SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

SSC & SEP SARIMA

Webinar

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Summary Minutes

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Observers & Participants

Dr. Nick Farmer

Other observers and participants attached.

The Scientific and Statistical Committee of the South Atlantic Fishery Management Council convened via webinar on May 7, 2018, and was called to order by Dr. Marcel Reichert.

INTRODUCTION

DR. REICHERT: Let's get started. I want to welcome everyone, especially the members of the SEP. I cannot see a list of participants, but, Mike, do you need a round of introductions from us for the recording?

DR. ERRIGO: Actually, no. I think that's fine. I have the list of all the people who are here, and so I think that will be fine.

DR. REICHERT: Thank you. I am asking all the members to state their name before they say something. That will help with the recording, and it will also help to identify folks. I would like to review and approve the agenda. Are there any comments on the agenda? Hearing or seeing none, and no one raised a hand, then we approve the agenda.

We have an action item to review the SARIMA model and its utility providing managing advice for the council regarding commercial trip limits, and note that prior to the -- We discussed this at our last SSC meeting, and we had some recommendations for the council, but we also had some questions, and, prior to the SEP meeting, and after the council received the SSC report, the council also requested that the SSC take another look at the model. Mike, correct me if I'm wrong, but we have Nick Farmer on the webinar, who conducted the analysis, and he has prepared the presentation, correct?

DR. ERRIGO: Yes, Nick is on the line.

DR. FARMER: I just emailed out the presentation that I will be giving this morning to everyone.

DR. REICHERT: Thanks, Nick, for preparing that presentation, and I will hand it over to you.

REVIEW OF THE SARIMA MODEL

DR. FARMER: All right. Sounds good. I am going to try to make this fairly quick, but we want to talk about Regulatory Amendment 27, which intends to modify commercial regulations, including fishing seasons, trip limits, seasonal closures, and size limits for snapper grouper species, and the intention for the council is to enable equitable participation and minimize discards, and so I wanted to touch real quick on the big challenge for the analysis, which is that most of the species in Regulatory Amendment 27 are indirectly-harvested species that are caught while fishermen are pursuing other more highly-desirable or more common stocks.

There is usually a fair amount of uncertainty in the historical data, and those actions that do involve targeted species are often considering rearranging seasonal closures, and therefore they require the extrapolation of catch rates, periods that have been closed, either recently or for a long time period, and a lot of those stocks also have a very complex recent management history which requires either a lot of adjustment on the catch rate projection side or just some assumptions.

I prepared two sets of catch rate projections, and, when I say catch rate, what I'm talking about is a projection of landings in pounds per open federal day for each month of the fishing season, and so it's a daily catch rate, but it varies on a monthly basis, if that makes sense, and so there are two models that I used, one which I will refer to as the Last 3 model, and that is the mean monthly catch rates from 2014 through 2016, and so just a simple average, and then there is a SARIMA, or Seasonal Autoregressive Integrated Moving Average Model.

The Last 3 model is the mean and standard deviation from 2014 through 2016, and that's used to generate monthly mean and 95 percent confidence interval projection estimates for daily catch rates, and then we expand those daily catch rates into estimates of monthly landings by multiplying by the number of open days in each month.

The SARIMA model is a lot more rigorous. It's based on Box et al. 2013, and there's an autoregressive component that represents the lingering effects of previous observations, and there's an integrated component, which represents temporal trends, and there is a moving average component, which represents lingering effects of previous random shocks, or error, and it's a SARIMA model, as opposed to an ARIMA model, because there are up to two differencing terms considered, and one is an annual differencing term and the other is a monthly differencing term.

We explored all possible combinations of single-difference, monthly, and annual SARIMA models, and so there is about eight models that can come up from that, and they were fit using conditional lease squares, and this process is described in more details in Farmer and Froeschke 2015, which is an attachment in the SSC briefing book. Model selection for the best fitting model of those eight was guided through examination of stationary tests, autocorrelations, inverse autocorrelations, partial autocorrelations, cross-correlations, residual diagnostics, and AIC.

There are some theoretical differences between these models. The Last 3 is a simple average, and it's highly sensitive to recent trends, because it's only based on recent data. The SARIMA model is a statistical fit to the data, and it's based on a much longer time series. I think most of the SARIMA models were fit from 1997 forward, and so that's accounting for any seasonal and/or interannual trends, including population trends and trends in increasing or decreasing effort in the fishery, and it is sensitive to recent trends, but it also captures long-term trends, and, at least in our paper on recreational fisheries forecasting, it was shown to provide a superior fit to catch trends as compared to using recent years data.

My advice for selecting the best model when no validation is available is that, if the Last 3 and the SARIMA projections are very different, that's an indication that the historical data is not informative of future trends. If the Last 3 and SARIMA projections are similar, but the 95 percent confidence intervals are very wide, that suggests high variability in the historical data, and that was true pretty much across the board, and then, if the Last 3 and SARIMA projections are similar, and they have relatively tight 95 percent confidence intervals, that's an indication that you have a robust prediction, where it's robust both to process error and model error. If validation is available, which validation did become available for these models, then here's what I did. This is something that you all haven't seen or discussed yet, and I think this is the way to go.

