20. Assessment of the Shark stock complex in the Gulf of Alaska (Executive Summary)

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November 2014

Executive Summary

The shark complex (spiny dogfish, Pacific sleeper shark, salmon shark and other/unidentified sharks) in the Gulf of Alaska (GOA) is assessed on a biennial stock assessment schedule. GOA sharks are a Tier 6 complex, however, the ABC and OFL for spiny dogfish are calculated using a Tier 5 approach with the survey biomass estimates considered a minimum estimate of biomass. The complex OFL is based on the sum of the Tier 5 and Tier 6 (average historical catch between the years 1997 - 2007) recommendations for the individual species. For this summary, we have updated the time series of catch through October 1, 2014 to reflect any changes that might have occurred in the Catch Accounting System (for the years 2003 – 2014). For further information regarding the assessment, please refer to the last full stock assessment, which is available online (Tribuzio et al. 2011, http://www.afsc.noaa.gov/REFM/docs/2011/GOAshark.pdf). A full stock assessment document will be presented in next year's SAFE report. A document was presented to the September Groundfish Plan Team and subsequently to the Science and Statistical Committee (SSC) at the October North Pacific Fisheries Management Committee (NPFMC) meeting, which addresses specific concerns expressed by the SSC regarding the potential effects of the observer program restructuring on the estimates of shark catch. That document is appended to this executive summary.

Summary of changes in Assessment Inputs

Changes in the input data: There were no changes made to the assessment inputs because this was an off-cycle year.

Changes in assessment methodology: There were no changes in assessment methodology.

Summary of Results

For 2015 we recommend the maximum allowable ABC of 5,989 t and an OFL of 7,986 t for the shark complex. Catch in 2013 was 2,165 t and in 2014 was 954 t (as of October 1, 2014). Prior to the 2013 Observer Restructuring, on average 23% of total shark catch occured after October 1. In 2013, 58% of the shark catch occurred after October 1. The complex was not subjected to overfishing last year. The ABC/OFL for the shark complex is the sum of the computations for the individual species. A Tier 5 approach is used for calculations of spiny dogfish, where exploitable biomass (B) is equal to the average of the biomass estimates from the last three trawl surveys (2009, 2011, 2013), the OFL = M*B, and the ABC = 0.75*OFL. The remaining shark species follow a traditional Tier 6 approach with the OFL = average historical catch (1997 – 2007) and the ABC = 0.75*OFL.

Spiny Dogfish Quantity	As estimated or *specified last* year for: 2014	2015	As estimated or *recommended this* year for: 2015	2016
M (natural mortality rate)	0.097	0.097	0.097	0.097
Tier	6*	6	6	6
Biomass (t)	76,452	76,452	76,452	76,452
F_{OFL}	0.097	0.097	0.097	0.097
$maxF_{ABC}$	0.073	0.073	0.073	0.073
F_{ABC}	0.073	0.073	0.073	0.073
OFL (t)	7,416	7,416	**7,416**	7,416
maxABC (t)	5,562	5,562	5,562	5,562
ABC (t)	5,562	5,562	**5,562**	5,562
Status	As determined *last* year for: 2012	2013	As determined *this* year for: 2013	2014
Overfishing		n/a		n/a

*While spiny dogfish are a Tier 6 species, a Tier 5 approach is used. They are not in Tier 5 because the trawl survey biomass is not considered reliable for the species.

Pacific sleeper, salmon and other sharks Quantity	As estimated or *specified last* year for: 2014	2015	As estimated or *recommended this* year for: 2015	2016
Tier	6	6	6	6
OFL (t)	571	571	**571**	571
maxABC (t)	427	427	427	427
ABC (t)	427	427	**427**	427
Status	As determined *last* year for: 2012	2013	As determined *this* year for: 2013	2014
Overfishing		n/a		n/a

Summaries for Plan Team

Species	Year	Biomass[1]	OFL[2]	ABC[2]	TAC	Catch[3]
Shark Complex	2013	76,979	8,037	6,028	6,028	2,165
	2014	76,452	7,986	5,989	5,989	954
	2015	76,452	7,986	5,989		
	2016	76,452	7,986	5,989		

[1]This is spiny dogfish biomass only, because the biomass estimates for the remaining shark species in the complex are not used for ABC and OFL calculations. The biomass used for the spiny dogfish ABC and OFL calculations for 2014 - 2016 is the average of the 3 most recent trawl survey biomasses (2009, 2011, and 2013).
[2]ABC and OFL are the sum of the individual species recommendations, Tier 6 (avg catch 1997-2007) for Pacific sleeper shark, salmon shark and other/unidentified sharks and a modified Tier 6 (biomass * M) for spiny dogfish.
[3]Catch as of October 1, 2014.

Responses to SSC and Plan Team Comments on Assessments in General

Because of the government shutdown in 2013, there was only sufficient time to compile SSC and Plan Team comments in last year's assessment. Since this is an "off" year and only an executive summary is

presented, we respond here to priority comments. For comments relevant to or requiring a full assessment and/or model run, we will present responses in the next full assessment.

"The Teams recommend that stock assessment authors calculate biomass for Tier 5 stocks based on the random effects model and compare these values to status quo. In addition, the Teams recommend that the working group examine autocorrelation in subarea recruitment when conducting spatial simulations for evaluating apportionment." (Plan Team, September 2014)

Various approaches to calculate biomass based on the random effects model were presented to the Plan Team in September 2013. Continued efforts are underway to determine the most appropriate approach for the species in this complex and will be presented in the next full assessment. Survey data do not support this approach for all of the species in the complex, but the authors are investigating using the random effects model on the full complex as well as some of the individual species.

"The Teams recommended that SAFE chapter authors continue to include "other" removals as an appendix. Optionally, authors could also calculate the impact of these removals on reference points and specifications, but are not required to include such calculations in final recommendations for OFL and ABC." (Plan Team, September 2013)

This will be included in the next full assessment.

"The SSC encourages assessment authors of stocks managed in Tier 5 to consider the recommendations found in the draft survey averaging workgroup report." (SSC, December 2012)

Please see the first comment in this section.

