Seward survey region were available for sampling but were not selected. When designing the removal study, we deliberately excluded the high halibut density areas in the west of Area 3A. In those areas, we were very concerned about the possibility of a saturation effect on some sets, with no measurable decline in daily catches because removals were a very small fraction of the local population. From the results of the removal study, it is likely that movement of fish into the catchable population was so high that catches did not decline during the five days of fishing at each station. However, it seems reasonable to assume that the number of fish moving is proportional to the local density: if density is high, as is the case in western parts of Area 3A, then more fish will be moving than in low density areas In this case, we would not expect local movement to be more of a factor in the lack of observed declines in catches in relatively low-density areas than it would be in high-density areas.

**4. Would shifting the survey grid on a regular or occasional basis have any impact on survey CPUE values and trends?**

A very important advantage to using the same set of stations each year is that you get more precise estimates of trends with time. Selecting a new set of stations each year would introduce extra variability into estimates of trends because there is more variation between CPUE at different stations than there is between different measurements of the same station.

However, there is more to this question than the matter of achieving good precision in trends. By chance, the mean of a selected sample of stations will differ somewhat from the true population mean, with smaller differences expected on average when variability is low and sample size is large. When a sample of setline survey stations in a regulatory area is selected once and used over many years, it is likely that the mean of that sample will remain consistently different from the true annual mean over time. This is not the same as bias, which depends on repeated samples being different on average than the population, whereas here we are following a single sample of stations through time. Further, the estimation of time trends will not be biased when based on a single systematic sample of stations. What we desire is that the mean (annual mean or mean trend) of the selected sample of stations should be "close" to the population mean, that is, any differences from the true mean are likely to be small. The probability that the mean of the sample is "close" to the population mean depends on the underlying variability and the sample size, and is reflected in the size of the standard error (SE) and the sample coefficient of variation (CV). If these values are considered unacceptably large in an area, then the solution is not to select an entirely new set of stations each year. That might produce estimates with somewhat different means, but with similar variability, and would give no expected improvement over the current survey (and would make trend estimation less precise, as discussed above). The simple answer would be to increase sampling effort in an area in order to improve the precision of average CPUE estimates to "acceptable" levels (for example, so that CVs are below 20%), thereby improving the chances that the sample mean is close to the true mean.

**5. Would a survey designed for apportionment purposes be different from the current survey design?**

Possibly. The current survey design has excellent spatial coverage, but in smaller regulatory areas, the 10-nautical mile grid means that sample sizes are relatively low. This is not a problem when estimating biomass on a coastwide basis in the Stock Assessment, but when closed area assessments were done, there were often insufficient data to fit separate assessment models for smaller areas like Area 2A and Area 4CDE. Similarly, when using setline CPUE for apportionment of coastwide biomass among areas, ideally all proportions would be precisely estimated. However, mean CPUE is estimated very imprecisely in Area 2A (Hare and Clark 2009), and while the absolute effect on that area's shares of biomass might be small, because it is a small area in terms of biomass, the difference can be large relative to the local biomass.

Staff are in the process of developing a proposal for augmenting the survey in Area 2A, which has by far the greatest uncertainty (though it is unbiased) in its estimate of CPUE, and therefore in estimates of its apportionment share. The proposal will be available for discussion prior to the annual meeting.

Hare, S.R. and Clark, W.G. 2009. Assessment of the Pacific halibut stock at the end of 2008. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2008: 137-201.

