14: ASSESSMENT OF THE DEMERSAL SHELF ROCKFISH STOCK COMPLEX IN THE SOUTHEAST OUTSIDE DISTRICT OF THE GULF OF ALASKA

Kristen Green (kristen.green@alaska.gov), Mike Jaenicke, and Scott Meyer

Executive Summary

The demersal shelf rockfish (DSR) assemblage (yelloweye, quillback, copper, rosethorn, canary, China, and tiger rockfish) is assessed on a biennial cycle, with full stock assessments conducted in odd calendar years to coincide with new survey data. This year, although an odd year, we present an executive summary as we develop a statistical age-structured model for 2014. In addition, we are transitioning from a submersible (*Delta*) to a remote operated vehicle (ROV) as our visual survey vehicle. The future age-structured model will incorporate submersible/ROV density estimates, commercial, sport, and subsistence fishery data, and International Pacific Halibut Commission survey data. The last full stock assessment can be accessed here: ftp://ftp.afsc.noaa.gov/afsc/public/Plan_Team/Nov2009/GOAdsr.pdf. In this stock assessment document, we present two options. The first option is based on our historical methodology of using the most recent survey derived yelloweye rockfish density estimates for each management area in the Southeast Outside (SEO) to calculate the total available DSR biomass. The second option was developed based on the September 2013 Plan Team discussion regarding the risk in continuing to roll forward the most recent year of survey data from each management area, rather than using a model-based approach to incorporate interannual variability. At the Plan Team's recommendation, we present this second option: a random walk time series model estimate of biomass in which process errors are estimated as a random effects approach (Appendix 1).

Summary of Changes in Assessment Inputs

Changes in the input data:

Catch information and average weights for yelloweye rockfish catch from the commercial fishery were updated for 2013. Yelloweye rockfish density was derived from the most recent survey data for all management areas. For this assessment, yelloweye rockfish density was updated for one of the four management areas, Central Southeast Outside (CSEO) using the most recent survey data (ROV-derived). DSR habitat area was also updated for CSEO for this stock assessment based on the best available information from fishery logbooks, side scan, and multibeam data.

Changes in the assessment methodology data:

An alternate survey vehicle (ROV in lieu of a submersible) was used to collect the 2012 survey data for CSEO. Visual survey design and methodology, however, was the same as in previous years. For option two, see Appendix 1 for the description of the random walk time series model estimates of biomass; this is a new methodology.

Summary of Results

Total yelloweye rockfish biomass is estimated for each management area in the Southeast Outside SEO) Subdistrict as the product of density, mean yelloweye rockfish weight, and area estimates of rockfish habitat. Yelloweye rockfish density is derived from line transects conducted from the most recent submersible or ROV survey in each management area. Average weights are from incidental catch of yelloweye rockfish in the commercial halibut fishery, and when available, in the directed DSR commercial fishery. Area estimates of DSR habitat are a combination of National Oceanic Survey data, sidescan and multibeam data and commercial logbook data. The changes in average weights in each management area (4.36 to 4.06 kg in East Yakutat (EYKT), 3.33 to 3.19 kg in CSEO, and 3.68 to 3.53 kg in Southern Southeast Outside (SSEO) resulted in small decreases to the biomass estimate for each

management area (4,770 to 4,439 mt in EYKT, and 4,461 to 4,283 mt in SSEO). Biomass in the Northern Southeast Outside NSEO (1,305 mt) remained the same as no new fishery weight samples were taken in 2013. There was a relatively large decrease in biomass for CSEO (4,051 to 3,247 mt); this is due to a decrease in both the average weight as well as the density estimate in CSEO from 1068 to 752 fish/km^2. Although the ROV is a new survey vehicle, we have rigorously examined the assumptions of this method, and feel this is the best available information available regarding yelloweye rockfish density in CSEO. Overall yelloweye rockfish biomass for 2013 is 13,274 mt; a decrease from 14,588 mt in 2013.

Demersal shelf rockfish are particularly vulnerable to overfishing given their longevity, late maturation, and sedentary and habitat-specific residency. We recommend and use a harvest rate lower than the maximum allowed under Tier 4; F=M=0.02. This rate is more conservative than would be obtained by using Tier 4 definitions for setting the maximum allowed ABC ($F_{40\%}$=0.026). Continued conservatism in managing this fishery is warranted given the life history of the species and the uncertainty of the biomass estimates.

