International Pacific Halibut Commission
Stock Assessment Workshop
June 27-28, 2007
Nexus Hotel
Seattle, Washington

Note: The following summarizes key points of the workshop and is not intended to be a verbatim transcript. Appended to this summary is a list of questions posed by participants and the staff responses.

Wednesday, June 27

IPHC Director, Dr. Bruce Leaman, introduced the external scientific reviewers Drs. Chris Francis and Paul Medley from the Center for Independent Experts (contracted through University of Miami), who attended the meeting as a component of an IPHC independent assessment review, and Dr. Steve Martell of UBC Fisheries Centreas moderator of the workshop.

Dr. Martell's opening remarks included recognizing that there has been a substantial change in the halibut assessment from a closed area to a coastwide approach. This workshop is being held to look at the technical details of the model, the data going into the model, and the method for apportioning the coastwide biomass into IPHC regulatory area biomass. Material concerning the 2006 assessment was made available on the IPHC website prior to the meeting (http://www.iphc.washington.edu/halcom/newsrel/2007/nr20070509.htm).

Dr. Leaman presented an overview of Pacific halibut management: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0701bml.pdf). Discussion of the presentation included clarification of CEY and harvest rate. There was a comment that it appears IPHC deliberates catch limits privately and that the 2007 results were a surprise to the public at the January Annual Meeting. Dr. Balsiger agreed that perhaps the Commission was not explicit enough at the public session in explaining the rationale for how it arrived at catch limits for 2007 and will try to improve in the future.

Ms. Heather Gilroy presented commercial fishery removals with no discussion following: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0702hg.pdf).

Mr. Gregg Williams presented other removals: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0703gw.pdf) There was discussion of assumed observer coverage in the Bering Sea trawl fleet and whether scientists believed that the rate of observer coverage reflected the actual percentage of the catch. It was clarified that the 30% target coverage for vessels 60-125 feet in length and 100% coverage for vessels greater than 125 feet referred to hauls made and not directed catch. Therefore, the actual catch observed could vary from the haul coverage targets. It was noted that for the stock assessment model, the current year's figures for bycatch mortality are used. For some fisheries

that is a estimated number for the entire fishery and for others it is a projection based on partial year's data.

Mr. Claude Dykstra presented setline survey information: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0704cd.pdf). There was discussion of the presence of commercial fishing immediately before the survey fishes on a station and how this event is taken into consideration. The NMFS sablefish survey was given as an example of a survey where commercial vessels are asked to cease fishing prior to survey fishing. The IPHC staff noted that there are many survey vessels fishing at the same time and the logistics of limiting access at these sites as the survey progresses would be prohibitive. Furthermore, the survey should reflect what is happening on the grounds and if commercial fishing lowers CPUE at certain sites, then that is the reality. Also, factoring fishing pressure into the CPUE in some fashion would be difficult.

There was significant discussion of the survey design. Some participants suggested that the systematic sampling design is not unbiased to relative abundance in certain areas. For example, the design results in lower variance in areas where the continental shelf is wider and there are more stations. However, the stations are assigned systematically, so that sampling is in proportion to the amount of bottom area, i.e., the wider the shelf, the greater number of stations. It was also noted that the survey begins at 25 fathoms and there may be some halibut in more shallow areas. The staff explained that these shallow areas have been fished before but that it is technically difficult to fish the shallows.

A discussion took place of how species composition is estimated in the survey. The staff explained that the systematic 20% hook sampling appears to represent abundance of common species fairly well, but is less precise for less common species. There have been two detailed analyses of 20% vs. 100% sampling and both concluded that the present procedures were unbiased but the precision of estimation decreased with lower occurrence of a species. It was also noted that such results occur for any subsampling scheme and are not unique to the IPHC procedure. A 100% hook count for species composition requires a third sampler and the survey vessels generally carry two samplers. The exception is in British Columbia where the commercial fishers have funded a third sampler to account fully for bycatch.

Following a short break, Dr. Ray Webster presented the PIT tag study results: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0705rw.pdf). Following clarification of points from the presentation, it was suggested that if harvest rates are different among areas, then this will result in a redistribution of biomass relative to proportional harvest. The staff commented that it could be happening for example in Area 2 where the harvest rate appears to be higher.

The fact that fish appear to be migrating from Areas 4A and 3B to Area 3A, but virtually no fish appear to be migrating from Area 2C to Area 3A was noted. The staff acknowledged this also and speculated that density dependence could be altering distribution, i.e., a large biomass in Area 3A is inhibiting recruitment into the area. In addition, migration on the eastern side of the stock appears to be primarily in an eastward and southward direction, where recoveries have been sufficient to establish a trend.

There was discussion of Area 4A in terms of Bering Sea side versus Gulf side. The staff noted that the halibut from the Bering shelf Closed Area likely recruit to the Bering Sea side of Area 4A.

The following suggestions were made to staff:

- to analyze whether the fishing mortality is different for the year following release of tags.
- to analyze how the Gulf side compares to the Bering Sea side of Area 4A, and also look at how many halibut actively move from the Bering Sea side to the Gulf side.

Dr. Clark presented IPHC data pre-processing practices: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0706bc.pdf). It was noted that processes of smoothing the data are different for survey versus commercial data. The staff agreed to revisit the topic later in the workshop. There was some discussion of sex composition and the high site fidelity of PIT tagged fish. Dr. Clark noted a study done in 2005 that looked at commercial fishing recoveries within 10 miles of PIT tag stations, and suggested that perhaps with the coastwide model, the proximity to stations should be adjusted. Also mentioned was that mean depth distribution changes from east to west but the model includes 0-300 fm depth in all areas, however staff noted that catch of halibut below 300 fm was very low (< 3%) in all areas.

The following were requests of staff:

- to look at the halibut tagged on the Gulf side of Area 4A and the resulting recovered area.
- to check depth distribution by area and resulting tag recoveries.

Following a break for lunch, Dr. Clark presented the IPHC stock assessment model: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0707bc.pdf). He began with a description of the basic 'vanilla' model. There was significant discussion of catchability. It was explained that the definition of catchability is the proportion of the population that will be caught with one unit of effort. In the assessment, there are different catchabilities assigned to each fishery and in the coastwide version, there is one estimated value each for males and females. Dr. Francis suggested that while using one value for the coastwide catchability for the commercial fishery is likely not a problem, it may be for the survey and that value should be allowed to fluctuate. Staff commented that commercial catchability is allowed to fluctuate in the model but survey catchability is not.

There was some discussion of natural mortality and removal accounts. It was noted that the total groundfish fishery in Area 2B is a different fishery currently than in the past, with 100% of removals in all fisheries now being accounted for. The staff agreed that the better estimates could impact results in the model and that discard mortality numbers in B.C. are much lower than in the past. Ultimately, the most influential variables in the models are the selectivities and the catchabilities.