**6. What is the actual impact of depth-stratified vs. unstratified survey CPUE on apportioned estimates of Regulatory Area biomass?**

The following table illustrates how regulatory area CEYs based on depth-stratified survey CPUE would have differed from unstratified survey CPUE apportionment.

| Year | 2A | 2B | 2C | 3A | 3B | 4A | 4B | 4CDE |
|---|---|---|---|---|---|---|---|---|
| 2001 | 0% | 14% | 7% | -3% | -3% | 6% | -5% | -2% |
| 2002 | -1% | 10% | 5% | -1% | -4% | -2% | 3% | 2% |
| 2003 | -12% | 8% | 4% | -4% | -3% | 10% | 6% | 0% |
| 2004 | 22% | 1% | 4% | -5% | -1% | 10% | 10% | -1% |
| 2005 | 7% | -1% | 5% | -4% | 1% | 7% | 10% | -1% |
| 2006 | -10% | 5% | 4% | -4% | 1% | 3% | 16% | 0% |
| 2007 | 7% | 2% | 5% | -2% | 1% | 0% | 12% | -3% |
| 2008 | -22% | -1% | 3% | -4% | 0% | 9% | 26% | -1% |
| 2009 | -7% | 5% | -1% | -4% | 1% | 1% | 16% | 2% |

The computations are based on a running three-year average. No depth-stratified mean is computed for Area 4CDE due to the lack of a setline survey for most of that regulatory area (the changes in Area 4CDE's CEY percentage occurs solely as a result of changes in the other areas). The depth-stratification adjustments are independent of the hook competition adjustments.

While staff does not recommend applying either adjustment to determine regulatory area CEYs, it is possible to apply either or both to the straight survey CPUEs

**7. What is the variability of estimated recruitment of 8-yr olds among areas and years?**

To answer this question, it is necessary to apply relative survey catches of 8-year olds among regulatory areas with a selectivity correction for differences in area-specific size-at-age. The following table lists estimated area-specific percentages of age-8 recruitment (along with total coastwide recruitment in millions).

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2A | 1% | 2% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| 2B | 10% | 10% | 8% | 6% | 8% | 6% | 7% | 5% | 10% | 10% | 9% | 14% |
| 2C | 9% | 5% | 6% | 9% | 12% | 7% | 7% | 5% | 6% | 6% | 7% | 6% |
| 3A | 30% | 27% | 19% | 23% | 17% | 31% | 24% | 22% | 18% | 21% | 22% | 11% |
| 3B | 26% | 31% | 40% | 26% | 17% | 17% | 38% | 47% | 48% | 30% | 36% | 27% |
| 4A | 9% | 8% | 9% | 16% | 18% | 21% | 12% | 9% | 8% | 13% | 11% | 19% |
| 4B | 4% | 2% | 3% | 8% | 8% | 1% | 1% | 1% | 1% | 1% | 1% | 2% |
| 4D | 2% | 6% | 6% | 4% | 6% | 6% | 3% | 3% | 2% | 3% | 3% | 5% |
| 4EBS | 8% | 8% | 8% | 7% | 13% | 9% | 7% | 6% | 6% | 15% | 11% | 14% |
| Total R | 10.026 | 8.815 | 8.004 | 9.024 | 15.263 | 17.723 | 13.995 | 14.251 | 23.977 | 36.399 | 30.419 | 19.028 |

**8. What would be the effect of a fixed-catch (with minimum level) harvest strategy in Area 2A on (i) Area 2A halibut abundance, and (ii) Coastwide halibut abundance?**

It is difficult to answer either part of this query with certainty in the absence of conditions on harvests in the other regulatory areas. However, the history of catches in 2A over the past 30 years gives some guidance in responding to part (i). Total removals in Area 2A averaged around 0.5 M pounds between 1974 and 1985, then averaged around 1.0 M lbs between 1985 and 1996 and have been at about 1.5 M lbs since then (see page 187 of the 2008 RARA or page 125 of the 2009 Annual Meeting Bluebook). Commercial CPUE has decreased by 70% since 1999 while survey CPUE has decreased by 60% since 2000. Commercial effort increased 400% over the same time frame in order to maintain the removal levels. These indices strongly suggest that the current level of removals in Area 2A is not sustainable. During the earlier period of 1974-1996, commercial CPUE was relatively stable and both commercial and survey CPUE increased over the period 1995-1999 - this was likely due to the strong 1987 year class which increased biomass levels in all regulatory areas into the late 1990s. These data suggest that a fixed level of catch that would be sustainable over the long term would be in the order of 0.5 Mlb.