For the 2014 fishery, the recommended acceptable biological catch (ABC) for DSR is calculated by applying the harvest rate (F=M=0.02) to the yelloweye rockfish biomass and then increasing the ABC by 3% to account for other DSR in the assemblage (based on the previous year's commercial harvest species assemblage). This results in a 2014 ABC of 274 mt, a decrease from the 2013 ABC of 303 mt.The overfishing level (OFL) is set using $F_{35\%}$=0.032 and adjusting 3% for the non-yelloweye rockfish species landed in the complex. This results in an OFL of 438 t. Per the 2009 Board of Fisheries (BOF) decision, subsistence DSR removals are deducted off the ABC prior to the allocation of the total allowable catch (TAC) between the commercial and sport fisheries. In the current assessment, 7 mt was deducted from the ABC for DSR caught in the subsistence fisheries. This equates to a total DSR TAC of 267 mt. In 2006 the BOF allocated the SEO DSR TAC in the following manner: 84% to the commercial fishery and 16% to the sport fishery, thus 224 mt is allocated to commercial fisheries, and 43 mt is allocated to sport fisheries for 2013.

Reference values for DSR are summarized in the following table, with the recommended ABC and OFL values in bold. The stock was not subjected to overfishing last year.

	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity	2013	2014	2014	2015
M (natural mortality rate)	0.02	0.02	0.02	0.02
Tier	4	4	4	4
Yelloweye Biomass (t)	14,588		13,274	
$F_{OFL} = F_{35\%}$	0.032	0.032	0.032	0.032
$maxF_{ABC}$	0.026	0.026	0.026	0.026
Specified/recommended F_{ABC}	0.020	0.020	0.020	0.020
Total DSR ABC (Yelloweye ABC/0.97) (t)	303		**274**[1]	274
Total DSR OFL (Yelloweye OFL/0.97) (t)	487		**438**[1]	438
Total DSR max ABC (t)	395		356	356
Status	As determined last year for:		As determined this year for:	
	2011	2012	2012	2013
Is the stock being subjected to overfishing?	No	n/a	No	n/a

[1] This year the DSR ABC and OFL were increased by 3% as the previous year's commercial catch is used to determine the percentage of non-yelloweye DSR.

Updated catch data (t) for DSR in the Gulf of Alaska as of November 9, 2013 (NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database, http://www.akfin.org are summarized in the following table.

Year	EGOA Catch Total[1]	EGOA ABC	EGOA TAC[1]
2012	176	293	240
2013	217	303	249

[1] TAC and Catch are for the commercial fishery only.

Area Apportionment

The ABC and OFL for DSR are for the SEO Subdistrict. The State of Alaska manages DSR in the Eastern regulatory area with Council oversight and any further apportionment within the SEO Subdistrict is at the discretion of the State.

Summaries for Plan Team

Species	Year	Biomass	OFL	ABC	TAC[1]	Catch[1]
	2012	14,307	467	293	240	176
	2013	14,588	487	303	249	217[2]
	2014	13,274	438	274		
	2015		438	274		

[1] TAC and Catch are for the commercial fishery only.

[2]Updated commercial catch data (t) for demersal shelf rockfish in the Southern Outside District as of November 9, 2013.

Responses to SSC and Plan Team Comments on Assessments in General

"The SSC recommends that the authors consider whether it is possible to estimate M with at least two significant digits in all future stock assessments to increase validity of the estimated OFL. 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)**

"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)**

"In conformity with the main recommendations of the working group, the Teams recommended the following: 1. Assessment authors should routinely do retrospective analyses extending back 10 years, plot spawning biomass estimates and error bars, plot relative differences, and report Mohn's rho (revised). 2. If a model exhibits a retrospective pattern, try to investigate possible causes. 3. Communicate the uncertainty implied by retrospective variability in biomass estimates. 4. For the time being, do not disqualify a model on the grounds of poor retrospective performance alone. 5. Do consider retrospective performance as one factor in model selection." **(Plan Team September 2013)**

"The Teams recommended that each stock assessment model incorporate the best possible estimate of the current year's removals. The Teams plan to inventory how their respective authors address and calculate total current year removals. Following analysis of this inventory, the Teams will provide advice to authors on the appropriate methodology for calculating current year removals to ensure consistency across assessments and FMPs." **(Plan Team September 2013)**

"The Teams recommended that research priorities be compiled in conjunction with the annual assessment cycle. Species-specific priorities would be forwarded to the SSC via the Plan Team report in November rather than as a separate agenda item for the joint Teams. Topics would be checked to see if they are an existing research priority; if new, the necessary accompanying information for the database would be provided. Revised or new priorities would be added to each stock/assemblage summary and could be compiled into a section of the Plan Team reports. The Teams requested SSC review in October of this new Joint Plan Team protocol for compilation of annual 5-year research priorities." **(Plan Team September 2013)**