Dr. Clark continued his presentation with fitting of the model. He noted that the model fits well with data for both females and males in the survey but are divergent with males in the commercial fishery. Several models have been tried and thus far, there are no better fits that cure

the retrospective problems. Dr. Francis suggested that instead of fixing the data outside the model, do it inside instead. In addition, fit the CPUE without a scalar at all and perhaps maybe slightly larger ones on other parameters.

Dr. Clark presented penalties and weights with little discussion.

Following a break, Dr. Clark presented alternative model fits. Following some discussion of the data being used for the alternative model fits, the staff agreed to look into reasons for the difference in male and female selectivities in the Freeform and the Smooth Ten models.

Dr. Martell reminded the attendees that the staff were trying to be open about the subjectivity that goes into the model and one purpose for this workshop is to air out that subjectivity and see how different assumptions can lead to divergent views on management outcomes.

There was some discussion of the IPHC staff's evaluation of gains and losses in the different model fits. Dr. Leaman explained that the staff does not expect to go back to closed-area assessments given the compelling evidence of migration and its estimated impacts. The IPHC Commissioners in attendance reserved judgment on this change pending this workshop and further study.

There was further discussion of closed area versus coastwide assessment models. It was pointed out that these two options were at the extremes and that there were other options in between. The staff noted that there are two separate topics, one is the assessment and the other is apportionment. Exploitation is higher in the east than in the west and the coastwide model protects the stock as a whole. There was a suggestion that PAT tags could be used to look at migration rates. The staff responded that the project is possible, but would be costly, and they had been unsuccessful at getting funding for a large PAT tag project. Dr. Francis suggested including information on migratory movements that we already have as well as what-if scenarios into the coastwide assessment model to see how the results change. The staff commented that they are confident that area assessments would be very sensitive to that information, that it is incomplete or lacking in several areas, and its use would encumber the assessment with the same problems as exist in the closed-area assessments. It was agreed that such a process could be a valuable simulation exercise but in the absence of accurate and detailed migration estimates of high precision, the model results would be largely driven by values in which we cannot place great confidence. There would also be a need to reconcile this information with the survey results. It was suggested to treat them as random effects. There was a comment that in the closed-area assessments there were declining trends in the stock that the model did not pick up, and that a better understanding of the reasons for this is crucial. A counterpoint was made that it is not a biological problem, but may be from the timing of how the fishery is executed and results may carry over into selectivity.

Dr. Martell redirected the discussion back to the alternate models. He commented that there is too much weight (and double fitting of age composition data) being put on age and he suggested downgrading the age composition and focusing further on the survey CPUE. The large effective sample sizes on the age-composition information may be one source of the retrospective bias in

the assessment model. Age composition alone does not give information on absolute abundance and that is important to remember when making allocations.

Dr. Clark presented area apportionment strategies: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0708bc.pdf). He noted that the declines in survey biomass indices for Areas 3B and 4 were expected given the low historical exploitation in these areas and the 'fishing down' effect of higher exploitation rates in more recent years. Concerning relative catchability among areas, he showed that the recovery rate of PIT tags per 10,000 fish scanned was similar in Areas 3A and 3B. If for instance, catchability was actually higher in an area, the expectation would be a higher recovery rate of PIT tags in that area. There was some discussion of the use of trawl data. Dr. Francis asked the staff to produce for the workshop, an estimate of absolute abundance based on trawl surveys.

A discussion of hook competition ensued. Dr. Clark conducted an analysis of hook competition among areas and noted that except for possibly Areas 2A, 4B and 4D, CPUE is consistent among areas on the survey. He examined bait competition and found that the fraction of baits recovered on survey stations is consistent across Areas 2B-4A. It was further explained by staff that some studies suggest a local depletion effect around the gear in some areas and not necessarily a loss of bait scent. It was noted that competitive interference from bycatch or other halibut could be important, but the analysis indicates that it is not a significant factor in the interpretation of survey CPUE. Dr. Richards asked if there are research projects being designed to deal with these questions. Dr. Clark concluded that setline survey CPUE appears to be a consistent index of density in Areas 2B-4A, and a case could be made for scaling upward in Areas 2A and 4B but there is no objective means to choose the appropriate scalars.

Discussion was opened to look at methods of biomass allocation among areas. It was noted that fundamentally, it is a policy decision, but that decision should be based on sound science and sustainability. Sablefish apportionment was described and it was noted that it is the goal to harvest sablefish at equal rates across the range. From a migratory standpoint, 30-40% of sablefish can move in a year and smaller individuals are more likely to migrate than larger ones.

The final discussion of the day was a summary of apportionments done by the Council for other species such as rockfish, pollock, and cod.

Thursday, June 28th

Dr. Clark presented the results of the alternative model fits that had been suggested in the last session: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0709bc.pdf). The major features changed were to remove any double fitting of data (catch at age but not CPUE at age; male and female catch at age but not total catch at age; total CPUE in number but not total CPUE in weight) and survey CPUE variance scalar set to one. In general, these model modifications had very little effect on either the fit of the model to the data or the resultant estimates of exploitable biomass. Discussion points included:

- the merits of allowing catchabilities for both commercial and survey CPUE to fluctuate each year and how that is distinguished from the error for each year. No conclusion was drawn and the discussion was temporarily tabled.
- the robustness of the estimation for catchability. It was noted that good aging data and a good handle on trends helps.
- the contradictory conclusions of different data sources. One trend suggests that the stock size is decreasing and the other suggests a downward trend only if selectivity has remained constant in recent years. Therefore, the two conclusions might be that there truly is a downward trend, but the other explanation might be that there are more smaller fish and a lower age composition. It was suggested that a third data source, the NMFS trawl survey in this case, may be looked at for information on incoming year classes. Staff noted that exceptionally strong cohorts are generally observed in the trawl surveys several years before their appearance in the exploitable stock. However, it was also noted that cohorts observed in Bering Sea trawl surveys may not index cohorts in the Gulf of Alaska.

Dr. Steven Hare presented the IPHC harvest policy: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0710sh.pdf). He concluded that it appears Area 2 is currently harvested too high and the other areas about normal. It was requested that Dr. Hare look at catchability and harvest levels at the edges of areas. Substantial discussion took place regarding coastwide versus closed-area approach at assessment. It was iterated that there are two components, the assessment itself and then the apportionment. The justification for the Commission's decision to not adopt the coastwide assessment at the 2007 Annual Meeting was made. Dr. Balsiger pointed out that the Commission was not rejecting the coastwide approach, but rather wanted to understand it better. It was further clarified that the coastwide model along with the 20% harvest rate were all part of the same package at the Annual Meeting, and when the Commission voted not to adopt the coastwide model, they by default agreed to go status quo on the harvest rates as well.