"The SSC concurs with the Plan Teams' recommendation that the authors consider issues for sablefish where there may be overlap between the catch-in-areas and halibut fishery incidental catch estimation (HFICE) estimates. In general, for all species, it would be good to understand the unaccounted for catches and the degree of overlap between the CAS and HFICE estimates, and to discuss these at the Plan Team meetings next September." (SSC, December 2011)

The authors of HFICE we unable to delineate the overlap between CAS and HFICE (Tribuzio et al. 2014). The HFICE authors recommended waiting for more years of restructured observer program data so that a comparison between the two procedures can be made. The SSC reviewed that recommendation again with regards to the GOA shark assessment at its October 2014 meeting and agreed with the authors to delay decisions about using HFICE until more data is available (see Appendix 20.A of the 2014 BSAI or GOA shark assessments).

SSC and Plan Team Comments Specific to this Assessment

"*With respect to the historical catch time series, the Team recommends that authors complete an evaluation of a comparison of HFICE estimates to the new time series."* (Plan Team, September 2014)

The authors are expecting to do a comparison of the new catch time series and the HFICE catch estimates when more data become available.

"Team members also suggested that the authors look into the feasibility of establishing discard mortality rates for shark species and summarize what data and studies have evaluated this." (Plan Team, September 2014)

There is very little literature on the discard mortality of the shark species in the BSAI or GOA. The limited research that has been conducted on spiny dogfish was based on animals captured during research trawls. Hook and line gear is the predominant gear type which catches both spiny dogfish and Pacific sleeper shark and research into the discard mortality from that gear type is necessary. There is ongoing research into the mortality of skates from hook and line gear type, which the authors will consider upon the completion of that project.

"The SSC discussed observed increases in shark catch in 2013 and the implications of incorporating shark catches in areas 649 and 659 in the assessment. With respect to adding catch from areas 649 and 659, the SSC recognizes that if the authors account for catch from additional regions, then they will need to consider how they will adjust the historical catch time series for shark removals from areas 649 and 659. Furthermore, the authors will need to consider the connectivity of the subset of the population in areas 649 and 659 to the other regions in the GOA. Finally, the authors will need to consider whether the catch reported in 2013 is representative of the historical catch or whether it was impacted by the new observer deployment program. The SSC requests a full stock assessment in 2014 because of the importance of these issues when estimating biological reference points for a species managed in Tier 6." (SSC, December 2013)
Please see Appendix 20.A for responses to these comments.

"The SSC notes that the CIE non-target review provided comments on the utility of continued exploration of the length-based and surplus production models. The SSC requests that the authors consider these comments and that they report to their justification for continuing or dropping this line of research. The SSC looks forward to the authors' responses to the CIE review comments." (SSC, December 2013)
Please see Appendix 20.A for responses to these comments.

"The Plan Team encourages the inclusion of the HFICE data in future models, and possibly some measure of fishing effort. Also, the Team suggested that using some alternative series (e.g., the ratio estimator for the period prior to 2003) may be useful for sensitivity analysis." (Plan Team, September 2012)
The authors do not agree with including HFICE catch estimates in models at this time. As described in Tribuzio et al. (2014), the HFICE estimates have a number of caveats associated with them that preclude inclusion. The authors are expecting to do a comparison of the new catch time series and the HFICE catch estimates when more data become available.

"Develop biomass indices for lowest tier species (Tier 5 for crab, Tier 6 for groundfish), such as sharks, and conduct net efficiency studies for spiny dogfish. Explore alternative methodologies for Tier 5 and 6 stocks, such as length-based methods or biomass dynamics models." (SSC, June 2012)
These investigations are underway. The authors are examining the use of tagging data to estimate survey catchability as well as a variety of biomass models for spiny dogfish.

"The assessment authors indicated that they intend to compare results from this demographic modeling analysis with results from planned biomass dynamic models and length-based models. The SSC encourages these efforts and urges the authors to incorporate these models into an improved stock assessment for spiny dogfish in the near future." (SSC, December 2011)
The biomass models are still being developed and are planned to be presented with a comparison to the demographic models in the next full assessment.

"The SSC recommends that total shark catches should be incorporated into the historical catch estimates and OFL/ABC determinations. This is an important issue, as HFICE estimates approach current ABCs." (SSC, December 2011)
The authors agree that the historical catch time series needs to include all sources of removals. However, the authors do not feel that the HFICE catch estimates are appropriate to use to recreate the historical time series. Please see Tribuzio et al. (2014) for descriptions of the concerns over using HFICE, including issues with double counting of catch. The authors are expecting to do a comparison of the new catch time series (i.e. with the new restructured observer program) and the HFICE catch estimates when more data become available, which may enable the recreation of a historical catch time series.

CIE Review of Non-Target Assessments, comments specific to this assessment

"Until recommendation 6 is addressed (review of bottom trawl survey) the bottom trawl surveys as combined are not generally useful as an absolute estimate of stock biomass; and further should not be used for management purposes until these issues are successfully resolved."
The authors agree and do not recommend moving any of the sharks in the BSAI to a Tier 5 method.

"If using the Tier 5 methods, investigate appropriate means of converting survey biomass to absolute biomass (i.e. catchability) and alternative Fmsy proxies besides F=M."
The authors are investigating the possibility of using tagging data to estimate survey catchability, as well as biomass models. Demographic models have been conducted and results will be compared to biomass models in the next full assessment.

"That all shark stocks in the BSAI/GOA area are split to have separate OFL/ABC by species and region, and that the OFL be based on the Tier 6 approach as the average catch of each species individually."
Splitting the shark species in the BSAI may not be feasible, as the ABC/OFLs would be quite small and likely difficult to manage.

"Using the maximum or average catch for Tier 6 may not be appropriate, alternatives could be to use an upper bound of a one-sided 95% or 99% confidence interval."
Alternatives to average and maximum catch (e.g. percentiles of the maximum catch) have been presented in the past for the shark assessments (e.g. Tribuzio et al. 2010a). For this assessment, we present and recommend using the average historical catch. The concern about using average catch is that, by rule, the catch will exceed the average in half of years. In the case of BSAI sharks, current catch is well below the historical average (the historical time series used to calculate ABCs and OFLs is from 1997-2007), and unlikely to increase to that level. Thus, using the average catch is currently the most appropriate option.