Responses to SSC and Plan Team Comments Specific to this Assessment

Team members questioned the average weight calculation. The author noted that numbers of fish are available and the average weight is applied to all. This is using commercial catch data only and no size composition data are available. Team members questioned whether weight differences could be apportioned by area. She noted that length frequency data can be collected with the ROV. The Team recommends stratifying weight differences by area to evaluate how average weight differs by area and to evaluate ROV weight data compared with previous data. The author noted that video analysis should be available for use in the assessment next fall. **(Plan Team November 2012)**

Weight data are collected by management area and applied to the density estimate for each management area to determine total biomass for the stock assessment. Further stratification within a management area would result in a reduction of sample sizes and the loss of accuracy and precision. Our port sampling resources for sampling additional fish are limited. We are able to collect length frequency data using the ROV, and we are in the process of evaluating those length data for future use.

We look forward to a full analysis of the pilot ROV survey data and a revised survey design applicable to this assessment as soon as practical during the next assessment cycle. We also look forward to seeing a report on the age structured model for this stock that has been under development for some time. The SSC requests the authors provide a summary of all sources of yelloweye mortality in the GOA including a rationale for which source of mortality may be included in the assessment. We continue to encourage the investigation into alternative surveys (e.g., IPHC longline survey) in the assessment. **(SSC December 2012)**

We appreciate the Plan Team and SSC's patience as we pursue an alternative survey vehicle. We are planning on including two years of ROV survey data and methodology in a SAFE document that will be submitted to the Plan Team next September (2014). This will be in conjunction with a draft age-structured assessment model that will include ROV and submersible surveys, commercial and sport fishery data, and IPHC longline survey data. We had hoped to have a draft SAFE this year, but we have undergone another staffing change in our Biometrics division, which has delayed our progress. As for the sources of DSR mortality, we have historically included this in our document. Please note the table on the following page under *Fishery:* Total DSR Removal. Per the 2009 Board of Fisheries, subsistence catch is deducted from the ABC prior to allocation of the TAC as described in the *Summary of Results*, above.

"The Team recommended that the authors look into differences between length frequencies from the ROV survey versus the commercial fishery. Are there discards from the commercial fishery that are not being accounted for, or is there another reason that length frequencies are different?"
(Plan Team September 2013)

We thank the Plan Team for their recommendations on this topic and we are continuing to explore the length frequency data and potential sources of error or bias in these results. We will be reviewing the 2013 survey data this winter and will compare the length frequencies from the ROV survey to the commercial fishery landings.

Since so many of the area specific density estimates are based on dated survey data, the Plan Team recommended that the authors provide time series estimates and smoothing as an option for the Plan Team for the November meeting (additional analysis). The data could be run through the random effects model developed by the Teams' survey average working group."
(Plan Team September 2013)

We appreciate this suggestion, and have provided the results of the random walk time series model estimates in Appendix 1 of this document.

The Plan Team recommended that the authors provide a draft SAFE to the Plan Team next September (2014) with the revised ASA model and 2012 and 2013 ROV survey data. The 2014 survey data will not be available for the September 2014 draft document, but may be available for the November 2014 meeting. The Plan Team recommended that the authors also continue to look into the IPHC longline survey data as another index of yelloweye rockfish relative abundance to include into the ASA.
(Plan Team September 2013)

We agree with this plan and have provided an executive summary for this November's meeting with an expanded Appendix containing the random walk time series model results for an alternate option for calculating DSR biomass. We continue to work on a draft age-structured assessment and will incorporate the fishery data, ROV and submersible survey density inputs, and the IPHC survey data if applicable into this model. A draft SAFE will be presented to the Plan Team in September 2014.

"The SSC received the Plan Team report on the Southeast Demersal Shelf Rockfish (DSR) assessment. In light of the change in survey methodology from use of a submarine to use of a remotely operated vehicle (ROV) without the ability to do a side-by-side comparison, the SSC recommends authors review earlier comparisons of submarine and ROV equipment (O'Connell and Carlisle 1994) for potential differences in coverage." **(SSC, October 2013).**