The 60% U.S./40% Canadian split policy for Area 2 catch was discussed. It was noted that the 1979 Protocol to the Halibut Convention between Canada and the United States allowed the Commission after 1981to alter that policy in light of 'pertinent information', which includes estimates of biomass distribution and available yield.

Further discussion points included:
- details of the slow up, fast down policy adopted by the Commission.
- the target versus actual harvest rate in different areas. The goal whether using the coastwide or any assessment model is to harvest all areas at the same rate. Given the survey-based apportionment, that should allow a build-up of biomass in the east where the estimated harvest rate has been substantially higher for the past several years.
- the even application of a harvest policy across all areas and transparency of management.
- the fact that, if the survey-based apportionment is correct, the high exploitation rates on the eastern side of the stock have been partially offset by migration and that is why they may have sustained higher harvest levels. However, there has been an increase in exploitation in the western areas since 1998 and the absolute number of migrants may now be lower than historically.

Dr. Hare presented how the IPHC treats bycatch and sport catch data sets in the assessment: (http://www.iphc.washington.edu/halcom/meetings/workshop2007/presentations/ws0711sh.pdf). Following a break, there was discussion of the data sets, clarification of bycatch impacts, and the types of information available. The areas of concern were limited observer coverage requirements for some fisheries in Alaska, the lack of length data for the sport fishery, and the possibility of visiting the impact of the sublegal mortality on the sector of the fishery from which it came. The issue concerning vessels in Alaska being able to choose when to take an observer and the resulting assumed observation rate was also raised.

Dr. Martell summarized the proceedings with three points:

1. There has been a radical change from the closed area to a coastwide assessment. The closed area assessment had problems with sparsity of data, conflicting data sets, and the assumption of closed populations. The rationale for adopting a coastwide approach was to avoid these problems. However, the change introduces additional assumptions; the data are aggregated and the way they are analyzed is not insensitive to potential differences in catchability in each area.
2. Regarding apportionments, right now the setline survey is used with an assumption of constant catchability among areas. Bathymetric contours are different and if the area habitats were mapped, there would likely not be good correlation of catch by depth ranges among areas. This problem needs to be groundtruthed and tagging may be a way to do that.
3. The problem now is what to do in the interim.

The floor was opened to discussion of point 3.

Dr. Jim Ianelli commented that given what was presented for migration rates, the issue of allocation does not have a strong biological basis. Many issues are outside of conservation or scientific concern. He advised that the Commission would be prudent to come up with a formula of constant allocation.

There was a recommendation that the staff blend the commercial and survey CPUE at different rates to see what happens.

Dr. Richards thanked the commission staff and the contributors to the meeting. She noted that the Commission's task will be to make policy decisions around the scientific advice. There should also be some alternate methods of apportionment explored instead of CPUE only. Forecasting is still not comfortable and looking at longer term shifts in effort and the resulting effects to achieve an optimally harvested stock, needs more work.

Dr. Balsiger agreed that the workshop was helpful in his gaining understanding of the model.

Dr. Leaman noted that there are two processes; this workshop and then the independent review. A report of the proceedings and conclusions will be worked up by staff and available around the beginning of August.

Comments on the structure and content on this and of future assessment workshops included:

- this workshop was valuable for those not trained as scientists and/or in stock assessment to better understand the process, but peer reviews (e.g. STAR panels) are also encouraged.
- Area 2A representatives suggested a meeting with staff within the next couple of months to further discuss the concepts. Area 2B representatives were also invited.
- a peer review every few years to devise pro-rated apportionments instead of having the apportionment fluctuate with survey CPUE annually.
- a recommendation for less modeling and more groundtruthing.
- a recommendation that while this meeting, with the hybrid of a peer review and industry workshop was very helpful, perhaps every other year would be enough for the future.
- urging the IPHC to continue with this type of forum and taking impacts of apportionment decisions on small communities such as in Area 2A, into consideration.
- a recommendation that all user groups including charter fleet participate in this type of process.
- a recommendation for future workshops to focus on only one or two aspects of the assessment such as migration, or the model, etc.

Dr. Leaman agreed to make the presentations available via the IPHC website and thanked the attendees and staff for their participation.

Meeting adjourned.

Attendees

IPHC staff
Bill Clark
Claude Dykstra
Heather Gilroy
Steven Hare
Tom Kong
Bruce Leaman
Tim Loher
Lauri Sadorus
Ray Webster
Gregg Williams

IPHC Commissioners
James Balsiger
Ralph Hoard
Laura Richards
Gary Robinson

Other invited participants
Steve Martell – Convener, UBC Fisheries Centre
Chris Francis – CIE External Peer Reviewer

Paul Medley – CIE External Peer Reviewer

Others

First Name	Last Name	Title	Organization/Agency
Bob	Alverson	Executive Director	Fishing Vessel Owners Assoc
Kerim	Aydin	Supr. Fishery Biologist	NMFS/AFSC
Ashleen	Benson	Ph.D. Student	Simon Fraser University
Don	Bodenmiller	Fish Biologist	ODFW
Terri	Bonnett	Halibut Coordinator	Fisheries and Oceans Canada
Dave	Carlile	Fisheries Scientist	ADF&G
Tom	Casey	Consultant	
Sean	Cox	Professor	Simon Fraser University
Nick	Delaney	Comm. Fisherman	Kodiak Vessel Owners Assoc
Yvonne	deReynier	Groundfish Branch Chief	NMFS/NWR
Jane	DiCosimo	Staff specialist	NPFMC
Martin	Dorn	Fishery Biologist	NMFS/AFSC
Sharron	Elwood	Comm. Fisherman	
Garrett	Elwood	Comm. Fisherman	
Wes	Erikson	Comm. Fisherman	HAB
Yongwen	Gao	Researcher	Makah Fisheries Management
Dana	Hanselman	Fishery Biologist	NOAA
Thomas	Helser	Fishery Biologist	
James	Ianelli	Assessment scientist	NMFS/AFSC
Tom	Jagielo	Senior Research Scientist	WDFW
Steve	Joner	Fishery Biologist	Makah Fisheries Management
Robert	Jones	Marine Biologist	NW Indian Fisheries Commission
Jacquelynne	King	Scientific Advisor	Fisheries and Oceans Canada
Linda	Kozak	Consultant	Kodiak Vessel Owners Assoc
Loh-Lee	Low	Scientific Advisor	NOAA
Sandra	Lowe	Research Fisheries Biologist	NMFS/AFSC
Joe	Macinko	Comm. Fisherman	
Charles	McCallum	Fishery Biologist	Lake and Penninsula Borough
Scott	Meyer	Fishery Biologist	ADF&G
John	Moller	Fleet Manager	Adak Fisheries
Melvin	Moon	QNR Director	Quileute National Resources
Kris	Northcut	Harvest Manager	Quileute National Resources
Peggy	Parker	Executive Director	HANA
Stan	Sargent		
Joe	Schumacker	Fishery Biologist	Quinault Indian Nation
John	Secord	Comm. Fisherman	Halibut Advisory Board
Paul	Spencer	Research Fisheries Biologist	NOAA
William	Stockhausen	Fishery Biologist	NOAA
Russell	Svec	Fishery Manager	Makah Fisheries Management
Chuck	Tracy	Staff Officer	PFMC
Theresa	Tsou	Senior Research Scientist	WDFW

