Updated spatial analysis of BSAI blackspotted/rougheye rockfish exploitation rates

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Executive summary

In 2014, the concept of a "maximum subarea species catch" was formulated by the BSAI Plan Team as a label for "subarea harvest recommendations that are not included in the OFL/ABC specifications", and was intended to communicate harvest levels in a transparent manner that would allow progress in meeting management goals to be easily monitored. A 'maximum subarea species catch' for blackspotted/rougheye rockfish in the western Aleutian Islands (WAI) for 2015 is 46 t. The 2015 catch (through August 29) in this area was 62 t, an 'overage' of 16 t. Additionally, catches and exploitation rates in the EBS have been increasing recently and are now comparable with the exploitation rates in WAI.

The reference U_{abc} is introduced here as the exploitation rate which would result from harvesting the recommended ABC. For Tier 3b stocks such as AI blackspotted/rougheye rockfish in which the harvest recommendations are based on F values less than $F_{40\%}$, U_{abc} is thus is more comparable to actual management advice than $U_{F40\%}$, which is the exploitation rate which would result from fishing at $F_{40\%}$. Exploitation rates in the WAI have been reduced for 2014 and 2015 (to date) and are near $U_{F40\%}$ but above U_{abc}, leading to the "overage" identified above.

Recent Plan Team and SSC minutes indicate that the 'maximum subarea species catch' is interpreted as a management goal (as opposed to auxiliary information that could potentially be of interest to the fishing industry). However, BSAI blackspotted/rougheye rockfish are unique among north Pacific stocks in that a putative subarea management goal is not reported in the harvest specification table and published in in-season catch reports. This absence of information can hinder accessibility of information by the public and the ability to easily monitor management progress, and may be a contributing factor to the 'overage' in 2015. In short, there appears to be some interest in limiting exploitation rates in the WAI, but this area has not been recognized as a spatial management unit.

Following the process developed by the Council for evaluating spatial management units may improve matters. BSAI blackspotted/rougheye rockfish have been labeled as having a "strong concern" regarding stock structure. The current interpretation of the stock structure policy is that for stocks with "strong concern", a process of identifying a suite of tools that could be could be used to achieve conservation and management goals, and the economic and management implications of these tools, "must be activated." This has not been completed for BSAI blackspotted/rougheye rockfish, perhaps because it is not clear who has responsibility to initiate the Council's process for evaluation of spatial management units. Clarification of the role of the Plan Teams in this process was requested in the minutes of November 2013 and November 2014 Plan Team meetings, along with requests for guidance on several other issues pertaining to stock structure and spatial management. Addressing these issues may help achieve the objectives of accessibility of information and monitoring of progress in meeting management goals.

Introduction

In September, 2014, the BSAI Plan Team requested "continued annual reporting on the status of the population [of blackspotted/rougheye rockfish] in each AI management area". This follows the presentation, in 2013, of 7 metrics relating to genetic connectivity, the distribution of harvest, exploitation rates, and trends in occurrence, estimated biomass, and mean size from the trawl survey.

The most recent analysis of the status of blackspotted/rougheye rockfish within AI management areas was conducted in November 2014, and new information included in this analysis is the finalized 2014 catch and the catch for 2015 (through August 29, 2015). This report is mostly focused on the metrics which would be affected by updated catch data, which are the area-specific exploitation rates and the spatial distribution of catch within the BSAI. In addition, a plot of the time series of mean age from the trawl survey, by subarea, is presented.

A map of the BSAI subareas is shown in Figure 1; the western AI (WAI), central AI (CAI), and eastern AI (EAI) refer to areas 543,542, and 541, respectively. The EBS refers to areas numbered between 508 and 530 in Figure 1, a portion which is the 'southern Bering Sea' (areas 518-519) that is sampled by the AI trawl survey.

Area-specific harvest

In most years from 2004- 2015, the harvest in the WAI has been the largest or near the largest of any of the BSAI subareas, and has contributed between 30% and 50% of the BSAI harvest (Figure 2). The harvest in the EBS has been increasing, with an average harvest from 2013-2015 of 26 t compared to an average harvest of 15 t from 2004-2008.