In response to part (ii), we note that Area 2A has consistently been the smallest, in terms of exploitable biomass, of the IPHC regulatory areas. Importantly, it is also the easternmost area and therefore is almost certainly an area that serves only as a destination area, and not a source area, of migrant halibut. These two factors suggest that catches within Area 2A will have little measurable impact on the coastwide halibut stock, as measured by exploitable or spawning stock. However, it is entirely possible that a too-high fixed catch level in Area 2 may have a long-term detrimental effect is there is a local spawning stock-local recruitment relationship. If such a relationship exists, and it would be precautionary to assume that it is so, then harvesting the Area 2A population in such a manner that compromised the spawning biomass could eventually seriously jeopardize the long-term productivity of Area 2A.

**9. Could we present the short-term results of widget simulations, along with the longer-term endpoint results?**

We are working on alternative ways of presenting short-term simulation results for future meetings. The widget was originally developed to illustrate long-term (equilibrium) population effects under different assumptions of population dynamics and fishery processes. Initial conditions (for example initial age structure), transient effects (for example lag between settlement at age 0 and recruitment at age 8) and stochastic processes (affecting both population and fishery dynamics) are expected to be more influential on short-term simulations and therefore must be properly addressed in the modeling framework. The current version of the widget initializes populations (year 1) based on the distribution of age-eight recruitment that is selected by the user. The initial age structure is a stable-age structure in the absence of fishing and migration. The populations are projected forward using the migration scenario selected by the user and reach equilibrium distributions in less than 40 years in the absence if fishing (see Figure 1). The fact that some populations go down or up until they reach equilibrium is a result of the effects of migration on the assumed initial age structure. The assumed initial age structure has no effect on the equilibrium end point of the simulations, but will result in different short-term results depending on what initial age structure we use. For future short-term projections we plan on using initial age structures derived from the most recent stock assessment and in that case the populations would not be allowed to reach equilibrium but would be projected forward under user-specified migration and fishing scenarios. Figure 2 shows the time series of harvest rates corresponding to the simulation run of Figure 1, HR=0 for the first 40 years and then HR=0.2 for all areas. Figure 3 shows the resultant time series of catch by area of the scenario run.

It is important to note that the goal of the widget is to provide a user-friendly tool for initial exploration of long-term effects of alternative policies under alternative scenarios of population dynamics. This should not be confounded with short-term or mid-term projections/forecasts from current conditions. Attempting to do so with the current widget would be using the wrong tool for the wrong job. Future modeling work will address short-term results using more appropriate approaches.