Jack	Turnock	Assessment scientist	AFSC
Shizhen	Wang	Fisheries Biometrician	Quinault Indian Nation
Tom	Wilderbuer	Flatfish assessment scientist	NOAA
Mark	Wilkins	Survey manager	AFSC/RACE
Gary	Williamson	Comm. Fisherman	Delta, BC
Robert	Wurm	Comm. Fisherman	Linden, WA
Phillip	Wyman	Comm. Fisherman	AK Longline Fisherman's Assoc.

Appendix

Questions from the stock assessment workshop, June 2007

IPHC Staff

1. What portion of mark recoveries from Area 4 were released north rather than south of the Aleutian chain?

The following table shows all commercial 2003-2006 tag-recoveries from Area 4 releases by recovery area. Here Areas 4A and 4B are divided into their northern (Bering Sea: 4A.bs, 4B.bs) and southern components (Gulf of Alaska: 4A.goa, 4B.goa). The dashed horizontal and vertical lines separating the Bering Sea and Gulf of Alaska areas are to facilitate comparison of movement within and between the two large geographical regions.

	Recovery area									
Release area	**2B**	**2C**	**3A**	**3B**	**4A.goa**	**4B.goa**	**4A.bs**	**4B.bs**	**4C**	**4D**
4A.goa	8	7	11	6	12	1	1	0	0	0
4B.goa	1	1	0	0	0	4	0	0	0	0
4A.bs	1	0	2	0	1	1	14	1	1	0
4B.bs	0	0	1	0	0	0	0	1	0	0
4D	1	0	1	0	0	0	1	0	0	15

		Recovery area									
Release		bs → bs				bs → goa					
area	**No. rel.**	**4D**	**4C**	**4B.bs**	**4A.bs**	**4B.goa**	**4A.goa**	**3B**	**3A**	**2C**	**2B**
4D	979	15	0	0	1	0	0	0	1	0	1
4B.bs	347	0	0	1	0	0	0	0	1	0	0
4A.bs	1285	0	1	1	14	1	1	0	2	0	1
4B.goa	789	0	0	0	0	4	0	0	0	1	1
4A.goa	2171	0	0	0	1	1	12	6	11	7	8
		goa → bs				goa → goa					

Only one fish released in the Gulf side of Area 4 was recovered in the Bering Sea, a 4A fish that stayed in 4A. Five (out of 21 recovered) 4A Bering Sea releases crossed to the other side of the islands. One (of two) 4B Bering Sea fish moved out of the Bering Sea (showing up over in 3A), along with two out of 18 Area 4D fish (one went to Area 3A and one to Area 2B). These numbers do not account for recovery rates or scanning rates, but they appear to indicate that the majority of the fish tagged and released in the Bering Sea has stayed in the Bering Sea, although there is clearly enough transfer to avoid any genetic segregation of Bering Sea and Gulf of Alaska fish.

2. Does depth distribution of halibut vary from east to west?

Figure 1, shown at the workshop, shows the relationship between depth and survey CPUE in each area for the years 2001-2006. The plots show the depth effect from a generalized additive model fit in which year was a factor and depth was a smooth term. Using peak CPUE as a measure of distribution, halibut are distributed with peak abundance occurring between about 75-150 in the eastern portion of the stock but extending down to about 200 fm for the western areas (Area 3B and westward). However, in all areas the range of significant halibut abundance, as well as catch by the commercial fleet, is covered by the distribution of survey stations from 25-275 fm.

3. Does the estimated sampling variance of the commercial catch at age/sex include the variance of the proportion female estimated with the fitted logistics?

Yes; the standard multinomial variance based on sample size is scaled up by 1.05^2 to incorporate a 5% coefficient of variation of the estimated proportion female.

4. What does the site fidelity seen in survey recoveries of PIT tags mean for the mark-recapture analysis?

Last year 83 PIT tagged fish were recovered on the setline survey, with 66 of these (around 80%) recovered on the survey station on which they were released. These raw recovery data imply a high degree of site-fidelity of tagged fish, and potentially that tagged fish do not mix well with the untagged population, at least during the summer months when the survey fishing (and tagging) occurs. As almost all recoveries come from commercial fishing, poor mixing will be a problem if there is a mismatch between tag-release locations and commercial fishing locations and this segregation persists throughout the year, even if the fish move off the survey locations. If this is true, on average, an individual tagged fish will be less likely to be recovered than an untagged fish, and the resulting low recovery rates will lead to negatively biased estimates of rates of commercial fishing mortality from the tag-recovery modeling. Preliminary analysis shows some evidence for a mismatch of the distribution of commercial catch location and tag-releases. However, we note that the setline survey recoveries may be misleading, in that fish that are not on or near a station at the time of the survey are less likely to be recovered, and so the true degree of site fidelity is likely to be overestimated from the raw survey data. More detailed examination of these data and the effect of poor mixing of tagged and untagged populations are ongoing.

5. Should the weighting of survey data in the model be time and area invariant or should there be both temporally- and spatially-dependent weighting terms?

This question may have arisen out of some misunderstanding. The coastwide survey CPUE is presently calculated by weighting the area-specific CPUE by bottom area, and calculating a CPUE for each year independently, so this is already being done.

6. Why does the survey apportionment procedure use a 3-year running mean of survey CPUE rather than e.g. a 5-year forward-weighted average?

We have used an unweighted 3-year running mean for doing survey apportionment among several IPHC regulatory areas since the mid-1990s. Adding years makes the running mean more susceptible to bias resulting from trends in the CPUE series if the trends among areas are

different, which they clearly are. Forward weighting increases the variance of the running mean. We conducted trials with various options and found the 3-year running mean performed well in terms of bias and variance for trends up to 10% per year. It is stable in practice, too. The estimated area apportionments for the last ten years (Fig. 2) change over time but in a gradual fashion.