We appreciate the SSC's concern and are also disappointed that a side-by-side study was not possible despite our best efforts. We reviewed O'Connell and Carlile (1994) in detail prior to developing an ROV survey for Southeast Alaska. In the O'Connell and Carlile (1994) study, technical difficulties with the ROV precluded the collection of sufficient yelloweye rockfish observations for a density estimate, Thus, no comparisons could be made between the ROV and the submersible in terms of catchability. The paper's conclusions that the submersible was a better vehicle for surveying were correct, in that the ROV that was used did not perform well. However without an ROV-derived density estimate, no conclusion could be made regarding the differences in fish observations between the two vehicles. After consulting with the original authors of the paper, as well as the ADF&G Central Region staff, who have successfully been running ROV surveys since 2002, the consensus was that the improvements in ROV technology and maneuverability in the past 18 years are substantial, and there was merit in attempting a second trial of an ROV for stock assessment surveys. Although we were not able to conduct a side-by-side comparison study, Yoklavich et al. (2013) published a preliminary report that describes fish abundances derived from an ROV versus a submersible (the Nuytco *Dual Deep Worker*). Although the *Dual Deep Worker* is designed differently than the *Delta*, this represents the best comparison data available from a submersible versus an ROV. We look forward to reviewing the final report from this study, but it is promising that abundance estimates and CVs for large, solitary, demersal rockfish species were similar among the two vehicles in this study. Our results to date indicate that the ROV is promising tool for assessing DSR in the Eastern Gulf of Alaska. Although we cannot make a direct comparison between the two survey vehicles,

the 2012 ROV survey density estimate was within the range of the previous density estimates for CSEO and followed a similar trend line. The associated CV (12%) was within the range of variance estimates (11–20%) calculated from previous submersible density estimates in CSEO.

Fishery

2013 Total DSR Removal

The total directed and incidental commercial catch of DSR is accounted for in the table below through October 1, 2013. This will be updated through November 7, 2013 at which date both the directed and halibut fisheries will be closed, and thus catch for 2013 can be accurately accounted without the need to project through the end of the year. Incidental commercial catch includes DSR caught in the lingcod, Pacific cod, halibut, and sablefish fisheries. Overages refer to primarily to DSR landed in excess of the allowed bycatch of DSR in the halibut fishery (equal to 10% of the target species). Recreational removals are projected for 2013 as described in the following section. Research catches are based on yelloweye rockfish reported on fish tickets from the IPHC survey. Subsistence removals (7 t) are estimated using ADF&G subsistence harvest data and deducted from the ABC prior to allocation of the TAC. Catches are not projected through the end of year since the commercial fisheries (directed and incidental) are closed in SEO as of November 7, 2013.

Preliminary recreational, research, subsistence, and commercial catch from 2013 in metric tons.

2013 DSR Catch SEO (t)	***Directed Commercial***	***Incidental Commercial[1]***	***Recreational Fisheries[2]***	***Research***	***Subsistence***	***Total***
Landed	127	63	30	4		224
Estimated	0	1	5		7	13
Overages	3	21	0			24
Total	**130**	**85**	**35**	**4**	7	**261**

[1] All commercial incidental landings through November 9, 2013 (halibut, lingcod, Pacific cod, sablefish).
[2] Sport landings are preliminary estimates for 2013.

2012–2013 Recreational Fishery Removals

The 2012 harvest biomass was estimated using a combination of Statewide Harvest Survey (SWHS), creel survey, and charter logbook data. The total removals were estimated as the sum of the mass of the harvest (retained catch) and release mortality (Brylinsky et al. 2009). Harvest biomass estimates were stratified by user group (charter, non-charter) to reduce potential bias caused by non-proportional sampling. Harvest from the EYKT (East Yakutat) portion of the Southeast Outside (SEO) area was also included in the harvest estimation, although the harvest was less than 0.1 mt. Estimating the proportion of non-charter harvest that came from the SEO waters of each SWHS area continues to be problematic due to the lack of data from a comprehensive set of landing sites for non-charter harvest. This was addressed by applying the outside proportion calculated for the charter fleet from logbook data to the non-charter harvest as well. Non-charter removals accounted for 27% of the sport removals in 2012.

Because SWHS estimates are only available through 2012, preliminary estimates were provided for 2013. Charter and non-charter harvest were projected separately. Charter harvest for each SWHS area was projected from mandatory charter logbook data through July 31 using linear regression. The only inseason data available for the non-charter sector is from creel survey interviews. Because the relationships between creel survey data and SWHS estimates were weak, the SWHS non-charter harvest was projected using ARIMA time series forecasts. Candidate models for each area were evaluated using Akaike Information Criteria corrected for small sample sizes. This is the same method the SSC recommended for non-charter halibut projections.

The 2013 preliminary release mortality biomass was also estimated using the same method as last year, including the assumption that released rockfish experience 100% mortality (Green et al. 2012). Beginning in the 2013 season, all charter operators in Southeast Alaska were required to possess and utilize deep-water release devices for releasing rockfish. Discussions on what mortality rate to apply to 2013 charter released rockfish estimates will occur prior to finalizing the 2013 charter release mortality estimates in October 2014. The release proportions from logbook data were applied specifically for yelloweye rockfish, and the release proportion for all other non-pelagic species was applied to the remaining DSR species. Efforts to improve harvest projections are ongoing. Harvest projections for charter and non-charter sport fisheries are imprecise due to high year-to-year variability in the harvest estimates.