Current management does not recognize blackspotted/rougheye rockfish in the WAI as a spatial management unit, despite the high exploitation rates and diminished abundance in this area being the primary factors that led to concerns over subarea stock status. In 2014, a "maximum subarea species catch" was formulated by the BSAI Plan Team as a label for "subarea harvest recommendations that are not included in the OFL/ABC specifications", and was intended to communicate harvest levels in a transparent manner that would allow progress in meeting management goals to be easily monitored (Plan Team minutes, November, 2014). For WAI blackspotted/rougheye rockfish, determination of the WAI maximum subarea species catch for 2015 followed a process identical to that which would have been followed if subarea ABCs existed, and resulted in a value of 46 t for 2015. The 2015 catch of WAI blackspotted/rougheye rockfish (through August 29, 2015) is 62 t, an "overage" of 16 t and 36%.

The maximum subarea species catch, was included (as a footnote) in the recommended OFLs and ABC from the SSC (SSC minutes, December, 2014), but not included in the final harvest specifications provided by the NOAA-Fisheries Alaska Regional Office.

Mean age by BSAI subarea

Previous reports to the BSAI Plan Team have included time series of estimated mean size of blackspotted/rougheye rockfish within BSAI subareas, and have indicated that the mean size has decreased more in the WAI than in other subareas (Figure 3a). In this report, we extend this analysis to also examine time series of mean age, as high exploitation rates would be expected to reduce the number of older fish. The time series of mean age (Figure 3b) data corroborate the time series of mean size, and indicate that the mean at age has declined the most in the WAI. The mean age in the WAI from the 1994 – 2002 surveys averaged 33 years, whereas the mean age in the 2004-2012 surveys averaged 21 years. Analyses of length composition data (Spencer and

Rooper 2014) indicate that the decline in mean length is due primarily to the decline in large (and older) fish, with some increase in recruitment in recent years.

Area-specific exploitation rates

Area-specific exploitation rates are defined here as the yearly catch within a subarea divided by an estimate of the subarea biomass at the beginning of the year. Area-specific exploitation rates are generated to assess whether subarea harvest is disproportionate to biomass, which could result in reductions of subarea biomass for stocks with spatial structure.

For each year from 2004 through 2015, the biomass for the 3 AI subareas was obtained by partitioning the estimated total biomass (ages 3+) at the beginning of the year for the AI portion of the stock (obtained from 2014 BSAI blackspotted/rougheye stock assessment (Spencer and Rooper 2014), and the projection model run in 2014) into the AI subareas. The biomass estimates from the 2014 stock assessment and the projection model are assumed to be the best available information on the time series of total biomass, and this method can be considered a "retrospective" look at past exploitation rates. The distribution of biomass across AI subareas was obtained by fitting a random walk smoother (with changes in biomass modeled as random effects) to the time series of biomass within each subarea, and computing the relative spatial distribution of the smoothed results. Catches through August 29, 2015, were obtained from the Catch Accounting System database.

Harvest recommendations for the EBS portion of the stock are made with Tier 5 methods that obtain abundance from averaging survey biomass estimates. The biomass used for EBS exploitation rates were obtained by applying the random walk smoother to the SBS and EBS slope survey biomass estimates, and summing the two time series of smoothed estimates.

To evaluate the potential impact upon the population, exploitation rates in the AI were compared to three reference levels. The first two have been presented to the BSAI Plan Team previously and are: 1) 0.75 times the estimated rate of natural mortality (M), which is the fishing mortality F_{abc} that produces the allowable biological catch for Tier 5 stocks; and 2) the exploitation rate for each year that would result from applying a fishing rate of $F_{40\%}$ to the estimated beginning-year numbers, and this rate is defined as $U_{F40\%}$. The $U_{F40\%}$ rate takes into account maturity, fishing selectivity, size-at-age, and time-varying number at age, and thus may be seen as more appropriate for Tier 3 stocks because harvest recommendations are based upon this age-structured information. AI blackspotted/rougheye rockfish were assessed as a Tier 5 stock prior to 2009, and as a Tier 3 stock since 2009.