*"Dogfish: Clearly, there is some connection to the stock of dogfish residing the Pacific Northwest region just to the south. The connection with the assessed unit to the south should be explored further. One method of doing so would be to simply treat the BSAI through the NWP as a single unit. In the interim, average catch in the 1997-2007 should be feasible for both components. It is recognized that the GOA dogfish uses a biomass*M approach. However, in keeping with conclusion 1 the average catch is probably a more robust measure."*
A coast-wide assessment may be the most biologically appropriate strategy, but it is not possible at this time. The authors agree that using the average catch to calculate ABC/OFLs is more conservative than using an unreliable biomass estimate and assuming that F=M. However, the average catch approach will create ABC/OFLs likely to be exceeded, and given that spiny dogfish are a non-target species and recent changes to the observer program, average catch may not be appropriate. The authors recommend consideration of alternates to the F=M assumption (i.e. Fmsy from demographic models) or using a confidence interval around the average catch, such as 90% upper CI to set ABC/OFLs until a biomass model is approved.

"Salmon shark: they might be better off being assessed outside of the AFMC jurisdiction as a highly migratory species. Regardless, catches and encounters with inshore fisheries needs to be addressed sooner rather than later for this stock. In the interim, average catch can serve as a good proxy, but that suggestion is made grudgingly given how litter is known about this stock."
The authors agree that salmon shark (and the other shark species) may be more appropriately managed as highly migratory species; however, that system does not exist in the GOA or BSAI at this time. Further, catch in Alaska state fisheries is not accounted for, which needs to be addressed to accurately monitor the species.

"Pacific sleeper shark: What data are available is disturbing. While most of the individuals encountered are juvenile, the overall fishery dependent and independent data suggests a declining trend. As such,

while average catch is probably the only measure available for informing an OFL, SSC and managers should be aware that more precaution is warranted until further information is gathered."
The authors agree with the CIE reviewers that trends in Pacific sleeper shark catches are concerning and a more conservative approach may be warranted.

"It is appropriate to base the assessment of shark on Tier 6, and not Tier 5, since the AFSC bottom trawl surveys are directed at groundfish species. Also, the bottom trawl surveys do not necessarily cover the spatial range of many shark species as suggested by the large interannual variability in CPUEs, and therefore do not provide reliable biomass estimates."
The authors agree that the surveys do not reliably represent shark biomass, particularly for Pacific sleeper shark and salmon shark. Spiny dogfish is technically a Tier 6 species, but a Tier 5 approach is used to estimate ABC/OFLs, however, efforts are underway to develop methods to estimate a reliable biomass for this species.

Literature Cited

Tribuzio, C.A., K.B. Echave, C. Rodgveller, P. Hulson, and K.J. Goldman. 2011. Assessment of the Shark Stock Complex in the Gulf of Alaska. *In* Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska for 2011. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501. Pgs. 1393 – 1446.

Tribuzio, C. A., J. R. Gasper, and S. K. Gaichas. 2014. Estimation of bycatch in the unobserved Pacific halibut fishery off Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-265, 506 p.

Appendix 20.A GOA and BSAI Shark Assessments

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September 2014

Executive Summary

At the December, 2013 council meeting, the SSC requested a full Gulf of Alaska (GOA) shark assessment for the 2014 assessment cycle (typically full assessments for the GOA sharks are conducted in odd years) to address questions specific to the assessment regarding the catch estimates based on data from the newly restructured observer program. We are presenting this document in lieu of a full assessment to address SSC comments for the following reasons: 1) there was no GOA survey in 2014; 2) the shark complex is dominated by spiny dogfish in the GOA and ABC/OFL calculations are based on the survey biomass for that species; 3) the contribution to the ABC/OFL from the remaining Tier 6 species (catch history) is small (~7% in 2013), thus the impacts to the complex from adjustments (if any) in the ABC/OFL from the observer restructuring would be small; and 4) with only 1 year of the new time series of catch estimates, it is not reasonable to make comparisons to the old time series. A full assessment for the Bering Sea/Aleutian Islands (BSAI) sharks is planned, as is normal for an even year.

Aside from the request for a full GOA assessment, the SSC made the below comments:

"The SSC discussed observed increases in shark catch in 2013 and the implications of incorporating shark catches in areas 649 and 659 in the assessment. With respect to adding catch from areas 649 and 659, the SSC recognizes that if the authors account for catch from additional regions, then they will need to consider how they will adjust the historical catch time series for shark removals from areas 649 and 659. Furthermore, the authors will need to consider the connectivity of the subset of the population in areas 649 and 659 to the other regions in the GOA. Finally, the authors will need to consider whether the catch reported in 2013 is representative of the historical catch or whether it was impacted by the new observer deployment program. The SSC requests a full stock assessment in 2014 because of the importance of these issues when estimating biological reference points for a species managed in Tier 6.

The SSC notes that the CIE non-target review provided comments on the utility of continued exploration of the length-based and surplus production models. The SSC requests that the authors consider these comments and that they report to their justification for continuing or dropping this line of research. The SSC looks forward to the authors' responses to the CIE review comments."

The sections below address these comments. We address the above comments in regards to the BSAI areas as well.

SSC comments regarding the impacts of observer restructuring on the shark assessments

The SSC comments can be paraphrased into four questions:

1) Are the 2013 estimates of shark catch comparable to the historical time series of estimated shark catch?
2) Will (how will) the catch history time series be adjusted if areas 649/659 are included in assessment?
3) Is there connectivity between sharks in 649/659 and the other regions of the GOA?
4) How do these issues affect Tier 6 (catch history) species ABC/OFL estimates?

1) Are the 2013 estimates of shark catch comparable to the historical times series of estimated shark catch?

The restructured observer program was put into effect to address longstanding concerns associated with the old program about data quality and cost equity among participants (77 FR 770062). Implementation of this program is considered an improvement over the previous observer system and an analysis of the first year under the restructured program was presented at the June 2014 council meeting (Faunce et al. 2014). The report presented to the Council explains how the observer program changed, thus we will not be covering the finer points of the restructured observer program in this document. The change from the previous observer deployment regime may result in relatively small changes in estimated catch for target species, but for sharks, there is potential for significant additional estimated catch. In particular, the restructuring includes newly available catch estimates from the Pacific halibut (*Hippoglossus stenolepis*) IFQ fishery, which was not available prior to 2013 due to the lack of observer coverage on vessels participating in this fishery. Here we report the estimated catch from 2003-2012 (historical time series) and from 2013 (restructured observer program data). However, we make no conclusions here regarding changes in the catch time series because of confounding issues in the catch estimates which may or may not be a result of observer restructuring.