All the models were fit with data through 2016, and that was because Regulatory Amendment 27 was developed way back when, and that was the last time series point that we had available. Now we have data for 2017, and so what I've done is I compared the Last 3 and SARIMA predictions

to 2017 for each action in Regulatory Amendment 27, and I compared those to the observed data for 2017 that became available about a year into the development of Regulatory Amendment 27. I provided my recommendation for the best fitting model based on that 2017 retrospective fit in comments to council staff for each of the actions back in early February of 2018, and so this is our chance to finally talk about those.

I'm just going to walk you through each of the actions that involve catch rate projections, and so this is Action 1, which is the split season and modified commercial trip limit for blueline tilefish. My comments here is that the Last 3 and SARIMA model catch rates were extremely close, and that suggested relatively robust estimates of closure dates for the various alternatives.

Here is your SARIMA model fit, and I'm going to show you a lot of these, and so I'm just going to walk you through, and this is your daily catch rates in pounds per open federal day, and this is your time series of model fit, and so you can see there is kind of a burn-in period, and then the model begins fitting to the observed data and the observed -- That is denoted by these circles, and the blue bands here are the 95 percent confidence limits, and then you can see the terminal data here and then the projection of the model fit.

You can see that blueline tilefish was relatively stable in the past, and then it started to get kind of noisy, and you have a few management things going on here and increased targeting. The catch rates start skyrocketing, and the model sort of interprets that recent trend as being a big driver for model fit in the future, and the Last 3 model fit, of course, averages over 2014 through 2016, and so it's also looking very carefully at this same time series, which is why the models have very similar outcomes.

Looking at projected landings by month with a 95 percent confidence interval, you can see the differences, and they are relatively consistent on a monthly basis, with the Last 3 in gold and the SARIMA in blue, and these 95 percent confidence intervals are shown with the error bars here, and you can see that there is a lot of noise for the core of the season, especially July and August, and there are some differences throughout the time series. However, when you get to the final answer, the cumulative landings time series look very similar, and this is actually an instance where the Last 3 model fit has a wider confidence interval than the SARIMA model, which is not common.

Then this right here -- We'll be looking at a few of these graphics, and so just to orient you to this type of graphic, but this is your cumulative landings in millions of pounds whole weight for both the SARIMA over here on the right and the Last 3 on the left, and this is your mean prediction as the solid line and your 95 percent confidence interval as the dotted line for the upper and lower limit, and then this is your ACL, your commercial annual catch limit, is the dark black horizontal line.

Anyway, the models provided very similar fits. Therefore, in the table that I provided to council staff back in February, I included both models, and so you can see these are the projected closure dates under the Last 3 and the SARIMA model. If you're just glancing between the mean estimates, the 7 July versus 13 July, 12 June versus 25 June, 11 August versus 9 August, and they are very similar in terms of what they predict is going to happen.

Moving on to Action 2, we are asked to establish a commercial split season for snowy grouper, and there have been numerous changes in trip limits and other regulations for snowy grouper, and that likely makes the recent data a poor predictor of future trends. The projections are poorly informed, and the SARIMA model interprets the much higher observed catch rates in 2015 and 2017 as a rapid acceleration in fishing pressure, and the Last 3 prediction is more consistent with observations of recent fishing pressure and the increasing ACL.

Based on fits to 2017, the Last 3 model was an 11 percent underestimate of the observed data, whereas the SARIMA model was a 147 percent overestimate, and so the SARIMA model way overestimated or way overinterpreted the recent trends, and so I'm recommending the Last 3 model for that action. However, caution should be exercised in the interpretation of the results, because the SARIMA model's predictions are very conservative as compared to the Last 3, and there are broad confidence limits for the Last 3 prediction.

Here is the SARIMA fit, and you can see how it takes this jump here in the last piece of the time series and interprets that as very important to the future trend, and so it's kind of a skyrocketing catch rate predicted. Here is your projected landings, and you can see, relative to the ACL, that the SARIMA model predicts that you're going to hit that annual catch limit much sooner than the Last 3 model.

Under the projected closure dates, I sent to council staff a table, and I have an asterisk denoting the Last 3 is the preferred model, and, again, you can see, under the no action, you have a difference between a projected closure date of 21 September as opposed to 19 March, and so it's a huge contrast in projection results.

Under Action 3, the commercial season and modify the commercial trip limit for greater amberjack, the SARIMA model projects much higher future catch rates than the Last 3 model, due to higher catch rates in 2016 relative to prior years. There are October closures recently that suggests some stabilization in the 2016 and 2017 catch rates. We haven't been closing earlier, and it's been kind of a consistent closure date the last few years, and, for the fits to 2017, the Last 3 was within 9 percent of the observed, whereas the SARIMA is a 32 percent overestimate, and the Last 3 model predictions are thus recommended to guide management decision-making for this action.

Here is your SARIMA fit, and you can see it's a very consistent pattern through time, and then there is a little bit a jump here kind of towards the end, and the SARIMA model really interprets that as kind of a new normal stabilization of a higher catch rate, whereas the Last 3 integrates across this time period here, and so it has lower estimates, and you can see, again, the Last 3 results in a projection of a much longer season with much tighter confidence limits, as opposed to the SARIMA, which is saying, well, there is a lot of variability in that historical data and a big change recently, and so it interprets that as, yes, you're either going to close really early or you could be open or closed early. You look at these confidence limits, and the model is poorly informed, basically. We're looking at projected closure dates, and, again, this table was provided to council staff, and the Last 3 has an asterisk, and you can see the projected closure dates, and there is a lot of alternatives and sub-alternatives here.

