Atlantic States Marine Fisheries Commission

ISFMP Policy Board

October 27, 2016
8:00-10:30 a.m.
Bar Harbor, Maine

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

1.	Welcome/Call to Order *(D. Grout)*	8:00 a.m.
2.	Board Consent *(D. Grout)* • Approval of Agenda • Approval of Proceedings from August 2016	8:00 a.m.
3.	Public Comment	8:05 a.m.
4.	Executive Committee Report (*D. Grout*)	8:15 a.m.
5.	Review Revisions to Conservation Equivalency Guidance Document (*T. Kerns*) **Final Action**	8:25 a.m.
6.	Update on Climate Change Working Group (*T. Kerns)*	8:40 a.m.
7.	Discuss Risk and Uncertainty Policy Workgroup White Paper (*J. McNamee)*	8:50 a.m.
8.	Habitat Committee Report (*T. Kerns*) • Review and Consider the Sciaenid Habitat Source Document **Action** • Review the State Reports on Climate Change Initiatives • Review the Draft Letter to BOEM regarding Seismic Testing **Action**	9:20 a.m.
9.	Atlantic Coastal Fish Habitat Partnership Report (*P. Campfield*)	9:40 a.m.
10.	Law Enforcement Committee Report (*M. Robson*)	9:50 a.m.
11.	Review Non-Compliance Findings, If Necessary **Possible Action**	10:00 a.m.
12.	Other Business/Adjourn	10:05 a.m.

The meeting will be held at the Harborside Hotel, 55 West Street, Bar Harbor, Maine; 207.288.5033

MEETING OVERVIEW

ISFMP Policy Board Meeting
Thursday October 27, 2016
8:00-10:30 a.m.
Bar Harbor, Maine

Chair: Doug Grout (NH) Assumed Chairmanship: 10/15	Vice Chair: Jim Gilmore (NY)	Previous Board Meeting: August 3, 2016
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 3, 2016

3. Public Comment – At the beginning of the meeting public comment will be taken on items not on the agenda. Individuals that wish to speak at this time must sign-in at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Chair will not allow additional public comment on an issue. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. Executive Committee Report (8:15-8:25 a.m.)
Background • The Executive Committee will meet on October 25, 2016.
Presentations • D. Grout will provide an update of the committees work
Board action for consideration at this meeting • none

5. Review Revisions to Conservation Equivalency Guidance Documents (8:25-8:40 a.m.) Final Action
Background • The Executive Committee tasked staff to update the Conservation Equivalency Guidance Document to reflect the current practices of the Commission. • In August MSC and ASC reviewed proposed revisions and made recommendations to the Executive Committee and Policy Board. • Based on direction from the Executive Committee and Policy Board staff updated the Conservation Equivalency Guidance Document for review and approval by the Executive Committee and Policy Board (**Supplemental Materials)**.

Presentations

- T. Kerns will review the revised Conservation Equivalency Guidance Document

Board action for consideration at this meeting

- Approve the Conservation Equivalency Guidance Document (2016)

6. Update on Climate Change Working Group (8:40-8:50 a.m.)

Background

- The Climate Change Work Group was tasked with developing science, policy and management strategies to assist the Commission with adapting its management to changes in species abundance and distribution resulting from climate change impacts.
- The Work group met via conference call to brainstorm how to address the Policy Board task (**supplemental materials**)

Presentations

- T. Kerns will review the Climate Change Workgroup Progress

Board action for consideration at this meeting

- none

7. Discuss Risk and Uncertainty Policy Workgroup White Paper (8:50-9:20 a.m.)

Background

- Previously, the Board approved the purpose statement for the Commission's Risk and Uncertainty Policy.
- The Risk and Uncertainty Policy Workgroup met to develop their recommended decision-tree framework for a Commission policy and created an example for the Board to review. (**Meeting Materials**)

Presentations

- J. McNamee will review Risk and Uncertainty Policy Workgroup White Paper

Board guidance for consideration at this meeting

- Provide feedback on the decision-tree framework

8. Habitat Committee Report (9:20-9:40 a.m.) Action

Background

- The Habitat Committee met October 20 – 21 in Portland, Maine. They welcomed their newest member, Oliver Cox, from Maine, finalized updates to the 2017 Action Plan, and discussed ideas for new management series documents, among other topics.
- The Habitat Committee finalized the Sciaenid Habitat Source Document (**Meeting Materials**), the State Reports on Climate Change Initiatives document (**Meeting Materials**), and the draft letter to BOEM regarding seismic testing (**Supplemental Materials**).
- The Artificial Reef Committee welcomed Michael Malpezzi from Maryland Department of Natural Resources, who will be replacing Erik Zlokovitz.

- The Artificial Reef Committee will be serving on the steering committee for an artificial reef symposium at the 2017 American Fisheries Society Meeting in Tampa, Florida.

Presentations

- T. Kerns will present the Habitat Committee updates.

Board action for consideration at this meeting

- Approve the Sciaenid Habitat Source Document
- Approve the Letter to BOEM regarding Seismic Testing

9. Atlantic Coastal Fish Habitat Partnership Report (9:40-9:50 a.m.)

Background

- ACFHP met October 18-20 in Portland, Maine. Highlights include presentations on local projects, reports on science and data mapping initiatives, and a full day workshop dedicated to updating the Conservation Strategic Plan.
- ACFHP's chair, Kent Smith, is currently attending the NFHP Science and Data Committee Workshop and Board Meeting in Pensacola, FL. Discussion topics include the NFHAP-USFWS funding allocation methodology, Beyond the Pond 501(c)3 capacity, and an update on the fish habitat legislation. ACFHP will report on discussions at the winter meeting.
- ACFHP received 9 proposals for FY2017 NFHAP-USFWS funding, and has evaluated and ranked the projects for recommendation to the USFWS.

Presentations

- P. Campfield will present ACFHP updates.

Board action for consideration at this meeting

- None

10. Review Non-Compliance Findings, if Necessary

11. Other Business

12. Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

ISFMP POLICY BOARD

The Westin Alexandria
Alexandria, Virginia
August 3, 2016

These minutes are draft and subject to approval by the ISFMP Policy Board
The Board will review the minutes during its next meeting

TABLE OF CONTENTS

INDEX OF MOTIONS

1. **Approval of Agenda by Consent** (Page 1).

2. **Approval of Proceedings of May 2016 by Consent** (Page 1).

3. **On behalf of the South Atlantic State/Federal Fisheries Management Board, move to recommend that the ISFMP Policy Board develop a complementary Fishery Management Plan for Cobia** (Page 9). Motion by James Estes. Motion carried (Page 12).

4. **On behalf of the South Atlantic State-Federal Fisheries Management Board, move to recommend to the Policy Board that the South Atlantic Board is the appropriate venue to develop the FMP for Cobia** (Page 13). Motion by James Estes. Motion carried (Page 13).

5. **Move to task the Habitat Committee to draft a base letter to express the Commission's concerns regarding seismic testing and its possible impacts on fisheries and fish habitat, for review by the Policy Board at the Annual Meeting** (Page 25). Motion by Tom Fote; second by Eric Reid. Motion carried (Page 26).

6. **Motion to adjourn** by Consent (Page 41).

ATTENDANCE

Board Members

Patrick Keliher, ME (AA)
Rep. Jeffrey Pierce, ME, proxy for Sen. Langley (LA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Doug Grout, NH (AA)
Ritchie White, NH (GA)
Bill Adler, MA (GA)
Dan McKiernan, MA, proxy for D. Pierce (AA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Jason McNamee, RI, proxy for J. Coit (AA)
David Borden, RI (GA)
Rep. Craig Miner, CT (LA)
David Simpson, CT (AA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Steve Heins, NY, proxy for J. Gilmore
Emerson Hasbrouck, NY (GA)
Brandon Muffley, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Andy Shiels, PA, proxy for J. Arway (AA)
Loren Lustig, PA (GA)
Tom Moore, PA, proxy for Rep. Vereb (LA)
John Clark, DE, proxy for D. Saveikis (AA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
David Blazer, MD (AA)
Rachel Dean, MD (GA)
Ed O'Brien, MD, proxy for Del. Stein (LA)
John Bull, VA (AA)
Rob O'Reilly, VA, proxy for J. Bull (AA)
Doug Brady, NC (GA)
Michelle Duval, NC, proxy for B. Davis (AA)
Robert Boyles, SC (AA)
Malcolm Rhodes, SC (GA)
Pat Geer, GA, proxy for Rep. Nimmer (LA)
Spud Woodward, GA (AA)
Jim Estes, FL, proxy for J. McCawley (AA)
Martin Gary, PRFC

(AA = Administrative Appointee; GA = Governor Appointee; LA = Legislative Appointee)

Ex-Officio Members

Staff

Bob Beal
Toni Kerns
Ashton Harp
Amy Hirrlinger

Guests

Sherry White, USFWS
Debra Lambert, NMFS
John Carmichael, SAFMC
Russ Allen, NJ DFW
Bob Ballou, RI DEM

The ISFMP Policy Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, August 3, 2016, and was called to order at 2:30 o'clock p.m. by Chairman Douglas E. Grout.

CALL TO ORDER

CHAIRMAN DOUGLAS E. GROUT: Welcome all; this is the meeting of the ISFMP Policy Board. Before I go any further, we have a long time member of our ASMFC family that is retiring in a month -- at the end of the month. I would like to have David Simpson come up. We have a little token of our esteem here, for the many years that you've been putting in on technical committees and Management and Science Committee; and the last eight years as a board member.

We have the compass rose pen that will keep you in the right direction for all the years that you've helped steer the commission in the right direction over the years. I greatly appreciate all the time and effort and your expertise that you have put in; both at the technica1 level and at the policy level. I think you and I started about the time, became board members about the same time; but you get to retire earlier. Thank you very much, We appreciate that. (Applause)

MR. DAVID G. SIMPSON: Well, you know I was not really expecting anything. I had told a couple of people that I thought I had to. I was going to pull an A.C. Carpenter; you know, just kind of slip away and see if I went unnoticed. Really, it has been a big privilege and a pleasure to be able to work with the commission.

From things I've said in the past, I think you all know how much I respect and admire this group and the process, the way we do things, how we do things; working with all of you for many, many years, some of you for decades. Toni and I worked on a lot of stuff for a lot of years; summer flounder, scup, black sea bass, lobster and other stuff too I'm sure. Tina and Laura and Bob, this has just been great; and all of you folks, I just can't thank you enough. Again, it really has been a privilege and a pleasure, so thanks. (Applause)

APPROVAL OF AGENDA

CHAIRMAN GROUT: Well. Thank you again, Dave, and we do have an agenda here; and I believe there are a couple other items that people would like to add to the agenda. I know John Clark; you came up and expressed something.

MR. JOHN CLARK: Shad and River Herring Board Chair, Bill Goldsborough and I would like to add to the agenda a brief discussion of the upcoming, I think it was just released, a white paper to the Mid-Atlantic Council. The Mid-Atlantic Council will be discussing shad and river herring management at their upcoming meeting; and then if I understand correctly, voting on their final decision on that in October before the annual board meeting, the annual ASMFC meeting, that is. I was hoping that perhaps the Policy Board can come up with some action to send a request to the Mid-Atlantic Council to let them know our interest in managing the species through our plan working with them on this issue.

CHAIRMAN GROUT: Okay, we'll add that. Is there anything else that we need to add to the agenda? Toni, you said there were another couple items.

MS. TONI KERNS: There was a letter that the Sturgeon Board has requested to send to NOAA on the critical habitat designations. Bob was the chairman of that board, so I think he'll address that.

CHAIRMAN GROUT: All right, anything else, changes to the agenda? Is there any objection to the agenda as modified?

APPROVAL OF PROCEEDINGS

CHAIRMAN GROUT: Seeing none; we also have proceedings from our May, 2016 meeting in our briefing packet. Are there any changes or additions to those proceedings? Seeing none; are there any objections to approving the proceedings? Seeing none; the proceedings are approved.

PUBLIC COMMENT

CHAIRMAN GROUT: Our next item is the opportunity for the public to provide comment on things that are not on the agenda. Is there anybody from the public that has something they would like to speak to the Policy Board on?

STATE DIRECTORS MEETING REPORT

CHAIRMAN GROUT: Seeing none; we'll go to the next agenda item, which is a report by the Chairman on the State Directors meeting we had on Monday, with NOAA Fisheries.

This was an excellent, well attended meeting. Everybody at the meeting thought it was an excellent opportunity for the directors to be discussing issues of common interest with our partners in management. The first thing we talked about was federal budgeting priorities that the commission had.

On our list of priorities for federal budgets was ACA funding. I think we've discussed this before that we have seen increases in the past in the council and commission line, but Atlantic Coastal Act funds have remained flat, so we've been trying to get at least a similar increase to what the commissions have been getting.

We also have a priority FIN and ACCSP funding, SEAMAP, NEAMAP funding, Horseshoe Crab Survey funding, MRIP funding, MRIP-APAIS funding obviously now that we're taking on the APIS Survey, and then jurisdictional fisheries grants; which clearly affect all the states, not only here on the Atlantic Coast, but throughout the coastal United States.

We also had an agenda item on lobster and crab management, and that discussion essentially turned into a discussion about ways to improve commercial reporting via incentives and disincentives. We had a very long and lengthy discussion, and came up with some different thoughts and certainly a lot of people are interested in seeing how we can get to electronic reporting; which would make things much more efficient in the future.

Obviously, it is something we'll have to work on with our fishing industry on those things. Also, we talked about MRIP and APAIS, now that the commission is conducting the Access Point Intercept Survey. We talked about the status. It seems to be going well, during the initial year here with a few minor hiccups. One of the things that surprised some of the states that have not been involved, is the fact that the headboat samplers had to actually pay a fare to get on some of the for-hire vessels; and in one state they actually were required to tip the mates, even though they weren't catching fish or having fish filleted. There was a discussion about that and we've actually referred some of these issues to our Rec-Tech Committee. Further on, we also had more discussion about recreational data, particularly this year with bluefish and black sea bass estimates; the final estimates being very different than what the preliminary estimates were.

We also were concerned about the timing of it, and we're asking about the reasons for the delays in releasing the final estimate. We were told that it was basically because of the large changes. National Marine Fisheries Service wanted to look into that in detail, and find out the reasons and be able to speak informatively about it to us.

They've also developed new business rules for MRIP staff to use when we have low sample size strata, which was one of the problems that was occurring in the charterboat strata on MRIP. You may have seen in your e-mail, some of the charterboat estimates were revised based on new methods they have for low sample size; they essentially collapsed the waves.

There was also discussion about some states have mandatory logbooks, and why they couldn't be used where they have 100 percent mandatory logbooks in some states for charter and parties, and why they couldn't be used instead of MRIP. The response was that logbooks still need MRIP and ACCSP approval before the methods used for these state logbooks could be used for landings info for management.

Then, of course, I think a lot of you heard; we got an update on the revised estimates in the final black sea bass and bluefish rules. Black sea bass was essentially status quo, and with bluefish under the final rule, $1.6 million transfer to the commercial fishery is going to occur. We also had a discussion about coral management and National Monument designation.

In coral management the New England Council continues to work on an amendment to the Habitat FMP. One of the things, when we were discussing monument designation and the commission's position on this, we were given advice that we should be looking sometime in the near future for potentially a proposal being put forward to comment on, and the importance of the commission providing comment on that if and when a proposal comes out.

We also discussed the impacts of the Spring Bottom Trawl Survey out of the Northeast Fisheries Science Center. It had a delay in starting, and actually had a breakdown in the middle where they had to stop. They did complete all of the stations that were required, but of course because of the late start the temporal distribution of the survey was very different than what it has been in past years.

We were asking for input on how that was going to affect assessments of ASMFC managed species. The Center is going to be working on that on a species by species basis, and then what can be done in the future to prevent these things from happening or how to address them. I think we received an e-mail this week from Bill Carp, talking about looking at the use of industry-based platforms as backups for the Bigelow Surveys.

We also had a brief discussion about aquaculture permitting, because NMFS had received a request for aquaculture in the EEZ that would have included striped bass and other species. NOAA Fisheries committed to have future discussions with ASMFC about any potential aquaculture; particularly involving commission managed species in the EEZ. We asked for an update on National Standard 1 Guidelines, and were told that the proposed changes are still at OMD for review and "will be out sometime in the future." We also discussed the New England Fisheries Management Council request to be involved in management of summer flounder, scup and black sea bass.

We asked GARFO when that decision might be made. They indicated they wanted to discuss this request with the Mid-Atlantic Council first, and then also in the fall, they will be talking about it at the NRCC meeting; and after that they will make a decision on what they will do with the New England Council's request to get involved with black sea bass, fluke, and scup management.

Finally, we updated each other on where our Atlantic sturgeon Section 10 permitting process was right now; and committed to providing these updates on an annual basis. Are there any questions from the Policy Board about this? Okay seeing none; I'll move down to the next item, which is another report by me.

EXECUTIVE COMMITTEE REPORT

CHAIRMAN GROUT: This is from the Executive Committee meeting; which was two hours as opposed to seven hours. It should be a little bit quicker.

We had a discussion about, the Executive Director asked us to provide input on ASMFC being leads on staff assessments, and are states still comfortable with this. The issue that brought this up was we've had one or two assessments where the commission stock assessment biologists have taken the lead, and as we've gotten close to completing the assessment, some of the states may not have been fully involved with it; and then were coming up with concerns about the assessments.

The Executive Committee still felt that having the ASMFC leads on these assessments was a good process, and we should continue it and that we will work as directors to try and encourage our stock assessment biologists and technical committee members to speak up if they have concerns early on in the process; early and often.

We also have reviewed the Conservation Equivalency Document that Toni will be going over with you as one of our Policy Board agenda items. We made comments on that. We also reviewed a white paper that was produced by staff on PDT membership, board members being on PDT of the species.

After considerable discussion on this, the original issue with this was there was a concern brought up by some of our commissioners that having board members as Plan Development Team members might have an optics problem with the public. With the potential thought that that particular board member might get two bites of the apple; both in developing the plan and also voting on the final measures in the plan.

After considerable discussion, the Executive Committee felt that the benefits that these board members provide to helping develop these fisheries management plans outweigh the optics issues that may occur with the public. We also began work -- you remember last time we had Collette come and give us a review on Roberts Rules of Order.

One of the things that she recommended to us was to have a document of specific commission procedures that we have that may vary slightly from Roberts Rules of Order. We're still working on this. We provided input to the staff on this. We'll consider it again at the fall meeting, and bring it before the policy board at that time for consideration and approval. We also had a discussion about potential renaming of the Hart Award. With the recent passing of one of our longtime, highly regarded commissioners from Maine, Pat White, there was a proposal put forward to rename it to the Hart-White Award.

We had a discussion about the appropriateness of that and also discussed potential other options, such as maybe naming our awards of excellence after Pat White. We actually sent that to the Awards Committee for further discussion. I know the LGAs had a discussion on that and your discussion will be sent to the Awards Committee; along with the Executive Committee for some resolution again at the fall meeting.

Finally, we some Saltonstall-Kennedy funds that the commission has been getting. Originally, we expected that it was going to be $500,000.00 and the Executive Committee had made some recommendations on how that would be spent. Bob came to us and said that that amount of money is actually only going to be $200,000.00.

The Executive Committee had a discussion on how we would trim down the projects that we would use that on. Essentially, our recommendations are going to be that $150,000.00 of that be used for some of the South Atlantic fisheries independent surveys; such as the longline surveys in several states.

Then the remainder of that would be used to help offset the shortfall that the Maine/New Hampshire Trawl Survey is experiencing this year. Those are the issues that we went over at the Executive Committee. Are there any questions on any of those items? Okay, thank you very much. Now we will move on to the next agenda item; which is Toni giving us a review of our stock rebuilding performance.

MS. KERNS: I am going to just take this brief moment to let the commission know that we have hired a new FMP coordinator, his name is Michael Schmidtke. He did a lot of the blueline tile assessment work with the Mid-Atlantic Council and the South Atlantic Council; presented to their SSCs. He is a PHD candidate out of Cynthia Jones' lab in Old Dominion University; and he will be starting with us on September 1st. We're excited to have him.

I made it easy, it's another Mike. You don't have to learn a new name. We're ready to go. We're ready to have him aboard.

2016 ANNUAL REVIEW OF STOCK REBUILDING PERFORMANCE

MS. KERNS: With that, I am going to go through the 2016 annual review of stock rebuilding performance. As everyone recalls, this is a part of our Strategic Plan for the five-year plan that is ongoing.

The first time we did this was in 2009, and we used the information from the discussion that we have today to help build the 2016 Action Plan; which we will review at the annual meeting. The objective of this program is to validate the status and the rate of progress for our species. If the Policy Board feels that the rate of progress is not what you're looking for, then today would be where we would try to identify some corrective action; whether to take some information back to those boards or back to TCs or staff to work on with those groups.

Again, what we're looking back for feedback today is information to get into the 2017 Action Plan process, and then direct feedback to the specific boards. As you recall, we have five categories; rebuilt sustainable, recovering rebuilding, concerned, depleted and unknown; and each of our species are put into these five categories. For the rebuilt and sustainable, it is pretty much the same list that we had last year; the Gulf of Maine, Georges Bank lobster, Atlantic herring, menhaden, black drum, bluefish, scup, Spanish mackerel, and spiny dogfish. We moved striped bass into the recovering rebuilding section and took red drum out of recovering rebuilding; so we swapped those two species.

I am going to go through the species of concern, where we're taken some action in the past year or had some new information. For black sea bass, we are currently undergoing a stock assessment for black sea bass; which will be completed in December. Black sea bass has a unique life history characteristic which contributes to the uncertainty regarding the stock size, response to exploitation; therefore, the OFL cannot be specified for the fishery, which means that a level of catch cannot be derived from the model results.

We've been using either a constant catch approach or using a data-poor model, in order to determine what the quota is for black sea bass. We are trying to develop reference points and assessment methods to account for this unique life history in the assessment work that is ongoing; and we're exploring a spatially structured stock assessment to address these incomplete mixings of the stock.

We're trying to evaluate the implications of range expansion to the stock and the fishery dynamics, to help us set forth a management plan in the future. For the Atlantic coastal sharks we have several different coastal sharks, but I just wanted to point out here, and hopefully, you can see this in the table; if not it is in your document on the briefing materials;

that in 2015 the bluefin sharks were found to be not overfished and overfishing is not occurring, as well as the Atlantic smoothhound were not overfished and overfishing was not occurring.

To complement the shark conservation act of 2010, the board implemented a fins naturally attached policy for all sharks; with the limitation for the smoothhounds. Harvesters can remove the fins of smooth dogfish, provided the weight of the fins onboard does not exceed 12 percent of the total weight of the smooth dogfish carcass; as well as that the total composition of the catch is at least 25 percent smoothhound, and that is what was approved at the board meeting yesterday.

For horseshoe crab we have put forward to do a benchmark stock assessment for 2018 this year. This will be a unique stock assessment, where most of it will be done pretty much behind closed doors; because of the confidential nature of the biomedical data. The Stock Assessment Subcommittee will be looking at a regional approach so that we can give the board a better understanding of what's happening in each of those regional categories for horseshoe crab.

But dedicated funding is continued to be needed for a coastwide survey to help inform those regional stock assessments, or we should broaden other surveys by the geographical regions. Biological reference points are needed, as well as a mechanism to include biomedical data and mortality estimates in regional assessments; without compromising data confidentiality. We wanted to keep moving forward to try to work with the biomedical groups, so we don't have to have these black box assessments.

For red drum, we had a benchmark stock assessment that was presented to the South Atlantic Board in 2016. The desk reviewed models with a stock synthesis framework suggested that overfishing is occurring in both the northern and southern regions. The board had some questions about the unique life history of red drum; and the results of those assessments and how those life history parameters feed into the different parameters of the model. The Technical Committee is working on five large tasks, and will be reporting out to the South Atlantic Board on those tasks, so that the board can then determine how they want to move forward with management; in response to those Technical Committee tasks, as well as the findings of the stock assessment.

For summer flounder, the 2016 ABC was decreased by 29 percent to reflect the declines in the stock size that we've been seeing; as well as the board approved regional management measures, which is a more precise use of the MRIP data. Next week, summer flounder, scup, and black sea bass and bluefish will be subject to the joint management meeting.

I am sure that many folks have heard in the rumor mill that the summer flounder stock is continuing to decline. This is partially because the stock overestimates SSB in the terminal year as well as overestimates recruitment; and we have not had any real good recruitment classes in recent years, and most of them have been below average. We will figure out how to move forward next week here.

For tautog, the coastwide portion of the stock assessment found the fishery to be overfished and overfishing was occurring. Regional assessments were also completed, and as we heard yesterday, the TC completed an additional set of regional assessments, and have moved forward with the Plan Development Team to look at a four-region approach to develop management measures, as well as we have initiated a tagging program for the commercial fishery to address some of the concerns that we've been seeing with the black market fishery and unknown catch.

Additional species of concerns that were in the list were Atlantic croaker, and the winter flounder Gulf of Maine Atlantic croaker is currently undergoing a stock assessment. The results of that will be out this fall or this winter. With winter flounder Gulf of Maine, as well as the southern New England/Mid-Atlantic, we continue to try to work with the New England Council; as well as through the NRCC to try to move forward on management measures that will help this stock move forward in rebuilding.

The board continues to set very precautionary measures for both of these stocks, which don't seem to be responding to these minimal management measures. For depleted species, for southern New England lobster the stock is depleted and overfishing is not occurring. Abundance is at approximately 42 percent of the threshold, and the current exploitation is below the threshold.

Estimates for recruitment are near zero, and they are at the lowest on record. The TC has been advising the board to use output controls to manage the fishery, while the board continues to use input measures. Before the most recent assessment came out, the Technical Committee had advised 50 to 75 percent reductions for the southern New England lobster management areas; and the board approved a 10 percent reduction, and then took some additional reductions in traps for Areas 2 and 3.

With the results of the new assessment the board is considering a 20 to 60 percent increase in egg production; and tomorrow we'll have a lot of discussions on how the board is going to move forward with measures in southern New England. For northern shrimp, we still are seeing failed recruitment in that fishery. The Technical Committee and Stock Assessment Committee don't expect to see any recovery until at least 2017. The Section continued to implement a moratorium in 2015, and initiated an amendment to look at limited entry in the fishery.

The Section moved forward with having the Plan Development Team look at quotas for each of the states with a fishery. The trawl survey is ongoing right now, and I think they are seeing some maybe good things there. Ashton went on it, so you could ask her about it if you're interested.

Then we received an assessment for weakfish this year. The 2016 assessment found that we are still below the mortality thresholds, and we're below the SSB thresholds. We have very strict regulations on the harvest of weakfish in both the commercial and recreational fishery and continue to have those.