In 2014, it was observed that the $U_{F40\%}$ reference rate assumes that the age structure of the stock is equivalent across the subareas, and that harvest recommendations are based on fishing at $F_{40\%}$. The assumption of equivalent age structure across areas is likely not met (as shown in Figure 3), but it is unclear how to obtain reliable estimates of subarea age structure without a spatially explicit population model. The assumption that harvest recommendations are based on $F_{40\%}$ are also not met because the stock has been determined to be in Tier 3b (i.e., the harvest recommendations are based on F values less than $F_{40\%}$). An additional exploitation rate reference, U_{abc}, is introduced here to provide a reference level more comparable to the actual management advice. U_{abc} is defined as the actual AI ABC divided by the *current* estimate of beginning year biomass. In addition to reflecting changes in relative depletion for Tier 3b stocks (i.e., the amount by which the recommended F is below $F_{40\%}$ due to the slope in F in the control rule), retrospective changes in estimates of abundance, growth, selectivity, etc. can result in temporal changes in U_{abc}. Assuming our current estimates represent the best available

information, U_{abc} indicates our best estimate of the exploitation rates that would result in the historical recommended ABCs.

The U_{abc} for the EBS is computed in a similar manner, but because the harvest recommendations for this area are based on Tier 5 methods the issue of comparability between the recommended F and $F_{40\%}$ do not apply.

Exploitation rates in the WAI have declined in 2014 and 2015 (to date) from generally higher levels from 2004-2013. The 2014 WAI exploitation rate was 3% higher than $U_{F40\%}$, whereas the preliminary 2015 WAI exploitation rate is 88% of the $U_{F40\%}$ level. The U_{abc} values in the AI have decreased since 2009 (the first year in which ABC was determined from an age-structured model) (Figure 4a). In 2009 and 2010, the U_{abc} was larger than $U_{F40\%}$ because the fishery selectivity curve that determined the actual ABC levels was higher for many ages than the current estimate of fishery selectivity. The 2011 and 2012 values for U_{abc} were similar to $U_{F40\%}$. From 2013-2015, the ratio of biomass to $B_{40\%}$ was lower due to relatively recent strong years classes that has increased mean recruitment and $B_{40\%}$, resulting in reductions in F_{abc} and U_{abc} due to the control rule ramp in F for stocks below $B_{40\%}$. From 2009-2015, the exploitation rates in the WAI have exceeded U_{abc} in each year except 2011.

Exploitation rates in the EBS have been increasing (Figure 4b), reflecting increased catches (Figure 2). The exploitation rates have generally been below the Tier 5 F_{abc}, which is 0.025 for blackspotted/rougheye rockfish. The U_{abc} for the EBS largely tracks the Tier 5 F_{abc}, and differs over time because the survey smoother is now used to obtain abundance whereas the actual ABC in most years was based on a three-survey weighted average. For comparison, the U_{abc} and $U_{F40\%}$ for the Aleutian Islands are also shown on the plot of EBS exploitation rates, and illustrate that the Tier 5 management advice for the EBS results in higher exploitation rates than that for the Tier 3 advice for the AI. Assuming that growth, fishing selectivity, maturity, etc. in the EBS is comparable to the AI, the exploitation rates in the EBS generally exceed the AI values of $U_{F40\%}$ and U_{abc} in recent years. From 2009-2015, the EBS exploitation rate exceeded the AI $U_{F40\%}$ each year except 2012, and exceeded U_{abc} in each year except 2009 and 2012 (when it was 94% of the AI U_{abc}).

Conclusions

The maximum subarea species catch was introduced as a method for producing subarea harvest recommendations. In 2015, the catch of blackspotted/rougheye in the WAI of 62 t (through August 29) exceeded the maximum subarea species catch of 46 t. Additionally, catches and exploitation rates in the EBS have been increasing recently and are now comparable with the exploitation rates in WAI.