Action 4 is the commercial split season and modified commercial trip limits for red porgy. There has been one recent closure of red porgy commercial harvest, and the landings from 2015 to 2017

were below the commercial ACL. The landings in 2017 were slightly lower than those in 2016, and that is a downward trend, and SARIMA really latches on to that and interprets that as a decline. In terms of the fits to 2017, the SARIMA model fit for 2017 was within 1.6 percent of the observed, and so that's a very nice model prediction. The Last 3 was a 24 percent overestimate, and, therefore, the SARIMA was recommended for this action. Here is your SARIMA model fit, and you can see that it kind of interprets this decline as continuing into the future, and you can see that it was actually fair low historically as well.

There is your projected landings through time. Alternative 1 shows you that the SARIMA model fit dark line here, and the mean is slightly lower than the Last 3 dark line here, and the Last 3, again, has tighter confidence limits, whereas the SARIMA has a very high upper confidence limit and basically no meaningful lower confidence limit.

Then you can see Alternatives 2 through 3 are talking about split seasons, and so you can see the model kind of walks you through here is your Season 1 ACL and here is your Season 2 ACL, and you're walking through it. There is your projected closure dates table, with SARIMA with an asterisk, and, basically, you're not predicting, for Alternatives 1 through 4, any closure other than the upper confidence limits of the closure, but, again, this is an instance where some level of caution should be exercised by the council, due to the differences in the model projections.

Action 5 is to modify the commercial trip limit for vermilion snapper, and that's an evaluation of 2017 observed catch rates, and it's suggesting that the SARIMA model provides a superior prediction, and so, for the Season 1, January 1 through May 17, 2017, the SARIMA model prediction was a 26 percent overestimate, whereas the Last 3 was an 83 percent overestimate.

For July 1 to October 17, SARIMA overestimated by 39 percent, and the Last 3 overestimated by 42 percent, and so it's fairly tight for Season 2 between the two models. In all instances, the models are overestimating landings relative to what we observed in 2017, and so that's a little bit of a concern as well. The SARIMA model projections are recommended to guide management decision-making. However, the predicted closure dates may be conservative.

Here is your SARIMA model fit, and then here is your projected landings through time, and you can see that the models are relatively close for Season 1, with SARIMA estimating a slightly lower trajectory kind of in the middle of the fishing year, as opposed to the Last 3, and you can see, for Alternative 1, that is a very nice instance where two models are providing almost identical answers, and that kind of trend persists in many of the results for vermilion snapper, and so I would say, for this particular action for vermilion snapper, you at least have some consistency between the models, and that suggest a robust estimate. However, a red flag is they did overestimate 2017 by a fair amount.

Here is your projected closure dates for Season 1. This may be an instance where the council can be a little less precautionary, because, as indicated by the retrospective fit, these models may be slightly conservative.

Action 8 is the next one that has any sort of catch rate projection in it, and this is not one where I applied any Last 3 or SARIMA models. This was for red grouper in the EEZ off of South Carolina and North Carolina. The trick with this one was it required backfilling of landings for the January

through April closed time period, which has been closed -- Portions of it have been closed for a very long time, and then half of it has been closed since mid-2009.

Assuming no temporal redistribution of effort, based on my backfilling, it suggested that Sub-Alternative 2a would eliminate 12 percent, 2b would eliminate 8 percent, and 2c would eliminate 18 percent of additional annual landings from the current closed time period, and the assumption that there would be no temporal redistribution of fishing effort actually appears substantiated by the commercial landings data, which I was surprised by.

You tend to assume that you will get redistribution of effort and you will get some inflation of landings in other time periods. However, I will show you this figure on the next slide, and that shows the elimination of four months of fishing substantially reduced the annual landings of red grouper off of North Carolina and South Carolina, and that decline has persisted through time. You can see this is the landings through time. January through April are denoted in the blue and May through December in the gold, and you can see January through April make up a fair amount of the North Carolina through South Carolina landings, and they drop off with the initiation of the closure, and your cumulative landings fall off the shelf for that area at that time period.

That is all I had to show you guys today, and I hope that was informative. I felt like doing the retrospective fit removed quite a bit of the uncertainty, in terms of which model to use, and it moved us away from kind of a theoretical model prediction, in terms of which model to use, and it moved us more into an empirically-validated model prediction, and that was really just -- It's not something that we'll always be able to do, but, in this particular instance, because this amendment took so long in development, we actually received data for 2017 halfway through the development of the amendment and could use that for some validation. If anyone has any questions, but that's all I had to say.

DR. REICHERT: Thank you, Nick. I appreciate that overview. I was looking at the agenda, and there is public comment, and so I would like to see if we have received any public comment or if anyone from the public is sticking up their hands on the webinar.

DR. ERRIGO: I do not have anyone with their hand raised.

DR. REICHERT: Thank you. Then I will open the floor for questions and comments from the committee for Nick. Anyone?

DR. DUMAS: Thanks, Nick. That was a great overview, and so it seems to me, based on your presentation, that sometimes you're recommending the Last 3 model as the preferred model and other times the SARIMA model as the preferred model, and I see why you do that, and so have you gone down the path of sort of building a model of when to use each model, and so a model of the two models, or just some criteria to use so that you could say which of the two models would likely be best to use in a particular situation and what are the factors on the ground, or the policy factors, that would cause one model to be better than the other ahead of time?