7. Can NMFS trawl survey data be used to check for differences in setline survey catchability among areas? How do you know that trawl survey catchability doesn't vary among areas, too?

Trawl survey catchability of halibut definitely varies among areas. It is clearly low in areas with a lot of rough bottom, like 2C and 4B. But between Areas 3A and 3B, where there is a broad, mostly trawlable shelf, there seems little reason to suspect a trawl survey catchability difference. The lack of coincident trawl and setline surveys, conducted with the same fishing gear in all areas, precludes a stock-wide comparison.

8. Do we have enough observations of incoming cohorts to try to estimate them? Are noisy observations of these age groups causing the retrospective pattern?

The first few estimates of incoming cohorts are always noisy, but that in itself should not produce a retrospective pattern.

9. Can the model reliably distinguish between strong incoming recruitment and high mortality of fully recruited fish?

Yes; the stock assessment estimates total mortality by tracking individual cohorts through the fishery, not by examining the age composition in a single year.

10. Some data are fitted more than once, e.g. the survey catch at age/sex and the survey CPUE at age/sex and the total survey CPUE? Isn't that redundant?

Yes, it is. In principle the catch at age/sex and the total CPUE contain all the information, and the CPUE at age/sex could be left out of the fit. Or the model could be fitted just to the survey CPUE at age/sex. But those non-redundant fits are different from each other because the data contain variance. Fitting to all three datasets requires the fit to track cohorts as well as fitting the catch at age and the total CPUE, which are all good things.

At the workshop the model was fitted with no redundancy and there was no effect on the biomass estimates.

11. Were the variance scalars estimated with raw rather than robust deviations?

Yes. In the coastwide data set there are very few outliers so as a practical matter this is not an important issue.

12. Were variance scalars estimated for all data types or only for catch at age/sex?

For all data types. The table below, shown at the workshop, has the working values of tau for each data type. The variance scalar is tau squared. The values of tau are mostly 2-3, meaning that sampling variance accounts for a quarter or less of the total variance of the observations about the model predictions. The remainder is process error and model specification error. The generally good fits of the parsimonious production model indicate that the model structure is appropriate, so most of the variance is process error.

	Females	Males	Total
Commercial catch at age	3.0	2.4	3.5
Commercial CPUE at age	3.1	2.6	3.7
Commercial total CPUE in number			1.6
Commercial total CPUE in weight			1.9
Survey age composition	1.3	1.3	1.6
Survey CPUE at age	2.5	2.6	2.9
Survey total CPUE in number			2.6
Survey total CPUE in weight			2.3

13. Are the biomass outputs calculated using the estimated true age composition and the estimated size at true age?

No. Those calculations use the observed size at the observed age. So, for example in a year with surface age readings, the spawning population in number at true age is calculated and then the corresponding surface age distribution is predicted by smearing the ages, and those numbers at each surface age are multiplied by the observed weight at each surface age to calculate the spawning biomass.

14. The survey apportionment of the estimated coastwide biomass among areas depends critically on survey catchability being equal in all areas. How can that be ground-truthed?

Lacking some independent, indisputable measure of relative density, it is impossible to know whether survey catchability is the same in all areas. It certainly varies among years, so it may well vary among areas within years. Because the survey apportionment is based on a 3-year running mean CPUE, the important question is whether the average survey catchability varies among areas. At the workshop the staff presented some analysis that at least failed to show any difference among areas:

(i) Trawl and setline survey data, although variable, produce similar estimates of relative abundance in Areas 3A, 3B, and 4A where the bottom is mostly trawlable.

(ii) The incidence of PIT tags in commercial landings (tags/10,000 fish scanned) is very similar in Areas 2B, 3A, and 3B, although higher in Area 2C. One would expect a lower incidence of PIT tag recoveries in areas where the survey catchability is lower, because a lower proportion of the stock would have been marked and released on the survey.

(iii) Analysis of survey hook occupancy data indicates that the competition by other species for baited hooks is similar in Areas 2B, 2C, 3A, 3B, and 4A (higher in 2A and lower in 4B and 4D).

15. When the model is fitted, equal weight is given to the catch at age and CPUE data. Why not put more weight on the survey CPUE when that is regarded as the most reliable indicator of stock trends?

Survey and commercial CPUE were given extra weight in some previous assessments, including the closed-area fits that were standard though 2006, because the fits were poor in some areas and extra weight was needed to achieve a satisfactory degree of agreement with the CPUE data. The coastwide fit agrees well with the CPUE series with no extra weight. It is generally good practice to avoid ad hoc weighting, so in the production model all of the weights were set to one. At the workshop several models were fitted in which the weight on the survey CPUE was increased by a factor of 4. The fits to the survey CPUE were nearly indistinguishable from the production model, and the biomass estimates were almost the same. The conclusion was that the unweighted model fits the CPUE data very well.

16. Survey apportionment is based on bottom area from 0 to 300 fm, but the survey only covers 20-275 fm. Would the proportions be different if the survey depth range were used?

New (and old) estimates of bottom area (in square nautical miles) between specified depth contours for all IPHC regulatory areas are presented in the following table. For each area, the percent of the coastwide total is also given. The Area 4A-BS (for Bering Sea) and 4D edge estimates both use 75 fathoms as the shallow contour (instead of 0 or 20 fathoms). The details of the computations are given in a report to be published in the 2008 RARA. A draft of the report may be obtained at http://www.iphc.washington.edu/staff/hare/html/papers/bottom_area.doc. Briefly, the new estimates are derived from a high resolution digital bathymetry dataset while the old estimates derived from hand tracing on NOAA charts.

	20-275 fathoms		0-300 fathoms		0-500 fathoms		0-300 fm. (old)	
Reg. area	N mi^2	%	N mi^2	%	N mi^2	%	N mi^2	%
2A	10561	4.1	13117	4.0	15304	4.4	12000	4.1
2B	22552	8.8	31695	9.7	33237	9.5	28000	9.5
2C	10064	3.9	16316	5.0	17137	4.9	15000	5.1
3A	42871	16.7	50872	15.5	52550	15.1	50000	16.8
3B	23735	9.3	30621	9.3	32289	9.3	30000	10.3
4A-GOA	8929	3.5	10914	3.3	12961	3.7	19000	6.3
4A-BS	7417	2.9	7736	2.4	9057	2.6		
4B	11892	4.6	15411	4.7	23286	6.7	16000	5.5
4D edge	12162	4.7	12405	3.8	13867	4.0	5000	1.7
4CDE shelf	106030	41.4	138670	42.0	138670	29.8	120000	40.7
Total	256213	100.0	327758	100.0	348359	100.0	295000	100.0

The improved digital bathymetry files used as a basis for the 0-300 fm calculations result in more bottom area in Area 4D (at the expense of the Area 4CDE shelf) but relatively small changes (~1%) for other areas. Using only the 20-275 fm range would result in more substantial changes. While the IPHC survey does not extend into any areas shallow of 20 fm, we know from commercial records that catches in these shallower areas are not insignificant: between 3 and 7% in most areas and around 50% in Areas 4C and 4D, thus it would be prudent to include these depths. Conversely, catches from deeper than 300 fm are small: 1% in areas 2A and 3A, 4% in Area 4A and less than 1% in all other areas.