The shark assessments include three main species of sharks: spiny dogfish (*Squalus suckleyi*), the Pacific sleeper shark (*Somniosus pacificus*) and the salmon shark (*Lamna ditropis*). However, the salmon shark is rare in federal fisheries and thus this response will focus on spiny dogfish and Pacific sleeper shark. The majority of shark catch occurs in the GOA, hence this response focuses primarily on the GOA region, but for informational purposes we are also including data for shark species in the BSAI.

The restructured observer program covers previously unobserved vessels operating in the Pacific halibut IFQ fishery and small vessels (40-60 ft). In previous assessments we have speculated that these sectors of the fleet (smaller vessels, Pacific halibut IFQ vessels) were a substantial source of catch for sharks in the GOA (Tribuzio et al. 2014), and that the catch estimates from the Alaska Regional Office Catch Accounting System (CAS) were not representative of true catch because of the lack of observer coverage on those vessels and because CAS programming procedures did not include Pacific halibut-only landings. In 2013, modifications were made to CAS so that catch and bycatch estimates could be made for the IFQ Pacific halibut fishery. These changes resulted in shark catch being estimated for all IFQ trips, including those on vessels <60 ft, which comprise a substantial portion of the IFQ fleet and those vessels which do not also land federal groundfish species (which were included prior to 2013). Estimates of shark catch in CAS (both spiny dogfish and Pacific sleeper sharks) on vessels <60 ft substantially increased in the GOA in 2013 (Figure 1) and proportionally contributed to the total catch more than in any other year (Figure 2). In the BSAI, the increase in estimated catch in 2013 was relatively small, but the portion of the catch resulting from vessels <60 ft was substantially larger (Figures 1 & 2).

In 2013, the estimated shark catch in the Pacific halibut fishery was relatively large, possibly due to the new observer coverage and changes in the estimation methods made in CAS. In the GOA, 2006 and 2009 (similarly in 2003 and 2008 in the BSAI) also had large catch estimates of sharks in the Pacific halibut fishery (Figure 3). While the Pacific halibut IFQ fleet was unobserved prior to 2013, catch estimates from vessels landing Pacific halibut would be generated by CAS when those vessels would also land federal groundfish and the catch estimates were based only on the federal groundfish. The anomalous catches have been investigated by staff at the Alaska Regional Office. In general, prior to 2013, there is little to no observer data available to calculate a rate of shark catch for the Pacific halibut target fishery, thus data were from observed mixed sablefish (*Anoplopoma fimbria*) and Pacific halibut IFQ trips. The observer data were used to estimate shark discards when a groundfish species was landed using post-strata described in Cahalan et al. (2010). In brief, post-stratification rules in CAS aggregate observer data to create discard rates using information of the highest possible resolution of spatial and temporal scale that corresponds with the trip characteristics of landed catch. However, when observer data with similar characteristics to the landed catch are lacking, discards must still be estimated. The post-stratification

rules in CAS allow estimates to be made using available observer information, which may require observer data to be aggregated across an entire FMP area to create a bycatch rate and estimate (Cahalan et al. 2010). For example, in 2006 and 2009 in the GOA and 2003 and 2008 in the BSAI, the aggregated post-stratification discard rates were driven by a small number of observed hauls in which there were relatively large catches of sharks and a small amount of groundfish retained, resulting in a large shark to groundfish rate. This rate represented the best available information from which to estimate, but it also resulted in relatively large estimates of shark catches. This scenario is not the case in 2013, where there was observer data available to create estimates of shark catch from the Pacific halibut fleet and CAS incorporates landing and discard information from the Pacific halibut fishery. However, it is not possible to determine if the large estimated shark catch in the 2013 Pacific halibut target group was an anomaly, a change in fishing behavior, or a result of the restructured observer program. Regardless, the catch accounting is more comprehensive in 2013 than prior years.

In 2013, the estimated catch of sharks in areas 649/659 also substantially increased (Figure 4). These areas also include the Pacific halibut IFQ fishery, which may occur in conjunction with state managed fisheries (e.g., a trip may include both Chatham sablefish and Pacific halibut). Shark discards are estimated on any trips where a groundfish species or Pacific halibut are landed, thus estimates were made regardless of whether the primary species landed was a state-managed species. It is not possible to determine if the increased 2013 catch estimates are a result of a change in fishing behavior or the observer restructuring, since discards were estimated for a portion of Pacific halibut fleet prior to 2013. The catch in these two areas is relatively small when compared to the total shark catch: on average, 3% of total shark catch prior to 2013 and 10% in 2013. A longer time series is needed to understand catch trends.

The 2013 catch estimates are not directly comparable to the prior 2013 catch estimates. The methods CAS uses to estimate catch of non-retained species have changed. Not only are trips where only Pacific halibut is landed included in CAS, but Pacific halibut is included in the calculation of discard rates. Two procedures would need to be completed to accurately compare 2013 catch estimates to historical catch estimates. First, the estimated catch resulting from Pacific halibut only landings will have to be removed. Second, a new discard rate will have to be calculated which does not include Pacific halibut. Such an analysis is beyond the scope of this document, but may also not be feasible given the structure of CAS.

2) Will (how will) the catch history time series be adjusted if areas 649/659 are included in the federal catch?

Catch of sharks in the Prince William Sound and inside waters of Southeast Alaska (NMFS areas 649/659) comes from a mixture of federal and state managed fisheries that are sometimes landed on the same trip, including Pacific halibut IFQ. Prior to 2013, if a vessel landed both Pacific halibut IFQ and groundfish on the same trip, a discard estimate was generated based on the federal groundfish landings only. However, if a vessel only landed Pacific halibut, discard estimates were not calculated. Starting in 2013, discards were estimated for all trips where Pacific halibut or groundfish species were landed, and estimates are based on both Pacific halibut and groundfish landings. The only trips where discards were not estimated are those containing only non-groundfish species (e.g., lingcod). Due to the complex mixture of fishing activity in state waters, and the lack of observer information on Pacific halibut vessels prior to 2013, the estimated catch in federal fisheries in 649/659 has historically not been included in the shark assessment. While it is not possible to determine if the recent increase in catch in these areas is a result of the observer restructuring and changes to CAS, an anomaly (meaning not representative of the time series), or a change in fishing behavior, these catch estimates are generated when landings of groundfish and Pacific halibut occur (i.e. federal landings) and we recommend that they be included in the GOA federal shark assessment. Further, there is no accounting of shark catch by the State of Alaska and the sharks occurring in areas 649/659 are not biologically distinct from the other regions of the GOA (see below).