DR. FARMER: For these indirectly-targeted species, the issue really comes down to whether the most recent one or two data points and any trend in those is real. In instances where you have extremely high catch rates in the terminal year of the data, the SARIMA model tends to interpret that as a launching-off of kind of a new regime of fishing, with increased effort and targeting, and,

if that bears true, then the SARIMA projections tend to do really well in the retrospective, once you get that data point in. When they don't, you kind of are splitting the difference. The SARIMA model is going to overestimate, and the Last 3 is going to underestimate, if you stayed flatline, and so this is an instance where these models both rely on historical data to inform what's going to happen.

The SARIMA is a lot more sensitive to trends in that historical data, obviously, because it's not a simple average. There is regression and lags built into how it operates, but, really, in instances where the trend is maybe not so much a fisheries trend or a population trend, but is really a trend associated with management pressure, such as the closure of another desirable species that is caught in cooccurrence with that one that you're trying to model, or there has been a recent management regulation implemented that caused an increase or decrease in the catch rate that is difficult to account for, then your input data for -- Like with blueline tilefish, there has just been such a major shift in terms of how targeting has taken place with that stock recently.

I don't know that I have like a really robust guiding principle for which model would be the best in those types of situations. I think, in a situation where you have a relatively stable fishery through time, the SARIMA model is going to be a better predictor. In instances where you have like a population trend underlying that you can incorporate that as a covariate, the SARIMA model will be better. I mean, theoretically, it's a better modeling approach, because it considers a lot more information in making its prediction. However, if the fishery is just hyperstable in the last three years, then the Last 3 is going to do a great job predicting what is going to happen in the future.

There is a reason why, historically, we have tended to use just kind of the last three, or even the last one, year in the data, and that's because our fisheries are so dynamic through time that the long-term historical data may not be super informative of the future trend, and so it really is going to come down to an evaluation of what the situation is on the ground in the fishery with regard to the recent management history, but, no, I don't have a great set of guidance in terms of which model prediction to use at this point.

I kind of like the recommendation that I give there under no validation available, where you're really accounting for both model error and process error by running a multi-model approach. When you're coming up with consistent predictions between the two, such as we saw with blueline tilefish and vermilion snapper, which, not surprisingly, are the most targeted species being considered in this amendment, those are well-informed by the data, and the trends are probably real and not being curbed by the availability of other species that are actually the target species on those trips.

That's kind of a reasonable multi-model approach that I lay out there, but there will be instances in the future where we have this opportunity to do kind of a post-hoc evaluation process and determine the best model as new data becomes available without rerunning all of the models.

DR. DUMAS: Thanks, Nick. I think that's great, and I didn't want my question to take away from the fact that I think this is excellent work and that you've done a great job, and there's clearly a lot of work that's been done. Looking forward, maybe if you, or someone else, has time to look at that, kind of building a model of which of the two models is best to use, maybe that's possible, and looking at what types of changes, what types of factors, cause one model to be a better predictor over the other in certain situations.

One way you could possibly look at that is to sort of go back in time and use each model to predict forward based only on the data that were available up to that point in time and then go forward through time using the models to make predictions each year ahead and see which model does better each year and then relate that to what changes were happening on the ground and do that across multiple fisheries, so you kind of have sort of a seemingly unrelated regression model, and you're looking across fisheries, and so you've got a model of each fishery, and you're looking across and then going through time.

You might be able to pick out some patterns of what types of management changes cause one model to do better than another, and we might have enough data to sort of get some idea or get some estimates for that, and so I would just leave that as a suggestion for possible work in the future, but thanks again, and this is great work.

DR. FARMER: Yes, and, in that Farmer and Froeschke paper, we somewhat did that, where we at least did several drop-one and drop-two type of scenarios to look at retrospective model fitting, just to make comparisons between SARIMA, GLM, GAM, and then the previous year of data, in terms of goodness of fit. The results were variable. However, overall, SARIMA was the winner.

With that said, the fisheries we looked at in that paper didn't have elaborate changes in management, and so that would be something where, if we could find good ways to incorporate those management changes in the SARIMA model, it might do a slightly better job of predicting the fit, and we do account for the seasonal closure dynamic by only expressing the input data as catch per open federal day on a monthly basis, and so we're at least accounting for that, and then I'm also accounting for historical trip limits and things like that, but, really, like I said, the big kind of missing wheel in the Regulatory Amendment 27 analyses is probably the species cooccurrence issue with the targeting of a desirable species and these landings time series really not being influenced by fishermen targeting of that species as opposed to the fishermen targeting some other more desirable species and then just indirectly catching some of these less-desirable species.

That is a point where working hand-in-hand with an economist or something like that to develop some more robust fit methods would be useful, but it's just one of those things where the data and the analyses are needed immediately, in order to get everyone moving on these regulatory amendment analyses, but then the amendment itself kind of drags on after we're done with our analysis, and the econ folks do their work and everyone else kind of jumps off of what that branch is producing, and so it's a timing issue, really, to develop those more robust models, but that would be something where it would be nice to figure out a method, kind of in some down time, and be able to incorporate that into future projections. I don't know if Jeff Pulver is on the line, and I think he's out today, but I am no longer in that branch, but that would be something for him to work on. I have moved over to a new position here at SERO.