The reference exploitation rate of U_{abc} is an improvement over $U_{F40\%}$ for Tier 3b stocks, such as blackspotted rockfish, in which harvest recommendations are based on F values below $F_{40\%}$. This reference level pertains to the exploitation rate which would result from harvesting the recommended ABC, and is thus is more comparable to actual management advice than $U_{F40\%}$, which is based on fishing at $F_{40\%}$. It is also more consistent with the method of assessing management performance for other north Pacific stocks with subarea management, in which comparisons between subarea catch levels and subarea ABCs are tracked in-season and are easily accessible to the fishing industry and general public. The fishing industry has taken steps to reduce exploitation rates in the WAI, but these exploitation rates are still above the U_{abc}, leading to the "overage" identified above.

Interpretation of the 'overage' of the maximum subarea species catch is problematic because both the meaning of this catch advice, and any potential management response if it is exceeded, is not clear. The development of the maximum subarea species catch in the 2014 Plan Team meetings was prompted by the interest of the fishing industry to voluntarily take steps to reduce the catch of blackspotted rockfish in the 2014 fishing season, and was seen as a way to more transparently communicate subarea catch advice. If the maximum subarea species catch is intended only as auxiliary information in those cases in which the fishing industry has volunteered to reduce their subarea catch beyond what the published regulations require, then one could argue that the term 'overage' should not be used. Alternatively, the maximum subarea species catch could be viewed as a management goal corresponding to desirable subarea exploitation rates, and this is indicated by the November 2014 Plan Team minutes which state "any suggested subarea catch level . . . be accessible to the public so that progress in meeting management goals can be easily monitored". Interpreting the maximum subarea species catch as a management goal is also consistent with an SSC request that this catch level be provided for any case in which there is a stock structure concern (SSC minutes, Oct 2014).

However, BSAI blackspotted/rougheye rockfish are unique among north Pacific stocks in that a putative subarea management goal is not reported in the harvest specification table and published in in-season catch reports. This absence of information can hinder accessibility of information by the public and the ability to easily monitor management progress, and may be a contributing factor to the 'overage' in 2015. In short, there appears to be some interest in limiting exploitation rates in the WAI, but this area has not been recognized as a spatial management unit.

Following the process developed by the Council for evaluating spatial management units (NPFMC minutes, October 2013) may improve matters. Briefly, the process consists of four steps that can be paraphrased as follows:

1) Scientific information on stock structure and conservation concerns are provided to the Council.
2) The Council (and NMFS) identify the suite of tools that could be could be used to achieve conservation and management goals, and their economic and management implications.
3) Further refinement of spatial management concerns and potential management responses should be discussed through steps 1 and 2 above.
4) Based on the information available through this process, the SSC should continue to recommend OFLs and ABCs that prevent overfishing of stocks.

A "strong concern" has been identified in two cases (BSAI blackspotted/rougheye rockfish and GOA skates), which Plan Team and SSC interpret as requiring that "steps 2 and 3 of the Council's process must be activated" (November 2014 Plan Team minutes and December 2014 SSC minutes). These steps have not been activated for BSAI blackspotted/rougheye rockfish, perhaps because it is not clear who has responsibility to initiate the Council's process. Clarification of the role of the Plan Teams in this process was requested in the minutes of November 2013 and November 2014 Plan Team meetings, along with requests for guidance on several other issues pertaining to stock structure and spatial management. Addressing these issues may help achieve the objectives of accessibility of information and monitoring of progress in meeting management goals.