Final estimates of 2012 and preliminary estimates of 2013 recreational DSR removals (retained and discard mortality, mt) in the SEO portion of Southeast Alaska. Estimates were stratified user group (charter, non-charter) but combined for this table.

Type of Estimate		***2012***	***2013***
Retained Harvest	Estimate	39.9	30.1
	StdErr	1.7	1.8
	95% CI[a]	36.6-43.2	26.5-33.7
Discard Mortality	Estimate	6.0	4.7
	StdErr	0.3	0.3
	95% CI[a]	5.4-6.6	4.1-5.3
Total	**Estimate**	**45.8**	**34.8**
	StdErr	2.0	2.1
	95% CI[a]	42.0-49.7	30.6-38.9

[a] Confidence intervals assume normal distribution of estimates.

Data Gaps and Research Priorities

The *Delta* submersible has been integral in the generation of a long (20+ year) time series of rockfish density data for stock assessment. The DSR stock assessment has been designed around the *Delta* as a survey tool, and now in its absence, we are transitioning to an ROV for use as a survey. We have conducted two ROV surveys to date, and plan to conduct a third survey next August 2014. The data from the August 2013 survey will be analyzed this winter. The ROV survey will be included as a data input in the yelloweye rockfish age-structured model.

Acknowledgements

The authors would like to thank Kamala Carroll for her help with data summaries.

Literature Cited

Green, K., D. Carlile, M. Jaenicke, and S. Meyer. 2012. Assessment of the demersal shelf rockfish stock for 2011 in the southeast outside district of the Gulf of Alaska. Chapter 14 IN 2011 Stock Assessment and Fishery Evaluation Report for 2012. North Pacific Fishery Management Council, Anchorage, AK.

Brylinsky, C., J. Stahl and D. Carlile. 2009. Assessment of the demersal shelf rockfish stock for 2010 in the southeast outside district of the Gulf of Alaska. Chapter 15 IN 2010 Stock Assessment and Fishery Evaluation Report for 2010. North Pacific Fishery Management Council, Anchorage, AK.

O'Connell, V.M., and D.W. Carlile. 1994. Comparison of a remotely operated vehicle and a submersible for estimating abundance of demersal shelf rockfishes in the eastern Gulf of Alaska. N. Am. J. Fish. Manag. 14:196-2

Yoklavich, Mary, Tom Laidig, Diana Watters, and Milton Love. 2013. Understanding the capabilities of new technologies and methods to survey west coast groundfishes: Results from a visual survey conducted in 2011 using the Dual Deepworker manned submersible at Footprint and Piggy banks off Southern California. [Final report to NMFS Science Advisor for Stock Assessments.] U.S. National Marine Fisheries Service, Santa Cruz, California. 28 p.

Appendix 1.

Time Series Random Walk Model Approach

Historically, total yelloweye rockfish biomass is estimated for each management area in the EGOA as the product of density, mean fish weight, and area estimates of rockfish habitat. Yelloweye rockfish density is derived using line transects conducted from the most recent submersible or ROV survey in each management area. However, at the Plan Team's September 2013 recommendation, in this Appendix we present a model-based approach developed by the Plan Team's survey averaging working group. In this approach, the estimates of yelloweye rockfish density in each management area were obtained by a random walk time series model in which process errors are the difference in density between successive years and are estimated as random effects.

Tables A1–A4 summarize model outputs for each management area. Figures A1–A4 show a graphical representation of the model estimated density and survey densities of yelloweye rockfish. The lower 90% confidence interval (Lower 90 (est)) of the model output for the 2013 density estimate (Tables A1–A4) was used to calculate area biomass. Biomass was calculated the same way as in previous stock assessments, i.e. as the product of yelloweye rockfish density, average weights from yelloweye rockfish sampled in the commercial fisheries, and area (km^2) of DSR habitat. Using the new model-derived density estimates, (but the same average weights and habitat area as in the main document) resulted in the following changes to the biomass estimate for each management area from 2012 (4,770 to 3,370 mt in EYKT, 4,051 to 2,828 mt in CSEO, 4,461 to 3,083 mt in SSEO and 1,305 to 724 mt in NSEO).