For Jonah crab, the commission implemented the Jonah crab FMP this year. The landings have increased 6.4 times since the early 2000s, with over 17 million pounds of crab that were landed in 2014. The status of the resource is relatively unknown. We don't have a lot of data that we can use for an assessment, including maturity estimates. There are a couple of states that are working on maturity studies, and as soon as we have that information we'll try to get a stock assessment conducted.

In the meantime, we're going to have the Jonah crab TC look at some stock indicators, to try to give the board some information on what kind of changes are occurring in the stock. Then some additional depleted species, shad and river herring, winter flounder in southern New England/Mid-Atlantic, sturgeon, spot and spotted sea trout. Spot is also undergoing an assessment that will be ready this fall; and that is all.

CHAIRMAN GROUT: Any questions for Toni? Ritchie.

MR. G. RITCHIE WHITE: The suggestion on northern shrimp, it is not possible that it can recover in 2017. You might want to move that date out a year or two.

MS. KERNS: That is the advice that we still have, so I was trying to stick with the scientific advice; but yes.

CHAIRMAN GROUT: Any other questions? Malcolm.

DR. MALCOLM RHODES: Just a question. Spotted sea trout are in depleted category? I mean, is that just in local areas?

MS. KERNS: I apologize, Malcolm. They should be under the unknown category, as well as Jonah crab.

MR. WILLIAM ADLER: This is more of an observation from the reports; particularly on black sea bass. I know there is really nothing here, because I believe it is the federal Mid-Atlantic that sets things with that wonderful SSC. But I have a big problem with the fact that nobody can increase the quota on black sea bass, when everybody says that's all they can catch everywhere. I suppose it's just an observation that I don't know what anybody can do to shake them loose to raise that quota; because it's ridiculous. I just wanted to put that on the record, I guess.

CHAIRMAN GROUT: Next week.

MR. ADLER: Get it changed.

MR. DAVID V. D. BORDEN: Just a suggestion for the future. On some of these species there are data limitations that cause some of the problems in terms of the board's adherence with regulations. For instance, there is a very limited lobster sampling program in the offshore areas, which now NOAA and some other organizations have started to address. But I think to the extent going forward that there are problems like that it would be useful to just have some kind of notation in here; so that it draws attention to the need for funding and better data collection programs.

CHAIRMAN GROUT: Good thought, Dave. Bill again.

MR. ADLER: I'm sorry, here I go again. On winter flounder, many times when we've had the board meetings, I brought up the fact on the particular chart that we have here that I think that the target, the top line there, is too high. It is almost like it has never been that high in recent memory; and yet the comments always come back, well it was there at one time, and it's off the chart to the left back in 1776 or whatever it was.

I think that the way this is put forward suggests that we have to really do a lot of work, and according to what I'm looking at here, the bar is too high. I've said this before that I think somebody should really look at perhaps lowering the bars a little more to the realistic thing. I just wanted that one on the record, too.

COMMISSION INVOLVEMENT IN COBIA MANAGEMENT

CHAIRMAN GROUT: Further comments, questions? Okay. The next agenda item is cobia, and whether we're going to potentially become managers of cobia. Toni is going to start it and then I guess Jim has a motion.

MS. KERNS: Just a quick refresher course on cobia and cobia management. Gregg Waugh came in and spoke to the Policy Board at the May meeting, and gave a bunch of this information; but just a reminder of where we are and why we're here. Cobia range from Nova Scotia to Argentina, the stock that we're really thinking about here is the stock that is on the Atlantic Coast, and that is divided up into two groups.

There is the Atlantic migratory group, which ranges from roughly Georgia up to New York, and then there is the Gulf group, which is the east coast of Florida; as well as the Gulf of Mexico. There is primarily bycatch in the commercial fishery, as well as a very valuable recreational fishery. Approximately 83 percent of the recreational harvest in state waters from Georgia north is occurring, and so that is why we have an interest in this fishery; because of that large state water catch.

Cobia is managed currently jointly via the South Atlantic Council and the Gulf of Mexico Fishery Management Council. The Mid-Atlantic Fishery Management Council has two seats on the South Atlantic Council, and so that is how they are involved in cobia management. The Atlantic migratory group, the South Atlantic Council sets the ABC, the TAC, and all the fishery specifications for that group. Then for the Gulf migratory group, the ABC is set by the Gulf of Mexico Council. The South Atlantic and the Gulf of Mexico Council determined a percentage of that ABC; basically a sub-allocation is given to the east coast of Florida.

Then the South Atlantic Council sets the regulations in order to meet that sub-allocation. There is a little bit of joint management going on there. Again, with the South Atlantic Council, the Mid-Atlantic Council has those two seats; and so they do have influence there on the Florida east coast fishery.

In 2015, the Atlantic migratory group cobia's ACL was 630,000 pounds, but landings far exceeded that at 1.5 million pounds. NOAA announced a closure for the Atlantic migratory group cobia effective June 20th in 2016, for that overage in the ACL from 2015. The closure impacted the range of all of those states; but the greatest impacts were seen in the Outer Banks of North Carolina, as well as the states Virginia to the northern extent of the range.

Virginia and North Carolina responded by changing their state specific regulations to lessen the impact of the closure. Then the South Atlantic Council requested that the commission consider joint or complementary management; largely in fact, due to that large state water catch that I told you about earlier, to help regulate that recreational fishery and to have state input on the management measures; to be able to better manage the cobia complex as a whole.

Yesterday the South Atlantic State/Federal Fishery Management Board had a very good, thorough discussion on cobia management and where they wanted to see this management go. They made a recommendation that the commission implement a complementary cobia management FMP. What does complementary mean? It would mean that we would not have to have lockstep measures with the council vote. We would put together an FMP that is somewhat similar to those management measures within the federal plan.

It would be most likely how complementary management has worked in the past, where the Federal Council would set the ABCs and the ACLs, and then the states would work with those ABCs and ACLs, in order to implement management measures within their state waters. We typically jointly look at stock assessments. Oftentimes, the federal partner takes the lead in those stock assessments though. States would do state survey work, they would also monitor their quotas if quotas were put in place.

You could still have state specific regulations that weren't those that mirrored the federal regulations at times that can work out without having negative impacts on state and federal permit holders; depending on how it is designed. The other thing that the board recommended was that the cobia FMP be a part of the South Atlantic State/Federal Fishery Management Board. I will turn it over to Jim for those specific motions that were made at the council.

CHAIRMAN GROUT: Jim.

MR. JIM ESTES: If we can have it up on the screen, please, I'll state the motion and then I'll talk a little bit about the rationale behind it; although Toni covered some of that. **On behalf of the South Atlantic State/Federal Fisheries Management Board, we move to recommend that the Policy Board develop a complementary fishery management plan for cobia.** Now, if I might, a little rationale; Mr. Chair.

CHAIRMAN GROUT: Absolutely. That is a motion by the board so it doesn't need a second. Go ahead, Jim, for the rationale.

MR. ESTES: Toni mentioned some of the rationale. First and foremost I think is that although it differs from state to state, in 2015 about 80 percent of the landings were from state waters, and so that makes a little bit of sense that the commission would have some part of the management. We also discussed a little bit how Atlantic States Marine Fisheries Commission might be a little bit more nimble, and we could react possibly a little quicker than the council could to things that might change.

As Toni mentioned, the South Atlantic Fisheries Management Council consists of three members each from the states of North Carolina through Florida; including federal partners; and the Mid-Atlantic Council has two members, and so there was a little bit of discussion about equal membership.

For example, I know that Virginia, I think, has one member there. Here we're all equal. Those were those main points, unless Michelle has something to add. By the way, we also were lucky to have Dr. Duval with us, because she now serves as Chair of the South Atlantic Fisheries Management Council; and she also serves on our board. It was very useful to have her with us.

CHAIRMAN GROUT: Any questions or discussion from the board? I have one question, and it's from the standpoint of the commission has been taking on a lot of different species in recent years. I wanted to get a feel from Toni or Bob. Do we have the staff capacity to take on yet another very important, probably based on some of the public comments I heard last week, relatively controversial management.

MS. KERNS: I think I'll start and then Bob can fill in anything that I might leave out. I think that if adding cobia, we will be at full, full tilt capacity for staff. I think we'll have to be quite cognizant and careful of our action planning, to make sure that we're not doing more than what we can handle; and then at times during the year we add additional amendments or addendas, and I think we'll have to look at the list and make sure that we prioritize the work that staff is doing.

It is not only our staff that will be impacted, but it is also states staffs for TC members, and stock assessment members, Plan Development Teams, et cetera, that will be cognizant of during those times. Your state members are also quite overloaded at times, and so we want to be cognizant of that. Do you want a budget as well, Doug or no?

CHAIRMAN GROUT: I don't need details in a budget, unless some of the board would. I just wanted some assurance from the staff that we weren't going to be taking away from other management board capacities to be able to move forward by taking this on without additional staff.

EXECUTIVE DIRECTOR ROBERT E. BEAL: Just a quick comment. Two points in addition to what Toni said. One is that we've hired a contractor to work on cobia right now to help out with the staff capacity, and that seems to be working out well. That is an option moving forward to deal with staff capacity. The other is sort of a more philosophical question, which is do the commissioners have time to deal with all the species that we have on our plates right now? We've got four meeting weeks a year, two at four days and two at three days; so that is 14 days a year for the commissioners to tackle all the species that they have to tackle.

That is a pretty big workload. I'm not saying that the cobia sort of is the snowflake that causes the avalanche and makes us not be able to do our work. I think it is just symptomatic of everything that we're doing. Everybody's busy and everybody's pretty well flat out. At the Legislators and Governors Appointees Lunch today, there was a bit of conversation about timing of briefing material and a lot of documents coming the Wednesday before meeting week as supplemental material.

That is another symptom of just being busy between our quarterly meetings. I think all those dimensions play into just prioritizing workload; and make sure that staff is working on the high priority of the folks around this table. As Toni said, we don't really have anyone sitting around the office looking for things to do; but we just want to make sure that we're hitting the most important projects that you want us to work on. Should this move forward, we just need to make sure cobia is in the right place in that prioritized list.

CHAIRMAN GROUT: I think that's a good point, Bob, because you've seen recently it has been difficult for boards to have the thorough discussion that they need, for different management actions within the timeframes that we're allowed; because we're only here three or four days a week. It may be something that we need to consider in the future, particularly for taking on additional species. I saw Michelle's hand and then Robert and then Ritchie.

DR. MICHELLE DUVAL: I'm sort of struck by some of the comments around the table. This is a little bit of déjà vu of similar conversations that we have around the South Atlantic Council table a lot. I know John Carmichael is sitting here in the back of the room. I am sure he would nod his head with regard to capacity and wanting to make sure that staff that are already running at full tilt, don't get overloaded.

Unfortunately, sometimes at the council level we have triage issues that we just simply have to deal with. I guess I am fully aware of the capacity issues here. I don't want to create even the start of the avalanche, but I do think that cobia does meet all the criteria for a species that we would consider for interstate management.

You know, there is certainly some controversy with regard to stakeholders, in terms of taking on cobia. I think I tried to address some of those concerns at the South Atlantic board meeting the other day. I think they are mostly related to assumptions that if the commission were to take on cobia that we would immediately move towards a state-by-state management approach.

I have tried to tell folks that may be certainly an option down the road, but that doesn't mean that that is something that the commission would consider out the gate. I do think that taking on management of cobia would alleviate those concerns about equal representation that Mr. Estes outlined. I think given the migratory nature of the species, given some of the distributional shifts that we are seeing, given some of the warm water conditions that we are seeing. I think that it would be wise for the commission to consider taking on cobia sooner rather than later.

MR. ROBERT BOYLES: I would like to echo Dr. Duval's comments just for the board's consideration, a reminder that fully 80 percent of the cobia caught on the Atlantic coast or caught in state waters, we just spent four and a half hours kicking the can down the road on a very important species; the percentage of quota which my state enjoys is zero.

We've had a request from a sister, delivered in body requesting us to consider taking over management. In South Carolina when we closed our fishery in state waters, as well as in coordination with the federal closure, my anglers asked me how come our sister states to the north are continuing to draw fish out of that population?

Their request of me is one of equity. My interest in this is I fully respect and appreciate fisheries triage. I think that is important for us all to take into consideration. But I will repeat what I said yesterday at the South Atlantic Board to quote Dr. Franklin, "We must all hang together, or surely we will all hang separately." I would urge the Policy Board to approve this motion.

MR. WHITE: I have more of a question than taking a position on this. The word, complementary, I guess I questioned. If we're going to put a lot of resources and effort into coming up with a management plan and managing this fishery, does that mean then that we are just following what the South Atlantic is asking us to do or telling us to do?

I would think that if 80 percent of the harvest is in state waters that the commission would be the lead entity, and the South Atlantic would be following the commission's lead. I guess I don't quite understand how this process would unfold.

CHAIRMAN GROUT: I guess our Executive Director would like to answer that.

EXECUTIVE DIRECTOR BEAL: I'll give it a try. Ritchie, I think a lot of the details still have to be developed. But if there is the maintenance of a federal component in a fishery management plan, then that portion of the management will be bound by the Magnuson-Stevens Act. The South Atlantic Council will, if they maintain their plan, which under this motion they would; will still be obligated to set ACLs and catch limits and accountability measures.

But I think the idea is that through working through the states and the commission, we'll be able to deal with a lot of the allocation issues and slow down the fishery so that the accountability measures that were triggered this year can be deferred or avoided altogether, and the fishery can be better managed and meet the needs of the states.

Because right now, depending on when the closures occur, it advantages and disadvantages certain regions of the coast. Working through the commission process, I think a lot of the commission work will probably be sort of spreading out the benefits or equalizing the benefits across all the states that have cobia.

CHAIRMAN GROUT: Further discussion on the motion? Dave.

MR. BORDEN: I'm supportive of the concept of doing this, but I would just like to note I agree with a lot of what Robert said. Where I get apprehensive is when I think about this many people following our normal FMP development process with PIDs and public hearings and all of those types, in a formal FMP. I think of all the time and effort and labor that go into that. I would go back to the point that Ritchie made is, the issue to me is complementary regulations, and not the full development of a FMP. I don't have the answer for this, but maybe there is a process that we could follow that would short-circuit a lot of our own procedures to try to minimize the workload. The operative phrase here I think is complementary regulations.

If we can simplify the way we develop those, I think it would behoove us, because this is sure to happen with other species. This is just the first one with climate change and all the rest of the things that are going on in the ecosystem. I think we should all expect that this is going to happen again.

MS. KERNS: David, I see some of the points that you're making and we could try to talk potentially to see how we could make some changes to our process potentially. But the commission would have an FMP. It would be largely based on the council FMP, but because it is complementary and not joint, it does allow for the commission to have unique measures that are not in the council plan. You could have some state-specific information within our FMP. It doesn't have to be like similar to summer flounder, scup, and black sea bass.

CHAIRMAN GROUT: Further discussion on the motion, seeing none; do you all need time to caucus on this? **Let me try this. Is there any objection to the motion? Seeing no objection**

to the motion, the motion passes. One of the things, there is a follow up on this, Toni and Bob, as we get into the fall meeting where we're looking at our action plan for the future.

I would like a special consideration given to, not only an analysis of staff capacity, but also of board and technical committee capacity at our current levels of fisheries management; to see if there is the potential that we may need to change things. Maybe we can do it the way it is, but go ahead, Bob.

EXECUTIVE DIRECTOR BEAL: Now related to that a moment ago you mentioned that some of the board meetings are tight, very tight. You indicated that some of the discussions may not be able to sort of develop and unfold and get into as much detail as you want. I think if that is a prevailing perspective of the commissioners that we're trying to jam too much in a meeting week. That would be good for us to know.

We're trying to accommodate all the decisions at staff level that we know need to happen during a meeting week to keep documents moving forward and everything else. But it is more of an art than a science, scheduling these meetings. Some go over, some go under and hopefully around five or six o'clock, we get done for the day. But if that is the sense that we're trying to do much in a meeting week or in a day or in a two-hour meeting or whatever it is. If we can get that feedback to staff, that would be helpful.

CHAIRMAN GROUT: Possibly one mechanism for getting that kind of feedback from our commissioners is we do that annual survey of how we're doing. Maybe we could add a question to that survey; do you think we need more time in our meeting week to thoroughly do our business?

EXECUTIVE DIRECTOR BEAL: Some of your meetings are entirely too long. But that is fair too.

CHAIRMAN GROUT: I agree. We need to have good meeting management. I know I didn't do a good job at Executive Committee in keeping us on time. But I know, from my observation today at Menhaden, Bob Ballou did an excellent job of moving things along, and we were still an hour behind.

MR. WHITE: Yes, because we used to have four, four-day meeting weeks; so we've dropped two days out of our schedule.

CHAIRMAN GROUT: Okay Jim, I believe you have another motion from the board. It's already up there. Okay. Should I read this into the record? I'll let the Board Chair read it into the record for me.

MR. ESTES: **On behalf of the South Atlantic State/Federal Fisheries Management Board, move to recommend to the Policy Board that the South Atlantic Board is the appropriate venue to develop the fisheries management plan for cobia**.

CHAIRMAN GROUT: **Again, this is a board motion. It does not need a second.** Is there discussion on the motion? Toni.

MS. KERNS: Just a quick note for those states that are not on the South Atlantic Board. If you have an interest in cobia or commissions, you can make a request to the Policy Board at any time to be able to declare into that species management board; especially if we're going to have a new species within that board, as well as that we offer seats to the councils on any of our management boards. The South Atlantic Council does have a seat on the South Atlantic State/Federal Board.

DR. DUVAL: Not to belabor this, but I do think that this is something that in terms of where board management of this species moving forward. I think that is something that can be a little bit flexible, and should the commission decide down the road that it really does require its own separate board or a subset of the South

Atlantic Board; you know we can certainly do that. It just seems like right now it is the best place to start.

CHAIRMAN GROUT: Further discussion on this motion? **Is there any objection from any states to this motion; states and federal entities? Seeing none; the motion passes.** Okay, that covers cobia management. We are now official cobia managers.

OVERVIEW OF THE CONSERVATION EQUIVALENCY GUIDANCE DOCUMENT

CHAIRMAN GROUT: Toni, do you want to give an overview of the Conservation Equivalency Guidance Document that we've been reviewing and making changes to?

MS. KERNS: I'll be quite brief on this, in the interest of time. The Executive Committee tasked staff to look at the guidance documents, and one of the guidance documents that we had not looked at in a very long time was the Conservation Equivalency Guidance Document. It just gave an overview of procedures of how states were supposed to go about putting together conservation equivalency plans. Over time as the commission has evolved, what was in that document and how we actually practiced started to separate from each other.

Staff, as well as the Assessment Science Committee and the Management and Science Committee, made some recommendations on how we can make changes to that document to reflect current practices. It includes recommendations on the timing of requests for conservational equivalency proposals; the information that needs to be contained, the evaluation of those proposals, how long they last. We'll be making language changes to the documents based on the recommendations that came out of the Executive Committee meeting and we'll present that to the Executive Committee at the annual meeting; and then present the document to the Policy Board for their review and approval at annual meeting, as well. Again, just to note that it is actually reflecting what our current practices are. There aren't any significant changes. I will highlight if there are any significant changes to current practice in my presentation at the annual meeting.

CHAIRMAN GROUT: Any questions for Toni?

RISK AND UNCERTAINTY POLICY WORKGROUP REPORT

CHAIRMAN GROUT: Okay, we'll move on to Risk and Uncertainty Policy Workgroup. Shanna has –

MS. KERNS: Jay's going to do it actually. He chaired that work.

CHAIRMAN GROUT: Jason, since he is Chair of the Workgroup, is going to do the presentation on this; and there will be an action for consideration of approval of the Risk Policy Statement.

MR. JASON McNAMEE: My name is Jason McNamee; I work for the Rhode Island Division of Marine Fisheries. I am the proud Chair of the ASMFC Risk and Uncertainty Policy Working Group. I've got a quick presentation here. I'll try to get through it quick, so we can get to the heart of the discussion.

Just brief introduction, at the November Executive Committee meeting, the Executive Committee reinitiated a process to develop a Risk and Uncertainty Policy for the commission. It had been attempted before. It got going and then got quiet. We wanted to get it going again. We felt a little more optimistic. This kind of discussion, this type of policy, it's becoming better understood. It's becoming more of a standard in scientific and management procedures.

Some recent examples emphasize the need to develop this policy. I will use a very contemporary example, maybe from this morning. I think the board could have used a little more guidance; I think it would have helped in the discussions this morning at menhaden. This is exactly what this type of policy is meant to do. It sets out that kind of criteria a priori, so you have that guidance.

It could have been that one piece that you needed this morning to help with that process. There have been other examples, striped bass I think it was last year, because there was no guidance, the Technical Committee ended up choosing a risk. It is really not a technical decision, it is a board decision, so a couple of examples there as to why these types of policies are important.

Some of the benefits of a risk policy, they've been used for many years now by the regional councils. There are some negative examples from really rigid applications of these types of policies. But there are also successful examples. It is not all negative. We tend to focus on the ones that get us jammed up; but there are some examples where these risk policies have benefited the management of the different stocks.

In our case, because they've been used for a while now, we have the benefit of hindsight, and so we can build a policy that has a little more flexibility associated with it. A couple more points on the benefits, one of the nice things about setting out the policy ahead of time, it provides a priori guidance to the technical committees for specifying recommendations; and these recommendations will be in line with what the board wishes. It kind of lines everybody up, makes them more efficient. It improves the integration of fisheries science and management by maintaining transparency and creating management level accountability.

That is another nice aspect of setting forth these types of policies. It allows the TCs to work a little more efficiently. You don't have to have that extra bounce, where the TC kind of comes back to the board and says, we need a little more guidance; and so that gets sped up, because that is already provided.

It also provides greater clarity in the process for the stakeholders; they kind of know ahead of time the things that are guiding some of your decisions. Back in April, the ASC and MSC both met at a joint meeting, and we began to scope out a plan for the development based on that request from the Executive Committee.

We created a plan, and what we wanted to do was develop a multidisciplinary working group to work on the policy. What we mean by multidisciplinary, we had members from the MSC, members from the ASC, as well as some board members. We kind of constructed this working group; and our first task was to develop the Risk Policy Statement.

We began working on that. Two products came out of the process to develop the Risk Policy Statement, and so I'll pause for a minute. The Risk Policy Statement is the overarching, guiding principles for the whole rest of the policy. This is that kind of couple of sentences right up front, very high level that sets out the perspective of the policy and the guidance that the following policy will follow; and so it is that high level statement.

We did it kind of in a sequential way, and we got two products. We got the feedback from our Multidisciplinary Working Group, we got some common threads. We had multiple people contribute; each kind of contributed very thematically similar things, which was kind of interesting. We synthesized some of those common threads; and I'll show you that on the next slide.

Then we produced the actual statement, and we'll give you a look at that, as well. The common threads that kind of popped up were consistently applied across all commission species. The people that were on the working group wanted something that kind of be comprehensive, used consistently across all of the species, and not just completely change what you're doing from species to species; you know where appropriate.

They thought it was important to incorporate social and economic factors. That is something we talk about a lot, but don't have a good mechanism for incorporating. This provides us an opportunity to do just that. Provide transparency for the commission process, I've talked about that a couple times, but when you set up this guidance ahead of time, it increases that transparency.

Flexibility should be built in so the policy can be amended and adapt to change. We don't want something that is static and really hard to change. We want something that is flexible that we review through time; and that is one of the things that we'll try and really harp on, as we build this and really keep in mind. A final kind of theme was to provide stability in management measures, and that is something that we talk about a lot but often don't achieve. Stability is another attribute that we can build into this policy. The second thing that we developed was the Draft Statement, so I'm going to yammer away here for a minute. You can ignore my voice and kind of look up there and read through that.

I promise you I am going to go to a slide at the end where the font is much larger, and give you some more time to kind of stare at that. But just a couple of comments before I click through; I've got two more slides. A couple of comments, the Draft Statement, as I mentioned, was sort of a sequential process for us. We asked the Working Group to kind of all contribute their ideal policy statement, and those got sent in.

We kind of coalesced them; and then synthesized them into a single statement, trying to grab everything that had come forward to us. At that point what we did was we put forward that synthesized statement. We had a conference call. We beat it up real good on the conference call, made some good modifications; made it a little more efficient, as well.

It might be hard to believe, looking up at that. But we did, and sent it back out; received a few more comments. The point of all of that is we worked on this pretty hard. We were pretty satisfied with the product, but now we want you all to take a look. Wordsmith it if you want, offer some advice; however you want to approach it.

Just to show you our next step, so establishing the Multidisciplinary Working Group, we did it. We checked that one off the list. Now we're developing the Policy Statement, and it is important for the continuation of this process to get that Policy Statement set; because that guides the process from here on out.

This is the opportunity to set that high level policy guidance, so we know how to proceed with the rest of it. That is what we're hoping to achieve at this meeting. Then we'll meet again and we'll begin to scope out a plan for the rest of the policy. We'll develop one thing we thought would be very useful, which is to develop some examples; so actually walk you through what the policy would do in a sort of example situation.

We've gotten some good feedback on how to that; one data poor, one more data rich, those kinds of scenarios. Then we'll present those examples to the board during the annual meeting. That is our kind of ideal timeline there. I will stop now for questions; I'm going to flip one more slide so that the statement will go back up on the board.

But one comment is with the retirement of Dave Simpson, we'll be down a member on the working group, so if anyone on the board would like to be involved with that, we would be happy to take on another member to offer that board member guidance to the process. With that I will stop talking, put the Policy Statement back up there and take any questions that you might have.

CHAIRMAN GROUT: Questions on the Policy Statement.

MR. ADAM NOWALSKY: This may be premature, but I'll try, anyway. In that the examples we're talking about seeing being driven by this policy statement. Are they similar to the risk policies that he federal council's might be using; such as the B to BMSY ratio is something, then do something with your quotas, or if the stock is overfished and overfishing is occurring do something else. Are we talking about applying something that mathematical that we see at the federal level; or are you contemplating something else? Any indicator of what that something else might be would help me in responding to this statement.

MR. McNAMEE: Yes, excellent question. That was as we began talking about this that is always the question. Are we going to get locked into some like super stringent rigid control rules? The way, at least at this point, that we are envisioning this policy to be applied mechanically is like a decision tree, where you bounce through a set of questions that you ask, based on the information and the species that you're working on. What we think that does relative to -- if you'll bear with me, I don't mean to offer that I know exactly what you're thinking.

But I think you are kind of envisioning a really rigid process. If X equals Y then some result happens. I think what we envision in the decision tree is more nuance to that, so we don't get locked into a really rigid result, based on one single element. There are a number of elements in there that we can all weigh, but in the end the goal is to get to a system that we all know ahead of time; and will kind of know how things are going to flow through that system.