References

Spencer, P.D., and C.N. Rooper. 2014. Assessment of the blackspotted and rougheye rockfish complex in the eastern Bering Sea and Aleutian Islands. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, pp. 1453-1536. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501

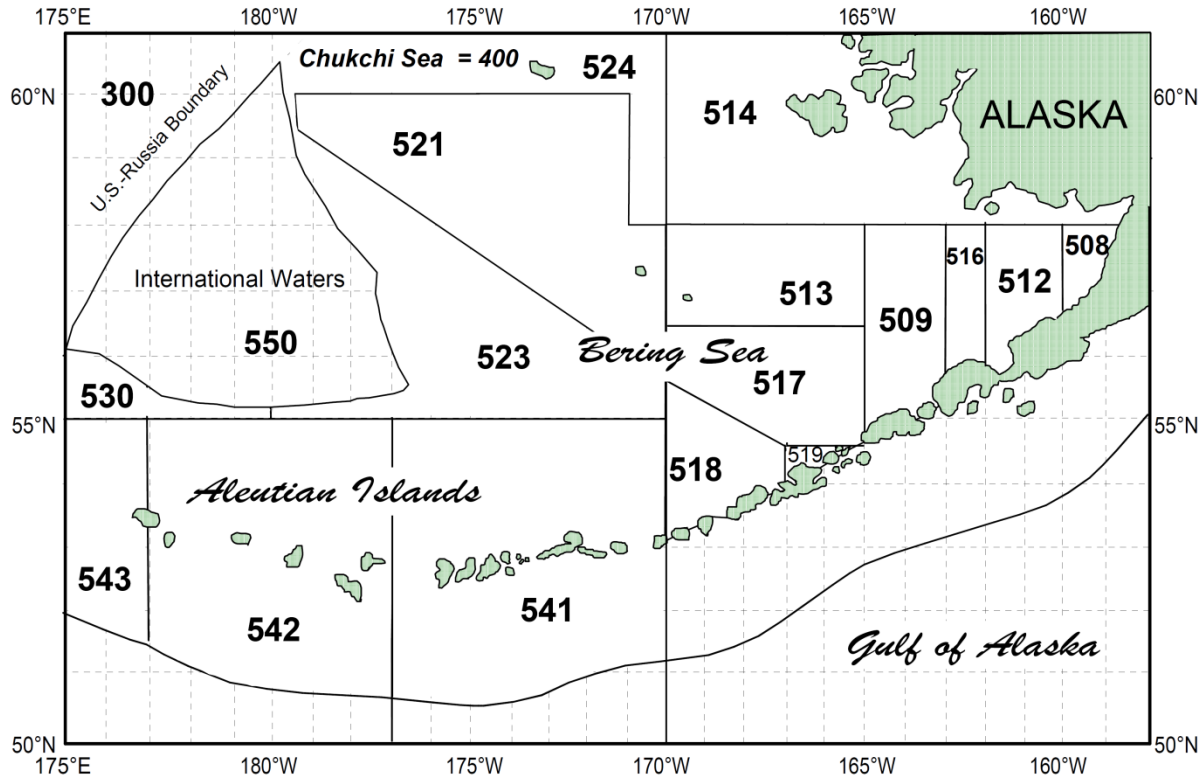

Figure 1. Map of statistical reporting zones in the BSAI management area. The western Aleutian area is zone 543 (which extends west to 170°E), the southern Bering Sea (SBS) zone comprises zones 518 and 519, and the central Aleutian Islands (CAI) and eastern Aleutian Islands (EAI) zones are 542 and 541, respectively. Figure obtained from the NOAA-Alaska Regional Management Office.