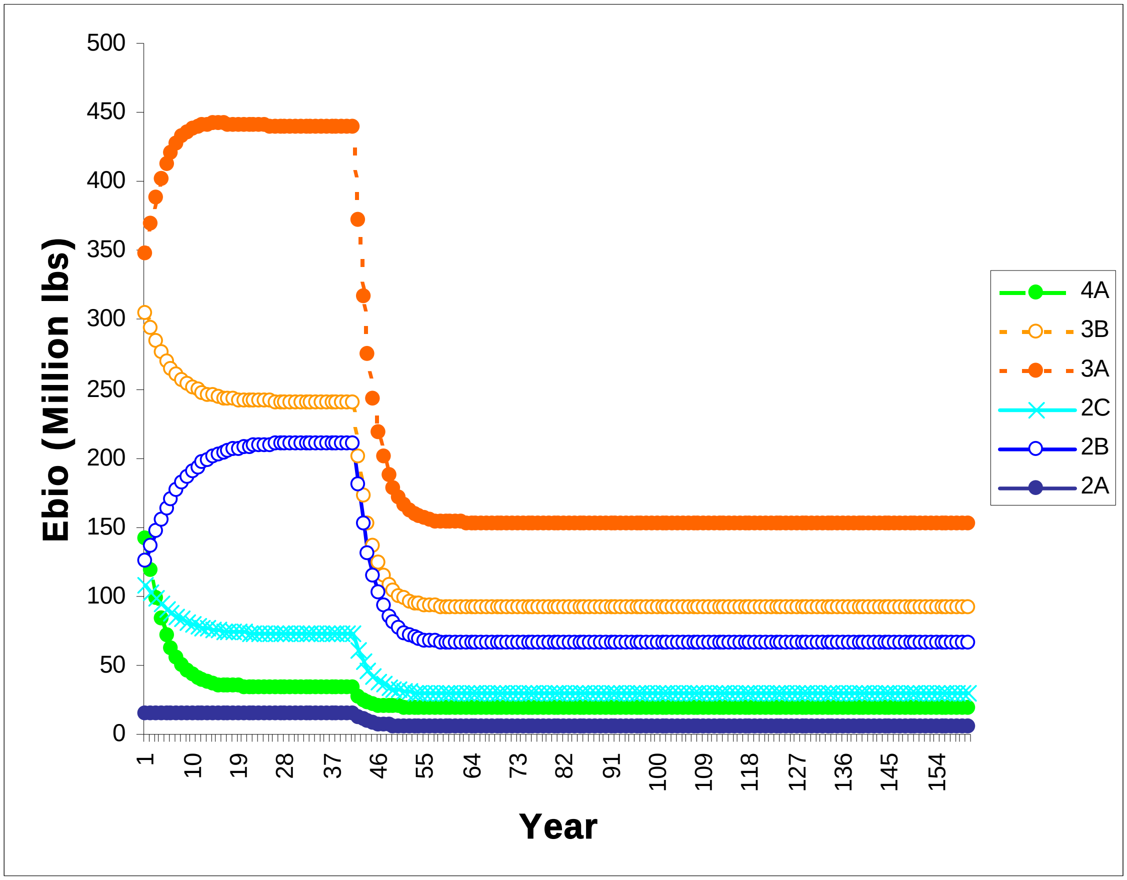


Figure 1. Time trajectory of exploitable biomass (Ebio) of a scenario with balanced harvest rates (HR= 0.2 for all areas after year 40 of the simulation), migration following PIT tag matrix, same growth pattern on all areas and recruitment distribution as estimated by recent surveys. The first 40 years represent a transition from initial age distributions without migration to equilibrium age distributions with migration added to the population dynamics.