Without being able to offer you the examples specifically, and we did actually go through a mock example at the ASC/MSC meeting, I don't know if that was provided. We didn't provide it to the board, but we did kind of begin to tinker with an example to see how it worked. We'll continue to do that. I can't be more direct with you at this point, because I don't know. We haven't gotten to that point yet.

CHAIRMAN GROUT: Other thoughts and questions and discussion on this? Steve.

MR. STEVE HEINS: Would you envision that this would only be applied to species that the council doesn't already apply a risk policy to, or is there going to be some relationship between commission policy and a council risk policy?

MR. McNAMEE: Good question. I don't envision this as being additive with preexisting risk and uncertainty policies that are out there. But one way that it could be helpful is, there is a process for management uncertainty for some of the jointly managed species; but by and large that management uncertainty aspect is not applied. This could supplement in that aspect of it, but I don't see it as double dipping on the risk; I guess for a lack of a better way to put it.

REPRESENTATIVE CRAIG A. MINER: To me, it describes what I've read in the charter. It is a condensed version. I appreciate the work you've done here. It looks something like what I expect to see from this commission or the board. It would be certainly benefited, and not only that but it is necessary by the demands of the charter that govern this body. I would like to see this move forward, so, good job.

MR. BRANDON MUFFLEY: I am glad to see this move forward. I was part of the original one that when this topic came about a number of years ago that kind of fizzled, so I'm glad to see this go. I think this provides a lot of benefits to the board members; and also to the public, so that they can see some rationale behind some of the decisions that we have. I don't know if this is a question specific to you, Jay, or more to Doug. What would be the way that we would implement this sort of policy?

Like structurally within the commission's guidelines and rules and regulations, how would this specifically be implemented and applied?

CHAIRMAN GROUT: I'm being consulted. Toni is providing me advice that it could be the decision of the board as to whether we want to incorporate this, for example, into the charter; or some of our existing documents as a policy, or we could have a standalone policy statement. Again, that is something that we would have to decide at this particular point in time.

MR. BORDEN: Question for Jason. Jason, did I understand you correctly that it if the commission adopts this, then it basically sets a framework for additional work that would be done; and then you would bring all of it back and ask for formal approval. I mean, if that is the case, my assumption is we don't need a motion at this point; just the acquiescence of the committee.

CHAIRMAN GROUT: That's the way I see it. I would like to have concurrence from this board that this is a policy statement that we would like to move forward with, and then the Working Group will complete their work and then come back and we'd have something that we'd formally adopt.

MR. BORDEN: I think it's a good first step, and I'm comfortable with it; given the fact that we're going to revisit the whole issue at some point with further details.

MR. NOWALSKY: I, as well, support the intent of what we're doing here. My only concern with this as written and I would be interested in feedback about where the specific verbiage came from, would be with regards to requiring full consideration of the uncertainty. I think, by its very nature, the level of uncertainty is uncertain.

I think, we, as managers, those that do the work, the public we represent, can always point to something else that we should be considering or didn't fully consider. What was the thought process to that particular phrase; and is there something else that was considered, the maximum consideration practicable; something to that regards that would allow for that understanding that it is by its very nature uncertain.

MR. McNAMEE: Great question. The idea behind that statement, I think, was to fully account for, to the extent we could, the uncertainties that are accounted for. I think that gets to Steve's question. Some uncertainties are already accounted for. We Monte Carlos sampled the output from the stock assessment.

We projected with uncertainty around parameters X, Y, and Z; and so there are certain things that we have accounted for uncertainty very explicitly, and we kind of itemized those, so we can see them. Then there are these remaining ones for instance that we don't necessarily do a good job of accounting for; economic uncertainty, social uncertainties, things like that. The idea with the statement is to lay bare what we've accounted for and what we've not accounted for; and how we deal with it at that point.

CHAIRMAN GROUT: Further discussion, further comments? What I've heard from those who've spoke, I see support for moving forward with this. Are there any objections to having the Working Group take this and develop examples, and bring back something that we can look at for consideration and potential approval at the fall meeting, or the next available meeting? Seeing none; thank you very much, Jason, for the work of the Working Group on this. I appreciate your leadership on that. Okay, next on our agenda is Lisa Havel with three reports; 10, 11, 12.

HABITAT COMMITTEE REPORT

DR. LISA HAVEL: My first report will be on the Habitat Committee. On May 11th and 12th, the Habitat Committee met in Cape May, New Jersey. They had a presentation by Dr. Ken Able from Rutgers University, reviewed the process for making recommendations to the Policy Board, reviewed the 2016 Action Plan progress, and finalized the topics and articles for the 2016 Habitat hotline, which will be shallow water habitats.

They also discussed climate change actions by state, and discussed seismic testing effects on fish habitat. This was submitted to the Policy Board in a memorandum in the supplemental materials; and I would like to go into more details about that now. Some background on seismic testing, the Habitat Committee discussed whether the effects of seismic testing warrant a position in comments by the commission.

Seismic testing includes oil and gas exploration, siting of offshore wind facilities, and characterization of sand resources. Testing uses loud blasts from air guns up to 180 decibels every few seconds for up to weeks at a time. This can cause temporary changes in functionality of areas for different species; making it a habitat issue.

This should be of interest to the commission, even if it is not a habitat issue. Seismic testing can cause behavioral disruptions in feeding and movement, which can have proximate effects on feeding and reproduction; and ultimately affect stock productivity. Impacts can be minimized if testing is timed to avoid key life history stages.

But you need more information for accuracy and precision in order to set those timings. Seismic testing can also cause injuries in marine organisms. The Habitat Committee's perspectives were influenced by comments from the Mid-Atlantic Fishery Management Council and the South Carolina Wildlife Federation. The Mid-Atlantic Council wrote to BOEM, opposing seismic testing on the U.S. East Coast, citing insufficient data on impacts to marine mammals and fisheries.

The South Carolina Wildlife Federation wrote to the South Atlantic Council, opposing offshore seismic testing and oil and gas development; and asked the council to at least protect essential fish habitat and habitat areas of particular concern in offshore waters. They also asked to designate special management zones, and send comments to BOEM and the Office of Coastal Resource Management.

The Habitat Committee recommends that the commission adopts a position similar to these organizations; and convey that position to BOEM and other entities, and we have the possibility to move this forward today. The Habitat Committee also wanted to include that seismic testing is used to locate oil and gas resources, as I stated. That can have additional detrimental effects to managed species, if oil and gas drilling does start to occur.

CHAIRMAN GROUT: Okay, we have a request from the Habitat Committee to write a letter expressing the commission's concerns about this seismic testing. I would like to have a discussion on this; and also any questions that you may have for Lisa, concerning the Habitat Committee's position on this. Tom, you had your hand up?

MR. THOMAS P. FOTE: I've been in this argument a long time, Rutgers University basically doing seismic testing off New Jersey, and they weren't even doing that; they were doing it for archeological. Under the guise of doing for climate change, they really were looking for – they want to sell the papers for oil and gas drilling, but they couldn't do that off New Jersey, so they did it under the guise of looking how 60 million years ago climate change affected them; and that was totally absurd.

But the latest one is that the Manasquan Ridge, the boats were out there doing seismic testing; not on the magnitude that Rutgers was doing, but a slow one. They were looking for sand granules and to destroy the Manasquan fishery, Manasquan Ridge, which has been a fishing hole for hundreds of years off New Jersey.

Jimmy Loveland just pointed out the fact to me that he went out, and some of you know Jimmy; he was on the Mid-Atlantic Council. He went out the week before and was getting a couple of boxes of summer flounder. Right after they did the testing, all they were getting were three or four fish from the same area.

It dramatically effects, whether it kills them or not it does move them out of the area. The seismic testing is not doing anything good for fishermen, so it is either we do all drilling or we do sand mining for this. I understand we have to do beach replenishment. Usually, I don't bring the Jersey Coast Newspaper here, but there are two interesting articles; one is from the New York Times that a book that a gentleman is putting together right now, and looking at sand mining around the world.

A lot of it is due to major construction that is going on, Singapore and other areas of the world; and how they are destroying all the reefs, all the lumps, everything that is going on. It is just not unique to New Jersey or Florida or any other place that are doing this kind of testing and mining. I'll leave copies on the table, please take a look at the article. I asked Tina, I'll send her the New York Times article so she can send it out in the next commission mailing; but I support a letter going out. If you need a motion, I'll make a motion.

MR. DOUG BRADY: I'm relatively new here. Has this been something that's been on the plate for a while, or is this the first time that this has come in front of the entire commission?

CHAIRMAN GROUT: I believe it is the first time we've had any requests like this.

MR. BRADY: I'm not necessarily opposed to it, but I'm not sure if it doesn't require some more thought if you are going to make these strong statements. This is the first I've seen it. That's just my opinion.

MR. FOTE: Over the years, we've commented on certain projects that would affect spawning areas; anything that affects fisheries, and we have written this type of letter before. In the last 25 years I remember writing quite a few, especially when all the Governors Appointees and Legislative Appointees were on the Habitat Committee. We would look at different issues like this and approve them. We do it after careful discussion and getting all the facts. But we would do letters on that. A lot of it was to protect striped bass habitat or other habitats. The same way we were looking at the dredging issues, or supporting NMFS in some of their habitat issues that they were going on and write a letter in support of them.

MR. MUFFLEY: I also would support a letter from the commission on this issue. As Tom had mentioned, it has been a very active issue in New Jersey, not just for oil and gas exploration; but as Tom had mentioned, under scientific studies in regards to climate change issues, so it has been used for other purposes.

One of the things that I would recommend that be included in the letter is the need for additional research and studies to take place; because that is one of the things we are really lacking, is to understand what these impacts are. Most of the studies that have taken place or have taken place either in laboratory settings to try to understand what the impacts are, or when they evaluated impacts to fisheries, they've been in Europe and in other locations.

We don't have anything specific to the Atlantic Coast to definitively say, what happens when this testing takes place? We have information from the fishermen, but I think we need something more comprehensive; so I would recommend that the letter also discuss the need for research to get a better understanding on the issues.

MR. CLARK: I was just curious, Lisa, did the Habitat Committee also look into coordinating with the Ocean Action Plans that are being developed in both the northeast and the Mid-Atlantic; because I know this is an issue that has come up with the Ocean Action Plan to try to coordinate planning of these type of activities, and limit where they take place?

DR. HAVEL: That did not come up at our meeting, no.

MR. PATRICK C. KELIHER: I think any letter that is written needs to insure that BOEM is going to continually keep the commission apprised of any applications that are being submitted. Frankly, I'm more comfortable commenting on, instead of a blanket statement, commenting specifically to applications that may be submitted for permitting.

I'm sure the federal agencies will be commenting on any of these, and states with coastal zone management programs through the Federal Consistency Act, will be doing that as well. It feels good maybe to send a letter, but to be very specific on specific projects may be more appropriate.

MR. BOYLES: The South Carolina Department of Natural Resources has commented to BOEM on issues of seismic testing. I would point out to the Policy Board that my agency includes both the Marine Resources Division as well as the South Carolina Geological Survey. I reside at the South Carolina Marine Resources Center, which was established almost 50 years ago to promote ocean sciences research and development.

My concern with the letter, although I understand and appreciate some of the comments I've heard around the board about impacts of testing, unknown impacts on fish species. We mentioned that in our specific comments to BOEM. But at the same time, you know, our particular proposal off the South Atlantic, we made some very specific recommendations to BOEM; recognizing that we are interested in understanding what is out there on the shelf. I'm not comfortable with this vis-à-vis the perspectives, particularly from the Wildlife Federation. I understand where they are coming from, but just recognize that my agency has got a little bit broader portfolio.

CHAIRMAN GROUT: I have a quick question for you, Lisa. Then if I know the state of New Jersey wanted to make a motion. After I get the answer to the question, if you would like to put a motion up on the board for consideration by the Policy Board; I would take that after the question. I noticed in the Habitat Committee memo that it has been documented to actually demonstrate injuries to marine resources. What kind of injuries are occurring and to what resources, when this happens?

DR. HAVEL: It has been shown to decimate larval and egg stages, and then also there are sublethal affects like affecting hearing, causing injuries to fish hearing; which can effect orientation and reproduction.

MR. BRADY: I see the perspectives influenced by comments from, I guess that's Mid-Atlantic Fisheries Management Council and the South Carolina Wildlife Federation; and that this letter may take a similar position. Are those perspectives anywhere in our documents?

DR. HAVEL: They are in the supplemental materials.

MR. PATRICK GEER: Just to let you know, the South Atlantic Fisheries Management Council, through their Habitat AP, has a similar comment letter, statement that they put forward back in April of 2015. That is available as well.

CHAIRMAN GROUT: Does New Jersey want to put a motion up on the board for consideration, or not?

MR. FOTE: Before I make the motion, let me explain a couple of points. When we asked from New Jersey, we asked them to do it in the wintertime when there is no fish on those areas that would basically be disturbed; especially when the whales would be missing and the porpoises and everything else.

They refused to do it, because they are looking at when they can do it with graduate students. They are looking at doing it in the summertime that all the fish are there. That was one of the things. Also, the LMB was supposed to do research on the effects of this. As you know, once they did the seismic, they never do any of the research projects to tell us what happened after that; as Brandon pointed out.

Maybe the letter should go along with a motion that we send complementary letters, since we're doing complementary today with the South Atlantic and the Mid-Atlantic Council, asking for any project that is approved that the research needs to take place and needs to be funded before the project takes place, and that we get answers to what goes on there.

It is like when we do dredging. We don't do dredging when fish are spawning. It should be done when the fish are not in the area. It is not my problem if it is not convenient for the guys to blast, but we're here to look after fish and what the effects on fish are. That's one of the things I think we should state in the letter. Again, I understand, Robert, and we need to get research. But we need to get research that doesn't do it during fishing seasons or that will affect commercial fishermen and recreational fishermen; or damage fish, or damage marine mammals. That's my concern here, and if you could do it at alternative times, it is probably harder in the south but it is not harder in the north. There are whole times that there is no fish out there because nobody is fishing. That is one of the ways. I haven't worded the motion; I'm not good at that. I always left it to Pat Augustine.

Doug, do you want me to make a simple motion that we send a complementary letter to go along with the South Atlantic Council and the Mid-Atlantic Council, requesting that any seismic blasting or testing takes place when fish are not in the area, as much as possible, and that research needs to be done on any project that is; and funding for that research needs to be up front before you do the project.

CHAIRMAN GROUT: Did you get that? Once we get that up, I will see if there is a second, unless somebody would like to second it as they heard it. Okay, Eric Reid will second it as he heard it. We'll try and get that up on the board and have discussion on the motion for the discussion. John, as I was asking for a motion, I saw your hand whip up. Do you have something you would like to say?

MR. CLARK: I was just going to note that the Mid-Atlantic Council has a habitat policy and kind of a set of standards to how we respond to this sort of thing, so when one of these site-specific projects comes up, we could have staff write a letter relatively quickly; fire it around to the council, get it approved, and get it out, because often the timeline on these things is such that that sort of thing is a requirement. Maybe you want to take a look at that as well as the letter itself from the Mid.

CHAIRMAN GROUT: Michelle and I see a half hand up. Robert, do you want to speak, too? Michelle first.

DR. DUVAL: To follow up on Pat's comment about the South Atlantic Council letter, which is fairly broad in nature, the council does have energy policies and attach that and a letter to BOEM. I think it was rather general. I have, wearing my agency hat here, I have some of the same reservations as Robert does about sending a very specific letter.

I think I could support a broad letter that encourages advanced communication from BOEM to the commission, with regard to projects that may be occurring along the Atlantic Coast that would have the potential for overlap with our managed species and to encourage consideration of that when reviewing applications. You know, some general language like that. I just have concerns about my ability to approve a motion that is very specific, when my agency, as a whole, is considering specific impacts on projects on a case-by-case basis.

I mean, I don't think any of us want to see any kinds of seismic projects that would significantly impact the species that we're trying to manage here, or be at cross purposes with what we're trying to do. I'm trying to find some way to finesse this into an encouraging BOEM to come to us and work with us and give us a heads up on when some of these things are coming forward. But I'm concerned about my ability to support this motion, given specifics that my agency might not be able to support.

CHAIRMAN GROUT: Tom does that say what your motion is, or would you like to consider modifying your motion so that you might get support from the state of North Carolina?

MR. FOTE: I think this is pretty broad, because all I'm saying is that basically similar letters that you sent in the Mid-Atlantic Council, but because they promise to do the research, and they never do the research, I'm asking for some funding in there. I think it is pretty broad. I don't think it is particular to any project. But if you're going to approve these types of things, this is one of the things you have to do; if you want to Wordsmith that, I am fine with that.

MR. BOYLES: I may need to clarify a comment I made earlier. If you read the letter from the South Carolina Wildlife Federation, you look at Page 2, and if I may Mr. Chairman, I would like to read it. It is our understanding that the designation of the proposed areas as SMZs would also then be categorized as EFHs/HAPCs. This categorization would provide a stronger argument for protecting these important places from activities associated with energy exploration.

We encourage the SAFMC to address the energy development issue and all potential concerns regarding fisheries. To Mr. Fote's point, again, my agency wrote BOEM with concerns; and just for the board's knowledge BOEM had earlier indicated on the South Atlantic area off of South Carolina, they did not intend to lease any areas within 50 nautical miles of the coast.

Our comments were basically; well, if you're not going to lease anything within 50 miles of the coast, why test within 50 miles of the coast. I want to be clear to the board that we are concerned because of some comments New Jersey made earlier. There are documented impacts of seismic testing on fisheries.

I read the comment into the letter, because I think it is a little -- I'm not sure that it was clear and I certainly appreciate where the Habitat Committee is coming from. But if I'm not mistaken, the context of the letter from the Wildlife Federation was to the South Atlantic Council vis-à-vis their development of spawning special management zones. It was not specific to BOEM exploration and development, and I think it is important for the Board to recognize that; and because of that lack of clarity, I just would say I cannot support the motion.

MR. JOHN M. T. BULL: Hearing the concerns expressed around the table, and I have some concerns, as well. One of those concerns is that my agency; the Virginia Marine Resources Commission, has some permitting authority on transmission lines, whether it is renewable energy or if it is traditional oil pipelines. To that end, I really feel uncomfortable about interjecting Virginia at this point; when we may have a say in a permitting role down the road.

It strikes me with the concerns that are being expressed around the table, that maybe this is better to kick it back to the Habitat Committee, to at least come up with a draft letter that we could all review; and then maybe make some suggestions on just how broad it should be or how specific it should be.

MR. MUFFLEY: I won't speak for Tom, because he may have his own thoughts, and I definitely will not be able to speak for him very well. But I don't think that Tom is indicating we need to provide a letter specifically as to what the Habitat Committee was recommending. It was not for the commission to come out on some specific policy statement as to conduct seismic testing or not to conduct seismic testing with a specific area. I think it is to raise the issues of scientific seismic testing; what our concerns are from a fisheries management perspective; and to be more informed and have an open dialogue with BOEM about those particular issues; and to also address the specific research and our lack of real good understanding of what those impacts may be. I don't think it was to say, this should not happen here or there.

I think it was just to raise the issues that this commission may or may not have in regard to seismic testing. I think it was intended to be a little bit more broad, and maybe the Habitat Committee's recommendation was to be much more specific. I'm not really clear. That is my general sense of where this was to go.

MR. ERIC REID: I did second this motion; of course, it was a blank screen when I did it, but that's fine. I did it because I wanted to have this discussion. You're talking about asking for cooperation from BOEM. You're all dreaming, every one of you. Do you think you're going to get cooperation from BOEM?

Look at the proposed wind farm area up in the corner in the entrance to New York Harbor. There was no cooperation from BOEM on that; none. To think you're going to have an open dialogue with BOEM; I'm sorry, I don't think so. Mr. Keliher, I think you're asking for things you're never going to get. But I think what this commission needs to do, and I like Mr. Bull's suggestion of putting this back to the Habitat Committee, and I would like to send a base letter.

We build bases on management plans. I would like to send a base letter to BOEM, stating that we are concerned about their seismic testing and what it may or may not do to our fish; and be ready at any moment to send a topic specific letter to BOEM at any time, any time we so please, whether or not it will fall on blind eyes or deaf ears.

We won't have any hearing left because of seismic testing, I don't know. But my intent is to have this commission say that we're concerned and then pick our battles every time there is one. But do not think for one second you're going to have an open discussion with BOEM.

CHAIRMAN GROUT: Further discussion on this motion.

MR. FOTE: I was trying to be very broad here, and broader than what the Habitat Committee, but now if you want to send it back to the Habitat Committee to get them to draft a letter, and look at what the Mid-Atlantic Council does, look at what the South Atlantic Council does; and give that as guidelines to move forward, I have no problem doing this at the next meeting. It ain't going away.

John, unlike you, where they were talking about 50 miles offshore, when they do this in Jersey they are doing it four miles from the beach. They're doing it 12 miles from the beach, they are doing it right in front of us on all the habitat that's there; because they're looking for areas they are going to sand mine and they want to do it within three miles of the beach, even in state waters.

I'm sorry to say that one of our federal agencies caved into BOEM, because they knew that these were fish habitat areas like the Harvey Cedars Lump, the Sea Isle City Lump, and they're all gone, because I got caught sleeping. I really feel bad about that because I didn't know what they were doing. Excuse me; I was getting a little carried away. By the time I became alerted that they had already destroyed three of the major lumps that were historic fishing areas off New Jersey, now I'm trying to save the last couple that are left. I mean, we're not going to replace those lumps in my lifetime, your kid's lifetime or your grandchildren's and many generations. It only takes a couple of days, and of course that sand doesn't stay there; it winds up going a mile off the beach, but it never reduces that lump that was basically destroyed. That is the only thing I'm looking at.

CHAIRMAN GROUT: **Did I hear at the beginning of your comments there that you would be willing to modify this existing motion to essentially be a general letter based on the South Atlantic and Mid-Atlantic comments that would be drafted by the Habitat Committee. That draft would be brought back before the Policy Board in the fall for our consideration.**

MR. FOTE: Yes, if Eric agrees with that. Of course, I agree with Eric. I've been dealing with Bureau of Land Management for I don't know how many years, and I've run into the same problem; they just give us the wind and they do whatever the heck they want. It's almost as bad as the Army Corps of Engineers. I don't know which one is worse.

MR. GEER: Doug, just one last thing. I sit on the South Atlantic Council's Habitat AP, and I would like to say folks at BOEM have been pretty cooperative. In fact, they have a seat at the table now on that committee. Maybe that's what, I don't know if BOEM has a seat on the Habitat Committee or not for the commission. Maybe that's one way to open that dialogue, and have the same with the other councils, as well. It has made the discussions very lively. But at least the person is at the table with us at every meeting. That's a suggestion I would have.

CHAIRMAN GROUT: That's a good suggestion, too. I know the New England Council has had regular visits from BOEM in recent years. Tom, we've kind of revised this to more of a general letter that is going to be drafted by the Habitat Committee and brought back before the Policy Board for consideration. It is up there, I think on the bottom. Is that something more general that you prefaced your original comments with?

MR. FOTE: Yes, do I have to make that as a substitute motion? I can't make a substitute motion to my motion. I don't know parliamentary procedure for that, but yes. If it is acceptable to Eric, I would basically allow that to be the motion.

CHAIRMAN GROUT: Eric, is it acceptable to you?

MR. REID: It is acceptable to me.

CHAIRMAN GROUT: All right, sorry Dennis for not following my parliamentary procedure here, I know it's a motion of the full board. But I'll try to do a little better job next time.

DR. DUVAL: I think, if we could just add a few words indicating for review by the Policy Board at its next meeting; I think that would sort of complete the thinking. The way it is written now it almost sounds like they are going to draft a base letter, and then that letter is going to run off somewhere and we're not going to see it. I just want to make sure for everybody that that is clear.

CHAIRMAN GROUT: Is that okay with the maker of the motion and the seconder? Any other discussion on this?

MR. MUFFLEY: Not to the specific motion, but I want to be clear that I like Pat's suggestion of maybe, I don't think it needs to be reflected in the motion, but that the letter will if this group agrees, to invite BOEM to be a member or attend future Habitat Committee meetings or something to that effect. But I think that was a good idea; and I think it could be addressed in this letter, as well.

CHAIRMAN GROUT: Further discussion; okay, seeing none; I'm going to try this. **Is there any objection to this motion? Seeing none; the motion is approved, and we'll look forward to a draft letter at our fall meeting.** Boy, that fall meeting is getting full. All right, Lisa, next item.

UPDATE ON THE SCIAENID HABITAT SOURCE DOCUMENT

DR. HAVEL: Moving on, a brief update on the Sciaenid Habitat Source Document, we contracted Dr. Alison Derry to finish the first draft of the document. It was written and it is with the Subcommittee currently for editing; it is on track to be presented at the annual meeting, so it is getting even more full.

Finally, for the Habitat Committee, we provided comments on NOAAs Atlantic sturgeon critical habitat designations. Some members were excused because their states were already providing comments; but overall the Habitat Committee found the designations complete and factual, with minor comments. These comments were represented at the Atlantic Sturgeon Management Board meeting yesterday. With that, I'll take any questions.

CHAIRMAN GROUT: Any questions on the Habitat Committee report? Okay, seeing none; Artificial Reef Committee report.

ARTIFICIAL REEF COMMITTEE REPORT

DR. HAVEL: Moving on, Artificial Reef Committee, we had a joint ASMFC/GSMFC meeting March 14th and 15th in San Antonio, Texas. We have three new state representatives on the committee; Bradley Ennis from Florida, Alicia Nelson from Virginia, and Jason Peters from North Carolina. We were given presentations on reef monitoring efforts and Rigs-to-Reefs in the Gulf of Mexico, presentations on fish aggregation devices and artificial reefs in Japan.

ACFHP gave an update on the black sea bass habitat project, and I'll provide some of those updates in the next update to you all, and there are also state updates at this meeting. The Florida Fish and Wildlife Conservation Commission is jointly hosting a symposium at the American Fishery Society meeting in 2017 in Florida, and I will be serving as the commission representative on the Steering Committee for that symposium.

Our next meeting is February 7th and 8th in Florida, most likely Jacksonville. ASMFC and NOAA co-hosted a two day national artificial reef workshop here June 9th and 10th, here in Alexandria, Virginia. It was attended by approximately 70 people from around the nation, representing federal, state, nonprofit, commercial and recreational fishing entities.