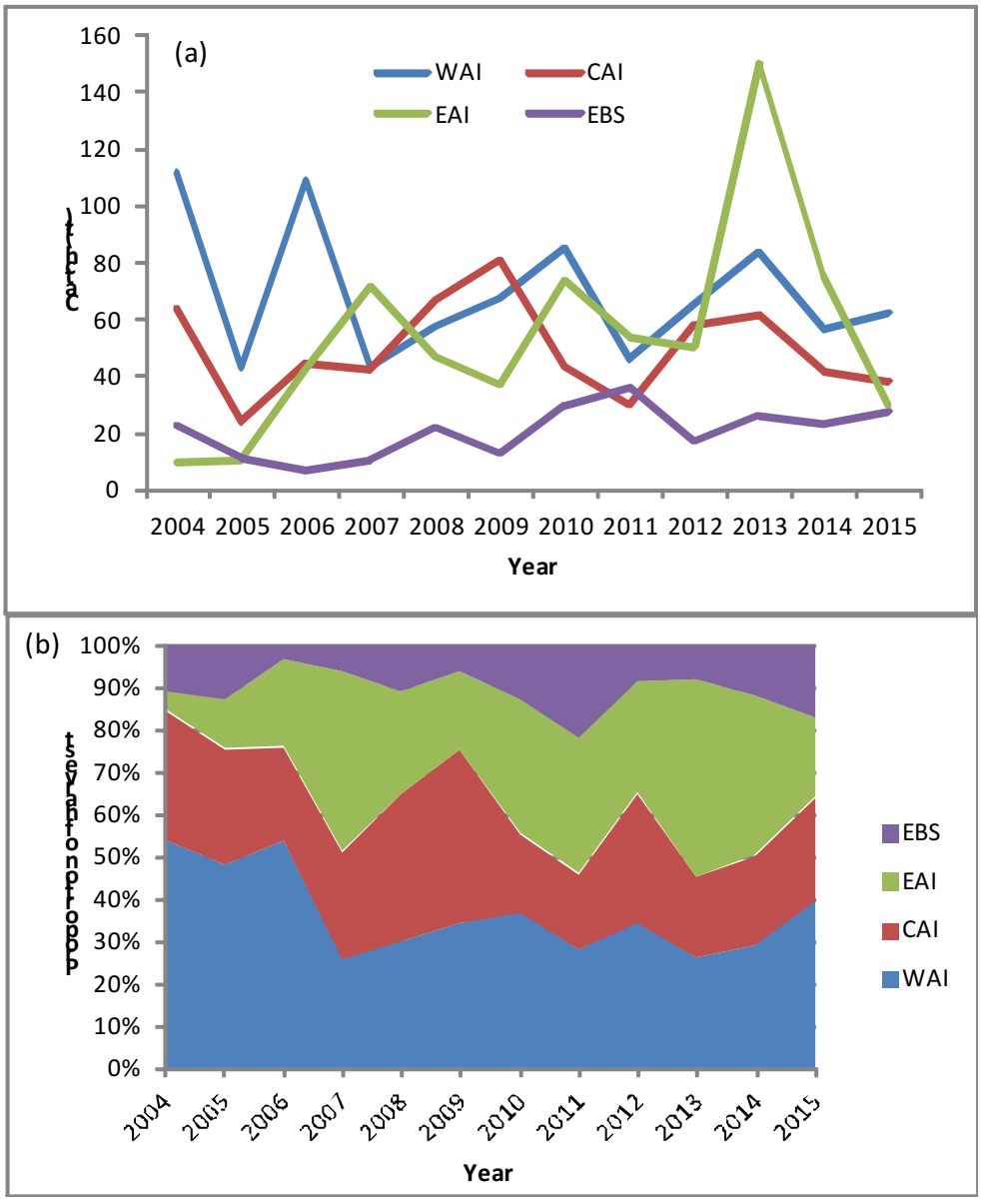

Figure 2. BSAI blackspotted/rougheye subarea catch for by BSAI subarea (panel a),and portion of harvest by BSAI subarea (panel b). Exploitation rates and catch for 2015 are preliminary and are based on the 2014 stock assessment and projection model, and catches through August 29, 2015.