DR. REICHERT: Thanks, Nick. One of the things that I thought of is there may be fisheries that have attributes that makes them more conducive to applying one, or we may have found out, after additional analysis, that there are fisheries that have attributes that make them more conducive to applying one over the other model, and so it would be really interesting to take a look at that.

For now, I have another question that is completely unrelated to the SARIMA, but you said the redistribution of red grouper, that there was a surprising result, that there didn't seem to be a lot of

redistribution, and I was thinking maybe that's due to the fact that the red grouper catches have been extremely low, and so would that be something that is an issue of detectability?

DR. FARMER: There is two things kind of going on. I don't know if my screen is still shared, but, in this graphic, you can see, post the January to April closure, you do see kind of almost a one-to-one response. If you subtracted that green bar from January through April of 2009 and compared the 2009 landings to the 2010 landings, they would be nearly identical, but then you also see that downward trend through time beyond there, and that exists in the historical data, and so, yes, I think there is two things going on.

There is no redistribution, or it could be that they are less available during those time periods off of North Carolina to South Carolina, and so that assumes equitable distribution, which is one of the points of Regulatory Amendment 27, right, is to reframe that equitable distribution of the ACL across areas, but certainly we've heard quite a bit from that region as well with regards to red grouper not doing well, and so that could be reflected in that downward trend. I mean, that's a pretty clear downward trend, if I ever saw one, from the implementation of that closure and even before.

DR. REICHERT: Okay. Anyone else have any questions or comments?

DR. NESSLAGE: The paper that you published was on recreational -- Is that correct? Is commercial fisheries data -- Can you speak to any differences in the performance of the SARIMA model with the different types of data?

DR. FARMER: I mean, theoretically, if the historical data are providing useful information, the commercial model, I would expect, would actually perform even better than the recreational model, because we have higher-resolution data that you can feed the SARIMA model, and so you can get twelve-month trends instead of six-month trends, because the recreational data is coming in in waves instead of months.

I wouldn't expect, if you were running it for a targeted species, that the SARIMA model would underperform for commercial. I would actually expect it to do better, and the recreational data also has a lot more uncertainty rolled into it, and that's something that we've been doing with our recreational red snapper, is forecasting -- Currently, we're using bootstrapping to encompass the uncertainty in the estimates, and it's fitting the model to bootstrapped time series instead of just the mean.

For the commercial data, I would expect, just due to the resolution of the data, that the SARIMA model would perform well. I feel like, for black sea bass and other targeted species, it has a pretty good track record of good performance, when we've done retrospectives in the past, and we've also used other modeling approaches, like GAM and GLM, but the SARIMA model and the Last 3 tend to be kind of like the go-to models, because they provide a nice contrast in methods and allow you to identify if there is kind of a recent trend happening that is going to be driving your model predictions.

DR. BUCKEL: Thanks, Nick, for the presentation. I am just curious, but these are -- Since several of these are non-targeted, as you were saying, I wonder, when you did the SARIMA modeling, if you looked at if the more targeted species were open or closed, and I'm just thinking like, if they

make a trip on a targeted species because it's open, then they're more likely go catch some of these non-targets. If something that's targeted is closed, then that -- Your predicted catch on a non-target would be zero, right, because they're not making the trip on the target, and so I was just curious if that -- Is it possible to include that as covariates in the SARIMA model, the opening and closing of targeted species in certain areas where these non-targets would be caught?

DR. FARMER: That isn't something that we did for this particular approach, but I think that that -- Looking at the outcomes from the approach, I think that that would be a very useful future approach, would be to incorporate some sort of covariate through the time series on a monthly basis with regard to the percentage of targeted species that are associated that are open at the time, something along those lines, and at least evaluate whether you get an improved model fit from that.

DR. BUCKEL: I would be interested in seeing that. Thanks, Nick.

DR. REICHERT: Thanks. Anyone else?

DR. ERRIGO: I don't see any other hands up for questions for Nick.

DR. REICHERT: Any other questions or comments before we go to the action items and formulate our recommendations? Nick, are you available to hang on for a little bit, in case something comes up?

DR. FARMER: Yes, that's fine.

DR. REICHERT: Okay. As I said earlier, the action items are to review the use of the SARIMA model and its utility for providing management advice. I would like to split that into two. One is the recommendations for the individual species that Nick mentioned and then maybe some overall recommendations, some of which we heard. I am asking the committee if the committee is supporting the recommendations and justifications that Nick presented in his presentation relative to the individual species that he mentioned. I will pause to see if anyone disagrees or has any comments to that.

DR. ERRIGO: I don't see any hands up.

DR. REICHERT: So I assume that that means that we as a committee support the recommendations that Nick presented in his presentation, and we can list those up, and, as a reminder to the committee, it's going to be part of the report that we will be providing at the upcoming council meeting, and so I mentioned last week that we have a pretty tight deadline, and so please include any comments you may have in your comments to the SSC report, and we would need that by the end of the week, before I forget to mention that.

Then we discussed some overall recommendations as to the applications of the models, and, unless I am misinterpreting what we discussed, do we agree that maybe, at the moment, both models could be explored routinely and the results, including the uncertainties, compared to aid in formulating recommendations for other species? Please let me know if I am misinterpreting the committee's discussions. Seeing none, then that could be -- Anyone?

MR. CARMICHAEL: There are some hands up, Marcel.

DR. REICHERT: Excellent.