17. At the workshop, the staff showed the ratio of setline survey to trawl survey CPUE at length and claimed that the data showed no difference among Areas 3A, 3B, and 4A. But there did appear to be some differences.

The data clearly showed that the ratio of setline to trawl CPUE in Area 3B was neither 2-3 times what it was in Area 3A nor was it consistently higher in Area 3B, which were the important points in considering whether the closed-area assessments were credible. Similarly, Area 4A shows higher ratios for smaller fish but the same ratios as Area 3A for larger fish. The staff is doing a more detailed comparison of trawl survey and setline survey data.

18. The staff presented GAM estimates of the relationship between depth and survey CPUE but there were no error bars. How precise are those estimates?

Figure 1 shows the fits replotted with 95% confidence intervals.

19. The depth-stratified mean CPUE is the same as the simple mean in all areas except 2A, but in view of the difference there, is there any reason not to compute a depth-stratified mean in all areas?

Not in principle. In practice there might be some confusion about different CPUE series appearing in different places but it is reasonable to use depth-stratified means to accommodate any depth effect. The data suggest that while the effect may not be large, it is not equivalent among areas (Fig. 1)

20. Will the change from closed-area assessments to a coastwide assessment with survey apportionment have a significant effect on capital values?

The estimates of coastwide abundance from the two procedures are about the same, but survey estimate of biomass in Area 2 is only about 15% of the coastwide total, whereas Area 2 has been receiving about 30% of the coastwide total according to the closed-area assessments. A complete implementation of proportional harvest according to the survey apportionment would therefore reduce the yield associated with Area 2 shares by about half, with yield for shares in Area 3B and 4 increasing in value. However, we also estimate that the use of a constant harvest rate policy in all areas would result in an increase of biomass in the eastern portion of the stock, so that the current decreased proportion of the stock in the eastern portion would be only a transitory effect of a survey-based apportionment. Historically, changes in yield associated with shares do not have a direct relationship with capital value because of the change in ex-vessel price per pound that may accompany any changes in yield per share. Increases or decreases in ex-vessel price per pound associated with supply and demand can act to offset changes in yield per share.

21. What apportionment methods other than the survey method could be used?

The setline survey data are the best information available for estimating the distribution of biomass among areas. Trawl survey data would be a possibility if we had comparable data in all areas, but we do not now and never will, because some areas like 2C and 4B are untrawlable. Commercial CPUE is available for all areas, but the comparison of commercial and survey CPUE shows that commercial catchability varies greatly among areas. Commercial CPUE is ten times survey CPUE in Area 2A, about three times in Area 2B, about the same in Area 2C, and so on. These differences do not result from differences in survey catchability; they result from the fishery targeting good grounds more or less effectively while the survey covers the whole area.

The staff has examined several other methods of apportionment, including the historical recruitment distribution as estimated by the closed-area assessments and historical fishery shares. However, none of these other metrics for apportionment incorporates the objective standardization of the survey metric. Historical recruitment estimates are subject to the same errors resulting from migration as the closed area assessments. Historical fishery shares reflect the distribution of fishing effort and are subject to severe biases resulting from the distribution of fishing effort. Using survey data for apportionment is not perfect, as we have noted, but it represents the most objective measure currently available.

Over the long term, we believe yield should be distributed among areas in proportion to biomass. Proportional harvest is standard practice in fishery management for good reasons. It protects the stock against disproportionate harvest of sensitive sub-components of the stock (e.g. behavioral groupings), about which there may be little or no knowledge, but departures can and do occur. The Commission has temporarily assigned catch limits that resulted in non-target harvest rates when there have been significant changes in either assessment methodologies or harvest policies, as a transition to new harvest regimes. However, it now appears that a disproportionate share of the halibut yield has been taken in Area 2 for some time resulting in very high exploitation rates and lower biomass than would result from harvesting at the target rate.

22. How about estimating biomass distribution using a mixture of survey and commercial CPUE?

The IPHC staff had considerable discussion on this proposal. The strongest objection to using commercial data for apportioning biomass is that the raw data consistently show strong differences in commercial and survey catchabilities among areas. The ratio of the two indices varies from 0.48 – 0.99 among areas and is consistent within areas, over time. Introducing commercial data into the apportionment process will embed these biases. However, it can be argued that incorporating some consideration of the commercial data could offset any temporal bias inherent in the survey data, which are collected over only a short portion of the year in each area. On balance, the strongly biased relationship of commercial and survey data convinces the staff to decline the use of commercial data for this purpose.

23. Will an apportionment of yield based on stock distribution at the time of the survey really achieve proportional harvest when fish migrate before, during, and after the survey?

Yes. The concern here is that if we estimate the correct stock distribution at the beginning of the year and allocate yield accordingly, it will be necessary to fish a lot harder in source areas of migration than in destination areas to catch the quotas, because fish will be leaving the source areas and entering the destination areas during the year. That line of reasoning is correct, but the disparity in fishing mortality rates that would result is small.

With a survey apportionment, we do not estimate stock distribution at the beginning of the year but in the middle of the year. Results of emigration and immigration are therefore reflected in survey CPUE, and the rate of fishing mortality is the same in all areas. A full analysis of these effects is posted at http://www.iphc.washington.edu/halcom/research/sa/papers/proportional.pdf.

24. The last three years of data in both closed-area and coastwide fits show declining CPUE that is not fitted well. What's the problem?

The coastwide fit actually tracks survey and commercial CPUE quite well, including the last three years. It is true, however, that survey catchability declined in 2005 and again in 2006. We can see this in model fits where the rate of fishing mortality in 2006 is fixed at various levels and the corresponding series of survey and commercial catchabilities are estimated year by year. In all cases survey catchability is seen to be quite variable among years and to decline in 2005 and 2006.

25. What is the desired distribution of spawning biomass? Will proportional harvest achieve that distribution, or should it modified in some way?