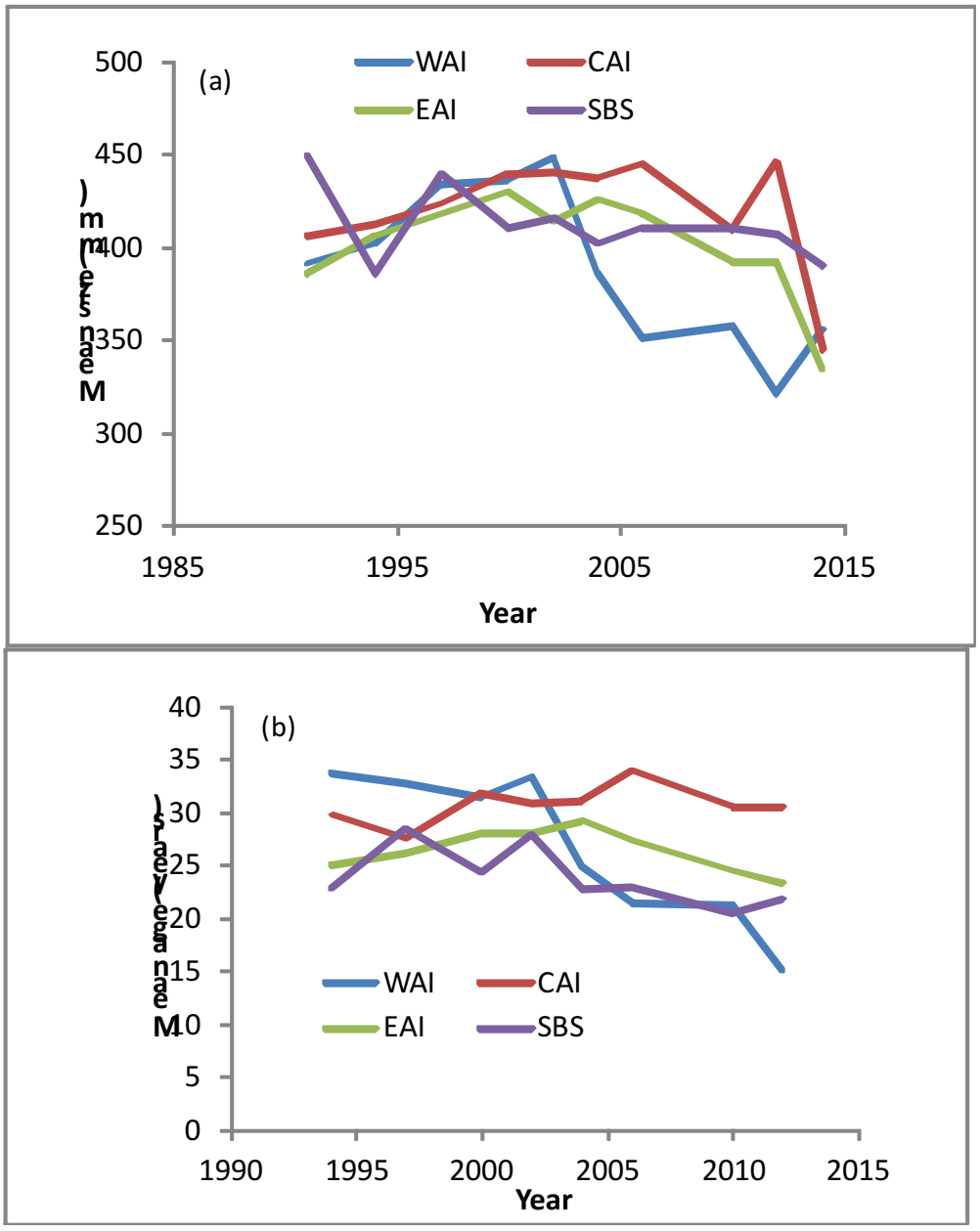

Figure 3. Mean size (a) and age (b) of blackspotted/rougheye rockfish in from the AI trawl survey, by subareas.