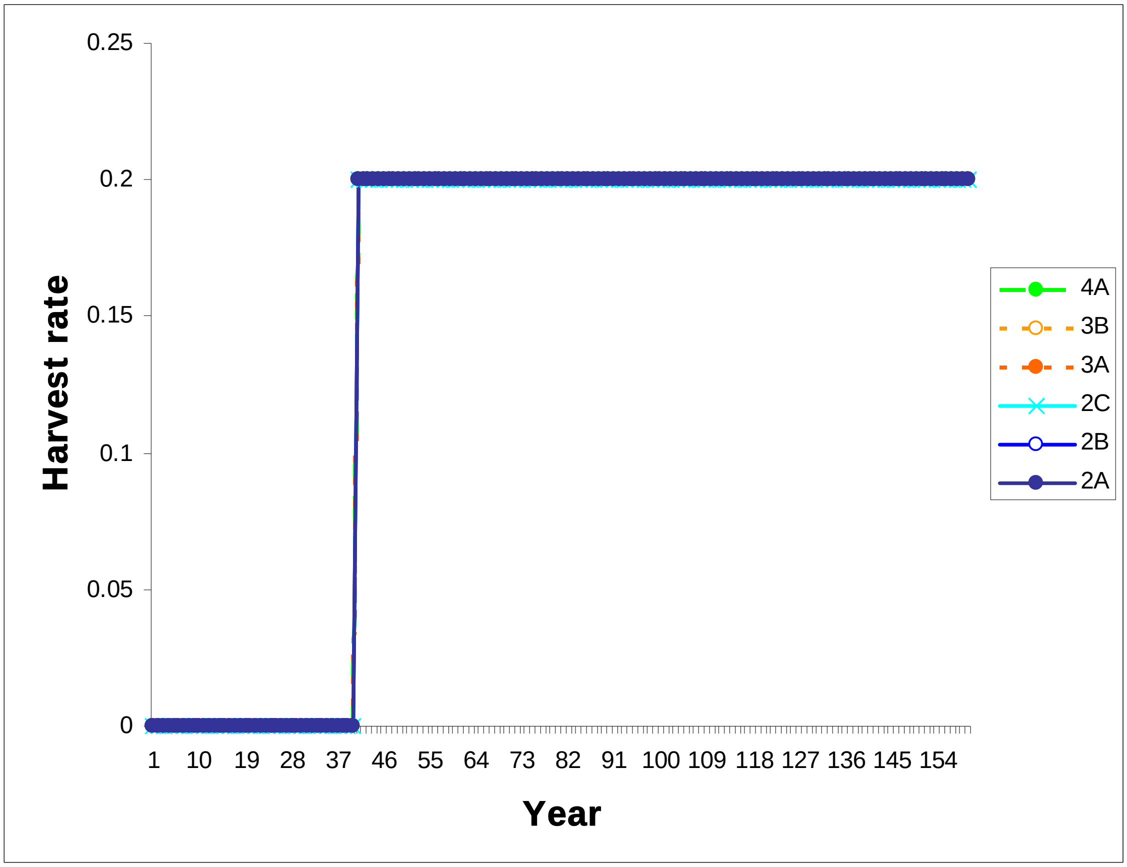


Figure 2. Time trajectory of harvest rates of a scenario with balanced harvest rates (HR= 0.2 for all areas after year 40 of the simulation), migration following PIT tag matrix, same growth pattern on all areas and recruitment distribution as estimated by recent surveys.