The total yelloweye rockfish biomass estimate using this approach is 10,005 mt (versus Option 1 in the main document of 13,269 mt). This alternate option would result in an ABC of 206 mt, a difference of 66 mt from Option 1 provided in the main document. Model estimates of density for 2013 were close to the survey densities, with the exception of NSEO (Figure A3), however in this area survey data are sparse (only two data points). Point estimates of yelloweye rockfish densities for CSEO and EYKT were forecasted to increase in 2013 in the model, while NSEO and SSEO were forecasted to decrease. However, the lower 90% confidence interval (Lower 90 (est)) was used to calculate DSR biomass in each area for the EGOA; and these densities were lower than the previous survey years. It should be noted that historically the lower 90% confidence interval was used from the *biomass* estimates (i.e. in Option 1); but in this option, the lower 90% of the *density* estimates is used to calculate biomass. The point estimate of biomass was then used to calculate the ABC in Option 2. Provided below is a summary of the two options.

	Option 1 (historic approach)	Option 2 (model-based approach)
Yelloweye biomass (t)	13,274	10,005
DSR biomass (t)	13,685	10,314
ABC (t)	274	206
OFL (t)	438	330
Max ABC (t)	356	268

If the model-based approach is used, the TAC would be 199 mt (after the ABC is decremented by 7 mt to allow for subsistence catch). The commercial and sport TAC (84%/16% split) would be 167 mt and 32 mt respectively.

Table A1. Central Southeast Outside (CSEO) management area. Mean (obs) is the observed submersible or ROV (2012 only) yelloweye rockfish density estimate. CV (obs) is the observed coefficient of variation from the survey. Mean (est) is the model derived density estimate. Upper (Lower) 90 (est) are the model-derived upper and lower 90% confidence intervals of the Mean (est). All density estimates are number of yelloweye rockfish per square kilometer.

Year	Mean(obs)	CV(obs)	Mean(est)	Log scale St. Dev.	Upper 90(est)	Lower 90(est)
1995	2929	0.188318	2788.99	0.165860	3663.86	2123.02
1996			2652.33	0.189606	3623.14	1941.64
1997	2534	0.198916	2522.37	0.160949	3286.94	1935.64
1998			2388.65	0.221417	3438.24	1659.47
1999			2262.02	0.248854	3406.28	1502.15
2000			2142.1	0.254189	3254.14	1410.08
2001			2028.54	0.238909	3005.14	1369.32
2002			1921.01	0.198305	2661.95	1386.3
2003	1865	0.111849	1819.17	0.106555	2167.69	1526.68
2004			1602.5	0.186551	2178.07	1179.02
2005			1411.64	0.207434	1985.71	1003.53
2006			1243.51	0.189833	1699.29	909.972
2007	1068	0.126591	1095.4	0.117575	1329.14	902.767
2008			1022.04	0.197461	1414.29	738.583
2009			953.594	0.227332	1386.03	656.076
2010			889.732	0.227796	1294.2	611.671
2011			830.146	0.199060	1151.77	598.334
2012	752	0.124516	774.551	0.121985	946.668	633.726
2013			774.551	0.226362	1124	533.744

Table A2. East Yakutat (EYKT) management area. Mean (obs) is the observed submersible survey yelloweye rockfish density estimate. CV (obs) is the observed coefficient of variation from the survey. Mean (est) is the model derived density estimate. Upper (Lower) 90 (est) are the model-derived upper and lower 90% confidence intervals of the Mean (est). All density estimates are number of yelloweye rockfish per square kilometer.

Year	Mean(obs)	CV(obs)	Mean(est)	Log scale St. Dev.	Upper 90(est)	Lower 90(est)
1997	4176	0.178567	3778.37	0.167419	4976.35	2868.79
1998			3458.74	0.187068	4705.03	2542.57
1999	2323	0.301422	3166.15	0.201611	4411.29	2272.47
2000			3190.33	0.214709	4541.8	2241.01
2001			3214.71	0.212923	4563.06	2264.78
2002			3239.26	0.195844	4470.54	2347.1
2003	3557	0.170748	3264.01	0.158609	4237.05	2514.42
2004			3026.83	0.203390	4229.54	2166.13
2005			2806.89	0.226727	4075.71	1933.07
2006			2602.94	0.235097	3831.95	1768.1
2007			2413.8	0.230137	3524.63	1653.06
2008			2238.4	0.210909	3166.76	1582.2
2009	1930	0.164873	2075.75	0.172713	2757.81	1562.38
2010			2075.75	0.240801	3084.66	1396.83
2011			2075.75	0.293497	3363.99	1280.85
2012			2075.75	0.338077	3619.95	1190.28
2013			2075.75	0.377427	3862.03	1115.67

Table A3. Northern Southeast Outside (NSEO) management area. Mean (obs) is the observed submersible survey yelloweye rockfish density estimate. CV (obs) is the observed coefficient of variation from the survey. Mean (est) is the model derived density estimate. Upper (Lower) 90 (est) are the model-derived upper and lower 90% confidence intervals of the Mean (est). All density estimates are number of yelloweye rockfish per square kilometer.