The objectives were to give an overview of the current state of the science, identify considerations for reefs as a management tool, identify challenges and needs for implementing artificial reefs, and discuss the potential for partnerships. There were presentations, panel discussions and weld café discussions. Topics included the history of artificial reefs, the potential as a management tool, the regulatory framework, NOAAs ecosystem-based management policy, regional accomplishments and challenges, current and future science, and looking towards the future. The workshop summary will be released this week. That is it for the Artificial Reef Committee, and I will be happy to take any questions.

MR. CLARK: I was just wondering if the Artificial Reef Committee is going to develop a policy on special management zones at artificial reefs. I know Delaware went through getting reefs designated as SMZs, and I believe New Jersey is interested in it now. Just curious if there was a policy being developed.

DR. HAVEL: South Carolina also has some as well. We are not currently working on a coastwide policy. But if that is something of interest to you, we can definitely talk about that.

CHAIRMAN GROUT: Other questions? Okay, ACFHP.

ATLANTIC COASTAL FISH HABITAT PARTNERSHIP REPORT

DR. HAVEL: Finally, a brief update on the ACFHP progress that we've been making over the last couple months. The ACFHP Science and Data and Steering Committees met in Cape May, New Jersey, May 9th through 11th, and we mostly discussed our conservation strategic planning; 2017 to 2021 will be the new five-year conservation strategic plan.

We are very busy this year working on updating it. Our Species Habitat Matrix was published in Bioscience, and we're working on our website for the Species Habitat Matrix. I am going to give a brief update on the black sea bass habitat progress since the last time I gave a presentation. We received a grant from the Mid-Atlantic Council to support habitat research in the Mid-Atlantic, and we awarded this grant to Dr. Bradley Stevens from the University of Maryland, Eastern Shore.

His project was titled Hab in the MAB: Characterizing Black Sea Bass Habitat in the Mid-Atlantic Byte. The contract has been signed and we're currently working on a press release; that will be released this week, likely. An update on our eelgrass conservation project, we received a grant from NOAA to replace traditional boat moorings with conservation moorings in Narragansett Bay.

This reduces eelgrass damage, increasing fish habitat. Monitoring has taken place this summer and the sign has been installed, so this project is complete. I will be presenting the results at Restore America's Estuaries meeting in December in New Orleans. Here is a visual of the sign that has been installed for everyone that walks by the estuary.

We received funding from NOAA to complete a Southeast Fish Habitat Mapping Project, and this is to spatially prioritize fish habitat protection and restoration sites using JS mapping and analysis. We were looking at habitat threats, fish presence/absence data, and existing or historical maps. This mapping project will take place from North Carolina to Florida.

Using our NFHP U.S. Fish and Wildlife funding for fiscal year 2016, we're going to be putting that funding towards ACFHP operations, a northeast napping project to complement the southeast mapping project that is being funded by NOAA; and also we are putting money towards the Bradford Dam Removal in Westerly, Rhode Island. This will open up 32 miles of spawning habitat and nursery fish habitat; benefitting shad and river herring, among other species. For FY2017 for the NFHP U.S. Fish and Wildlife funding, the announcement will be released August 11, and the deadline to submit proposals will be September 22. We'll be recommending proposals at the fall meeting in Maine. ACFHP would like to thank ASMFC for your continual operational support, and I'll take any questions.

CHAIRMAN GROUT: Questions of Lisa. Seeing none; thank you very much, Lisa for all three of those beautiful reports.

OTHER BUSINESS

MANAGING RESOURCES FOR THE BENEFIT OF ANOTHER FISHERY

CHAIRMAN GROUT: Next item on our agenda is Managing Resources for the Benefit of Another Fishery; Commissioner White.

MR. WHITE: I'll try to be as brief as I can. I'm going to have to educate all the commissioners that don't know about Atlantic herring on the complexities of Atlantic herring management before I get into the issue that concerns me. I'll try to go through it quickly. If anybody has any questions interrupt me, or if the northern three states that are involved in this feel that I left something out or I'm stating something incorrectly; interrupt me while I go.

Atlantic herring is managed jointly with the New England Fisheries Management Council, with the council involved in fishing and the commission involved in landings. Service sets the total annual catch limit, which is then divided across four management areas; we have a slide showing those areas.

The Service has seasonal limitations on allowable gear types in Area 1A, and Area 1A is the area that I'm going to talk about. January 1 to October 1, midwater trawl vessels, which are large hundred foot plus vessels, are banned. January 1 to July 15, small mesh bottom trawl vessels, mostly 50 feet and under are banned; and then allowed in specific areas off of New Hampshire and northern Massachusetts coast, where groundfish are not normally found.

They harvest very small volumes of herring. January 1 to December 31, purse seine vessels are allowed, and many use midwater trawl vessels as carriers. The Section then has divided the 1A quota into trimesters. Trimester 1, January 1 to May 30, there are no landings allowed. Trimester 2, January 1 to September 30, 72.8 percent of the quota is harvested, and Trimester 3, October 1 to December 31, or until the 1A Sub-ACL has reached 27.2 percent.

That is all done, nothing to do with herring management, only to do with lobster. Section further regulates effort by determining a number of landing days allowed each week by authorizing the three northern states, Maine, New Hampshire and Mass, to make in-season-landing-day adjustments. In addition, Section closes three defined areas within 1A when spawning is occurring.

Generally, these closures begin in eastern Maine and move down the coast through western Maine and Massachusetts/New Hampshire. The management of landing days, other than for spawning closure, is for the purpose of providing a steady flow of lobster bait for the lobster industry. This is the reason harvest is not allocated in the first trimester, as there is little lobster fishing during the winter.

The lobster fishery needs more bait than Area 1A quota provides, so it depends on landings from Area 3, and importation of menhaden from the south. The majority of herring is used for lobster bait, but it is not the exclusive use. The states of Maine, New Hampshire, and Massachusetts limit landings days to provide a steady flow of bait; often changing the landings days multiple times during the second and third trimester, going from seven days down to one or two or vice versa. This year a number of circumstances have created a severe lack of lobster bait. Industry stockpiles bait in coolers and freezers from Area 3 late in the fall to be ready for the beginning of spring. Last fall the herring fishery was closed early, in August, due to bycatch of haddock in Area3, therefore coolers were not filled to the level that they normally were.

During the second trimester currently ongoing, very little landings have been available from Area 3, because of haddock mixing with herring. The midwater trawl boats are not out fishing in Area 3. The purse seine fleets has added capacity as a few midwater trawl vessels change gear type and are now rigged with purse seines, which allows them to fish in Area 1A during Trimester 2.

This added effort provides the fleet with ability to harvest the entire Trimester 2 quota very quickly. The issue that concerns me, I believe the Atlantic herring fishery is the only fishery that the commission micromanages. When I say, that we're going to be starting an addendum that could regulate when a boat can land and how much a boat can bring into land on a daily basis; for the sole benefit of an industry involved in a different fishery, being lobster.

The commission is picking winners and losers in both the harvest of and the sale of herring for bait. Some large businesses would favor harvesting at a faster rate, and freezing the catch; while the smaller dealers and lobstermen want fresh bait on a steady basis. This year the quota would have been harvested prior to the commencement of spawning.

Since we have slowed harvest, the spawning closures will take effect this year. I believe this has a potential negative impact on herring resource, as the spawning closures are not perfect. Is it an appropriate role for the commission to be involved in managing the herring fishery for the benefit of the lobster industry, and making decisions that affect businesses that have nothing to do with herring management?

Is this the obligation of the commission, or should the states of Maine, New Hampshire, and Massachusetts be taking on this role? Commissioners have requested the Section begin an amendment to have the ability to limit amounts landed, as I said earlier, amounts landed on a daily and/or weekly basis per vessel, or per carrier.

I request the Policy Board consider establishing a policy to guide the Atlantic Herring Section going forward to either endorse what we have been doing, or making the recommendation that the Section should not be managing in this way, and that it is up to the three northern states to take on this role.

CHAIRMAN GROUT: Ritchie brought this item up at one of our Days Out meetings, and had asked that this be put on for the Policy Board to get our input on this. Again, what he's looking at is this. The question is, is it the role in commission management to be managing a resource for the sole benefit of another fishery? I have Dennis Abbot and any other comments we would like to have on this. Pat will be second.

MR. DENNIS ABBOTT: Just to add to what Ritchie said, every year we go through this exercise of setting the number of landing days. Although we set the landing days, we don't set the fishing days, and these large boats with refrigeration fish more days than there are landings days. Although this year Maine has closed the loop for Maine licensed boats to only be able to fish on those days.

We go into the year, also, not knowing how many vessels are going to be fishing. We don't know how many carriers are going to be fishing, and as a result we're trying to provide a steady supply of lobster bait for the Maine fisherman. It gets to be a more difficult task, as Ritchie described, every year.

MR. KELIHER: The state of Maine has a billion, with a B, dollar lobster fishery. In order to ensure that we have steady access to bait, we have had to micromanage this fishery. I think it's very appropriate that we do so. Area 1A does not come close with the total quota that it has to thoroughly supply bait to the fishery within New England; let alone, the state of Maine.

We now have a capacity problem. The capacity problem in my mind is related strictly to Area 3, where midwater boats are not fishing because of haddock bycatch issues, and waiting as late into the season as possible. What they are doing now is coming in to Area 1A to become carriers for the seine fleet.

Based on what we saw in June this year, the size of the schools, the availability of those schools to landing ports in both Rockland and Portland, we very likely would have exceeded the Area 1A quota in late June or early July. It was imperative that we take those type of micromanagement steps; yes, to benefit the lobster fishery.

Again, I appreciate the concerns being raised by Ritchie, but I disagree with the premise that -- I'm not saying he is saying we shouldn't be doing it, but I'm not sure that it is accurate that we don't frankly do it in other areas. I mean, all of the management that we do is to benefit one sector or another. This one does cross over into lobsters; but again, the importance of this fishery economically to the state of Maine shows me clearly that we need to do that.

MR. ADLER: The Massachusetts lobster fleet is involved in this too, and it is in need of the bait, as well. My concern if we abandon the current way we do things, and nothing is perfect but we try very hard with the three states, to get it right or close to. But my concern would be if the Atlantic States Section divorces itself from what it is doing.

If the states are told they can do what the Section does, I would think that if they were going to assign the states the ability to do basically what we do now, any amendment or addendum or whatever to the herring thing, I wouldn't want the wording to be that those states can't do what they feel is appropriate to manage this herring and supply the bait. I would just be concerned.

It wouldn't be so bad if the states could do it, if they would basically be doing what we do now; but we call it a Section. I wouldn't want an ASMFC plan, addendum, amendment, to restrict what Massachusetts, New Hampshire and Maine have been doing all along. I'll stop there for now.

CHAIRMAN GROUT: Okay, I have Ritchie, Dave Simpson, and Dave Borden.

MR. WHITE: I would like to clarify a little bit, and I know that I've had a hard time explaining this. First off, I would see if the commission felt that the three states should be doing it. I think the Section would allow seven days of harvesting. There is nothing in the herring resource that would not allow the herring resource to be called quickly; and it would probably be better for the herring resource if it were all harvested before spawning.

Then the states can always be more conservative, so the three states then through their licensing of these vessels, as the state of Maine did this year, could then make the decision that is a business decision, of slowing this up. My thinking is, what if something was found in herring that helped cancer; and all of a sudden an industry said, we need this and we need it during the winter.

Then what if Atlantic States, all of a sudden, says, okay, we're going to shift. This is a more important use than lobster bait, and we're going to make sure it is all harvested for this new industry, and it is all going to take place in January and February. I mean that is the same principal as what we're doing here. It would be the same as the menhaden board saying we're going to limit New Jersey's bait harvest, and we don't want them to catch it as fast as they do; because we need more to go to the Maine lobster industry.

That is the principal I'm coming from. I had a number of large bait dealers from Maine at our previous meetings, because I've stated this a number of times at our meetings, come up and say you're totally correct that the government shouldn't be involved in making these business decisions; but we need you to keep doing it. Anyway, I hope that is more helpful.

MR. SIMPSON: I've never quite understood the Section's role in management of sea herring since you are all equally represented on the New England Council, and the New England Council is setting the quotas, which determine how much can be removed and no more. I am concerned where you finished off, why we would get involved in the marketplace.

My understanding of the sea herring fishery is that the overwhelming majority of it goes to bait. I think there used to be more human consumption, but there is very little of it now. Wouldn't that take care of itself, and shouldn't it take care of itself? There is a supplier providing product to a user, and you would think the marketplace would self-adjust.

If we're going to tinker with the timing during which fishing operations occur, I would think we, as a commission, would want to focus our comments and direction on things like bycatch of river herring; other considerations, ecological considerations not economic ones or micromanaging a marketplace. I just am concerned about getting involved in that aspect of private enterprise.

MR. BORDEN: Philosophically, I like the idea of the government staying out of micromanaging businesses. But I think the reality is we all kind of tread a narrow line on this issue. If we were to just look at the value of the herring fishery and we compare it to the value of the Area 1 lobster fishery, I think the lobster fishery is worth 450 million dollars; Pat probably knows better than I do, but somewhere around there.

The herring fishery is worth a fraction, a small fraction of that. I think the issue that Ritchie is raising is valuable, in terms of a discussion, but to me it's kind of a multifaceted problem. If you look at it, I mean, it's a bait crisis is what is happening in industry. It's unfortunate that Steve Train isn't here to comment on it.

The things we do in the herring fishery, the things that we have done in the ground fish fishery, the cuts in menhaden historically, and the cuts next year in terms of the skate allocations, all have an impact. That is all bait that is going in to various lobster fisheries; whether they are inshore or offshore. I mean the other contributing factor here is there has been a rapid acceleration in the number of traps in the Gulf of Maine. You only need to look at Canada, Nova Scotia where they fish 350 to 400 traps. The industry easily can catch the same amount of lobsters that they can with 800 traps, and they use a fraction of the bait. There are a lot of different ways you can look at this. I think it is a worthwhile discussion. I'll be interested to see where it goes, though.

MR. KELIHER: Just for clarity's sake, the regulations that we put on the books this year were asked for by both the herring industry and the lobster industry. Both of them knew the fact that we needed to micromanage; in fact during the course of the winter the seine fleet saw that we were going to be having this issue.

The fact that they knew they needed to be managed and micromanaged, I think, says a lot. They know that they need to avoid a big glut of bait at any one time. It would not be able to be absorbed, and to be able to stretch bait out to help alleviate the shortages that David mentioned, was critical. I think I'll avoid making any comments on trap reductions on the microphone.

MR. ABBOT: It is unfortunate that Steve Train had to leave. At the LGA meeting I asked him how lobster fishing was, and he says right now it is really kind of lousy. He said part of it is because of the imposition of landing day restrictions by the state of Maine, in trying to do the right thing and trying to supply a steady amount of bait.

The price of a barrel of bait has gone from approximately $60.00 to $130.00. It has more than doubled; that is what the market has done. We pull on one end and it comes out the other end in a bad way. I just wanted to add that; that the price of bait has gone crazy this year, and he also added that down east Maine are catching so many lobsters, their profit margin is different and they don't mind paying the higher price, because their catch is so much greater this year as it was last year.

CHAIRMAN GROUT: I'm going to go to Dan, and then I would like to see if there is any discussion from people outside of the Herring Section region about this, whether they have any input one way or the other; because it does seem like this is turning into a Section meeting, or at least a northern states discussion of this. I was hoping if we brought this forward, it would be something that the full Policy Board would be discussing. But Dan, go ahead.

MR. DAN McKIERNAN: I regret that David's not here, he also had to leave, but he has been working in herring for about 40 years and I don't have that experience. But it seems to me that there is a question of governance that takes place here; that if it is not a Section vote, and it is just a three state gentleman's agreement, then I don't think in the future you would have the unanimity among the parties, or the potential for one or more states to break away.

Am I right to assume that because it's a Section vote, the states go back and they tell their bosses, I need to condition this permit or I need this rule, because the Section took this vote or else I'm going to be found out of compliance. Is that the essential question here as to why we do it through the Section, versus just a three-state agreement?

CHAIRMAN GROUT: Because we're managing this as a resource of a whole in this particular management action that we approved, essentially delegated authority to do these days out to limit the days fishing, just to the states that have landings from Area 1A; because that is really where it is. It was supposed to be, I believe, and the plan says it is supposed to be a unanimous vote, because it is supposed to be a consensus, because it is not a full section voting on these things.

MR. McKIERNAN: But are they not mandatory measures by the Section measures to adopt?

CHAIRMAN GROUT: We agree to all put those in.

MR. McKIERNAN: And if we don't?

CHAIRMAN GROUT: We would be found out of compliance?

MR. McKIERNAN: That's what I'm asking.

CHAIRMAN GROUT: Because it is part of the management plan. Any discussion from other board members? Yes, Adam.

MR. NOWALSKY: Well, I think the question I have is, is there a recommendation from Ritchie or somebody else as to what the actionable item would be here that we could weigh in on. I think the goal of getting input from the Policy Board as a whole is to get another set of eyes on this, per se. Okay, hear what you're saying. What would you propose do that we could give some feedback on?

CHAIRMAN GROUT: You can go ahead and say it. I have it written down that you were looking to consider either establishing a policy to endorse the management that we're currently doing, or should the Policy Board develop a policy that would direct the Herring Section to discontinue that type of management.

That is what Ritchie is looking for. Does the Policy Board feel this is something that they should weigh in on? Clearly, Ritchie feels that we should be out of this type of management. You've heard input from others that say we shouldn't be. Tom.

MR. FOTE: Are we manipulating the price of herring? Are we raising the price of herring to $160.00 a barrel to basically benefit certain sectors of this and disadvantage to other people? That's what I'm trying to figure out here, and I don't think that's our business. I don't think that is the Herring Section's business. I don't know. That is what I'm trying to figure out here from listening to the conversation, since I really don't attend the Herring Section meetings that often.

CHAIRMAN GROUT: There might be differing opinions on that. Pat, go ahead.

MR. KELIHER: This is a supply and demand issue. There is not enough supply, so the demand is very high, so the price of bait has gone up. They've been limited to 15 trucks for the week. In order for these boats that some are costing 3 to 4 million dollars a piece with operations and crews; they've had to raise the price of bait.

Did they raise it too high, probably? We're not saying what you've got to charge for bait. We're controlling the supply, knowing that the price was going to go up. If we had of caught it all up in June or early July, the Maine lobster industry would have been in a terrible, terrible situation. That would have been a bigger economic disaster than having to pay a high price for bait.

CHAIRMAN GROUT: Does the board want to weigh in on this with some kind of an action?

MR. SIMPSON: Despite what I said, I think not. I think what I would want to know is the commission process is that based on the fact that I heard there seems to be agreement from both fisheries that this is a good idea. I think when you develop these plans, if you're going out for public comment, you're considering both sides.

That, I think, would satisfy the commission's role here. I have philosophical beliefs that would suggest that we back away from managing these fisheries like we own them, and they're our business and we're going to meter out catch to satisfy another user that we manage. I think if there is a public process and you honor the balanced comment, then I think that is as much as the Full Commission should be concerned about.

MR. BORDEN: With your agreement, I would like to ask Ritchie a question if that's all right.

CHAIRMAN GROUT: Go ahead.

MR. BORDEN: Ritchie, you mentioned the groundfish haddock bycatch issue. To what extent has the Section thought about formalizing a recommendation that that bycatch allowance be raised? My memory of our catch performance in haddock is, I think, we're only catching 15 or 20 percent of the TAC. We've got record year classes in the fishery, so do we need to be this restrictive? If that is forcing the Area 3 boats into Area 1, then couldn't we encourage that by liberalizing the bycatch allowance?

MR. WHITE: The last thing in the world that I would want the commission to get involved in is groundfish. Since we're not, I have no ability to make any comments on haddock, because I'm not involved in that process, and we ought to stay out of it. But I mean that is clearly part of the problem.

I'm not saying that what we're doing should not take place, because I think the three states that are now doing this, and we're saying the Section, but this is not being carried out by the Section. This is being carried out by a subset of the Section; it is only Maine, New Hampshire and Massachusetts that are doing this. It is not always consensus when we pick the days.

The last time we altered the days, which was a couple weeks ago, Massachusetts did not agree with New Hampshire and Maine, and it was a two-to-one vote, and it went that way. But Massachusetts wanted more days and the other states decided against that. You have three states that are acting for the section and for the commission.

It is a public process. We hold either an in-person meeting or a phone meeting with the public; so it is an open and public process when we do this. I'm not suggesting that this shouldn't be done. It is a huge lobster industry, it is a lot of money and that needs to take place; but is it the commission's role to do it, or is it the three states that now do it, is it their role within their own regulations?

Maine went more conservative than the commission this year, and implemented trip limits down to the day and down to how many trucks a boat could bring in. They have the ability to do that for their licensed boats. If New Hampshire got the same regulations and Massachusetts got the same regulations, then those three states, if they all agreed, can be more conservative than the commission, and implement these kinds of regulations. That is my question. If the sense is that the commission should be doing this, and this is a proper role for us, then fine; and we'll continue on the way we're doing it.

CHAIRMAN GROUT: Okay, it's ten after five right now, I would like to see if there is going to be anybody from this Policy Board that wants to make a motion that would be a formal recommendation on this. If not, I think we've had a very thorough discussion of this. The discussion has been centered around the Section members.

Potentially, if the board does not have a mind to make a recommendation here, then maybe it is something that should be put up at the Section as a management action for recommendation. Is there anybody on the board that wants to put up an action here?

CHAIRMAN GROUT: Okay, seeing none at this point, we've had a good discussion on this and we do have a couple of other items under Other Business that we need to address.

LETTER TO THE MID-ATLANTIC FISHERIES COUNCIL CONCERNING SHAD AND RIVER HERRING STOCKS

CHAIRMAN GROUT: The first item is a letter. John Clark, I think you were looking for consideration of this commission sending a letter to the Mid-Atlantic Fisheries Council concerning shad and river herring stocks in the fishery.

MR. CLARK: I know the last thing we need is another agenda item today. Unfortunately, the timing on this one won't wait. In summary, Mike Luisi, who is the Vice Chair of the Mid-Atlantic Council, is here. I believe the Mid-Atlantic Council will be considering their management actions for shad and river herring at next week's meeting; and then they will be making final decisions before ASMFC meets again for the annual meeting.

Based on that, I thought based on consultations with Bill Goldsborough, the Chair of the Shad and River Herring Board that it would behoove the Policy Board to perhaps send another letter to the Mid-Atlantic Council, as we did back in 2012, when this was last considered by the Mid-Atlantic Council.

I guess at that time we sent a letter that raised our concerns, discussed all the efforts and sacrifices the ASMFC states had made to try to restore shad and river herring, and asked that all management approaches taken by the Mid-Atlantic Council would be, I believe the words we used were complementary and joint management approaches for these. Before we get into the specifics of what we would like in a letter, I think I would like to turn it over to Mike to ask what the Mid-Atlantic Council is considering at this time.

CHAIRMAN GROUT: Go ahead, Mike, and then Toni has a comment.

MR. MICHAEL LUISI: Wearing my other hat as the Vice-Chairman of the Mid-Atlantic Council, I think I can clarify very quickly where the council is in their discussions on shad and river herring. Three years ago the council took up the question about whether or not they wanted to consider shad and river herring as a council-managed species.

At the time they determined that it was neither required nor appropriate three years ago; however, they committed to revisiting that three years from then, which is putting us to the time period where we currently are. In the meantime a working group was established composed of regional, state and federal management partners; to address shad and river herring mortality.

Caps were set, there was no assessment work, there was no science driven work that would set harvest limits for shad and river herring; but that commitment was to revisit that issue in three years. On top of the council's commitment there were orders from the U.S. District Court that with some guidance as to how the council would take up the issue again; in reconsidering whether or not shad and river herring would be a council managed species. I think, where we are currently, between the commission and the council is that there are two issues.

One is, whether or not the commission wants to urge or write a letter suggesting the direction that the council should go in, regarding whether or not they continue the more ad hoc approach to managing shad and river herring, or do they take shad and river herring up as a managed species; which would essentially put that into a fishery management plan, for which ABCs would be set and there would be more management control centered around the science-based approach.

A white paper directing the council on that question was just sent out to us all just a couple days ago, so I have yet had the opportunity to review that paper. There is no plan to discuss this as clarification from what I think, I mentioned to John before, there is no current plan to discuss this at next week's council meeting.

The Shad and River Herring Committee will plan to meet the following week via webinar, I believe, to discuss the white paper and set forth the path for our October meeting; where the final decision will be made as to whether or not the council takes shad and river herring on as a managed species.

Now if they do, if the council goes forth with considering shad and river herring as a council-managed species, then I think the question comes as to whether or not the commission would suggest to the council either joint or complementary management measures going forward for the future. But right now, we're kind of in a limbo as to whether or not the council is going to maintain this ad hoc approach, which they would not have an FMP and would essentially continue working with this working group to address shad and river herring mortality.

That could be the path forward. We won't know until October. I don't know where to leave that as far as any decision here as to how this commission would like to help inform the council on their position. There are two positions. Should they take up the species as a managed species, and if so, perhaps a joint or complementary action should be considered. If any of my colleagues around the table here, who sit with me on the council, know anything differently from what I just said, please feel free to correct me. Thanks.

MR. CLARK: Thanks, Mike. Thanks for filling that in. It really does sound pretty much exactly like the situation we were in back in 2012 when this last letter was written, because the letter that the Policy Board did send to the council was stating the concerns of the commission about management.

At the time this one was written, it wasn't known yet which direction the council would go in on the management. I would say maybe the thing for the Policy Board to even just revisit the letter from 2012 and update it perhaps with some more recent information, and send it to the council just to urge action be taken on this issue.

CHAIRMAN GROUT: What is the pleasure of this board? Do we want to redraft the letter that we sent three years ago with more current information? Is there a way that we could send that letter out to the Policy Board, because some members were not originally on the commission at that time?

EXECUTIVE DIRECTOR ROBERT E. BEAL: Yes, 2012 seems like a long time ago sometimes. We can circulate the old letter and we can provide some updated information and maybe circulate sort of a track changes edited old letter to the Policy Board, with some updated information and things that have occurred since the last meeting; and see if that meets the need of the Policy Board. Then the committee is meeting, I think on the 18th, is that when it is? I don't know if we can get it turned around that quickly, but if so we can submit the letter before that meeting.

CHAIRMAN GROUT: Isn't the importance, and Mike and John, you can comment on this. Isn't the importance that we get the letter before the October meeting?

MR. LUISI: Yes, thank you. I think that is the important date, is to get a letter, if the Policy Board wants to send a letter to the council before their final decision; which will be in October. But I do want to just mention though, and it's been too long since I've seen the letter from 2012.

But if the 2012 letter was suggesting action, so prior to 2013 there was no action being taken by the Feds on river herring and shad management. Since 2013, like I said, it is not a council managed species, but action has been taken. In the update, just understand that action has been taken. It is whether or not we go to the next step in that action and consider it as a council- managed species.