Absent other compelling information, the desired distribution of spawning biomass would be something akin to its distribution absent fishing. Simulation modeling across a range of fishing and migration rates was conducted and reported in the 2007 RARA. The results showed that proportional harvest, i.e., the same constant harvest in all regulatory areas maintained nearly the same spawning biomass distribution as in the unfished state. The unbalanced harvest rates we now believe to have been in effect for at least the past decade – 50% of the target rate in the western areas and 150-200% in the eastern areas – leads to a substantial change in the distribution of spawning biomass. Specifically, the contribution of the eastern areas to the distribution is greatly decreased. At an annual migration rate of 0.06 and instantaneous fishing mortalities in the range of 0.20-0.30, the contribution of areas 2B and 2C to the spawning biomass change from 44% in an unfished state to an equilibrium value of 23-26% when the above described unbalanced harvest rates are applied.

26. To what extent is migration influenced by fishing? In particular, are we seeing migration from west to east because higher exploitation in the east has reduced densities there and created openings for migrants?

The question of density-dependent exclusions has not been investigated for large-scale population distributions. Certainly, studies of territorial fish in both tropical and temperate climates show dominance-based hierarchies of occupation of prime feeding or breeding habitats. The evidence of site fidelity seen in recoveries of PIT-tagged halibut from survey stations provides the potential for such a spatially-explicit behavioral process in halibut. The ubiquity of competitive exclusion as a biological process in populations suggests that higher densities of halibut repetitively occupying the same spatial niches would result in shifts in recruitment patterns relative to periods of lower population densities. Densities of halibut in the central Gulf of Alaska have been at record levels over the past decade, also evidenced by lower growth rates. In conjunction with higher exploitation rates in the eastern portion of the stock, it is reasonable to expect that migration to this eastern region may be higher than it would be under either conditions of lower density in the central Gulf, or lower exploitation rates in Area 2.

27. The survey apportionment assumes that halibut habitat is the same proportion of total bottom area in all areas. Is that true?

The survey apportionment makes no assumption about halibut habitat, which is not well defined in any case. The only assumption about habitat involved in the apportionment is that the survey samples each habitat in proportion to its presence. Survey stations are distributed uniformly in all areas, so they can be expected to sample different kinds of habitat in proportion to their occurrence in each area. An area consisting entirely of good habitat will produce a high

CPUE at all stations and therefore a high average CPUE. An area consisting of half good habitat and half poor habitat will produce a high CPUE at half the stations and a low CPUE at half the stations, so its average CPUE will be much lower than that of the good area. Habitat differences are therefore reflected in survey CPUE.

28. How about developing a model with explicit migration in which all of the area-specific data are fitted with area-specific parameters?

Such a model would obviously be the ideal way to accommodate movement of fish. However, it is critically dependent on precise knowledge of the rates of migration by all sizes of fish, at all times, among all areas. Further, if there were any temporal or biomass dependence in such rates, they would have to be estimated continuously. This would be a very large project that would present a number of significant technical difficulties, but the main drawback is that we would not be able to estimate the migration rates internally and the results would depend entirely on what rates we assigned externally. Given the evident difficulties in generating reliable estimates for all sizes of fish, it is highly unlikely that these rates could be known with precision sufficient for making catch limit recommendations.

29. The Commission should recognize that allocation is not a purely biological issue and deal with it by developing an allocation framework that considers both biological and policy issues.

The Commission does recognize that allocation is a subsequent process to biomass estimation. It has traditionally based catch limits on proportional harvest of the estimated biomass for each area. While alternate policy-based allocation formulae are possible, the staff believes that they would have to be consistent with the sustainable yield of the stock and, if the formulae were to have an equitable basis, then they would have to be consistent with the sustainable yield for each regulatory area as well. The staff does not believe such a policy-based approach will be functional unless it has this sustainable basis.

Existing policy-based allocation formulae (e.g. the allocative Catch Sharing Plan (CSP) of the Pacific Fishery Management Council for Area 2A) are implemented after the conservation (sustainability) decision has already been made (i.e., the CSP works entirely within the catch limit adopted external to the CSP). Ultimately, conservation and allocation can be separated but in the hierarchy of decisions, conservation and sustainability must be paramount.

30. How is sublegal bycatch accounted for in CEY calculations?

Total CEY (Constant Exploitation Yield) is calculated by applying a target harvest rate (presently 20%) to estimated exploitable biomass. Fishery CEY in each area (commercial catch in all areas, plus sport catch in Areas 2A and 2B) is calculated by subtracting from total CEY all other removals that are similar to commercial removals in their effect on the stock. These consist of all hook-and-line catches, legal-sized as well as sublegal, and all legal-sized bycatch.

Currently, sublegal bycatch in the trawl fishery is treated differently because it is mainly of fish with a modal length around 50 cm. The effect of these removals on the stock is some years off, and the geographic distribution of the impact is uncertain because migration rates and schedules are unknown. We can calculate that sublegal bycatch at present levels reduces coastwide recruitment at age 8 by 10%, and we include this level of pre-recruit mortality in the fishery simulations that we conduct when evaluating alternative target harvest rates. It turns out

that the choice of a target harvest rate is not very sensitive to the level of pre-recruit mortality, but in principle a reduction in sublegal bycatch mortality would increase both recruitment to the stock and total CEY.

Another option is for sublegal bycatch mortality in the halibut setline fisheries to be deducted directly from the CEY for the areas in which it occurs because almost all of it is close to the commercial size limit and, therefore, the impact on total yield to the stock is essentially equivalent to the impact of catching those fish somewhat later in time as legal-sized fish.. To implement such an accounting process would require annual estimates of sublegal size composition in all setline fisheries, as well as mortality rate estimates for the discards by each gear. Comprehensive treatment of this mortality would also require estimation of discards within the recreational fishery, which are substantial in some areas such as Area 3A. Such information does not presently exist and the current process of accounting for such mortality in the setline fishery through harvest rate adjustment is appropriate.