Year	Mean(obs)	CV(obs)	Mean(est)	Log scale St. Dev.	Upper 90(est)	Lower 90(est)
1994	839	0.272653	966.305	0.307095	1601.43	583.071
1995			995.137	0.280930	1579.73	626.877
1996			1024.83	0.264935	1584.62	662.793
1997			1055.41	0.260990	1621.34	687.014
1998			1086.9	0.269621	1693.6	697.538
1999			1119.33	0.289707	1802.72	695.003
2000			1152.73	0.319093	1948.46	681.964
2001	1420	0.307021	1187.12	0.355478	2130.36	661.509
2002			1187.12	0.376604	2205.7	638.915
2003			1187.12	0.396606	2279.48	618.235
2004			1187.12	0.415648	2352.01	599.17
2005			1187.12	0.433856	2423.52	581.49
2006			1187.12	0.451328	2494.19	565.015
2007			1187.12	0.468149	2564.17	549.595
2008			1187.12	0.484385	2633.58	535.11
2009			1187.12	0.500096	2702.53	521.458
2010			1187.12	0.515327	2771.1	508.555
2011			1187.12	0.530120	2839.36	496.329
2012			1187.12	0.544511	2907.37	484.717
2013			1187.12	0.558531	2975.21	473.666

Table A4. Southern Southeast Outside (SSEO) management area. Mean (obs) is the observed submersible survey yelloweye rockfish density estimate. CV (obs) is the observed coefficient of variation from the survey. Mean (est) is the model derived density estimate. Upper (Lower) 90 (est) are the model-derived upper and lower 90% confidence intervals of the Mean (est). All density estimates are number of yelloweye rockfish per square kilometer.

Year	Mean(obs)	CV(obs)	Mean(est)	Log scale St. Dev.	Upper 90(est)	Lower 90(est)
1994	1173	0.274733	1520.11	0.295456	2471.45	934.969
1995			1574.17	0.261752	2421.31	1023.42
1996			1630.15	0.228601	2374.35	1119.21
1997			1688.13	0.196284	2331.49	1222.3
1998			1748.16	0.165289	2294.39	1331.98
1999	1879	0.169867	1810.33	0.136521	2266.16	1446.19
2000			1850.26	0.154395	2385.26	1435.26
2001			1891.07	0.166384	2486.43	1438.27
2002			1932.78	0.173711	2572.09	1452.38
2003			1975.42	0.176957	2642.89	1476.51
2004			2018.99	0.176347	2698.48	1510.6
2005	2196	0.170357	2063.52	0.171840	2737.62	1555.4
2006			2063.52	0.199249	2863.88	1486.83
2007			2063.52	0.223320	2979.55	1429.11
2008			2063.52	0.245037	3087.92	1378.96
2009			2063.52	0.264018	3190.9	1334.45
2010			2063.52	0.283523	3289.74	1294.36
2011			2063.52	0.300927	3385.28	1257.83
2012			2063.52	0.317377	3478.14	1224.25
2013			2063.52	0.333016	3568.78	1193.16

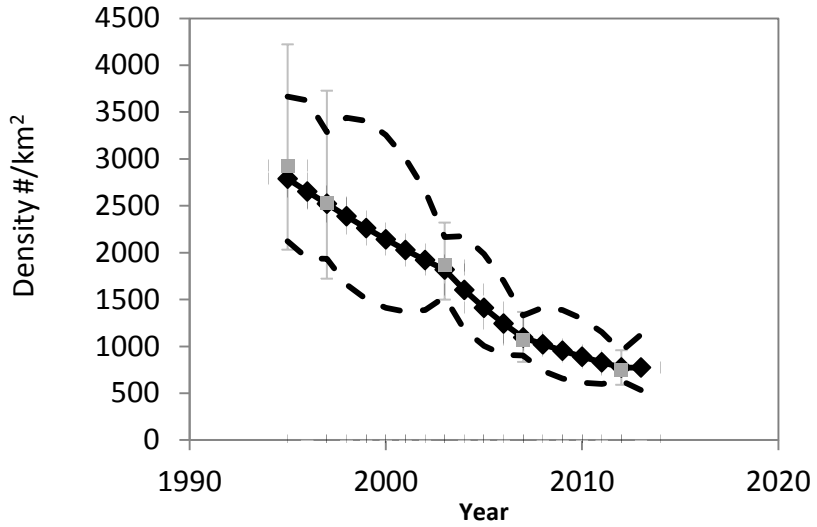

Figure A1. Central Southeast Outside (CSEO) observed (grey squares) and model-derived (black diamond) density estimates of yelloweye rockfish in (#/km^2). The grey triangle (2012 density) is the observed survey density from the remote operated vehicle (ROV). All other observed data are based on submersible surveys. Dashed lines are 90% confidence intervals.