DR. NESSLAGE: I am a little confused about what's happening, and so help me out, if you would. Are we going to see every species every time these analyses are done and approve them, like we're doing here, or is this going to be a blanket recommendation of the analysts? I guess I'm confused on what we're exactly doing here. Is it just this amendment, or are we going to -- I am not fully convinced that the SARIMA is outperforming the Last 3 for all species, and it's not for these species, necessarily, and I am just worried about what we're doing, and can you just clarify that, please?

DR. REICHERT: John and Mike, correct me if I'm wrong, or help me out, but the first recommendations that we made were relative to the current amendment, and I think the recommendations, the subsequent recommendations, were more general and not necessarily directly related to this amendment, but they were more recommendations to the approach of the modeling efforts, and that is some of the things that were mentioned earlier by Chris and others, and so that is if this method is going to be used for future analyses, then this should be taken into consideration. Does that kind of clarify what I meant by my recommendations, or my suggested recommendation?

DR. NESSLAGE: I think so. I think the SSC agrees with the recommendations for Amendment 27, but then, when we get to the second bullet, and it's underneath that bigger bullet, and that's why I'm worried about what we're saying in the future.

DR. REICHERT: Yes, and so we can move the last recommendation to maybe below, to make it clear that the first set is relative to Amendment 27, and then the rest is more general. Thank you. I think that's a good idea to keep it clear.

DR. NESSLAGE: Thanks.

MR. CARMICHAEL: Marcel, just to clarify, that bullet that is being typed on now, that is the SSC recommending that Regulatory Amendment 27 will use analyses based in some cases on the three-year average and in some cases on SARIMA.

DR. REICHERT: Exactly, and those were based on the -- The language I used was that the SSC supports the recommendations and justifications that Nick presented earlier, and we can lift that language out of the presentation. Does that make sense?

MR. CARMICHAEL: Yes, and it's just a little different direction, I suppose, than we've gone in a lot of situations of using multiple analyses.

DR. REICHERT: What do you mean, John? Do you mean that the combination of the Last 3 and the SARIMA?

MR. CARMICHAEL: Yes, for one action using the Last 3 and for another action using SARIMA.

DR. REICHERT: I agree, but I thought that -- That's what I was asking the committee. In Nick's presentation, there is some justification as to why, in certain instances, one model outperforms the other. I thought the -- That's why I was asking the question earlier. I thought that the committee agreed that that was an appropriate way of approaching this, and perhaps, in the future, that may change, but does that make sense? I would like some feedback from the committee.

MS. LANGE: I guess I do have some concerns, and I don't disagree with using the alternating methods, depending on how the fit was in this particular case, but, down the line, what happens if we wind up switching the next time we run the analysis on those species and what we recommend in SARIMA this time, because the data changed a little bit for the next added data point or two, we decide the Last 3, and I think I have the same concerns that I think John was expressing, where we're -- Either we're accepting a new model or we're not, and I'm not sure that changing between species is -- I guess what's going to happen when we add a data point to each of those species?

DR. REICHERT: Anyone on the committee?

DR. DUMAS: That's why I think having a model that tells you which model to use in a particular instance is good, whether it's a formal model or maybe just some heuristic algorithm, to say whether you're going to use SARIMA or the Last 3 model in a particular instance, and that sort of super model, or if it's just qualitative heuristic, that needs to come before the decision of which model to use in a particular instance, so that you can say we're using the same decision rule to decide whether to use SARIMA or Last 3 in any particular case, so that the decision of which one to use is not arbitrary.

I think some of the justification that Nick gave is correctly going down the road toward doing something like that, but we need something to say -- Maybe in Nick's head that's already clear, the criteria that helped him decide which of the two is the recommended model in a particular situation, but that might need to be clearer to stakeholders, sort of what are the criteria that are being used to decide whether SARIMA or Last 3 is the best model in any particular situation.

DR. FARMER: This is potentially something that I can help clear up. We had a similar discussion with the SEP, and I think there was a misunderstanding with regard to how we used these models, and so these models are useful for the management decision-making specific to Regulatory Amendment 27. We don't apply these models on an annual basis, for example, to manage the fishery.

What we do, in terms of in-season management of the commercial fisheries that are being affected by the decisions that the council will make that result from Regulatory Amendment 27, the Southeast Fisheries Science Center gets data from dealer reporting, and so they make in-season predictions using that dealer reporting data, which use a variety of different methods, and then they recommend a method, and it's not informed by the Last 3 or SARIMA modeling approaches. It's kind of a whole different in-season quota monitoring method.

The analyses for a council action amendment are performed by the Regional Office, and they tend to consider the data under all these different suites of management alternatives, whereas the Science Center's quota monitoring specific to particular fishing season doesn't care what the management actions are. It's really just looking at the landings coming in on a daily basis and making projections of when an overage may or may not occur.

These models, although they were generated for Regulatory Amendment 27 and provided some useful advice -- These methods may be used in the future for some subsequent amendment, but I don't envision these being living models for Regulatory Amendment 27. I mean, once the council selects preferred alternatives, these models are done, and so then, if the council comes up with a new amendment at some point, the analyst that is the lead analyst on that amendment may or may not apply these models to that particular species and situation. That will be informed by what's going on at the time and what kind of analytical methods are in that person's wheelhouse.