Estimates of shark catch in federal groundfish fisheries in areas 649/659 are available for the historical time series. The estimated shark catch in 649/659 over the entire time series is small relative to the other areas of the GOA (Figure 4). At this point, it is unknown if the higher magnitude of 649/659 shark catch estimates (10% of total GOA shark catch) is representative of the new time series or an anomaly. Regardless, including the historical estimated catch from those areas, will have a small impact on the total estimated shark estimated catch.

The addition of estimated catch from the Pacific halibut IFQ fishery may result in an increase in estimated shark catch, particularly in areas 649/659, in which case the historical time series of catch used will need to be adjusted. At this time, we are not prepared to speculate on the appropriate method for making adjustments. Any adjustment methods will need to consider separating estimated catch from vessels fishing only Pacific halibut (added to CAS in 2013) from those that landed both Pacific halibut and groundfish on a trip (in CAS prior to 2013), as well as compare HFICE catch estimates (currently only available 2001-2011, Tribuzio et al. 2014) to the 2013 and forward time series.

We recommend delaying adjusting the time series of estimated shark catch in areas 649/659 for three reasons: 1) it would be unwise to conduct such a calculation based on one year of data under the restructured observer program, and it is unknown how the restructured time series compares to the period prior to restructuring; 2) the estimated shark catch in areas 649/659 is small relative to the estimated shark catch in the rest of the GOA and the impact of including that catch in the total estimated shark catch is small; and 3) it appears likely the observer program restructure will continue to evolve over the next several years. Therefore, it is preferable to delay until sufficient data are available to better assess the magnitude of additional catches and the best method of adjustment.

3) Is there connectivity between sharks in 649/659 and the other regions of the GOA?

There are a number of biological justifications for including 649/659 estimated catches into the assessment. Research on the movement and genetics of the shark species has indicated that the populations are mixed across the full extent of the Gulf of Alaska, including areas 649/659, and much of the North Pacific Ocean. A stock structure analysis was presented for the GOA and BSAI shark assessments in September, 2012 (Tribuzio et al. 2012). The stock structure analysis demonstrated that there is no biological justification for managing the shark species as separate stocks within the GOA (including areas 649/659).

Tagging studies have provided an indication of the connection of these species within and outside of 649/659. Spiny dogfish are highly migratory, with some animals overwintering in GOA waters and others undertaking large migrations as far south as southern California and west to Japan. Spiny dogfish moved both into and out of area 659, and while no fish were tagged in area 649, tagged fish did move into area 649 (Tribuzio, unpublished data). Tagging studies of Pacific sleeper sharks suggested that they had potential for movements into and out of 649/659. Hulbert et al. (2006) showed Pacific sleeper sharks moving into 649 and the data suggested that they likely move regularly in and out of the area. Tagging of Pacific sleeper sharks within area 659 showed that they are highly mobile and have potential to move between areas. Detailed analysis of the tagging effort in area 659 is still underway (D. Courtney, NMFS, SEFSC, pers. comm.).

Genetic analyses support the tagging data, suggesting that the shark species are mixed across the extent of the eastern North Pacific Ocean. For example, Verissimo et al. (2010) did not find any discrete stocks across the range in the North Pacific Ocean for spiny dogfish. Similarly, preliminary results of an ongoing genetics study of Pacific sleeper sharks show that there are two lineages of Pacific sleeper sharks, but that they are evenly mixed across the range of the species, including areas 649/659 (S. Wildes, NMFS, AFSC pers. comm.).

4) How do these issues affect Tier 6 (catch history) species ABC/OFL estimates?

The ABC/OFLs for the shark complex in the GOA are calculated using a blend of Tier 5 and 6 approaches. The spiny dogfish ABC and OFL are calculated using a Tier 5-like approach (but they are still considered a Tier 6 species), where OFL=survey biomass*M and ABC =OFL*75%, which is then summed with the average catch history ABCs and OFLs of other shark species to arrive at a combined ABC and OFL for the whole complex. The majority of the estimated shark catch in the GOA is from spiny dogfish (total GOA estimated shark catch in 2013 was 2,420 t, of which 2,178 t was spiny dogfish, Figure 5), as well as much of the ABC and OFL coming from that species (ABC = 6,028 t, of which 5,600 t was spiny dogfish). Therefore, adjustments to the catch history in the GOA will likely have a small impact on the complex ABC/OFL because the Tier 5-like approach for spiny dogfish is based on survey biomass rather than catch history and this component represents the majority of ABC/OFL.

In the BSAI, the entire complex ABC/OFL is based on the maximum of the catch history. However, the impacts of the observer restructuring are likely less substantial. Estimated shark catch in the BSAI (2013 total estimated shark catch = 116 t, of which 69 t was Pacific sleeper shark) is substantially lower than the ABC of 1,022 t (Figure 5). Thus, the potential increase in catch from observer restructuring is unlikely to cause the shark catch in the BSAI to approach the ABC. When there is sufficient data (i.e. more years of catch estimates from the restructured observer program), the historical time series of catch may need to be corrected. It is not appropriate at this time to correct the historical time series based on only one year of data.

CIE comments regarding the shark assessments

The CIE reviewers did not have extensive comments regarding the shark assessments. Below are the key comments from the reviewers' documents and brought forward in discussions during the meeting.

From reviewer comments:

1) *Until the relative biomass from the various trawl surveys can be appropriately converted to absolute biomass, it may be better to use Tier 6 methods for sharks.*

   Spiny dogfish ABC and OFLs in the GOA are calculated based on a Tier 5-like approach (but still considered a Tier 6 species). All other species specific ABCs and OFLs are catch history based (average catch in the GOA and maximum historical catch in the BSAI). The Tier 5-like approach for spiny dogfish was adopted for the 2011 fishery (see the SSC minutes from the 2010 December Council meeting: http://www.npfmc.org/wp-content/PDFdocuments/minutes/SSC1210.pdf), based on the 2010 stock assessment (Tribuzio et al. 2010). The justification was that due to pelagic and transitory nature of spiny dogfish it was likely that trawl catchability was low and that the survey biomass estimates were likely a minimum biomass estimate.