MR. BEAL: My recollection is the last time we talked about this there was a direct conversation of, should ASMFC support a stock in the fishery designation or not; at the Mid-Atlantic Council, and we were split on that as a commission. I'm not sure without another vote or some other indication; I'm not sure how we include that yes or no regarding stock in the fishery in a letter, unless we get some more guidance from this group or the Shad and River Herring Board or something.

CHAIRMAN GROUT: But we did send a letter that did not take apposition then on stocks in the fishery. We did not take a position. Go ahead, John.

MR. CLARK: Ashton and Bill sent me the letter, and it did not take a position. It didn't urge the council to go into the stocks in the fishery. It more or less outlined the approaches that the commission would like to see when the council did start managing shad and river herring. For example it said, clearly detail the process by which ACLs and accountability measures would be set.

The commission prefers that ACLs and accountability measures apply only to catch and bycatch in federal waters. If this is not legally possible, the commission requests that it be the responsible party for determining any in-river portion of ACLs. The impacts of inconsistent federal and state water regulations on existing river systems, specific conservation measures, and regional approaches that are being considered; and t0hat type of recommendation was made by the letter.

CHAIRMAN GROUT: I would suggest that staff, a course of action here would be for commission staff to re-circulate an updated version of this letter for comment and input by the Policy Board. Once we get back that comment, any significant changes should be included in there and then send it out for an e-mail poll, as to whether we send it or not.

MR. WHITE: Might another option be to write a letter asking the Mid-Atlantic Board to delay making a decision, and then we send this to the Shad and River Herring Board for their recommendation back to this Policy Board; so that we can kind of fully flush this out. I just don't get the feel that we're kind of rushing this along without figuring all the ramifications.

CHAIRMAN GROUT: Do you have a comment Mike, on the timing?

MR. LUISI: Yes, I do. While it was a council commitment to reconsider this action, I did state that we also received orders from the U.S. District Court; and the U.S. District Court expects an answer by October. We don't have any opportunity to delay.

CHAIRMAN GROUT: That had sent up a whole series of hands. I originally had Emerson and then was it Adam; no, you're all set. I'm going to go with Emerson first, but I just want to know who's on deck.

MR. EMERSON C. HASBROUCK: Just having heard a brief synopsis of the previous letter that John just read off a couple of minutes ago; that got into some detail about what should and should not happen with ACLs and how they should be implemented and where. To me, that is quite a bit of detail that I think is premature at this point in time. That might be appropriate after we find out what the council's decision is on this, but I wouldn't support sending a letter with that type of detail in it right now; because we don't' know what the Council is going to do.

MR. NOWALSKY: I was going to suggest that staff request from the council staff, Jason Didden in particular, to get a copy of the documents that the River Herring and Shad Committee is going to be reviewing. Make those available, and the webinar will be open to the public on the 15th, and anybody here would have the opportunity to listen in.

Perhaps, a member of staff here could as well take notes and circulate any potential actionable item that this board could take up, the commission could take up via e-mail or something prior to what the council has to do in August. I'm not sure there is anything else the commission could do at this point.

CHAIRMAN GROUT: John.

MR. JOHN McMURRAY: Yes, almost of what I was going to say –

CHAIRMAN GROUT: Oh, sorry I was asking who wanted to be in the queue and I didn't see your hand up, John. I'm sorry. Go ahead.

MR. GROUT: Sorry about that. Yes, well most of what I was going to comment on and ask has already been covered. But I would be, of course, in support of the commission weighing in here, but I think at the very least you guys have to get a look at the white paper. I mean, we just got it and we haven't really had a chance to look at it yet. That would probably need to be a requirement before you guys wrote a letter. Of course, timing is an issue, so I don't know how it's going to work.

MR. CLARK: Yes, I just don't want to give everybody a complete sense of déjà vu here, but one of the first paragraphs of the letter said; given that the Mid-Atlantic Council has not yet determined whether it will move forward with Amendment 15 to designate shad and river herring as the stocks in the fishery, it is difficult to provide specific recommendations at this time. We were pretty much in the same boat in 2012. At the same time we did at least urge them the actions that were most important to the commission.

MR. NOWALSKY: I'll just add that in those documents that the council has already put together, one of them being what's called a Draft Decision Document, a little bit longer than what you might typically think of, a page or two cheat sheet. It has a section that contemplates interaction with the ASMFC moving forward.

It talks about joint or complementary management, similar to species we've talked about earlier. I would add that the council is well aware of the commission's interest in the species, and is taking those previous comments into consideration; and weighing those in how to work together moving forward.

CHAIRMAN GROUT: What is the will of this board? I've suggested a way forward. There have been some alternatives that have been put forward, as far as moving forward. One, the way I suggested was to reiterate and update some of the items in the original letter, and have it circulated to the board for any comments.

Then have a vote on it. There have been suggestions that that should wait until the white paper has been reviewed, and then get comments on the board from the white paper. I think one of the difficult things we have to deal with here is that we're not meeting between now and when the council takes up, so we have to try and develop a course of action today; if we're going to take action.

Adam just alluded to the fact that we already sent a letter and it sounded from his perspective, the council was taking into consideration the items that were put forward in that letter three years ago. Maybe we don't need, to reiterate the letter. Would there be any objection to resending a letter that is revised, in the way that I had suggested? Emerson, you're objecting?

MR. HASBROUCK: Yes, because I'm not sure what that letter is going to do; other than what has already been done. If the information we have is that in the council white paper, there is a section about how if the council decides to go forward with shad and river herring, a species in the plan; that there should be coordination and collaboration with the commission. What more are we expecting the council to do, other than to acknowledge the fact that if they go forward they should do it with us?

EXECUTIVE DIRECTOR BEAL: I tend to agree with the notion that the coordination is already there. We've got obviously a number of states that serve on the Shad and River Herring Committee, and then obviously on the Full Council, and then I serve on those, as well. I think the only sort of new piece of information we could provide is, does ASMFC support adding shad and river herring as a stock in the fishery; and I think that is where we were split in the past, so I'm not really sure how to move forward without a clear direction on that. But I think the coordination part seems to be handled pretty well already; in my opinion, anyway.

MR. MUFFLEY: I agree with, I think, where Emerson and Bob went. To me, I don't know what the point of sending another letter addressing general concerns may be; since we're in generally the same area we were in 2012. To me, the point of a letter would be to either support or not the Mid-Atlantic Council in making stocks in the fishery for shad and river herring. That would be the point of a letter. Otherwise, I'm not quite sure what we're going to accomplish.

CHAIRMAN GROUT: Okay, then I'll try the opposite. Is there any objection to not sending a letter? There is an objection from you, John?

MR. McMURRAY: Yes, sorry.

CHAIRMAN GROUT: Okay, then I need a motion one way or the other, John.

MR. McMURRAY: Well, Mr. Chairman, I am not ready to make a motion. I would just offer the suggestion that there is obviously going to be some new information in this white paper. I can't tell you what it is, because I haven't looked at it yet. But it is probably something that the commission is going to want to weigh in on.

MS. KERNS: Doug and I were just side-barring, and how about this as a way to move forward. I've just asked for Jason to get a copy of the white paper to distribute to the Policy Board in an e-mail, and we can distribute that as soon as I can get a copy of the white paper. Then we'll have a member of commission staff listening in on the call the week after the council meeting; and we'll write up a summary of that call.

Then depending on their recommendation, we could put together possible paths forward for the Policy Board to consider. Whatever direction that the council's committee is going, if it is the will of the Policy Board to want to make a recommendation about stock in the fishery or not stock in the fishery, we could do a conference call to discuss that and then have a vote on that; whether or not we make that recommendation in a letter, or we could do that via e-mail.

But I think that if the discussion is anything like it has been in the past, it would be a conference call that we would need to do. But noting that we would have to turn that conference call around quite quickly between now and then, so a doodle poll would have to be filled out quite rapidly; and time would have to be made flexible.

CHAIRMAN GROUT: Any thoughts on that particular course of action here? Yes, John.

MR. CLARK: I think that is a good suggestion. I should have said something earlier. But I think it is a good idea for the Policy Board to weigh in on this. I mean, the current, if I'm not mistaken, I think the ACL for the Mid-Atlantic for shad is pretty large; and there are a lot of shad and river herring being caught in the ocean fisheries.

It really does hurt the efforts that the commission has taken to try to restore these species. We've taken some very drastic actions. As you know, we've closed river herring fisheries up and down the coast. I don't see there is any harm in the commission at least updating the old letter or taking Toni's suggestion there. I think is a great way forward.

CHAIRMAN GROUT: Any other discussion on this particular option of moving forward?

MR. HASBROUCK: I wasn't on the commission back in 2012, so at that time was there a discussion by the commission or one of the boards about whether or not shad and river herring should be included as stocks in the fishery? Did that discussion take place already, and is that a discussion you think we can have via e-mail? I'm kind of thinking -- well, it depends on the answer to the first part of my question.

CHAIRMAN GROUT: Well, Toni was telling me yes, there has been a discussion. I think Bob also mentioned that there had been discussion and the commission were split on that; and so we did not specifically comment on whether there should be stocks in the fishery. I cannot tell you whether our commission would continue to be split.

I would be surprised if there weren't differing opinions on such an action. There has been discussion in the past, yes. That is why Toni was suggesting through this method that there be a conference call that is going to make the final decision on whether we send a letter. I have Andy and then Dave, was it you?

MR. ANDY SHIELS: I had a conversation with John Clark about this earlier today. I had an offline conversation with Mike Luisi a few minutes ago. I think, without putting words in John's mouth, the main purpose here is to make the board aware, make the council aware that the board has some interest in it.

I think Toni's approach is what we discussed just before she said it. That is the right way to go to put this on the radar, to get the information which is going to be available, not until the 15th. The subcommittee will work on this in the meantime, from the council. But on the 15th there will be a webinar, and then more people will have access to that information.

The council will meet next week, but probably isn't going to discuss this. The council then will meet in the first week of October, preceding the next meeting of ASMFC. I think serially and to go in the correct order, and to not threaten anyone; the approach is to follow the course that Toni suggested, get the information out there.

No serious decision has to be made at this point, and let's see where the webinar goes; and when that information is conveyed to the group, the comfort level, and if it calls for something bigger it can certainly be brought up at the annual meeting, because that schedule is not full enough yet. We're looking to add some more menhaden-like issues to it.

MR. BORDEN: I'll make this really short. I agree with Toni's suggestion. I think it's a good one. It is not a perfect solution, but the only thing I would add to that is if we're going to follow that course of action, I would encourage the staff to circulate whatever material becomes available on this issue to everyone, so that we can all inform ourselves before we do the conference call.

CHAIRMAN GROUT: Okay, I'll try it one more time. Is there any objection to moving forward with the action that Toni outlined? Seeing none; that is the course of action that we'll be taking.

STURGEON LETTER TO NOAA ON CRITICAL HABITAT DESIGNATION

CHAIRMAN GROUT:Thank you for a good discussion on this, and now we have one last agenda item and that is a sturgeon letter to NOAA on Critical Habitat Designation. Bob.

EXECUTIVE DIRECTOR BEAL: Hopefully, this letter discussion will go quicker than the last discussion of a letter. At the Sturgeon Board yesterday, I think most folks were there since this is a coastwide board, as the Sturgeon Board is. The board discussed the critical habitat designations for sturgeon, following the ESA listing.

They initiated a process of drafting a letter with a potential approval of that letter and submitting that to National Marine Fisheries Service, to comment on the critical habitat designation. The plan will be for staff to draft a relatively generic letter with just some overarching concepts on the critical habitat designations; with the understanding that the states are going to provide the river-specific comments for each of their river systems that are within their jurisdictions.

A generic letter will be circulated to the Shad and River Herring Board, and if folks are comfortable with that letter, then it would be forwarded to the National Marine Fisheries Service by September 1st. The question before the Policy Board is; since it is a letter from the commission, is the Policy Board comfortable with this process, and sort of comfortable delegating that final decision authority to the Shad and River Herring Board; since that is a coastwide board.

The membership generally mirrors the same folks that are around the table here. Again, it's going to be – what did I say – sorry, sorry, I got brainwashed over the last hour. Yes sturgeon, Atlantic sturgeon letter. Since the Atlantic Sturgeon Board is coastwide. If folks are comfortable with that process and comfortable delegating that decision to the Sturgeon Board, we can move forward through that course.

CHAIRMAN GROUT: Are you all comfortable with delegating that to the Sturgeon Board, which is disguised as a Policy Board? Any objections to that?

MS. ALLISON MURPHY: No objections, but just for the record; NMFS abstains.

ADJOURNMENT

CHAIRMAN GROUT: Okay. Is that close enough? Thank you very much for that, and I believe that is it on the agenda. It's been a long time, and my apologies to ACCSP for running so late here. It has been a tough day, and this meeting is adjourned.

Whereupon the meeting was adjourned at 5:43 o'clock p.m. on August 3, 2016.)

Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

TO: ISFMP Policy Board

FROM: Risk and Uncertainty Policy Workgroup

DATE: 10/5/16

SUBJECT: Recommended Decision-Tree Framework for Commission Risk and Uncertainty Policy

In the past, the Assessment Science and Management and Science Committees have attempted to develop a comprehensive risk and uncertainty policy for the Atlantic States Marine Fisheries Commission. This process has been revived as uncertainty becomes better understood and a standard element in scientific and management procedures. Recent management decisions emphasize the need to develop a policy to increase repeatability and transparency of our process. Uncertainty must be adequately accounted for in management decisions in order to meet management target levels, rebuild depleted stocks, and maximize resource utilization. When making fishery management decisions, the level of acceptable risk is ultimately a policy decision and should be clearly articulated to fishery stakeholders and other interested parties. Also, it has been increasingly noted that the lack of a risk policy leaves technical committees with unclear guidance on the acceptable level of risk to account for in their management recommendations. Risk and uncertainty policies have proven to be an effective tool for fishery management bodies to create decision-making accountability, and to maintain transparency throughout the management process by providing the necessary technical committee guidance to develop risk-based management recommendations. The Risk and Uncertainty Policy Workgroup has met several times to discuss the purpose, goals, and objectives of the Commission policy and develop a framework.

Policy purpose statement: *"The Commission recognizes that fishery information is inherently variable, and that successful management requires full consideration of this uncertainty and the associated risks on management decisions. The purpose of the Commission's Risk and Uncertainty Policy is to provide a consistent yet flexible mechanism to account for both scientific and management uncertainty in the Commission's decision making process in order to protect all Commission-managed stocks from the risk of overfishing, while minimizing any adverse social, economic, or ecosystem effects. This Policy seeks to maximize the long term benefits across all of our marine fishery resources by providing objective criteria to characterize both scientific and management uncertainty, and to evaluate management risk. Additionally, the Policy improves transparency in the management process, allowing for better communication among managers, industry, and other stakeholders."*

Goal: Adequately account for uncertainty at all levels of the Commission's management process to maximize informed decision-making

- Apply technical committee expertise to identify, and quantify where possible, sources of scientific uncertainty in the stock assessment process.
- Ensure that management uncertainty is captured in the stock assessment process or integrated into decision-making by utilizing knowledge of issues such as enforcement or non-compliance.
- Incorporate social and economic factors through application of current information and data while recognizing the need to develop more robust quantitative instruments.

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Goal: Consistently manage Commission species

- Apply across all Commission-managed species while incorporating nuances of each individual species.
- Provide stability with a standardized procedure that is predictable in process, although outcomes may not be predictable.
- Provide explicit guidance to the technical committee for specifying management recommendations that are in line with the Board's risk tolerance for all ASMFC-managed species.

Goal: Provide transparency in Commission's risk-management process

- Clearly articulate and document the sources of uncertainty and the potential repercussions of that uncertainty on management decisions to stakeholders and decision-makers.
- Specify where uncertainties are accounted for in the decision-making process.
- Create management-level accountability through explicit and documented reasoning during final risk acceptance process.
- Increase accessibility to and understanding of the decision-making process to promote better engagement with stakeholders and other interested parties.

Goal: Incorporate flexibility in the Commission's risk-management process

- Implement a standard policy for reviewing the process so there is an avenue to revisit the risk policy and procedures in the face of changing science and knowledge of different fish and fisheries.
- Account for uncertainty estimates that cannot be quantitatively assessed by allowing managers to accept a harvest level that is greater than or less than the level recommended by the technical committee through an explicit documentation of the departure from the quantitative advice, to achieve the risk objectives of the Commission.

A comprehensive risk and uncertainty policy would provide guidance on everything from choosing biological reference points to setting quotas for data poor species. The development of such a policy is the long-term goal of the Risk and Uncertainty Policy Workgroup, but the WG also recognizes the investment in time and resources it will take to bring such a comprehensive document to completion. This would require setting specific management objectives for each species and conducting a management strategy evaluation. Thus, the WG recommends that the development and deployment of the policy be implemented in phases, beginning with a decision tree approach that will allow the Commission to set acceptable risk levels when determining quotas for data-rich species.

The Commission frequently has to set quotas or harvest regulations with a goal of moving a population to, or keeping a population at, a sustainable level, which often is defined by a target and threshold. The management options to achieve this goal are usually evaluated through short-term projections. These projections take into account variability in recruitment, current status, growth, natural mortality, and/or other factors to determine a range of possible outcomes. A technical committee then evaluates what percent of projected outcomes are at or below the F threshold. This is a way of quantifying the risk of a harvest reduction or increase strategy with regard to the stock entering an overfishing state or an unsustainable population size, e.g. the lower the percentage of runs at or below the F target, the higher the risk of exceeding that target will be if the management program is implemented. Generally, smaller reductions or bigger increases will have a higher risk of failing to keep F at or below the target, and it is the Board's responsibility to decide what level of risk they are willing to accept in these management decisions.

The level of acceptable risk will vary from situation to situation. For species that are not overfished and not experiencing overfishing, the Board may accept a higher risk level than for species that are overfished. Likewise, the Board may want to apply a lower risk level for species that do not have robust assessments, or robust data to support harvest policy analyses. Life history characteristics specific to a species being managed may also influence the process of determining risk tolerance. Establishing guidance on what level of risk the Commission is willing to accept in different situations will allow technical committees to work more efficiently and provide the advice the Boards need, and will allow the public greater clarity in understanding the process of how catch advice is developed.

One possible way of providing this advice would be a decision-tree. Each technical committee would review a series of questions as part of their terms of reference for the assessment regarding stock status and the quality of the assessment and/or other information about that species, and arrive at a Board approved pre-determined level of risk (i.e., the probability of overfishing or of exceeding the F target, and the probability of the stock becoming overfished or declining below the SSB target) that would be used to develop catch advice. For example:

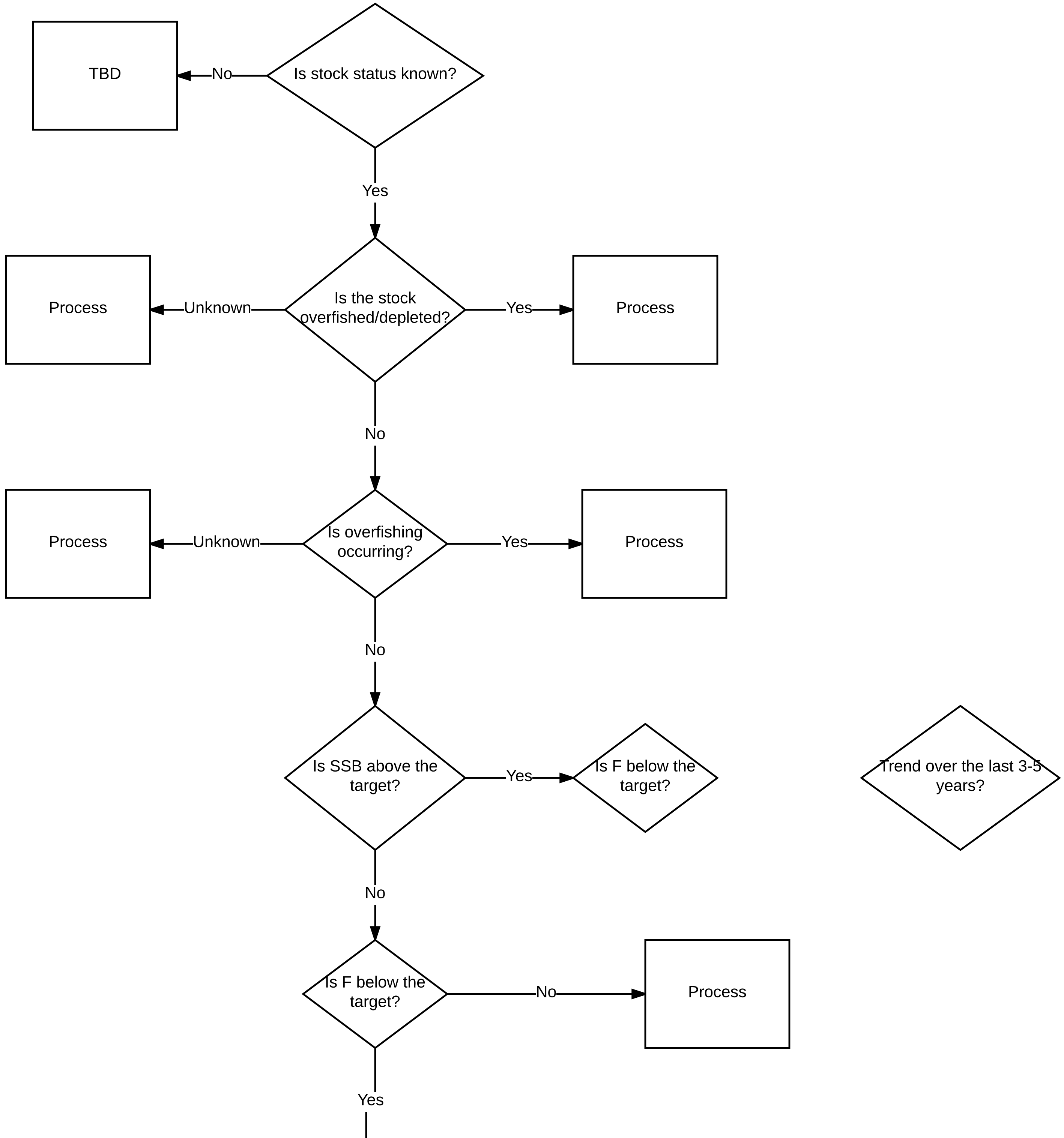
- **Can the stock status be determined?**
- **Is the stock status overfished/depleted?**
- **Is overfishing occurring?**
- **Is SSB above the target?**
- **Is F below the target?**
- **To what degree are the major sources of uncertainty captured within the assessment?**
- **Is there a negative retrospective bias (i.e. underestimating F and overestimating B)?**
- **Is this a long-lived, slow-growing species that would be difficult to rebuild?**

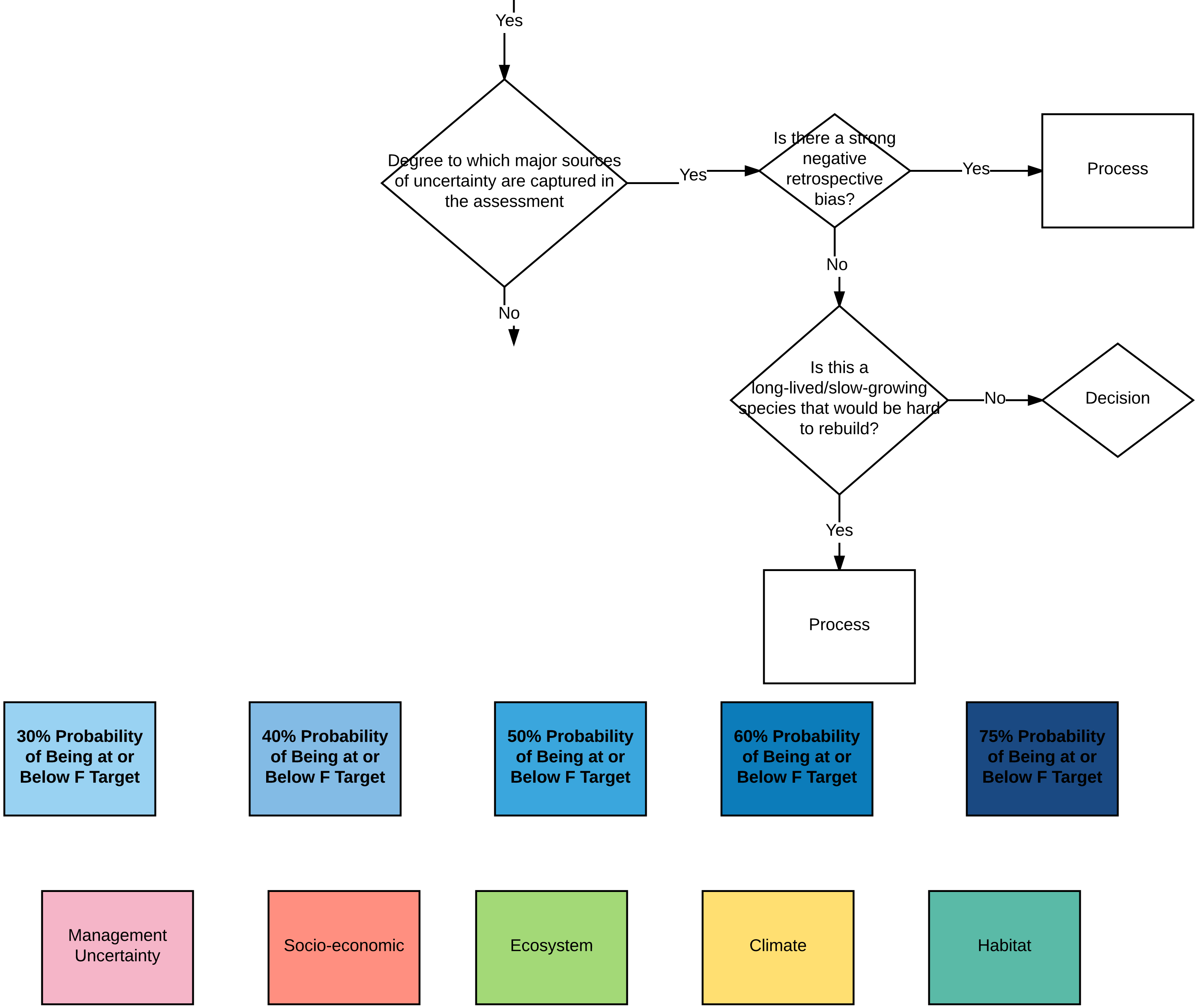
At the end of the decisions, a technical committee would know what probability of overfishing or becoming overfished to use in developing advice based on projections. These levels would be established through the overarching Commission risk policy for all species, but the application of this policy would still allow for some flexibility at the Board level. The Board may select a harvest reduction that is greater than or less than the level recommended by a technical committee to achieve the risk objectives of the Commission, but if they choose an alternate harvest reduction, they must be explicit about the level of risk they are assuming with regards to achieving the F target. This allows some flexibility for qualitative uncertainty estimates while still meeting the transparency and accountability goals of the Commission.