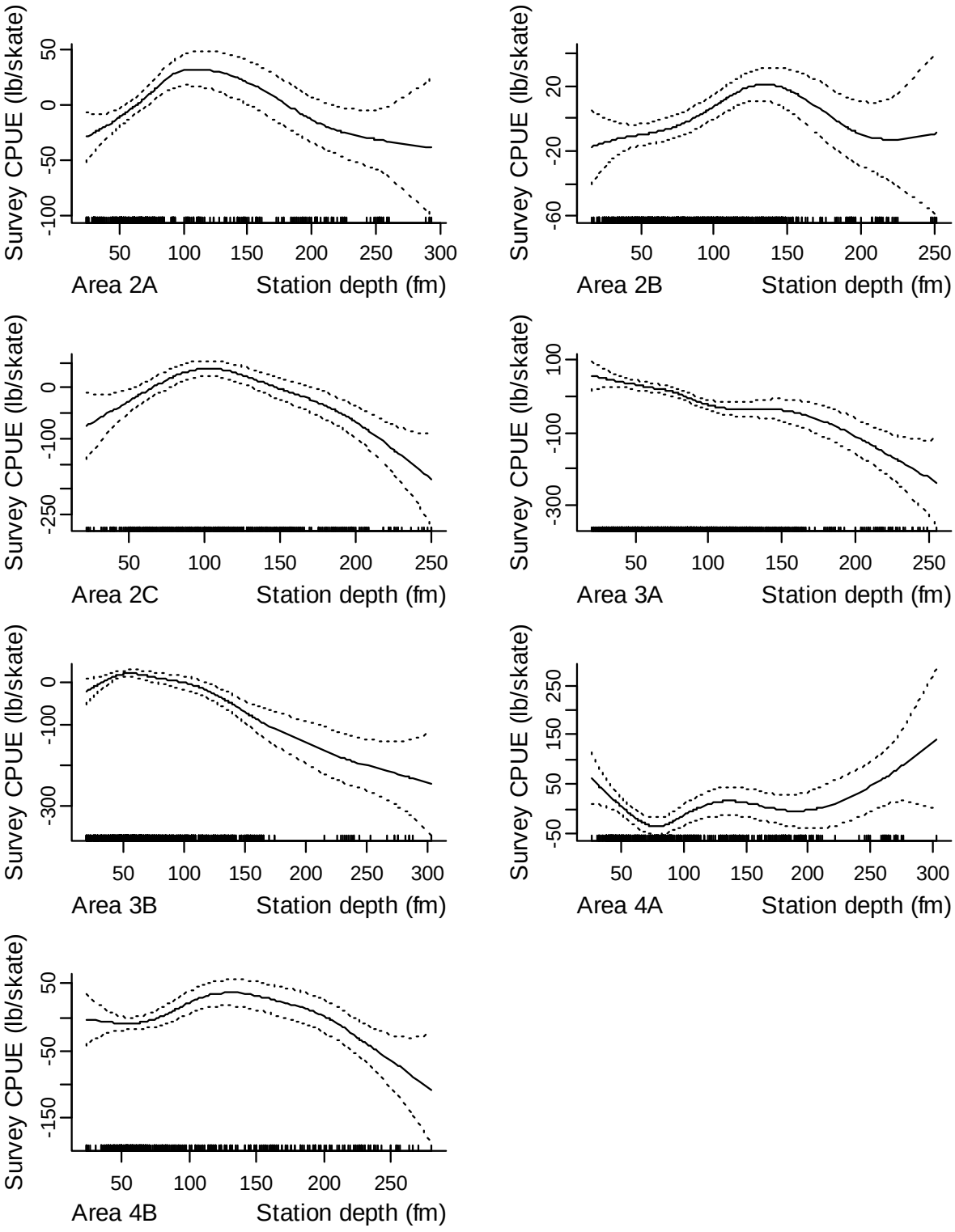

Figure 1. Relationship between depth and survey CPUE, from a GAM model fit (for survey years 2001-2006). The dotted lines show 95% confidence intervals. The ticks on the bottom axis show data points.

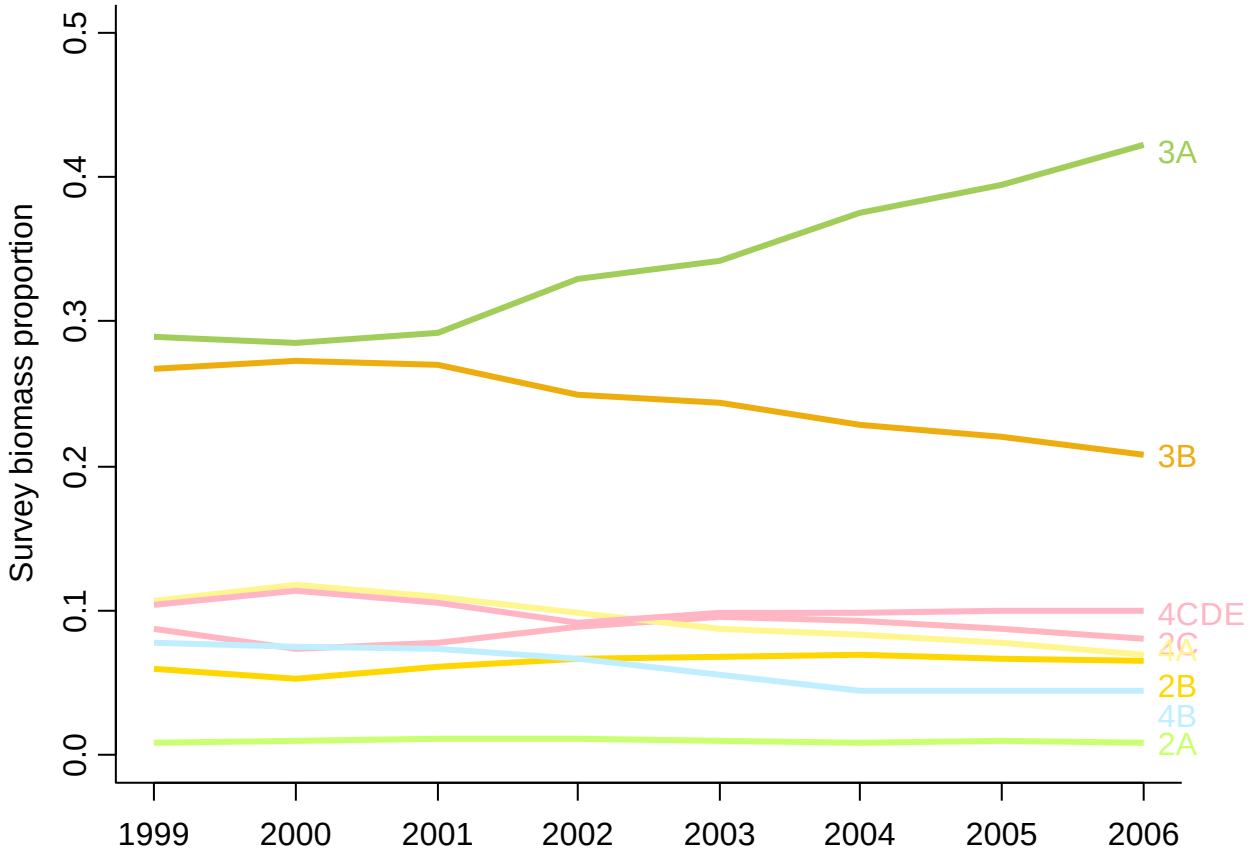

Figure 2. Estimated proportion of exploitable biomass in each area as estimated from bottom area and a 3-year running mean of survey CPUE.