2) *If using the Tier 5 methods, investigate appropriate means of converting survey biomass to absolute biomass (i.e. catchability) and alternative Fmsy proxies besides F=M.*

   The authors are investigating approaches for converting survey biomass estimates to absolute biomass. These include length based and surplus production models, as well as age-structured models. We are not presenting these models for PT and SSC review yet, as we plan to incorporate results of ongoing projects. These include results of an NPRB funded ageing study and an investigation into trawl catchability using tag data.

   An alternative F_{msy} proxy of F=0.04 was presented in the 2010 and 2011 assessments, based on demographic analyses (Tribuzio and Kruse, 2011), but were not accepted by the PT and SSC. If the alternative were applied to the most recent 3 year biomass, the ABC/OFL for spiny dogfish would be 2,294 and 3,058 t, respectively (down from 5,562

and 7,416 t, respectively). The resulting total complex ABC/OFL would be 2,722 and 3,629 t, respectively.

3) *Using the maximum or average catch for Tier 6 may not be appropriate; alternatives could be to use an upper bound of a one-sided 95% or 99% confidence interval.*

   Alternatives to average and maximum catch have been presented in the past (e.g. Tribuzio et al. 2010), for the shark and other assessments (e.g. GOA Octopus). However, this is an issue we hope to revisit for the 2015 GOA assessment. A recent study came out demonstrating how static catch history methods have a high probability of resulting in overfishing (Carruthers et al. 2014). Catch based methods with a dynamic adjusted scalar or depletion correction methods resulted in a substantially higher probability of resulting in an overfished population (defined as B/B_{msy}<50%). We plan to explore these depletion methods for Tier 6 alternatives.

4) *Other suggestions: species specific ABC/OFLs; incorporating state of Alaska survey data; coast wide spiny dogfish assessment; move salmon sharks to a highly migratory group for management*

   Unfortunately, many of these suggestions are not possible at this time. Species specific ABC/OFLs are likely too small to be managed for many of the shark species and moving the salmon shark to a highly migratory group is not possible because we do not have such a group in the Alaska region. We are beginning to compile data from state of Alaska surveys to incorporate into the assessment. A coast wide assessment for spiny dogfish makes sense biologically, but the infrastructure is not in place for such a management plan at this time.

Other items that came up during presentations/discussions

5) *Data does not support building a spiny dogfish model at this time*

   See response to #2 above.

6) *Need to continue efforts to improve age estimates*

   The authors are involved in a research project to improve age estimates. This project is funded by the North Pacific Research Board and is scheduled to conclude January of 2015. The goals of the project are to investigate a new method for ageing spiny dogfish and determine if growth estimates can be improved (i.e. reduce the uncertainty in the age estimates and growth parameters).

7) *Need to get more years of new observer data before constructing catch history to use in model*

   The authors agree with this comment, see discussion above.

8) *Investigate Pacific sleeper shark declining catches and survey indices.*

   This is an important topic that is currently under investigation.

Acknowledgements

We would like to acknowledge Craig Faunce and Jennifer Cahalan (FMA) and Jason Gasper and Jennifer Mondragon (AKRO) for their efforts to help us understand the observer restructuring and CAS and their assistance in writing this document.

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Figures

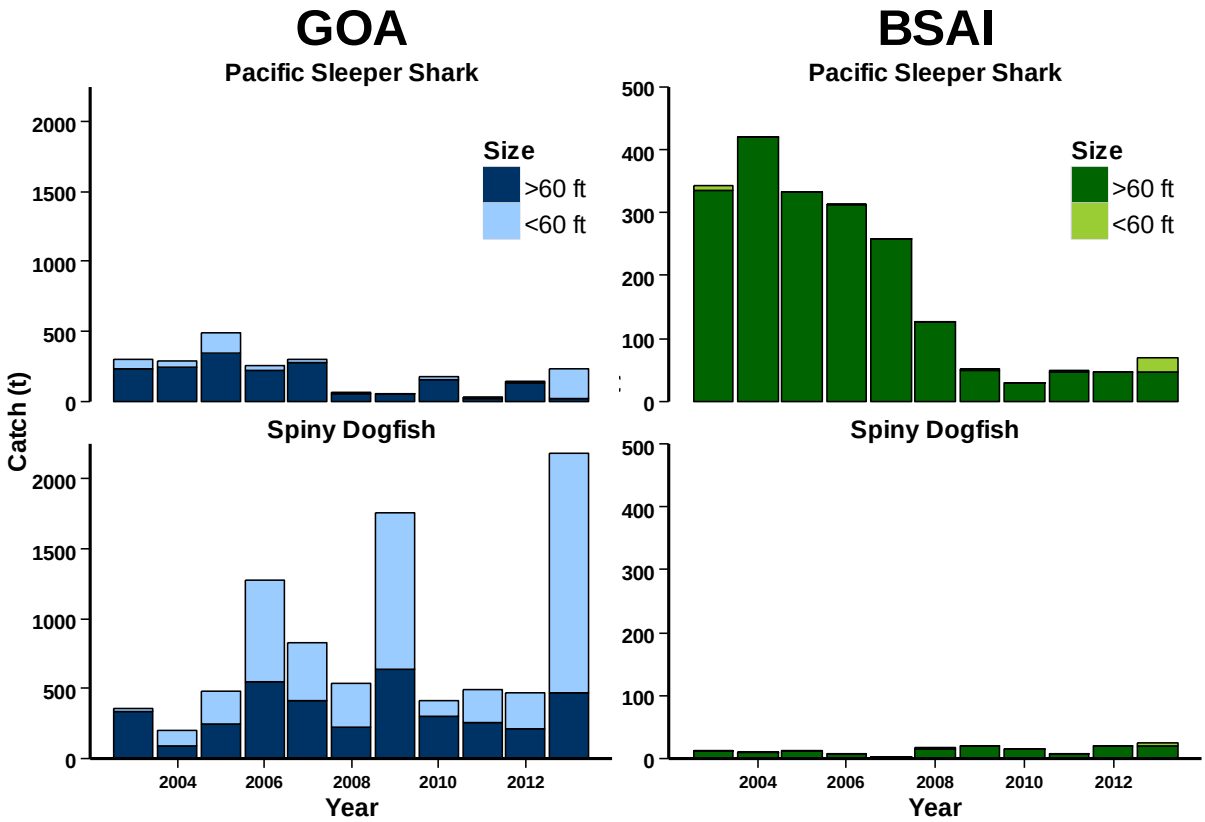

Figure 1. Catch Accounting System catch estimates (t) for Pacific sleeper shark and spiny dogfish in the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) by vessel size class.