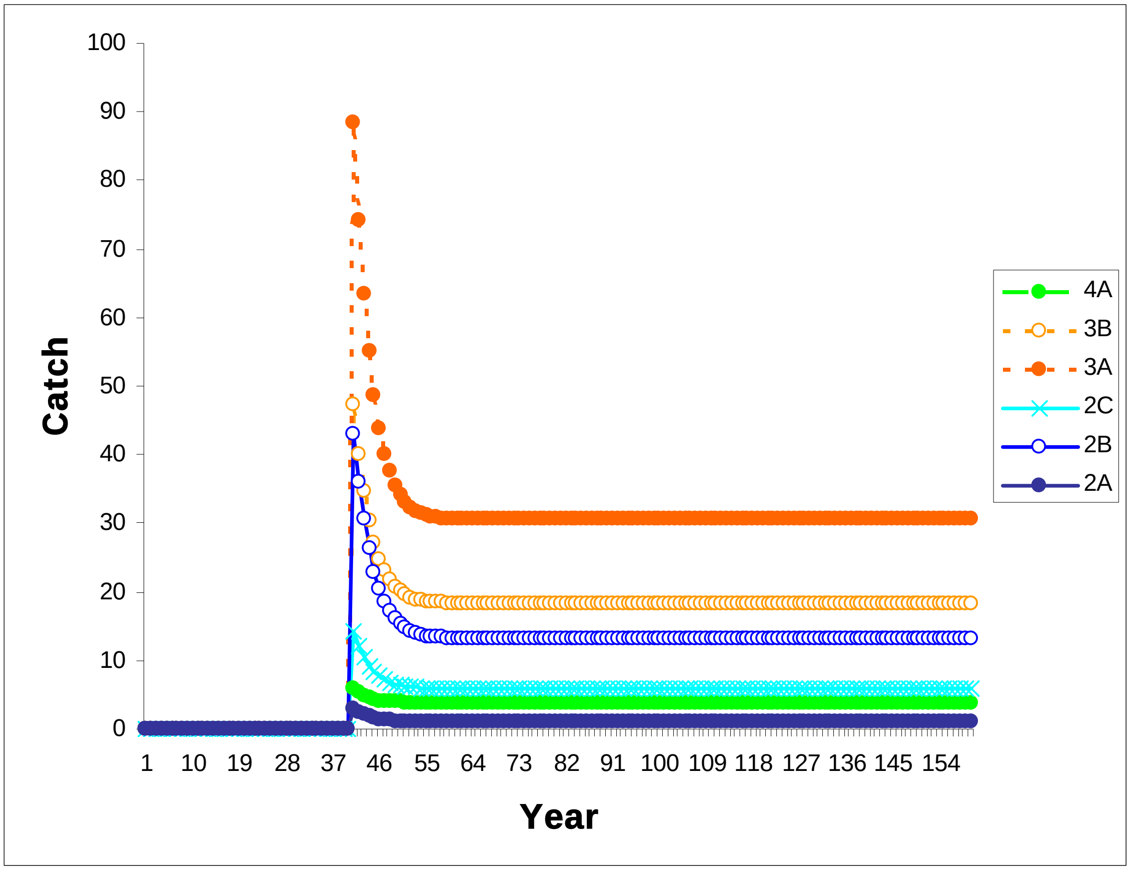


Figure 3. Time trajectory of catches of a scenario with balanced harvest rates (HR= 0.2 for all areas after year 40 of the simulation), migration following PIT tag matrix, same growth pattern on all areas and recruitment distribution as estimated by recent surveys.

**10. Can we put more realistic assumptions about fish movement for Areas 2A, 4B, and 4CDE into the widget?**

Future versions of the widget will include alternative migration matrices to evaluate the effect of different migration rates for Area 2A. In the intervening time, the current version of the widget can be used to explore the effect of varying migration rates into 2A (using the unequal migration rate option of the "Simple rate" widget tab, see 2008 RARA and 2009 Blue Book for setup of initial scenarios). Initial explorations suggest that larger migration rates into Area 2A result in projected lowered spawning biomass levels (both under simulations with balanced and unbalanced harvest rates) relative to scenarios assuming no immigration into Area 2A. The geographic scope of previously released widget versions did not include areas 4B and 4CDE, only 4A to 2A. However, we presented a preliminary widget version including 4B and 4CDE during the second day of BAW II. Since the overall simulation results (West vs. East differences in age structure as well as current spawning biomass level compared to unfished conditions) were very similar, we decided to use the six-area widget (4A to 2A) for simplicity. Our knowledge of movement patterns for areas 4B and 4CDE is still evolving and as more information becomes available, we will be able to incorporate them in our model simulations.

**11. Can we scale recruitment in each area to local abundance in each area – to explore potential density-dependent effects on recruitment?**

To address this question we will incorporate different relationships between local spawner density and local recruitment into our simulations. The goal is to describe processes potentially occurring at low and high local density and evaluate their potential effect on halibut dynamics. However, it should be noted that using a distribution of recruitment that maps exactly the distribution of spawning biomass (as it was suggested by workshop participants) will end up in a one-way road toward one area receiving most of the recruitment as a result of ongoing movement of halibut beyond the age of recruitment. Using different forms of density-dependence can prevent such an occurrence, but the simulations are likely to be highly sensitive to the nature of that relationship.

**12. Can we combine hook competition and survey timing adjustment factors in the widget simulations?**

Hook competition and survey timing are both annually varying factors. It would be possible to incorporate their impact in the widget simulations as fixed factors that increase or decrease regulatory area apportionments. The fixed factors could be set at the values found historically but it is not possible to estimate how they would vary in the future.