In September, the Risk and Uncertainty Policy Workgroup, met to discuss the development of the Commission's policy using a decision-tree framework. The group focused on populating a decision-tree using an example species that is fairly data-rich and therefore stock status could be determined. Quantitative and objective questions to assess the level of uncertainty surrounding a stock assessment and management process were incorporated into the decision-tree. All topics and questions that the group believed were more qualitative and subjective (either due to lack of data or general information) were placed into categories at the end of the tree. These categories could be used by the Board to describe their reasoning to flexibly change the risk level that the technical committees quantitatively access and recommend beforehand. An informational document could be distributed to the Board that would hold some of the qualitative information in a more descriptive way. The group also recommended creating a template for a formal Advisory Panel report that could provide additional information regarding some uncertainties, especially social science and economic concerns.

The WG added some “placeholder” levels of risk, using examples of Board queries from recent meetings but added some lower probabilities (30%, 40%, 50%, 60%, and 75% probability of being at or below F target). The group decided that stronger justification can come later from the Policy Board, ASC/MSC, and literature meta-analysis. For this example, the risk levels are disconnected from the rest of the chart since the WG did not create a quantitative measure to link them at this time. Giving each question an overall weight, and then scoring the questions relative to each other might make the process more quantitatively linked to each risk level for the final product.

The Workgroup is seeking feedback from the Board on acceptable levels of risk and what characteristics of the stock or the assessment would cause the Board to accept a higher or lower level of risk. Given that this rough draft of the decision-tree was created with only one example species, this is a small component of the final tool that will be the end product recommended to the Policy Board. Board members should consider if this framework is appropriate for accounting for risk and uncertainty in the Commission process.


TBD
No
Is stock status known?
Yes
Process
Unknown
Is the stock overfished/depleted?
Yes
Process
No
Process
Unknown
Is overfishing occurring?
Yes
Process
No
Is SSB above the target?
Yes
Is F below the target?
Trend over the last 3-5 years?
No
Is F below the target?
No
Process
Yes


Yes
Degree to which major sources of uncertainty are captured in the assessment
Yes
Is there a strong negative retrospective bias?
Yes
Process
No
No
Is this a long-lived/slow-growing species that would be hard to rebuild?
No
Decision
Yes
Process
30% Probability of Being at or Below F Target
40% Probability of Being at or Below F Target
50% Probability of Being at or Below F Target
60% Probability of Being at or Below F Target
75% Probability of Being at or Below F Target
Management Uncertainty
Socio-economic
Ecosystem
Climate
Habitat

Atlantic States Marine Fisheries Commission

Atlantic Sciaenid Habitats:

A Review of Utilization, Threats, and Recommendations for Conservation, Management, and Research

Prepared by:

Jimmy Johnson
North Carolina Department of Environmental Quality
Washington, North Carolina
Jimmy.Johnson@ncdenr.gov

January Murray
Georgia Department of Natural Resources
Brunswick, Georgia
January.Murray@dnr.ga.gov

Jay Odell
The Nature Conservancy
Richmond, Virginia
JOdell@tnc.org

Kent Smith
Florida Fish and Wildlife Conservation Commission
Tallahassee, Florida
Kent.Smith@myfwc.com

and

Lisa N. Havel
Atlantic States Marine Fisheries Commission
Arlington, Virginia
LHavel@asmfc.org

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CHAPTER 1: Introduction

The Atlantic States Marine Fisheries Commission (hereafter referred to as ASMFC or the Commission) is the principal agency responsible for the management of many sciaenid fish species in state waters. The mission of the Commission's Habitat Program is to work through the Commission, in cooperation with appropriate agencies and organizations, to enhance and cooperatively manage vital fish habitat for conservation, restoration, and protection, and to support the cooperative management of Commission managed species. One of the primary tasks of the Habitat Program is to develop habitat source documents on topics of immediate and broad interest to ASMFC Commissioners. Source documents provide detailed habitat information to inform conservation and management actions by ASMFC and diverse partners.

ASMFC coordinates interstate fishery management plans for Atlantic croaker, black drum, red drum, spot, spotted seatrout, and weakfish. This document is intended to provide up to date information on each of these species' biology, habitat needs, and habitat stresses.

General Sciaenid Information

Sciaenid fishes are found worldwide, containing approximately 70 genera and 270 species (Nelson 1994), of which 21 genera and 57 species have been described in the western Atlantic (Chao 1978). Globally, most sciaenids occur in marine and estuarine waters, while 28 species occur in freshwater. Marine species of sciaenids are found on shallow continental shelves in the Atlantic, Pacific, and Indian Oceans, but are absent from islands in the mid-Indian and Pacific oceans (Nelson 1994). Most sciaenids (with the exception of kingfish), produce deep drumming sounds by contracting and beating muscles against the swim bladder, hence the common names croaker and drum.

In the western Atlantic Ocean, sciaenids are found from Maine to Mexico, with centers of abundance most concentrated from New York to North Carolina, depending on the species. Sciaenids live in shallow coastal waters (less than 125 meters), and in larger bays and estuaries, including their tributaries. In general, they are euryhaline organisms, meaning they can adapt to a wide range of salinities, although preferred salinity varies with species and life stage. Sciaenids utilize a variety of habitats throughout their life stages, including sand and mud substrates, oyster beds, water column, and seagrass. As a group, sciaenids exploit the broadest range of foraging habits, consisting of polychaetes, bivalves, crustaceans, and fishes (Chao and Musick 1977). Their diets vary with locality, prey availability, life stage, and species.

Estuaries are important habitats for many sciaenids at every life stage. In the Mid Atlantic Bight, as many as 14 species can be present in estuaries as larvae, juveniles, or adults over the course of a year (Chao and Musick 1977; Cowan and Birdsong 1985; Able and Fahay 1997; Able et al. 2001). Weakfish, for example, use estuaries as primary spawning habitat (Nye et al. 2008), while Atlantic croaker and spot use them as nurseries and seasonal adult foraging grounds (Chao and Musick 1977; Sheridan et al. 1984). As dominant seasonal members of the estuarine fish assemblage, young sciaenids play important roles as both predators and prey (Dovel 1968; Chao and Musick 1977; Grecay and Targett 1996; Able et al. 2001).

Adults form spawning aggregations and release sperm and eggs into the water column. The spawning period occurs over several months, and often entails multiple spawning events, but timing varies by species. In fact, sciaenids partition out their spawning and nursery residences, which ultimately reduces competition. It's difficult to make generalizations about these species as a group because they have evolved to utilize distinct ecological niches in terms of feeding, timing of spawning, and spawning and nursery areas. For example, spot and Atlantic croaker spawn offshore in the winter, while other species such as weakfish, black drum, and northern kingfish spawn in the spring and summer in coastal areas. Spotted seatrout are essentially year-round estuarine residents who infrequently leave their natal estuary (Holt and Holt 2003; Lowerre-Barbieri et al. 2013).

Fertilized eggs float in the water column and hatch after 1-2 days depending on the species and water temperature. Soon after hatching, larvae are transported from coastal waters farther up into estuaries through active and passive processes. Nursery habitat use is also somewhat partitioned in space and time among species. For example, young-of-year black drum tend to be found in lower salinity habitats than other species of sciaenids. Young-of-year Atlantic croaker show up in late fall/early winter and overwinter in the estuary. Young-of-year spot are found in late winter/early spring, followed by black drum, weakfish, spotted seatrout, and finally red drum. Structurally complex nursery areas, such as seagrasses and marsh creeks, provide larvae and young fish productive feeding grounds and protection from predators (McIvor and Odum 1988; Hoss and Thayer 1993; Kneib 1997; Rountree and Able 2007). Because estuarine habitat provides such favorable conditions for juvenile growth and reduced mortality, this habitat is critical to ongoing productive coastal fisheries (Boesch and Turner 1984; Fogarty et al. 1991; Deegan et al. 2000).

Anthropogenic Impacts

Increasingly dense human populations along our coastlines threaten the health of estuaries and coastal waters. Widespread development, coastal armoring, pollution, and other human impacts have significantly altered the physical and chemical environments of estuarine and marine waters. Changes in hydrologic processes and runoff characteristics can increase turbidity and sedimentation and decrease light transmittance, which may lead to the loss of submerged aquatic vegetation. Anthropogenic alterations to the estuarine environment have been linked to changes in hydrography and salinity regimes, as well as food web modification, which can eventually reduce the quality of habitat for estuary-dependent fishes.

Temperature, salinity, and dissolved oxygen (DO), vary considerably in estuarine environments (Tyler et al. 2009) and these factors are known to affect sciaenid growth rates, spawning, and spatial and temporal distribution. As a group, sciaenids are habitat generalists rather than specialists and may therefore be relatively resilient to changes in abiotic factors. However, Atlantic coast estuaries have been profoundly altered. Despite their ability to take advantage of a range of habitats, sciaenids are not immune to habitat degradation or suboptimal conditions. For example, spotted seatrout are sensitive to cold and often are conspicuous features of "cold kills" in the northern estuaries of their range. In estuarine systems, perturbations to water quality are occurring at rates faster than natural selection can act on organisms to enable them to adapt to the new prevailing conditions (Horodysky et al. 2008).

Key Habitats

Because of the way different species of sciaenids partition their use of habitat, several different habitat types are key, including estuaries, salt marshes, freshwater marshes, oyster reefs, sea grasses, and mud banks/shores. The mouth of the estuary is also very important for staging. In coastal marine areas, the surf zone and sand bar complex is valuable nursery habitat for southern and gulf kingfish, and serves as adult habitat for spotted seatrout, weakfish, red drum, and others. In addition, the coastal shelf (in waters less than 125 m) is used for spawning by some species (i.e., Atlantic croaker).

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CHAPTER 2: Atlantic croaker

Populated with Habitat Section from Amendment 1 to the ISFMP (ASMFC 2005)

Section I. General Description of Habitat

Atlantic croaker was described by Petrik et al. (1999) as a habitat generalist. Field surveys of post-settlement croaker in estuarine nursery areas found no significant differences in abundances among submerged aquatic vegetation (SAV), marsh edge, and sandy bottom (Petrik et al. 1999). In a wetland system, Atlantic croaker along the Gulf Coast preferred non-vegetated bottom adjacent to wetlands rather than the marsh itself (Rozas and Zimmerman 2000). In North Carolina, Atlantic croaker have been documented to utilize SAV, wetlands, non-vegetated soft bottom, and to a lesser extent, shell bottom (Street et al. 2005). Juvenile croaker use these habitats for refuge and foraging and as a corridor through the estuary. In North Carolina, Atlantic croaker is one of the dominant juvenile fish species in the estuaries (North Carolina Division of Marine Fisheries, unpublished data). Because croaker utilizes multiple habitats, the effect of habitat change and condition on fish population is difficult to assess.

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Atlantic croaker spawn predominantly on the continental shelf, at depths ranging from 7 to 81 m (26 to 266 ft), but also in tidal inlets, estuaries (Diaz and Onuf 1985; Able and Fahay 2010). Atlantic croaker have a long spawning season that generally starts in late summer and continues to early spring, with peak reproductive activity occurring in late fall and winter (Diaz and Onuf 1985). In the Chesapeake Bay and North Carolina, spawning begins as early as August and usually peaks in October, whereas peak spawning occurs in November in the Gulf of Mexico (USFWS 1996).

Salinity

Atlantic croaker are a euryhaline species, capable of tolerating a wide range of salinity. It is suggested that this wide tolerance continues during spawning, as they are found to spawn in estuaries and adjacent coastal oceanic waters as far out as the continental shelf (Barbieri et al. 1994). Diaz and Onuf (1985) report that they typically spawn in polyhaline brackish waters.

Substrate

Although Atlantic croaker forage along the benthos, they are pelagic spawners in estuaries and offshore along the continental shelf (Chao and Musick 1977; Barbieri et al. 1994). These habitats tend to be dominated by soft sediment (mud and sand) (Townsend et al. 2004; Friedrichs 2009).

Temperature

Exact spawning locations may be related to warm bottom waters (Miller et al. 2002). Spawning is reported to occur at water temperatures between 16 and 25 °C in North Carolina (Street et al. 2005). In general, spawning is correlated with bottom temperatures higher than 16 °C along the Mid Atlantic Bight (Norcross and Austin 1988).

Dissolved Oxygen

Prolonged exposure to hypoxia has detrimental effects on reproduction in Atlantic croaker. Hypoxia has been linked to decreased gonadal growth, gametogenesis, and endocrine function as well as lower hatching success and larval survival (Thomas et al. 2007; Thomas and Rahman 2009). A study sampling from the dead zone in coastal regions of the northern Gulf of Mexico found that Atlantic croaker experiencing persistent hypoxia displayed an approximate 74 percent decrease in sperm production and a 50 percent decrease in testicular growth compared to fish collected nearby which were not under hypoxic conditions (Thomas and Rahman 2010).

Feeding Behavior

Atlantic croaker are carnivorous. Their diet consists mainly of polychaetes and some fish and arthropods in the spawning months (Hansen 1969).

Competition and Predation

Atlantic croaker were found to be a primary food source of dolphins residing in estuaries, who locate them by listening for their characteristic thrumming sounds (Gannon and Waples 2006).

Part B. Egg and Larval Habitat

Geographic and Temporal Patterns of Migration

After hatching, larvae drift into estuaries by passive and active transport mechanisms via floodtides, upstream bottom currents, and other large-scale and localized oceanographic processes (Joyeux 1998). Arrival time into estuaries varies regionally. Larvae are present as early as June on the Louisiana coast and as late as September in the Chesapeake Bay and on the North Carolina and Virginia coasts (USFWS 1996). Larval size at recruitment into Onslow Bay and Newport River estuary in North Carolina ranged from 4.3 - 9.9 mm standard length (SL)(Lewis and Judy 1983). Immigrating larvae into the Chesapeake Bay are typically 20-26 days old and are 5-7 MM standard length (Nixon and Jones 1997). Upon initial arrival in the estuary, larval croaker are pelagic. During ebbing tides, however, larvae move to the brackish, bottom waters where they complete their development into juveniles (Miller 2002). Restriction to surface water is likely dependent on amount of vertical mixing: they will be closer to the surface in turbulent areas if they are not dense enough to sink to the bottom (Hare et al. 2006).

Salinity

Pelagic eggs are found in polyhaline and euryhaline waters. After hatching, young enter estuaries and move to areas of low salinity (Hansen 1969). These fish migrate into the estuary in the saltwater wedge along the bottom (Haven 1957).

Substrate

Larvae will remain in the water column until mobility function is developed and body density increases enough to allow for settlement (Hare et al. 2006).

Temperature

Larvae can tolerate colder water temperatures than adults, but extremely cold temperatures may be a major source of larval mortality.

Dissolved Oxygen

Eggs and larvae of Atlantic croaker are pelagic and remain offshore for approximately two to three months before ingressing into estuarine nursery habitats (Poling and Fuiman 1998). Therefore, it is unlikely these stages will encounter hypoxic conditions until settlement into the nurseries.

Feeding Behavior

Atlantic croaker larvae are planktonic feeders. Because they primarily locate their food source visually, larvae feed during the day. They may search 12-120 L of seawater for food organisms in a 12 hour day (Hunter 1981).

Diet selection depends upon availability, size of the prey item in comparison to size of the growing larvae, swimming behavior and color of the food organism, as well as prey perception, recognition, and capture (Govoni et al. 1986). Atlantic croaker larvae eat tintinnids, pteropods, pelecypods, ostracods, and the egg, naupliar, copepodid, and adult stages of copepods (Govoni et al. 1983).

Competition and Predation

Larvae enter nursery habitats within estuaries from late summer to late winter with peak ingress occurring in the fall in the western north Atlantic (Able and Fahay 2010; Ribeiro et al. 2015). For larvae of Atlantic croaker that enter estuarine nurseries (i.e., seagrass beds) in the summer, this corresponds with the ingress of other estuarine dependent sciaenid species (e.g., red drum, silver perch, weakfish) (Ribeiro et al. 2015), giving rise to the potential for inter-specific competition among these sciaenid species in nurseries. In the Chesapeake Bay, ectoparasites were prevalent on Atlantic croaker larvae in late summer and early fall (Ribeiro et al. 2016), which is another potential source of mortaility in estuarine systems.

Similar to many other fishes, eggs and larval stages are commonly predated upon by gelatinous zooplankton, which reach peak densities in the Chesapeake Bay during the summer months (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part C. Juvenile Habitat

Geographic and Temporal Patterns

Juveniles use estuaries and tidal riverine habitats along the United States Atlantic coast from Massachusetts to northern Florida, and in the Gulf of Mexico, but are most common in coastal waters from New Jersey southward (Able and Fahay 1997; Robbins and Ray 1986; Diaz and Onuf 1985). Recruitment of juveniles into estuaries may be influenced by tidal fluxes in estuaries. For example, in the Pamlico Sound, North Carolina, a shallow estuary where tidal fluxes are largely controlled by wind, recruitment of juveniles is slower than the Cape Fear estuary, where tidal fluxes are dictated by lunar cycles average 1.5 meters (Ross 2003). The Cape Fear estuary is representative of most drowned river valley Atlantic coast estuaries. Juveniles remain in these habitats until early to mid-summer (USFWS 1996). Juveniles migrate downstream as they develop and by late fall, most juveniles emigrate out of the estuaries to open ocean habitats (Miglarese et al. 1982). Juvenile Atlantic croaker tagged in Delaware Bay, New Jersey remained in a localized area of the tidal creeks before fall egress into offshore waters (Miller and Able 2002.) Juvenile and adult croaker are tolerant to a wide range of salinity, temperature, and dissolved oxygen, but prey field seems to be correlated with the presence of croaker. Nye (2008) found that the presence of anchovy was a consistent predictor of croaker occurrence.

Salinity

Juveniles are associated with areas of stable salinity and tidal regimes and often avoid areas with large fluctuations in salinity. The upper, less saline parts of the estuaries provide the best environment for high growth and survival rates (Ross 2003; Peterson et al. 2004). Juveniles concentrate in oligohaline and mesohaline waters (0.5 - 18 ppt), although they may tolerate more extreme salinities (Diaz and Onuf 1985; Ross 2003). Ross (2003) showed that juveniles experience reduced mortality in less saline areas. Lower mortality in the less saline areas may be because of lower physiological stress in those environments (Ross 2003). Growth rates in juveniles may be affected by fluctuating salinities and temperatures (Peterson et al. 2004; Chao and Musick 1977). Large changes in salinity can alter the activity of croakers in a way that reduces local abundance; however, smaller changes do not appear to affect juveniles. Sharp fluctuations in salinity can cause intermediate growth rates and increase the bioenergetic costs for juveniles (Peterson et al. 2004).

Able and Fahay (1997) suggested that cold December waters in Delaware Bay are not conducive to survival of young croaker. Juvenile croaker prefer deeper tidal creeks because the salinity changes are usually less than in shallow flats and marsh creeks (Diaz and Onuf 1985). Salinity may affect the size distribution of juveniles within an estuary, which may be a result of changing physiological requirements as the juveniles develop (Miglarese et al. 1982).

Substrate

Substrate plays a large role in determining juvenile croaker distribution. Juveniles are positively correlated with mud bottoms with large amounts of detritus that houses sufficient prey (Cowan and Birdsong 1985). Sand and hard substrates are not suitable. Juvenile are often found in more turbid areas of estuaries with higher organic loads that provide a food source for individuals, but low turbidity is not a limiting factor in juvenile distribution (Diaz and Onuf 1985). The latter stages of young croaker are found more commonly in deeper channel habitats (Chao and Musick 1977; Poling and Fuiman 1998).

Depth

Juvenile Atlantic croaker live at a variety of depths, depending on the estuary. Many North Carolina estuaries and the coast of the Gulf of Mexico have small tidal fluctuations. In these areas, juvenile croakers amass in shallow, peripheral areas. In estuaries with greater tidal fluctuations such as the Delaware Bay, Chesapeake Bay, or the Cape Fear River Estuary, juvenile croaker assemble in deep channels (Chao and Musick 1977; Diaz and Onuf 1985).

Temperature

Field and laboratory data indicate that juveniles are more tolerant of lower temperatures than adults. Juveniles have been found in waters from 0.4° C - 35.5° C (USFWS 1996) but extreme temperature changes can incapacitate juvenile croakers (Diaz and Onuf 1985). Young-of-year (30-60 mm SL) will experience 100% mortality when exposed to 1° C for a period of 8 days. Prolonged exposure (12 - 24 d) to water temperatures of 3 °C can also lead to high mortality rates (Lankford and Targett 2001). Juveniles migrate from Delaware Bay, New Jersey to offshore waters from August to October when water temperature is 15 °C – 19 °C (Miller and Able 2002). Year-class strength also appears to be linked to overwinter survival of juveniles (Hare and Able 2007).

Dissolved Oxygen

Juveniles may favor conditions that can result in low dissolved oxygen (DO), although juveniles will move out of an area if DO levels decrease beyond preferred tolerances (Diaz and Onuf 1985). Severe hypoxia of bottom water and sediments, often associated with eutrophication, can negatively affect juvenile croaker, causing deaths, a reduced growth rate, and reduced prey availability (Street et al. 2005).

Feeding Behavior

In Delaware Bay, Nemerson and Able (2004) found that the largest concentrations of newly recruited Atlantic croaker were collected over soft bottom habitat containing a high abundance of benthic invertebrates, and that their diet was dominated by polychaetes and crustaceans (80%) with fish comprising <4%. Annelids were an important prey component of their diet. Juveniles consume fish, but not in large quantities as do adults (Avault and Birdsong 1969). Sheridan (1979) found that small croaker rely heavily on polychaetes, but also consumed detritus, nematodes, insect larvae, and amphipods. There is evidence that croaker are somewhat crepuscular in their feeding habits (Nye 2008).

Competition and Predation

There is a potential for interspecific competition among sciaenids in estuaries from late spring to fall because juvenile Atlantic croaker, silver perch, weakfish, and spot are most abundant (Chao and Musick 1977), although sciaenids exhibit variation in morphological characters that may reduce interspecific competition in estuarine nursery habitats (Chao and Musick 1977; Deary and Hilton 2016).

Part D. Adult Habitat

Geographic and Temporal Patterns of Migration

Atlantic croaker is one of the most common bottom dwelling estuarine species on the Atlantic Coast. Atlantic croaker range from the coastal waters of Cape Cod, Massachusetts to Florida, but croaker are uncommon north of New Jersey. Croaker are also found along the Gulf of Mexico coast with high abundances in Louisiana and Mississippi (Lassuy 1983). Juvenile and adult croaker are tolerant to a wide range of salinity, temperature, and dissolved oxygen, but prey field seems to be correlated with the presence of croaker. Nye (2008) found that the presence of anchovy was a consistent predictor of croaker occurrence.

Salinity

Adults are found in a salinity range from 0.2 - 70 ppt, but are most common in waters with salinities ranging from 6 - 20 ppt (Lassuy 1983; Eby and Crowder 2002). Adult croaker catch rates are negatively correlated with increasing salinities (TSNL 1982), but catch rates also vary with season. In spring, most adults are caught in salinity ranges from 3 – 9 ppt, but in summer, catch peaks in two ranges: the low salinities ranging from 6 – 12 ppt, and high salinities ranging from 24 – 27 ppt (Miglarese et al. 1982). Generally, adults avoid the mid-salinity ranges (Miglarese et al. 1982; Peterson et al. 2004). Mean total length positively correlates with bottom salinities (Miglarese et al. 1982). Turbidity, nitrate-nitrogen concentrations, and total phosphate-phosphorous concentrations also correlate positively with croaker abundance and catch (TSNL 1982).

Substrate

Adult Atlantic croaker prefer muddy and sandy substrates in waters shallow enough to support submerged aquatic plant growth. Adults have also been collected over oyster, coral, and sponge reefs, as well as man-made structures such as bridges and piers. Adult Atlantic croaker also use *Thalassia* sp. beds for refuge although abundance in the seagrass beds is temperature-dependent and changes seasonally (TSNL 1982).

Temperature
Temperature and depth are strong predictors of adult croaker distribution, and the interaction between the two variables may also influence distribution (Eby and Crowder 2002). Adult croaker generally spend the spring and summer in estuaries, moving offshore and to southern latitudes along the Atlantic coast in the fall. Their migration is in response to cooling water temperatures because croakers cannot survive in cold winter temperatures. Adults are found in waters from 5 °C - 35.5 °C, but most catch occurs in temperatures over 24 °C (Miglarese et al. 1982). Generally, fish older than 1 year old are absent in waters below 10 °C (Lassuy 1983). Optimal temperatures for growth and survival are not known (Eby and Crowder 2002).

Dissolved Oxygen
The distribution and extent of hypoxic zones in estuaries may also influence habitat use and distribution (Eby and Crowder 2002). Croaker generally shift from deep, hypoxic water to shallow, oxygenated waters during hypoxic events. Their distribution is further limited when hypoxic conditions occur in shallower waters. The lower threshold of DO for Atlantic croaker is about 2.0 mg L^{-1}. Below this limit, Atlantic croaker may not survive or may experience sublethal effects. Studies have shown that Atlantic croaker are virtually absent from waters with DO levels below 2.0 mg L^{-1}, suggesting they are very sensitive to the amount of DO present (Eby and Crowder 2002).

The size of a hypoxic zone influences habitat use as well. When hypoxic conditions spread in an estuary, Atlantic croaker are forced to use less suitable habitat. Atlantic croaker could incur increased physiological and ecological costs in these areas. For example, Atlantic croaker may face increased intra- and interspecific competition for available space or food in what are essentially compressed habitat zones. To avoid the increased ecological cost, croaker may return to waters with lower DO (Eby and Crowder 2002).

Feeding Behavior
Adult Atlantic croaker are opportunistic bottom feeders. The majority of their diet is benthic organisms and ≤20% consists of fish species (Avault and Birdsong 1969; Chao and Musick 1977; Nye et al. 2011). Sheridan (1979) found that large croaker rely heavily on polychaetes, followed by mysids and fish. Croaker have been found to be somewhat crepuscular in their feeding habits (Nye 2008).

Competition and Predation
Hypoxic zones may compress suitable habitat, increasing intra- and interspecific competition for available space or food. (Eby and Crowder 2002). Croaker compete with striped bass, weakfish, and possibly bluefish for anchovy in the Chesapeake Bay (Nye 2008).