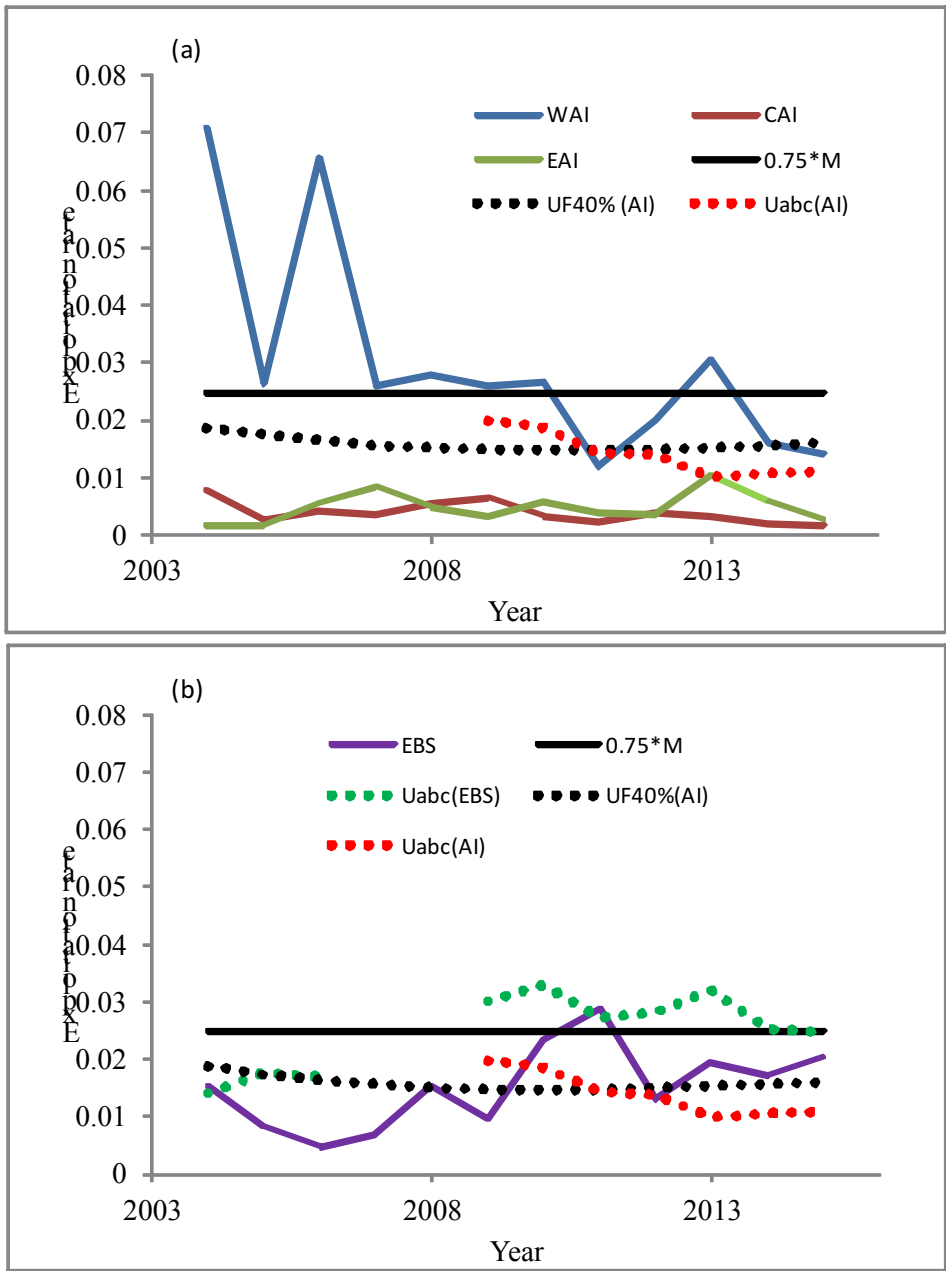

Figure 4. Exploitation rates within AI subareas for the AI portion of the stock (panel a), with reference exploitation rates of 0.75*M and the reference rates of $U_{F40\%}$ and U_{abc} (determined from the age-structured AI model). Exploitation rates within EBS portion of the stock (panel b), with the non-age-structured reference exploitation rates of 0.75*M and U_{abc} (EBS). For comparison, the age-structured reference rates for $U_{F40\%}$ and U_{abc} from the AI model are also shown.