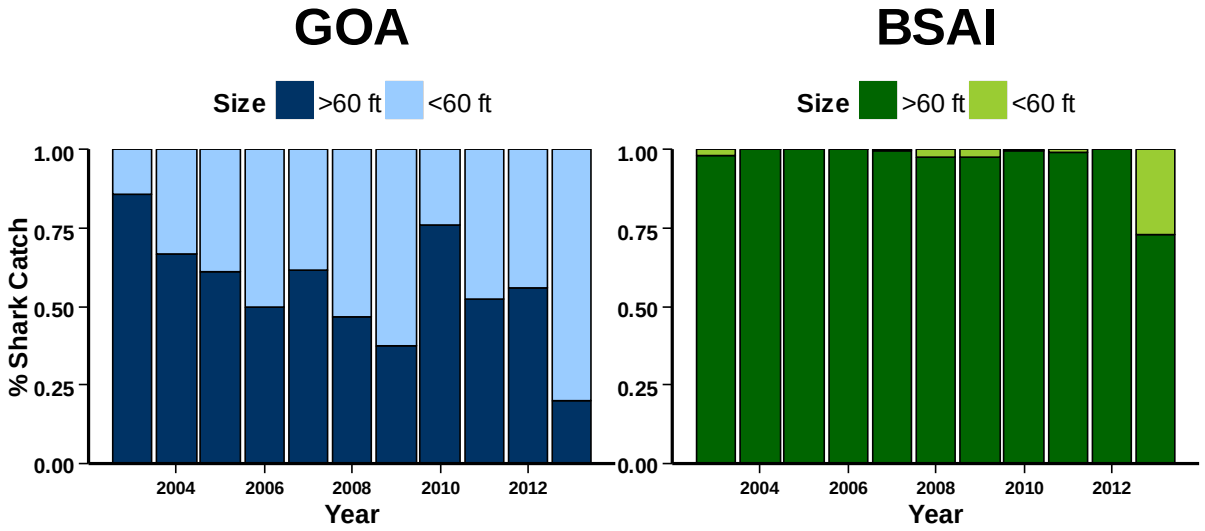

Figure 2. Proportional representation of shark catch by vessel size.

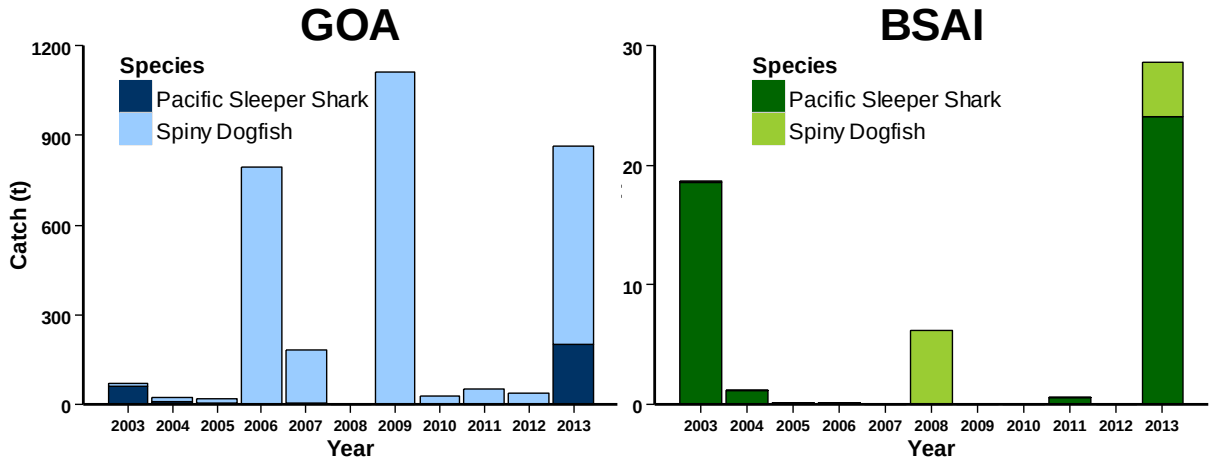

Figure 3. Catch Accounting System catch estimates (t) of spiny dogfish and Pacific sleeper shark in the Pacific halibut target category. Prior to 2013, estimated catch in the Pacific halibut target category was derived from vessels fishing both Pacific halibut and groundfish (generally sablefish IFQ); beginning in 2013 the estimated catches include vessels fishing only Pacific halibut IFQ.