I like using these methods, and this code is shared with the other analysts in the branch. However, they have other approaches to doing things, and so it's not clear to me what would be done in the future. It may be a situation where the most recent years, the most recent three years, the most recent five, the GLM, the GAM -- It's incumbent on the analyst to take a look at the input data and make a selection that is guided by their best judgment at the time, but I don't think that should envision these Last 3 and SARIMA models for these particular species and actions as having any influence that persists beyond the council's selection of a preferred alternative for Regulatory Amendment 27.

DR. REICHERT: Okay. I am slightly confused here now, because we are -- We were asked to review the use of the SARIMA model, but, from what I understand, you are saying that this may or may not be used beyond Amendment 27.

DR. FARMER: Yes, and that will depend on the situation at hand. I mean, if an analyst within the branch wanted to use the SARIMA model in the future, your guidance, with regards to what elements might be considered to improve that model, I think that's really well taken, and that could be applied in that instance. I think it's an effective modeling method, and we've got a peer-reviewed paper that kind of goes through why that is. However, it has its limitations, like any model does, and there are situations where it's appropriate and other situations where it doesn't do a great job.

DR. REICHERT: But that's something that we just discussed, in terms of there is -- In particular, Chris mentioned that, if it is decided that this is an appropriate modeling effort, then you can look at that and decide in what cases one model would be more appropriate than another. I am still a little unclear, because we have two things going on here. One is Amendment 27, and I think we made a recommendation, although I do understand Anne's and Genny's concerns relative to using one method in one species and another method for another, but I think your presentation laid out the justifications for the choice. Then the other one is a more general question about the SARIMA model, and so --

DR. FARMER: I mean, my recommendation would be to consider it one of many tools in the toolbox, and there are recommended uses for that tool, in terms of what kind of covariates would make it more or less effective, and those are sometimes needed and sometimes not, but I certainly wouldn't recommend saying it's not useful and removing it from the toolbox entirely.

I think it's very simple, in any instance, to generate the last three or the last year or the last five years model fit. You have to assemble that data to do anything more rigorous anyway, and so we tend to provide that regardless, but, in the instances where it seems like there are seasonal trends in the fishery, the SARIMA model is something that I would recommend using as a potential

modeling approach, but I don't know if you want to be more prescriptive than that, just because, whatever amendment it's applied to in the future, it could look very different from this one, and the SSC would have opportunity to review that amendment, as they do any amendment that goes under council consideration.

DR. REICHERT: I understand that. I am more thinking of our -- As a committee, and, again, I would like some feedback from the rest of the committee in terms of our review of the SARIMA model, and, if the committee wants to go no further than stating that this is one in a number of useful tools and we have some recommendations to potentially improve the tool or the comparison of this model over others, then I am completely happy with that, but that's a little bit different interpretation of the action item than I initially thought, which is perfectly fine, and so anyone on the committee? I would like some feedback relative to this point.

DR. SCHARF: I just wanted to echo your comments, Marcel. I am still a little bit confused as to exactly what our action items are, in terms of what we're recommending, but, broadly, about the models themselves, it definitely seems that -- I was a little bit surprised at how sensitive the SARIMA model was to some of the recent landings trends in a couple of the fisheries examples that Nick provided, given that my expectations going in was that the Last 3 was going to be more sensitive to those recent trends, and so, given that, it seems clear that these models are going to perform -- They may perform very differently for certain species, depending on recent trends, particularly these shocks that Nick referred to, whether they be environmental or regulatory or just changes in market conditions or accessibility, and so it certainly seems like it's going to take a lot of sort of careful thought to think about which model is going to be appropriate in certain situations, and, like Nick said, the analysts being able to use good judgment to do that, and I respect that and appreciate Nick's input on that, but, in terms of where we're going, in terms of our recommendations, again, it's a little unclear to me as to what our action items are.

DR. REICHERT: Thank you, Fred.

DR. DUMAS: I would just like to say that I think that the SARIMA modeling framework is a great step forward, and I think it can be, over time, modified, perhaps, to make it a little bit better. In terms of comparing the SARIMA versus the Last 3 and predictions based on very recent changes in the data, that could be -- That is just reflecting -- To some extent, that's reflecting the weight that the SARIMA model is putting on events that happened in the recent past and the weight that the SARIMA model puts on those recent events depends on the history of the data in that fishery.

The difference in the SARIMA model predictions versus the Last 3, that could be a good thing or a bad thing, and another bullet point, lower down, on the slide, saying the SARIMA is more susceptible to trends in the fisheries data than the Last 3, that bullet point may be true, but that's not necessarily always a bad thing. That could be a good thing or a bad thing, and it could either sort of increase the risk of uncertainty or decrease the risk of uncertainty between the two methods.

DR. REICHERT: Sorry to interrupt, but I think that would be a great point to add to that bullet point, and so go ahead.

DR. DUMAS: I think using the SARIMA type approaches is a good thing going forward, and there are other modifications of it that could possibly improve it, but I think it's a great step forward. As far as changes, recent large changes, in the data and how that affects the forecast for

both models, one way to look at that would be it's a change in the volatility of the data, and you could have volatility clustering as a concept in these SARIMA time series models, and that's something else that could be included in the model, and that could help improve it, if it were going to be used for other fisheries or other amendments in the future.