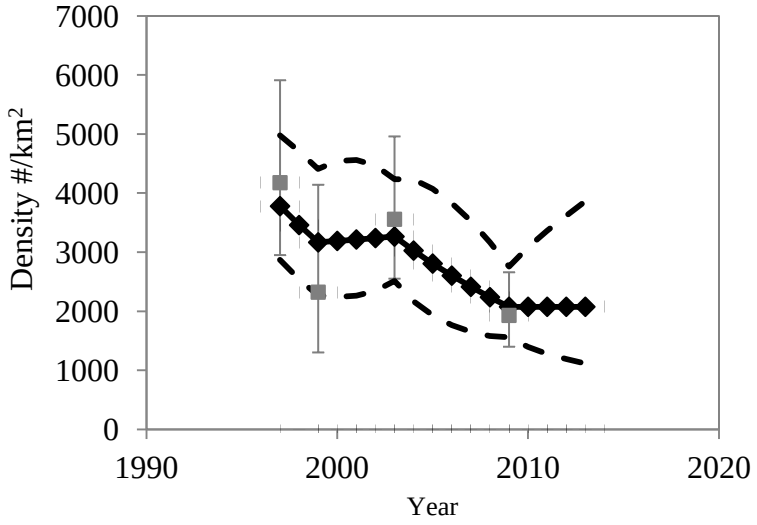

Figure A2. East Yakutat (EYKT) observed (grey squares) and model-derived (black diamond) density estimates of yelloweye rockfish in (#/km^2). Dashed lines are 90% confidence intervals.

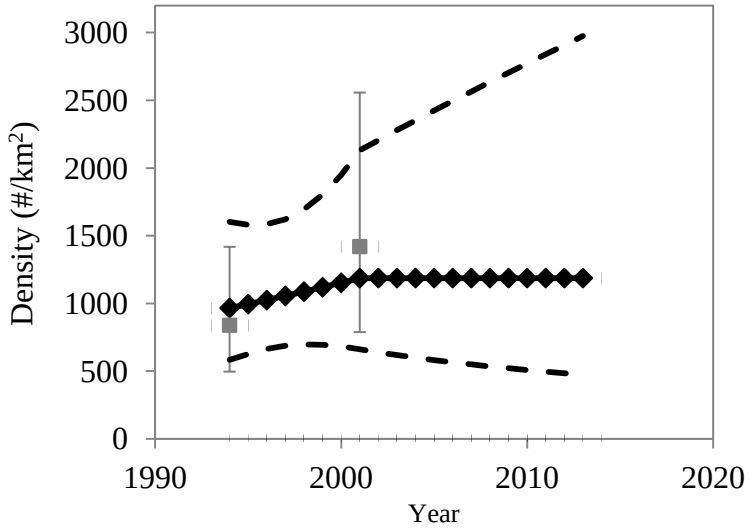

Figure A3. Northern Southeast Outside (NSEO) observed (grey squares) and model-derived (black diamond) density estimates of yelloweye rockfish in (#/km^2). Dashed lines are 90% confidence intervals.

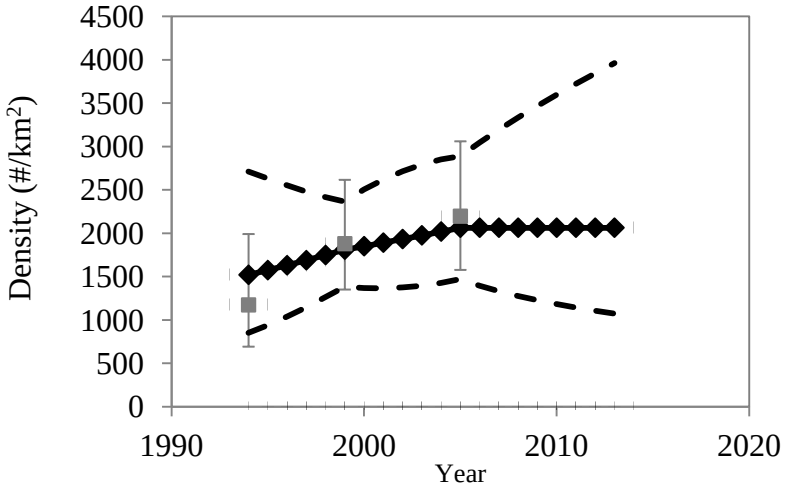

Figure A4. Southern Southeast Outside (SSEO) observed (grey squares) and model-derived (black diamond) density estimates of yelloweye rockfish in (#/km^2). Dashed lines are 90% confidence intervals.

(This page intentionally left blank)