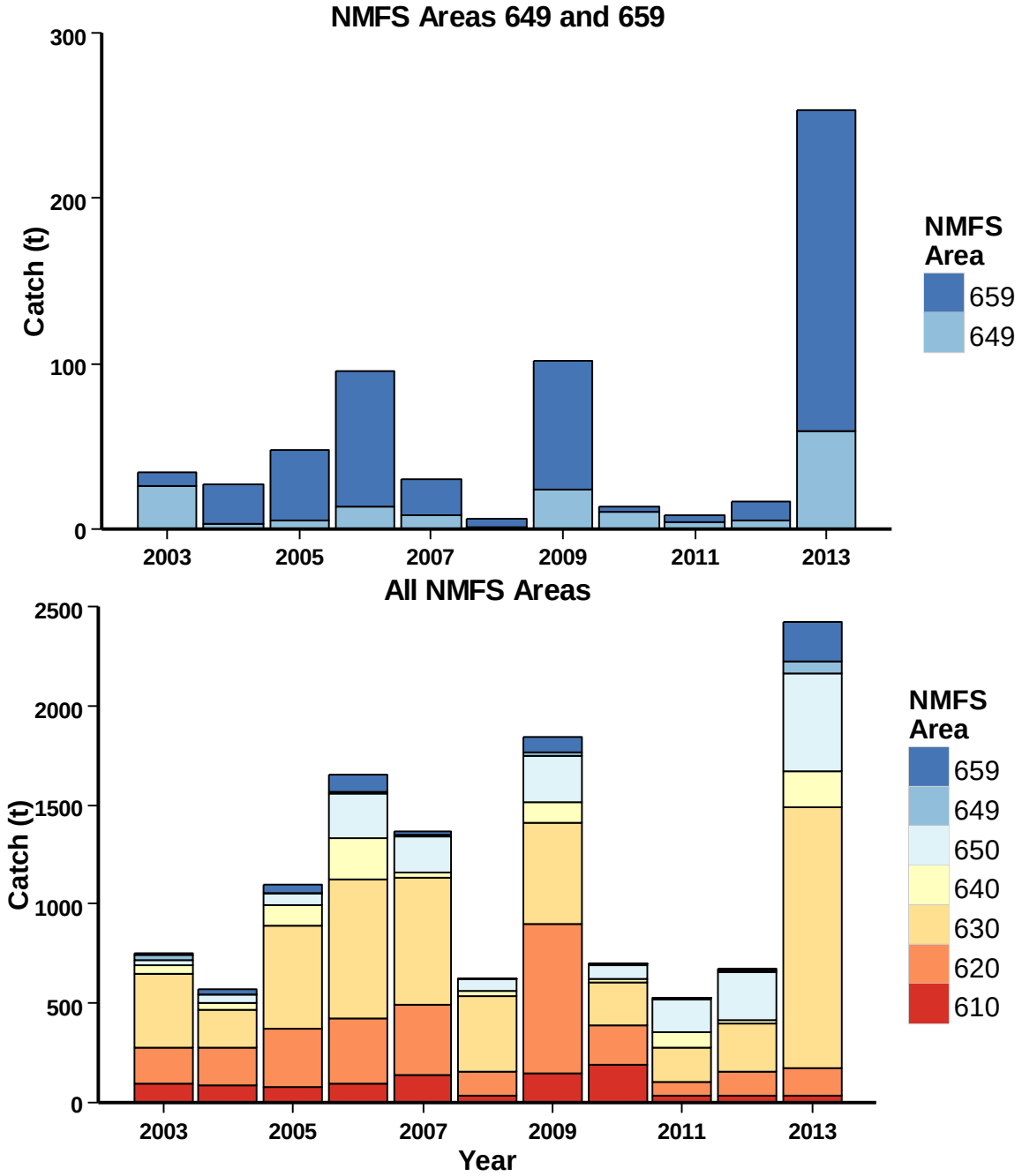

Figure 4. Top panel: Catch Accounting System catch estimates (t) for all sharks in NMFS Areas 649 and 659. Bottom panel: Catch Accounting System catch estimates (t) for all sharks from all Gulf of Alaska NMFS Areas.

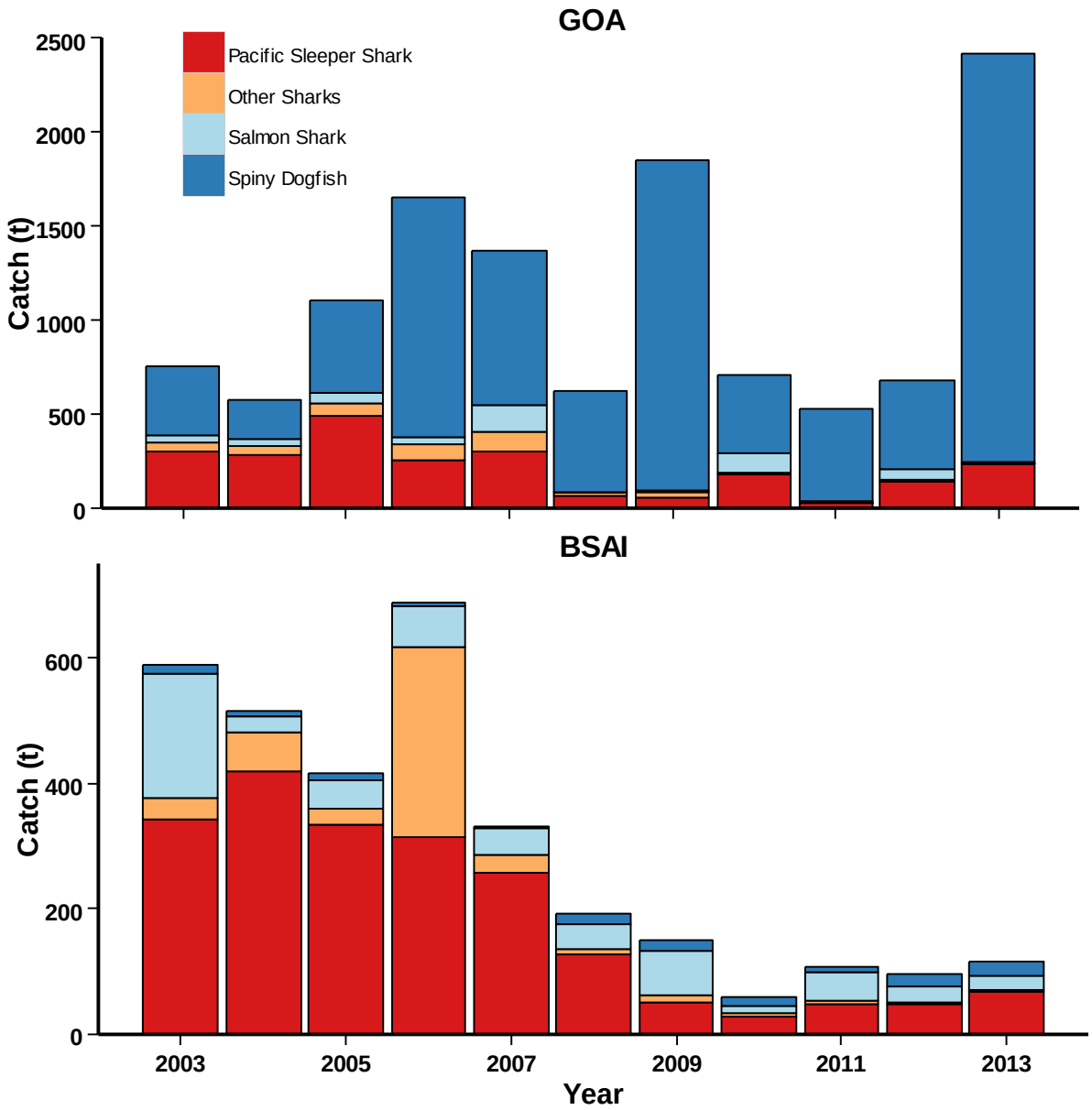

Figure 5. Catch Accounting System catch estimates (t) for all sharks in the GOA (top) and BSAI (bottom).

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