That said, the SARIMA model itself is a great step forward, but, if we are going to be deciding between two or more different models for application into a particular amendment or a particular fishery or a particular policy decision, then I think -- If we choose one model in some situations and another model in another, I think the stakeholders are going to want to know what criteria were used to decide between the two models, and that's going to have to be, I think, pretty clear to the stakeholders, so that they don't think that there is some agenda behind choosing one model over the other. I don't think there is in this case, and I think Nick has done a great job, but I think just helping to explain what he's done to stakeholders might require a little bit of additional effort, and that's all.

DR. REICHERT: Thank you. I appreciate that.

DR. WATERS: I think the immediate need for recommendation from us is to decide on a model for Regulatory Amendment 27, and I think Nick proposed a very good solution. He generated predictions of the closure dates for 2017, and then, depending on the outcome of that little experiment, he made a recommendation of a model for use in the future, and I think we ought to go ahead and follow his recommendations for the preferred model for Regulatory Amendment 27.

In the more general situation of which model is better, I think we can say that both models have a little bit of an inherent weakness to them, in that they use historical data, but they don't have any variables to reflect causative or behavioral changes in the fishery, and, of course, one thing that regulation does is it changes incentives and changes behavior, and so it might not be clear, in the bigger picture, if one model is preferred over the other, but, at least for Regulatory Amendment 27, I think Nick has proposed a very good solution, and I think we ought to follow his recommendations.

DR. REICHERT: I appreciate that. Thank you.

DR. SERCHUK: The comments that just preceded mine are very much of the type that I wished to provide. I have a feeling though, from my own perspective, that we're overthinking this. The first and foremost consideration was we have two models, and are there some instances where one model performs better than the other, and I think Nick has -- By doing both, he has shown that, yes, that is the case, and he has provided justification in all cases why either both models were acceptable or one model was superior to the other, and I think that is very good.

All models have deficiencies, and we know that, and I am reluctant to provide too much direction in the future, because we know that there will be model development. People will look at the existing models and try to improve upon it. We have had a suggestion that maybe we should have a model that sort of integrates both, and, if such a model is conducted, and if it performs better, then, of course, that's a model that we wish to consider in the future, along with any of the caveats that come along with it.

I don't want to be too prescriptive here, because model development is something that -- It's a research recommendation, and I don't want to see that we are circumscribing the type of research that needs to be done. We all know that there are plenty of new assessment models that have come out over the years, and the older ones have gone by the wayside, to the extent that the newer ones perform better, fit the data better, and they are closer to what we believe is happening in the stocks, and so I would try not to be too prescriptive on it, because we know that there are going to be new developments, and we welcome that, to the extent that they build upon the models that we already have. Thank you.

DR. REICHERT: Thanks, Fred, and I agree that we shouldn't be too prescriptive. That's what you alluded to, and I do believe that part of the task of the committee is to provide recommendations, in terms of potential improvements, but thanks. Any other hands up? Any other questions?

DR. ERRIGO: I don't see anyone else.

DR. REICHERT: Okay, and so let's take another look at the notes that Mike has written up, and we can do some wordsmithing later, but I just want to make sure that we have captured the overall recommendations of the committee and the comments the committee made. We agree with the recommendations of the analyst about Amendment 27, and I think Nick provided the -- I think the committee agreed that Nick provided some justification for the choices he made, and then we also made some recommendations and thoughts for a general recommendation of the model.

It's a tool among other tools, and I think the SSC feels that multiple tools should be explored, because there is strengths and weaknesses of the available models, or available tools, right now, and I believe those are the highlights of our notes. Any committee members, any comments or additional recommendations, either to the text or to what we just discussed or disagree with what I just mentioned?

MS. LANGE: I agree with what you said, but one comment I have is the very first bullet that talks about using cooccurring species, and I'm not sure we want to lead with that. I think the first thing should be our response to our initial request relative to Amendment 27.

DR. REICHERT: Good point, Anne, and I think that's -- Mike can move those around, and, again, please take a good look when Mike sends out those notes, and then we can take it from there, but you're absolutely right that we should lead with what our main recommendation is. Thank you. Anyone else? I will wait until Mike finishes typing. Thanks for keeping us with us, Mike. I appreciate that. Mike, I believe those are the action items and bullets that we were supposed to address this morning, and is that correct?

DR. ERRIGO: Yes, this is all for here.

DR. REICHERT: All right. Well, I think we addressed all the bullet points, and, unless anyone has any last comments, I want to thank Nick for his overview, and I want to thank the committee members for their contributions, as I said, and especially the SEP. Their report was very solid, and I really appreciate that, and, unless there is other business -- I do not have any other business. Mike, did anything else come up?

DR. ERRIGO: Just one thing. Kurt Schnier had to get off the webinar, but he did ask that -- He had a couple of thoughts, and I will just read them in. He wanted to mention that Nick did an excellent job with the presentation, and his thoughts were that the SARIMA model looks like it's best when there are clear seasonal trends, but the model seems to go astray when the recent data has outliers relative to prior years, but, all of that said, great work to Nick.

DR. REICHERT: Okay.

DR. ERRIGO: Most of that is already captured in here, and so I think we're good.

DR. REICHERT: Okay. Thank you. Anyone else before we adjourn? All right. Thank you for joining us, and, as a reminder, I need the comments on the SSC report, including the report of the webinar, and if you can send that to Mike and copy George and myself and Rob Ahrens by close of business on Friday, and then we will do our best to include all of that and send out the draft hopefully in the first half of next week. I appreciate it. Thank you, all, and have a great week.

(Whereupon, the meeting was adjourned on May 7, 2018.)

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