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat
Based on the life history requirements of Atlantic croaker, many shallow, estuarine ecosystems are essential. At all life stages, EFHs are characterized by soft substrates (mud and sand). For settlement, larvae prefer lower salinity ecosystems with SAV, but juveniles quickly move from these habitats to deeper channels (Chao and Musick 1977; Poling and Fuiman 1998).

Identification of Habitat Areas of Particular Concern

Estuaries, which are especially vulnerable to anthropogenic changes, are designated as Habitat Areas of Particular Concern (HAPCs) for Atlantic croaker, as well as for other species. Larvae are particularly vulnerable to changes in estuarine conditions. Environmental conditions in spawning areas may affect growth and mortality of egg and larval croakers (Eby and Crowder 2002).

Present Condition of Habitat Areas of Particular Concern

Estuarine areas may be functionally reduced in size or degraded by numerous activities, including but not limited to, development, dredging and filling, toxic chemical and nutrient enrichment discharges from point and non-point sources, habitat alteration (e.g., wetlands converted to agricultural use), failing septic systems, and alterations in seasonal runoff patterns (S.J. Vanderkooy, Gulf States Marine Fisheries Commission, personal communication). These events may reduce the quantity and quality of Atlantic croaker habitat. Scientists believe that Atlantic croaker are affected by these changes, but few specific studies have quantified the effects of habitat degradation on the fishery resource (S.J. Vanderkooy, Gulf States Marine Fisheries Commission, personal communication).

Many coastal and estuarine areas have inadequate water quality because of various land use activities. The Chesapeake Bay is one example of an area that experiences eutrophication from agricultural runoff. Excess nutrients entering coastal waters may cause algal blooms that reduce dissolved oxygen, resulting in hypoxic or anoxic conditions, especially during the summer months (R. Lukacovic, Maryland Department of Natural Resources, personal communication). Large hypoxic areas have also been documented in Louisiana's coastal waters during the summer due to nutrient loading into the Mississippi River from the Midwestern farm belt. These events can directly impact fisheries in the area (S.J. Vanderkooy, Gulf States Marine Fisheries Commission, personal communication).

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Atlantic Croaker

Juvenile croaker may be affected by hydrological modifications, water quality degradation, or habitat alterations. Hydrological modifications such as ditching and channelization increase the slope of the shoreline and water velocities in the altered stream. Higher water velocity and reduced natural wetland filtration can result in increased shoreline erosion, increasing sediment and non-point pollutant loading in channelized water bodies (White 1996; EPA 2001). Several studies have found that the size, number, and species diversity of fish in channelized streams are reduced and the fisheries associated with them are less productive than those associated with unchannelized reaches of streams (Tarplee et al. 1971; Hawkins 1980; Schoof 1980). Pate and Jones (1981) compared nursery areas in North Carolina that were altered and unaltered by channelization and found that Atlantic croaker and other estuarine-dependent species were more abundant in nursery habitats with no man-made drainage. They attributed this to the unstable salinity conditions that occurred in areas adjacent to channelized systems following moderate to heavy rainfall (>1 inch 24 h^{-1}).

Pollutants negatively affect growth and physical condition of juvenile Atlantic croaker, with significantly reduced growth rates and condition occurring with increasing pollutant conditions (Burke et al. 1993). Low concentrations of heavy metals can accumulate in fine-grained sediments, particularly organic-rich muddy substrates, to toxic levels, and can be resuspended into the water column (Riggs et al. 1991). Primary nursery areas in North Carolina often consist of such fine-grained sediments and are therefore susceptible to toxic contamination of bottom sediments (Street et al. 2005).

Severe hypoxia of bottom water and sediments, often associated with eutrophication, can adversely affect croaker populations through suffocation, reduced growth rates, loss of preferred benthic prey, changes in distribution, or disease (Street et al. 2005). Mass mortality of benthic infauna associated with anoxia has been documented in the deeper portions of the Neuse River estuary in North Carolina, in association with stratification of the water column in the summer (Lenihan and Peterson 1998; Luettich et al. 1999). During these events, oxygen depletion caused mass mortality of up to 90% of the dominant infauna within the affected area (Buzzelli et al. 2002). Utilizing a statistical model and field data, it was estimated that the extensive benthic invertebrate mortality, resulting from intensified hypoxia events, reduced total biomass of demersal predatory fish and crabs during summer months by 17 - 51% in 1997 - 1998 (Baird et al. 2004). The decrease in available energy from reduced benthos greatly reduced the ecosystem's ability to transfer energy to higher trophic levels at the time of year most needed by juvenile fish (Baird et al. 2004).

Alteration of natural shorelines has been shown to have a negative impact on juvenile Atlantic croaker populations. In a study along the Gulf Coast comparing fish abundance between unaltered and altered shorelines (bulkheads or rubble), croaker was most abundant at the unaltered unvegetated shoreline (Peterson et al. 2004). Other anthropogenic activities that can potentially degrade shallow shoreline habitat conditions include dredging and proliferation of docks and marinas (Street et al. 2005).

In spring and fall, moderate water temperatures and hypoxia may not be limiting Atlantic croaker distribution. However, in summer when water temperatures are higher, Atlantic croaker may avoid moderately hypoxic zones in order to avoid the additional physiological costs of staying in waters with less dissolved oxygen (Eby and Crowder 2002). As hypoxia increases in severity and scope within estuarine waters, croaker typically move to shallower parts of an estuary. Large hypoxic zones may limit adult croaker depth and temperature distribution, suggesting a shift in habitat use driven by the severity of a hypoxic event (Eby and Crowder 2002). Atlantic croaker may actually be limited to areas with higher-than-optimal temperatures during hypoxic events (Eby and Crowder 2002).

Unknowns and Uncertainties

Climate change is associated with a suite of perturbations to the prevailing conditions (i.e., temperature, dissolved oxygen, pH, salinity, turbidity, etc.) that will have direct and indirect impacts on the survival and growth of Atlantic croaker, although the magnitude of many of these impacts is not fully resolved. For example, gelatinous zooplankton abundance is expected to increase (Kemp et al. 2005), which may increase predation pressure on eggs and larvae of Atlantic croaker. In addition, hypoxic events are becoming more frequent (Kemp et al. 2005), shifting the distribution of croaker from favored juvenile channel habitats to shallow SAV habitats (Eby and Crowder 2002), which may increase interspecific competition through crowding in nursery habitats. Fish kills related to harmful algal blooms are also becoming a persistent issue in estuarine and coastal regions (Kemp et al. 2005) but the magnitude of these events is not known for Atlantic croaker. To understand how perturbations impact Atlantic croaker, baseline biological information is required (i.e., trophic interactions, sensory development, habitat use) in a developmental context.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Each state should implement a protection plan for Atlantic croaker habitat within its jurisdiction to ensure the sustainability of the spawning stock that is produced or resides within its state boundaries. Each program should inventory the historical and present range of croaker, specify the habitats that are targeted for restoration, and impose or encourage measures to preserve the quantity and quality of Atlantic croaker habitats.

1. States should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by Atlantic croaker for each life stage. Regulatory agencies should be advised of the types of threats to Atlantic croaker populations and recommend measures that should be employed to avoid, minimize, or eliminate any threat to current habitat quality.

2. State fishery regulatory agencies, in collaboration with state water quality agencies, should monitor hypoxic conditions in state waters (including estuaries and tidal basins) and report changes in Atlantic croaker abundance or habitat use.

3. Where sufficient knowledge is available, states should designate Atlantic croaker habitat areas of particular concern for special protection. These locations should be designated High Quality Waters or Outstanding Resource Waters and should be accompanied by requirements that limit degradation of habitat, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area (via restrictions on National Pollutant Discharge Elimination System (NPDES) discharge permits for facilities in those areas.

4. State fishery regulatory agencies should develop protocols and schedules for providing input on water quality regulations and on Federal permits and licenses required by the Clean Water Act, Federal Power Act, and other appropriate vehicles, to ensure that Atlantic croaker habitats are protected to ensure that specific water quality needs for Atlantic croaker are met.

5. Water quality criteria for Atlantic croaker spawning and nursery areas should be established, or existing criteria should be upgraded, as to ensure successful reproduction. Any action taken should be consistent with Federal Clean Water Act guidelines and specifications.

6. All State and Federal agencies responsible for reviewing impact statements and permit applications for projects or facilities proposed for croaker spawning and nursery areas should ensure that those projects will have no or only minimal impact on local stocks. Any project that would result in the elimination of essential habitat should be avoided.

7. Federal and State fishery management agencies should take steps to limit the introduction of toxic compounds known to accumulate in Atlantic croaker and that pose threats to wildlife and human health.

8. Each State should establish windows of compatibility for activities known or suspected to adversely affect Atlantic croaker life stages and their habitats. Activities may include, but are not limited to, navigational dredging, bridge construction, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

9. Projects involving water withdrawal from nursery habitats (e.g. power plants, irrigation, water supply projects) should be evaluated to ensure that larval or juvenile impingement or entrainment is minimized, and that any modifications to water flow or salinity regimes remain within croaker tolerance limits.

10. Each state should develop water use and flow regime guidelines to ensure the appropriate water levels and salinity levels are maintained for the long-term protection and sustainability of the stock. States should work to ensure that proposed water diversions or withdrawals from rivers upstream will not reduce or eliminate conditions favorable to Atlantic croaker.

11. The use of any fishing gear that is determined by management agencies to have a negative impact on Atlantic croaker habitat should be prohibited within habitat areas of particular concern (e.g. trawling in spawning or primary nursery areas should be prohibited).

12. States should work to reduce the input of contaminants to Atlantic croaker habitats.

13. States should work with the U.S. Fish and Wildlife Service, Divisions of Fish and Wildlife Management Assistance and Ecological Services, and National Marine Fisheries Service (NMFS), Offices of Fisheries Conservation and Management and Habitat Conservation, to identify hydropower dams that pose significant threats to maintenance of appropriated freshwater flows (volume and timing) to Atlantic croaker nursery and spawning areas and target these dams for appropriate recommendations during FERC re-licensing.

Habitat Research Recommendations

Although Atlantic croaker habitats have undergone loss and degradation; studies are needed to quantify the impact on Atlantic croaker populations. For example, there has been some speculation in recent years that extensive areas of low dissolved oxygen in the Chesapeake Bay killed most of the benthic organisms in the deeper water where croaker feed. Unfortunately, no research has been conducted to confirm the impact of hypoxia on food resources in this region (R. Lukacovic, Maryland Department of Natural Resources, personal communication).

The early life history of the Atlantic croaker is not well documented, yet events during this phase could have a significant impact on recruitment. A better understanding of this life stage of the species is needed to identify its habitat requirements, allowing scientists to evaluate the relative impacts of natural and anthropogenic disturbances.

Periodic review of various programs to monitor habitat and water quality could play an important role in understanding Atlantic croaker population dynamics. The following topics should be examined: nutrient loading; long-term water quality monitoring; hypoxia events; incidence of red tides, harmful dinoflagellates and *Pfisteria*; habitat modification permits; and wetlands protection.

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CHAPTER 3: Black drum

Updated research for life stages. EFH, HAPC, and Threats are populated with Habitat Section from the Interstate Fishery Management Plan for Black Drum Some of the black drum habitat sections were adapted from red drum's habitat needs.

Section I. General Description of Habitat

Black drum in the Atlantic form one population, and two separate populations exist in the Gulf of Mexico (Gold and Richardson 1998). Like many coastal species, oceanic spawning is followed by ingress of eggs and larvae to mid and upper estuarine habitats, although substantial variation likely exists with respect to settlement. Juvenile black drum are largely estuarine-dependent, but throughout the first year of life begin moving to the lower estuary and possibly into the coastal ocean by the fall of year one (Able and Fahay 2010). Geographic adult age structure has been suggested, with older individuals more common in the Mid-Atlantic Bight than in the South Atlantic Bight, although a general movement pattern has been described as north and inshore in the spring, and south and offshore in the fall, which may confound true patterns of habitat use.

Part A. Spawning Habitat[1]

Geographic and Temporal Patterns of Migration

In the Atlantic basin, black drum spawn from April to June in the northern range (Joseph et al. 1964; Richards 1973; Silverman 1979). Black drum have been reported to spawn in nearshore waters, particularly bays and estuaries (Hoese 1965; Etzold and Christmas 1979). In the Mid-Atlantic region, spawning in the mouth of the Chesapeake Bay and larger estuaries has been well documented (Able and Fahay 2010) and the presence of a large spring/early summer fishery on spawning fish in the Delaware Bay also supports evidence of spawning occurring inshore and in the spring. Studies in Florida suggest spawning occurs in deep waters inshore, from November through April, with peaks in February and March (Murphy and Taylor 1989). It is noteworthy that the drumming sound made by black drum is associated with spawning behaviors, and several studies have measured noise in an effort to describe reproduction (Gulf of Mexico, Saucier and Baltz 1993, Locascio and Mann 2011; South America, Tellechea et al. 2010).

Fitzhugh et al. (1993) noted a difference in sex ratios in Louisiana during the spawning season between fish caught offshore by trawls (dominated by males), and fish caught inshore by gillnet and haul-seines (dominated by females). These skewed sex ratios were not found before or after the spawning period. The authors concluded the catches reflected a true segregation of the sexes during the spawning period, suggesting the use of different habitats.

[1] Much of the information in this section comes from two spawning studies in the Gulf of Mexico. These studies focused on the acoustics of spawning, and included a great deal of environmental data. Therefore, the ability to generalize about spawning habitat is somewhat limited, and more research is recommended.

Salinity
Salinity during drumming aggregations has been reported to range from 18.8 - 20.8 ppt in Louisiana (Saucier and Baltz 1993). Based on coastal ocean and lower estuary reported spawning habitats, euryhaline or full seawater salinities would be expected as optimal.

Substrate
None of the spawning studies describe substrate in association with a particular spawning aggregation; however, Saucier and Baltz (1993) generally describe the study sites to be heterogeneous, and include silt, clay, mud, sand, and detritus, and Locascio and Mann (2011) describe their sites as soft muddy composite.

Temperature
From studies limited to the Gulf of Mexico, spawning aggregations have been associated with temperatures ranging from 18 – 22 °C (Locascio and Mann 2011) and with means of 18.8 °C (for large drumming aggregations) and 20.8 °C (for moderate drumming aggregations; Saucier and Baltz 1993).

Dissolved Oxygen
Saucier and Baltz (1993) present the only dissolved oxygen (DO) data associated with black drum spawning. They report means of 12.3 and 11.6 mg L^{-1} for large and moderate spawning aggregations, respectively. Inference on DO preference or tolerance ranges (or in other spatial spawning aggregations) should be approached cautiously.

Feeding Behavior
No published work has reported on the feeding behaviors of spawning individuals. It might be inferred—based on nearshore and estuarine habitats—that spawning black drum feed on the same food sources as adults, which includes primarily crustaceans and mollusks.

Competition and Predation
Competition among black drum and with other species is undocumented for spawning adults. Because spawning habitat is not yet described at a fine scale (microhabitat), it is unclear whether spawning habitats are limiting, and if competition exists for these habitats or inclusion in spawning aggregations. Predation of spawning adults is likely similar to adult *P. cromis*, although possibly depressed from both lower predatory metabolic demands from cooler winter and spring water temperatures, and the absence of many estuarine shark species until late spring (Ulrich et al. 2007).

Part B. Egg Habitat

Geographic and Temporal Patterns of Migration
Along the Atlantic coast, black drum eggs are spawned during the spring, from April to June in the northern range (Joseph et al. 1964; Richards 1973; Silverman 1979), and in February and March in the southern range (data from Florida; Murphy and Taylor 1989). Most spawning has been reported or estimated to take place nearshore in the coastal ocean, though some eggs have been sampled in the lower reaches of larger estuaries, such as the Chesapeake Bay (Daniel and Graves 1994). Spawning takes place when temperatures are between 17.5 and 19°C (Joseph et al. 1964; Richards 1973). Black drum eggs are pelagic, and at 20 °C hatch in less than 24 h (Joseph et al. 1964). Some migration from tidal

stream transport may take place; however, due to the short duration of the egg stage, it is unlikely that much distance is covered.

Salinity

Even though spawning occurs nearshore, black drum eggs in the coastal ocean are assumed to be exposed to full marine salinity (35 ppt) or at least polyhaline conditions for the brief duration before hatching (~24 hours).

Substrate

Since black drum eggs are pelagic and positively buoyant, substrate is not considered a critical habitat parameter.

Temperature

Spawning has been reported to take place when temperatures are between 17.5 °C and 19 °C (Joseph et al. 1964; Richards 1973), and thus optimal (or tolerated) egg temperatures are likely very similar.

Dissolved Oxygen

Because the egg stage of black drum occurs entirely offshore, eggs are likely only ever exposed to normoxic waters (>5 mg L^{-1}). It is not currently thought that DO is a limiting factor to survival of black drum eggs.

Feeding Behavior

Black drum eggs subsist entirely off of the yolk sac prior to hatch.

Competition and Predation

Black drum eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the oceanic or estuarine conditions). Predation of eggs undoubtedly occurs by a variety of oceanic and estuarine consumers. Specifically, Cowan et al. (1992) reported predation of black drum eggs by ctenophores and hydromedusae in the Chesapeake Bay with potentially very high levels of predation during years where both gelatinous predators have high abundances.

Part C. Larval Habitat

Geographic and Temporal Patterns of Migration

Black drum larvae hatch around 2.5 mm SL (Able and Fahay 2010) and ingress from nearshore and lower estuarine egg habitats using tidal stream transport to variable locations within estuaries. Overall the general pattern documented for larvae is to move from higher salinity areas to lower salinity estuarine habitats (from otolith microchemical analyses; Rooker et al. 2004), and Gold and Richardson (1998) used molecular methods to characterize black drum as estuarine-dependent in the early years. However, black drum may be less dependent on upper, oligohaline and mesohaline estuarine habitats as larvae have been collected in higher salinities of 21 ppt (Peters and McMichael 1990). As with other sciaenids, it is likely that larval black drum settle in a range of estuarine habitats with confounding of estuarine-specific habitat availabilities.

Salinity

Peters and McMichael (1990) collected larvae off the Gulf Coast of Florida in salinities ranging from 21 to 31 ppt. The larval stage of black drum likely uses the lowest salinity habitats of any life stage, although there are few records of larvae collected in low salinity, upper estuarine habitats.

Substrate
Peters and McMichael (1990) collected larvae off the Gulf Coast of Florida over a variety of substrates, including sand, mud, and shells. Larval collections in the Atlantic, particularly with respect to substrate, are poorly known.

Temperature
Peters and McMichael (1990) collected larvae off the Gulf Coast of Florida in water temperatures ranging from 21.9 °C to 24.6 °C.

Dissolved Oxygen
DO demands are likely met offshore, as well as inshore after ingress. Both of these habitats typically do not experience hypoxic conditions in the winter and spring, although no published studies have reported on any limitations.

Feeding Behavior
Like most larval fish, black drum feed on their yolk sac initially (up to 4 days, or to an estimated 2.8 mm SL; Joseph et al. 1964). Post-yolk sac larvae then begin to feed generally on zooplankton (Benson 1982), and more specifically copepods (Peters and McMichael 1990).

Competition and Predation
Black drum larvae may experience density dependence, although this phenomenon has not been documented and the variety of settlement habitats may release them from specific habitat or spatial constraints. Additionally, the species' relatively long spawning season may mitigate against a temporal bottleneck for habitat. Larval black drum are likely subject to predation by a range of estuarine predators; particular attention to hydromedusa and ctenophore predators has been hypothesized to impact recruitment in years of low black drum production and high densities of hydrozoans (Cowan et al. 1992).

Part D. Juvenile Habitat

Geographic and Temporal Patterns of Migration
Broadly, juvenile black drum likely use a range of estuarine habitats. Small juveniles have been documented in upper and middle parts of estuaries, where salinities are low (<6 ppt; Able and Fahay 2010). However, by the summer months, juveniles begin moving down in the estuary into tidal and marsh habitats and are not found in rivers. By the fall, some juveniles are even found in ocean habitats. Beach seine sampling in Florida nearshore lagoons found high levels of juveniles, indicating juvenile black drum remain inshore (Peters and McMichael 1990).

Salinity
Salinity exposure is likely variable both across a cohort as well as the individual level. Some juveniles have been sampled in lower estuary, high salinity (>30 ppt) locations (Peters and McMichael 1990), while others have reported juvenile black drum in freshwater (Frisbie 1961; Thomas and Smith 1973). Some reports have discussed a size effect to down-estuary movement, in which migrations to lower

estuarine or oceanic habitats is influenced by size. In general, smaller individuals inhabit low salinity tributaries whereas larger individuals inhabit higher salinity regions found at the mouths of bays and rivers (Frisbie 1961).

Substrate

Peters and McMichael (1990) reported juvenile black drum over unvegetated mud bottoms, and Pearson (1929) reported muddy, estuarine bottoms as the most common juvenile substrate. However, as with salinity, juveniles likely use a range of habitats and substrates.

Temperature

Juveniles likely experience a range of temperatures throughout their first year in an estuary. Juveniles in the Gulf of Mexico primarily sampled over summer and fall months were captured at 20.8 °C - 26.3 °C (Peters and McMichael 1990). Winter temperature drops are common causes of estuarine fish kills, and black drum are vulnerable to this condition (Simmons and Breuer 1962). McEachron et al. (1994) noted black drum in several winter kills in Texas coastal waters, though the length data suggests many of these fish were adults and not juveniles.

Dissolved Oxygen

Currently, there is no known information on juvenile black drum sensitivity to DO levels.

Feeding Behavior

Small juveniles primarily feed on amphipods, mollusks, polychaetes, and small fishes (Peters and McMichael 1990). As juveniles grow, Peters and McMichael (1990) found their consumption of shrimp, crabs, fish, and mollusks became more dominant, with the shift correlating to the development of pharyngeal jaw toothplates and molariform teeth.

Competition and Predation

Based on the within-estuary movement during the first year of life and wide use of estuarine resources, little is reported on competition among black drum or with other estuarine species, although they likely compete with other sciaenids (Sutter et al. 1986). Pharyngeal teeth permit black drum to eat a wide variety of mollusks and other prey items, which may limit competition on a single food source (Sutter et al. 1986). Predation of juvenile black drum likely takes place by estuarine predators, such as spotted seatrout, jacks, sharks (Murphy and Muller 1995).

Part E. Adult Habitat

Geographic and Temporal Patterns of Migration

While adult black drum likely move between estuarine and nearshore habitats, multiple investigators have noted two trends. The first trend is the expected movement toward deeper waters with age (i.e., out of tidal creeks and into lower estuaries). The second geographic pattern involves general adult movements north and inshore during spring, and south and offshore during fall (Richards 1973; Murphy and Taylor 1989). Jones and Wells (2001) note the possibility of age separation, with greater proportions of older fish north of Cape Hatteras, North Carolina. However, it is unclear what proportion of the Atlantic population undergoes migration or whether they are influenced by factors other than spawning. Even the literature has been inconsistent in regard to how to characterize adult habitat use. For example, Sutter (1986; citing Hoese and Moore 1977) stated that adult black drum are predominantly estuarine but other studies have cited an ocean residency period. Given the long lifespan of black drum

(>50 years) and factors driving adult habitat use (e.g., spawning migration, general seasonality), it is likely that they use a variety of inshore and nearshore habitats.

Salinity
Lower estuarine and coastal oceanic environments used by black drum are likely polyhaline or full seawater. Black drum are commonly found in waters with a salinity range of 9-26 ppt (McIlwain 1978) but individauls can tolerate salinities as low as 0 ppt and as high as 80 ppt (Gunter 1956; Simmons and Breuer 1962; Leard et al 1993).

Substrate
Adults likely use a wide variety of habitats and substrates, and Sutter (1986) suggests that adults are most common over sand and soft bottoms where oysters and clams can be found. Black drum in Louisiana were observed to avoid large, open areas of soft sediment (George 2003).

Temperature
McIlwain (1978; in Sutter 1986) reported black drum adults in a range of temperatures consisting of 12 °C - 33 °C. The range reported here may be interpreted as a suitable range, and more extreme temperatures may be tolerated.

Dissolved Oxygen
No studies have reported on dissolved oxygen requirements for black drum, though there is little reason to suspect that adults experience sustained periods of limited dissolved oxygen. Both their mobility and range of habitats suggest that they are not constrained to or by specific, low oxygen environments.

Feeding Behavior
Adult black drum continue their predation on benthic crustaceans and mollusks, although Ackerman (1951) reported surface feeding on menhaden. Blasina et al. (2010) reported on black drum in Argentina and also found crustaceans and mollusks to dominate the diet. With efforts underway to rehabilitate Atlantic oysters, some have looked into the ability of black drum to depress recovering oyster populations (Benson 1982; Brown et al. 2008).

Competition and Predation
Competition among black drum is likely minimal as there are no suspected habitat or forage limitations regularly imposed on adults. Adult black drum, based on their large size, are unlikely to be consumed, but have been documented to be preyed upon by sharks (Murphy and Muller 1995).

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat
Prior to transfer of management authority for red drum from the South Atlantic Fishery Management Council (SAFMC) to ASMFC, the SAFMC reviewed the Essential Fish Habitat (EFH) and HAPC designations for Red Drum. The SAFMC concluded the EFH and HAPCs would still be protected, as similar areas had been designated for other federally managed species. As a result, these areas, which also serve an important role in the black drum life cycle, have retained protection and are referenced here and in the Amendment 2 to the Red Drum FMP (ASMFC 2002).

The designated EFH includes tidal freshwater, estuarine emergent vegetated wetlands (flooded salt marsh, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (seagrass), oyster reefs and shell banks, unconsolidated bottom (soft sediment), ocean high salinity surf zones, and artificial reefs (SAFMC 1998). The area covered ranges from Virginia through the Florida Keys, to a depth of 50 m offshore.

Identification of Habitat Areas of Particular Concern

For black drum, HAPCs includes the following habitats: tidal freshwater, estuarine emergent vegetated wetlands (flooded salt marshes, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (seagrasses), oyster reefs and shell banks, unconsolidated bottom (soft sediments), ocean high salinity surf zones, and artificial reefs. These areas overlap with the designated HAPCs for red drum, designated in Amendment 2 to the Red Drum FMP (ASMFC 2002). These HAPCs include all coastal inlets, all state-designated nursery habitats (i.e. Primary Nursery Areas in North Carolina), sites where spawning aggregations of red drum have been documented and spawning sites yet to be identified, areas supporting submerged aquatic vegetation, as well as barrier islands off the South Atlantic states as they maintain the estuarine environment in which young black drum develop.

A species' primary nursery areas are indisputably essential to its continuing existence. Primary nursery areas for black drum can be found in estuaries, such as coastal marshes, shallow tidal creeks, bays, tidal flats of varying substrate, tidal impoundments, and seagrass beds. Since young black drum move among these environments, it is difficult to designate specific areas as deserving more protection than others. Moreover, these areas are not only primary nursery areas for black drum, but they fulfill the same role for numerous other resident and estuarine-dependent species of fish (i.e., other sciaenids) and invertebrates.

Similarly, juvenile black drum habitat extends over a broad geographic range and adheres to the criteria that define HAPCs. Juvenile black drum are found throughout tidal creeks and channels of southeastern estuaries, in backwater areas behind barrier islands and along beach fronts during certain times of the year. It is during this period that juveniles begin moving between low and higher salinity areas (Rooker et al. 2004). Therefore, the estuarine system as a whole, from the lower salinity reaches of rivers to the mouth of inlets, is vital to the continuing existence of this species.

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Black Drum

Threats to black drum habitats include the following: loss of estuarine and marine wetlands, loss of oyster reefs, coastal development, nutrient enrichment of estuarine waters, poor water quality, hydrologic modifications, and alteration of freshwater flows into estuarine waters.

Present Condition of Habitat Areas of Particular Concern

Coastal Spawning Habitat: Condition and Threats Coastal Spawning

It is reasonable to assume that areas where coastal development is taking place rapidly, habitat quality may be compromised. Coastal development is a continuous process in all states and all coastal areas in the nation are experiencing significant growth. The following section describes particular threats to the nearshore habitats in the South Atlantic that meet the characteristics of suitable spawning habitat for black drum.

One threat to the spawning habitat for black drum is navigation and related activities such as dredging and hazards associated with ports and marinas (ASMFC 2013). According to the SAFMC (1998), impacts from navigation related activities on habitat include: direct removal/burial of organisms from dredging and disposal of dredged material, effects due to turbidity and siltation; release of contaminants and uptake of nutrients, metals and organics; release of oxygen-consuming substances, noise disturbance, and alteration of the hydrodynamic regime and physical characteristics of the habitat. All of these impacts have the potential to substantially decrease the quality and extent of black drum spawning habitat as well as prey resources.

Besides creating the need for dredging operations that directly and indirectly affect spawning habitat for black drum, ports also present the potential for spills of hazardous materials. The cargo that arrives and departs from ports includes highly toxic chemicals and petroleum products. Although spills are rare, constant concern exists since huge expanses of productive estuarine and nearshore habitat are at stake. Additional concerns related to navigation and port utilization are discharge of marine debris, garbage, and organic waste into coastal waters.

Maintenance and stabilization of coastal inlets is of concern in certain areas of the southeast. Studies have implicated jetty construction to alterations in hydrodynamic regimes thus affecting the transport of larvae of estuarine-dependent organisms through inlets (Miller et al. 1984; Miller 1988).

Estuarine Nursery, Juvenile and Sub-adult Habitat: Condition and threats

Coastal wetlands and their adjacent estuarine waters constitute primary nursery, juvenile, and sub-adult habitat for black drum along the coast. Between 1986 and 1997, estuarine and marine wetlands nationwide experienced an estimated net loss of 10,400 acres. However, the rate of loss was reduced over 82% since the previous decade (Dahl 2000). Most of the wetland loss resulted from urban and rural activities and the conversion of wetlands for other uses. Along the southeast Atlantic coast, the state of Florida experienced the greatest loss of coastal wetlands due to urban or rural development (Dahl 2000). However, the loss of estuarine wetlands in the southeast has been relatively low over the past decade although there is some evidence that invasion by exotic species, such as Brazilian pepper (*Schinus terebinthifolius*), in some areas could pose potential threats to fish and wildlife populations in the future (T. Dahl, personal communication).

Throughout the coast, the condition of estuarine habitat varies according to location and the level of urbanization. In general, it can be expected that estuarine habitat adjacent to highly developed areas will exhibit poorer environmental quality than more distant areas. Mollusks, which are a dominant component of the black drum diet, bioaccumulate toxins in their tissues (Shumway et al. 1990) although the impact of this bioaccumulation on black drum is not known. Hence, environmental quality concerns are best summarized on a watershed level.

Threats to estuarine habitats of the southeast were described in Amendment 2 to the Red Drum FMP (ASMFC 2002). Due to the black drum's dependence on estuarine habitats throughout its early years, these same threats are likely to impact black as well as red drum.

Nutrient enrichment of estuarine waters throughout the southeast is a major threat to the quality of estuarine habitat. Forestry practices contribute significantly to nutrient enrichment in the southeast. Areas involved are extensive and many are in proximity to estuaries. Urban and suburban developments are perhaps the most immediate threat to black drum habitat in the southeast. The almost continuous expansion of ports and marinas in the South Atlantic poses a threat to aquatic and upland habitats. Certain navigation-related activities are not as conspicuous as port terminal construction but have the potential to significantly impact the estuarine habitat that black drum require. Activities related to watercraft operation and support pose numerous threats including discharge of pollutants from boats and runoff from impervious surfaces, contaminants generated in the course of boat maintenance, intensification of existing poor water quality conditions, and the alteration or destruction of wetlands, shellfish and other bottom communities for the construction of marinas and other related infrastructure.

Estuarine habitats of the southeast can be negatively impacted by hydrologic modifications. The latter include activities related to aquaculture, mosquito control, wildlife management, flood control, agriculture, and silviculture. Also, ditching, diking, draining and impounding activities associated with industrial, urban, and suburban development qualify as hydrologic modifications that may impact the estuarine habitat. Alteration of freshwater flows into estuarine areas may change temperature, salinity and nutrient regimes as well as alter wetland coverage. Studies have demonstrated that changes in salinity and temperature can have profound effects in estuarine fishes (Serafy et al. 1997) and that salinity partly dictates the distribution and abundance of estuarine organisms (Holland et al. 1996). Hence, black drum are probably as susceptible as any other estuarine organism to such changes in the physical regime of their environment.

Oyster reefs in Louisiana are a preferred habitat (George 2003) and oysters are a common prey (Blasina et al. 2010). However, in the Chesapeake Bay, oysters have been reduced to 1% of historical levels (Kemp et al. 2005), which represents a significant decline in both a preferred habitat and prey of black drum.

Adult Habitat: Condition and Threats

Threats to the black drum's adult habitat are not as numerous as those faced by postlarvae, juveniles, and subadults in the estuarine and coastal waters. Current threats to the nearshore and offshore habitats that adult black drum utilize in the South Atlantic include navigation and related activities, dumping of dredged material, mining for sand and minerals, oil and gas exploration, offshore wind facilities, and commercial and industrial activities (SAFMC 1998).

An immediate threat is the sand mining for beach nourishment projects. Associated threats include burial of bottoms near the mine site or near disposal sites, release of contaminants directly or indirectly associated with mining (i.e. mining equipment and materials), increases in turbidity to harmful levels, and hydrologic alterations that could result in diminished desirable habitat.

Offshore mining for minerals may pose a threat to black drum habitat in the future. Currently, there are no mineral mining activities taking place in the South Atlantic. However, various proposals to open up additional areas off the Atlantic coast to seabed mining have been introduced by the Federal Executive and Legislative branches.

Offshore wind farms may also pose a threat to black drum habitat at different life stages in the future (ASMFC 2011). Currently, there are no offshore wind farms established in the United States. However, the Atlantic coast is a potential candidate for future wind farm sites.

Unknowns and Uncertainties

Habitat preferences, physiological tolerances to temperature, salinity, and dissolved oxygen, and life history information is lacking for black drum. Without these data, it is extremely difficult to predict how black drum populations will respond to climate variability, ocean acidification, environmental toxins, and hypoxic conditions. For example, during an hypoxic event black drum are mobile and are able to avoid hypoxic waters whereas their prey (sessile mollusks) are unable to avoid these conditions, potentially increasing mortality of black drum prey. Therefore, there are many ecological linkages in estuarine and coastal ecosystems that need to be examined to understand direct and indirect impacts of habitat degradation on the various life stages of black drum.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Particular attention should be directed toward black drum habitat utilization and habitat condition (environmental parameters). A list of existing state and federal programs generating environmental data such as sediment characterization, contaminant analysis, and habitat coverage (marsh grass, oyster beds, submerged aquatic vegetation) should also be produced and updated as new information arises. Habitats utilized by black drum range from the tidal freshwater out to and likely beyond, the shelf break. Thus, virtually any study generating environmental data from estuarine or coastal ocean systems could be of value.

1. Where sufficient knowledge is available, states should designate black drum HPACs for special protection. These locations should be accompanied by requirements that limit degradation of habitat, including minimization of non-point source and specifically storm water runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area.

2. Where habitat areas have already been identified and protected, states should ensure continued protection of these areas by notifying and working with other federal, state, and local agencies. States should advise these agencies of the types of threats to black drum and recommend measures that should be employed to avoid, minimize, or eliminate any threat to current habitat quality or quantity.

3. States should minimize loss of wetlands to shoreline stabilization by using the best available information, incorporating erosion rates, and promoting incentives for use of alternatives to vertical shoreline stabilization measures (e.g., sea walls), commonly referred to as living shorelines projects.

4. All State and Federal agencies responsible for reviewing impact statements and permit applications for projects or facilities proposed for black drum spawning and nursery areas should ensure that those projects will have no or only minimal impact on local stocks. Any project that would eliminate essential habitat should be avoided, if possible, or at a minimum, adequately mitigated.

5. Each State should establish windows of compatibility for activities known or suspected to adversely affect black drum life stages and their habitats, with particular emphasis to avoid spawning season. Activities may include, but are not limited to, navigational dredging, bridge construction, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

6. Each state should develop water use and flow regime guidelines, where applicable, to ensure that appropriate water levels and salinity levels are maintained for the long-term protection and sustainability of the stocks. Projects involving water withdrawal or interrupt water flow should be evaluated to ensure that any impacts are minimized, and that any modifications to water flow or salinity regimes maintain levels within black drum's tolerance limits.

7. The use of any fishing gear that is determined by management agencies to have a negative impact on black drum habitat should be prohibited within habitat areas of particular concern. Further, states should protect vulnerable habitat from other types of non-fishing disturbance as well.

8. States should work with the USFWS's Divisions of Fish and Wildlife Management Assistance and Ecological Services, and National Marine Fisheries Service's Offices of Fisheries Conservation and Management and Habitat Conservation, to identify hydropower and water control structures that pose significant threats to maintenance of appropriate freshwater flows (volume and timing) to black drum nursery and spawning areas and target these dams for appropriate recommendations during FERC re-licensing.

9. States should conduct research to evaluate the role of submerged aquatic vegetation and other submersed structures in the spawning success, survival, growth, and abundance of black drum. This research could include regular mapping of the bottom habitat in identified areas of concern, as well as systematic mapping of this habitat where it occurs in estuarine and marine waters of the states.

10. States should continue support for habitat restoration projects, including oyster shell recycling and oyster hatchery programs as well as seagrass restoration, to provide areas of enhanced or restored bottom habitat, which serve as nurseries or foraging grounds.

11. Water quality criteria for black drum spawning and nursery areas should be established, or existing criteria should be upgraded, to ensure successful reproduction of these species. Any action taken should be consistent with Federal Clean Water Act guidelines and specifications.

12. State fishery regulatory agencies, in collaboration with state water quality agencies, should monitor water quality in known habitat for black drum, including turbidity, nutrient levels, and dissolved oxygen.

13. States should work to reduce point-source pollution from wastewater through improved inspections of wastewater treatment facilities and improved maintenance of collection infrastructure.

14. States should develop protocols and schedules for providing input on water quality regulations, and on Federal permits and licenses required by the Clean Water Act, Federal Power Act, and other appropriate vehicles, to ensure that black drum habitats are protected and water quality needs are met.

Habitat Research Recommendations

The Interstate Fishery Management Plan for Black Drum (2013) states three research needs for black drum habitat.

- Expand existing fishery independent surveys in time and space to better cover black drum habitats, if possible (especially adults).
- Conduct otolith microchemistry studies to identify regional recruitment contributions.
- Conduct new and expand existing acoustic tagging programs to help identify spawning and juvenile habitat use and regional recruitment sources.

Additional research objectives also need to focus on resolving the preferred and physiological tolerances of black drum, at all life stages, for temperature, salinity, and dissolved oxygen. Studies also need to examine the impact of black drum consuming mollusks in polluted, industrialized regions since mollusks bioaccumulate toxins.

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CHAPTER 4: Red drum

Populated with text from the Red Drum Habitat Addendum (2013)

Section I. General Description of Habitat

Part A. Spawning Habitat

Red drum (*Sciaenops ocellatus*) spawn from late summer to late fall in a range of habitats, including estuaries, near inlets, passes, and near bay mouths (Peters and McMichael 1987). Earlier studies have illustrated that spawning often occurred in nearshore areas relative to inlets and passes (Pearson 1929; Miles 1950; Simmons and Breuer 1962; Yokel 1966; Jannke 1971; Setzler 1977; Music and Pafford 1984; Holt et al. 1985). More recent evidence, however, suggests that in addition to nearshore vicinity habitats, red drum also utilize high-salinity estuarine areas along the coast (Murphy and Taylor 1990; Johnson and Funicelli 1991; Nicholson and Jordan 1994; Woodward 1994; Luczkovich et al. 1999; Beckwith et al. 2006). Direct evidence of red drum spawning has been documented deep within estuarine waters of the Indian River Lagoon, Florida (IRL) (Murphy and Taylor 1990; Johnson and Funicelli 1991). More recently, an intensive 2 year ichthyoplankton survey consistently collected preflexion (2–3 mm) red drum larvae up to 90 km away from the nearest ocean inlet from June to October with average nightly larval densities as high as 15 per 100 m3 of water in the IRL (Reyier and Shenker 2007). Acoustic telemetry results for large adult red drum in the IRL further support estuarine spawning of this species within the IRL system (Reyier et al. 2011)

Geographic and Temporal Patterns of Migration

Red drum have a range extending from the Long Island south to the western Gulf of Mexico but it rarely occurs north of the Chesapeake Bay. Although spawning can occur in a variety of nearshore habitats, it often occurs near the mouths of large embayments from July to October (Able and Fahay 2010). Peak spawning takes place between August and September. In addition, red drum are thought to return to natal estuaries for spawning (Bacheler et al. 2009a; Patterson et al. 2004).

Salinity

High salinity, coastal estuarine areas provide optimal conditions for egg and larval development, as well as circulation patterns beneficial to transporting larvae to suitable nursery areas (Ross and Stevens 1992).

Substrate

Substrate sediments in spawning habitats are fine to coarse, unconsolidated sands. Current regimes conducive to larval transport ensure that fine sediments are sorted out of the substrate mix. Little is known regarding specific substrate types where spawning occurs within true estuarine habitats, but limited estuarine ichthyoplankton studies on red drum suggests recently hatched larvae are found over a mix of sand, sand-shell hash and sand-mud substrates. However, the release of gametes during spawning occurs in the surface waters, away from the benthos (Barrios 2004).

Temperature

Spawning in laboratory studies have also appeared to be temperature-dependent, occurring in a range from 22 °C to 30 °C but with optimal conditions between temperatures of 22 °C to 25 °C (Holt et al.

1981). Renkas (2010) was able to duplicate environmental conditions of naturally spawning red drum from Charleston Harbor, South Carolina in a mariculture setting, and corroborated that active egg release occurred as water temperature dropped from a peak of approximately 30 °C during August. Cessation of successful egg release was found at 25 °C, with no spawning effort found at lower temperatures (Renkas 2010). Pelagic eggs, embryos, and larvae are transported by currents into nursery habitats for the duration of egg and larval stages (Peters and McMichael 1987; Beck et al. 2001).

Dissolved Oxygen

Little information exists regarding specific dissolved oxygen (DO) concentrations in relation to red drum spawning. Preliminary passive acoustic surveys in North Carolina waters suggest that DO levels of bottom waters may play a significant role for red drum aggregation formation. Spawning fish were significantly lower at sites with DO levels of bottom waters below 2.5 mg/l (Barrios 2004)

Feeding Behavior

No published work has reported on the feeding behaviors of actively spawning individuals. It might be inferred—based on nearshore and estuarine habitats—that spawning red drum feed on the same food sources as adults, which includes primarily larger fishes, crustaceans, and mollusks. Limited sampling of adult red drum in North Carolina revealed blue crab (*Callinectes sapidus*) made up 51% of the diet by number and occurred in 48% of the stomachs (Peacock 2014). The same study found the diet of adult red drum in South Carolina was more diverse than in North Carolina, where red drum consumed mostly Atlantic menhaden (*Brevoortia tyrannus*) and a diverse group of marine decapods and brachyurans.

Competition and Predation

Predation on spawning adults is likely similar to other adult red drum, depending on habitat. Various shark species (e.g. bull shark, *Carcharhinus leucas*; blacktip shark, *C. limbatus*) are potential predators of spawning adults.

Part B. Egg and Larval Habitat

Nelson et al. (1991) reported that red drum eggs are commonly encountered in several southeastern estuaries, in salinities above 25 ppt. Laboratory experiments in Texas (Neill 1987; Holt et al. 1981) established that optimum temperature and salinity for hatching and survival of red drum larvae are 25 °C and 30 ppt, respectively. The spatial distribution and relative abundance of eggs in estuaries mirrors that of spawning adults in the fall (Nelson et. al. 1991). Eggs and early larvae utilize high salinity waters inside inlets and passes and within the estuary. In Florida, Johnson and Funicelli (1991) collected viable red drum eggs in Mosquito Lagoon, Florida, in average daily water temperatures of 20 °C – 25 °C and average salinities of 30 - 32 ppt. The largest number of eggs collected during the study was in depths ranging from 1.5 to 2.1 m and highest concentrations of eggs were found at the edge of the channel.

Geographic and Temporal Patterns of Migration

Upon hatching, red drum larvae are pelagic (Johnson 1978) and growth rates are temperature-dependent (Holt et al. 1981). They make the transition between pelagic and demersal habitats within a few weeks after reaching nursery habitats (Pearson 1929; Peters and McMichael 1987; Comyns et al. 1991; Rooker and Holt 1997; Havel et al. 2015). They ingress into lower salinity nursery habitats in estuaries using tidal (Setzler 1977; Holt et al. 1989) or density-driven currents (Mansueti 1960; Bass and Avault 1975; Setzler 1977; Weinstein 1979; Holt et al. 1983; Holt et al. 1989; Peters and McMichael

1987; McGovern 1986; Daniel 1988). Once in the nurseries, red drum larvae grow rapidly (Baltz et al 1998).

Red drum larvae along the Atlantic coast are common in most major southeastern estuaries, with the exception of Albemarle Sound, and they are abundant in the St. Johns and Indian River estuaries, Florida (Nelson et al. 1991). Data on the spatial distribution of red drum larvae in the Gulf of Mexico has been summarized by Mercer (1984). More recently, Lyczkowski-Shultz and Steen (1991) observed diel vertical stratification among red drum larvae found in depths <25 m at both offshore and nearshore locations.

Salinity

Red drum eggs have been commonly encountered in several southeastern estuaries in high salinity waters (above 25 ppt) (Nelson et al. 1991). The highest numbers of eggs were gathered in average salinities from 30 - 32 ppt at the edge of the channel (Johnson and Funicelli 1991). Salinities above 25 ppt allow red drum eggs to float while lower salinities cause eggs to sink (Holt et al. 1981). However, early stage red drum larvae were commonly found within estuarine waters of the Indian River Lagoon, Florida in salinity as low as 20 ppt (Reyier and Shenker 2007).

Spatial distribution and relative abundance of eggs in estuaries, as expected, mirrors that of spawning adults (Nelson et al. 1991); eggs and early larvae utilize high salinity waters inside inlets, passes, and in the estuary proper.

Substrate

Upon hatching, red drum larvae are pelagic (Johnson 1978; Holt et al. 1981). Newly hatched red drum spend around twenty days in the water column before associating with benthos (Rooker et al. 1999; FWCC 2008). The size at settlement is determined by the substrate of the settlement site (Havel et al. 2015). Daniel (1988), however, found larvae younger than 20 days old already settled in the Charleston Harbor estuary.

Temperature

Larval red drum (1.7 - 5.0 mm mean SL length) were found in temperatures between 26 °C – 28 ° C (Lyczkowski-Shultz and Steen 1991). Research conducted in Mosquito Lagoon, Florida, found viable red drum eggs at average daily water temperatures ranging from 20 °C to 25 °C (Johnson and Funicelli 1991). In Texas, laboratory experiments conducted by Neill (1987) and Holt et al. (1981) concluded that an optimum temperature for the hatching and survival of red drum eggs and larvae was 25 °C.

Dissolved Oxygen

Mean DO concentration where larval red drum were captured in the Indian River Lagoon, Florida was 6.3 mg/l (Reyier 2005).

Feeding Behavior

Larval red drum are opportunistic feeders (Bass and Avault 1975). In Louisiana waters, larvae < 15 mm fed heavily on zooplankton (e.g. copepods and copepod nauplii) whereas in Florida larvae (8 – 15 mm) in Tampa Bay feed primarily on copepods, mysids, and polychaetes (Peters and McMichael 1987).

Competition and Predation

Little information is available on competition or predation on larval red drum. Predators of larval fishes include a variety of organisms (planktonic crustaceans, chaetognaths, larger planktivorous fishes, and gelatinous organisms) (Duffy et al. 1997). Red drum spawn in the Gulf of Mexico from late summer to early fall, which coincides with elevated numbers of several species of jellyfish that represent dominate predators of eggs and larvae (Kraeuter and Setzler 1975). For example, during peak red drum spawning season in the Indian River Lagoon, no red drum eggs were collected when high ctenophore numbers were present (Johnson and Funicelli 1991).

Part C. Juvenile Habitat

Juvenile red drum utilize a variety of inshore habitats including tidal freshwater habitats, low-salinity reaches of estuaries, estuarine emergent vegetated wetlands, estuarine scrub/shrub, submerged aquatic vegetation, oyster reefs, shell banks, and unconsolidated bottom (SAFMC 1998).

Geographic and Temporal Patterns of Migration

The distribution of juvenile red drum within estuaries varies seasonally as individuals grow and begin to disperse. Along the South Atlantic coast, they utilize a variety of inshore habitats. Late juveniles leave shallow nursery habitats at approximately 200 mm TL (10 months of age). They are considered subadults until they reach sexual maturity at 3 - 5 years (C. Wenner, personal communication). It is at this life stage that red drum use a variety of habitats within the estuary and when they are most vulnerable to exploitation (Pafford et al. 1990; Wenner 1992). Tagging studies conducted throughout the species' range indicate that most subadult red drum tend to remain in the vicinity of a given area (Beaumarriage 1969; Osburn et al. 1982; Music and Pafford 1984; Wenner, et al. 1990; Pafford et al. 1990; Ross and Stevens 1992; Woodward 1994; Marks and DiDomenico 1996; Adams and Tremain 2000). Movement within the estuary is most likely related to changes in temperature and food availability (Pafford et al. 1990; Woodward 1994).

Tagging studies indicate that late age-0 and 1 year-old red drum are common throughout the shallow portions of the estuaries and are particularly abundant along the shorelines of rivers and bays, in creeks, and over grass flats and shoals of the sounds. During the fall, those subadult fish inhabiting the rivers move to higher salinity areas such as the grass flats and shoals of the barrier islands and the front beaches. With the onset of winter temperatures, juveniles leave the shallow creeks for deeper water in the main channels of rivers (9 - 15 m) and returned again to the shallows in the spring. Fish that reside near inlets and along the barrier islands during the summer are more likely to enter the surfzone in the fall.

By their second and third year of growth, red drum are less common in rivers but are common along barrier islands, inhabiting the shallow water areas around the outer bars and shoals of the surf and in coastal inlets over inshore grass flats, creeks or bays. In the northern portion of the South Carolina coast, subadults use habitats use broad, gently sloping flats (up to 200 m or more in width). Along the southern part of the South Carolina coast, subadult red drum inhabitat narrow (50 m or less), fairly level flats traversed by numerous small channels, typically 5 - 10 m wide by less than 2 m deep at low tide (ASMFC 2002).

Salinity

Wenner et al. (1990) collected post-larval and juvenile red drum in South Carolina from June 1986 through July 1988 in shallow tidal creeks with salinities of 0.8 - 33.7 ppt, although the preferred salinity range in the Indian River Lagoon is between19 to 29 ppt (Tremain and Adams 1995).

Substrate
In general, habitats supporting juvenile red drum can be characterized as detritus or mud-bottom tidal creeks as well as sand and shell hash bottoms (Daniel 1988; Ross and Stevens 1992). Within seagrass beds, investigations have shown that juveniles to prefer areas with patchy grass coverage or sites with homogeneous vegetation (Mercer 1984; Ross and Stevens 1992; Rooker and Holt 1997). In a Texas estuary, young red drum (6 - 27 mm SL) were never present over non-vegetated muddy-sandy bottom; areas most abundant in red drum occurred in the ecotone between seagrass and non-vegetated sand bottom (Rooker and Holt 1997). In South Carolina, Wenner (1992) indicated that very small red drum occupy small tidal creeks with mud/shell hash and live oyster as common substrates (since sub-aquatic vegetation is absent in South Carolina estuaries).

Temperature
Juvenile red drum are tolerant to a wide range of temperatures (8.5 – 33.5 °C) (Bacheler et al. 2009b; Able and Fahay 2010). In the winter of their first year, 3 - 5 month old juveniles migrate to deeper, more temperature-stable parts of the estuary during colder weather (Pearson 1929). In the following spring, juveniles become more common in the shallow water habitats.

Dissolved Oxygen
In estuarine creek habitats in the Indian River lagoon, FL (IRL), subadults and small adult red drum were collected in waters with mean DO levels ranging from 5 ppm to 10 ppm (year round) (Tremain and Adams 1995). Within main lagoon habitats in the IRL, large subadults were found in DO concentrations ranging from 4 to 12 ppm (Adams and Tremain 2000).

Feeding Behavior
Larger juveniles are opportunistic feeders foraging on mysids, amphipods, palaemonid and penaeid shrimp, crabs, small fishes, and other sciaenids (Bass and Avault 1975). A higher diversity in prey items was found in stomachs of red drum collected over sand bottoms vs mud bottoms (Odum 1971). In Tampa Bay, FL, juvenile red drum to 75 mm fed primarily on mysids, polychaetes, amphipods, and insects in juveniles to 75 mm, with crabs and fish dominant in larger juveniles larger than 105 mm (Peters and McMichael 1987).

Competition and Predation
Small juvenile red drum are prey for numerous estuarine fish species and likely compete with other sciaenids. Larvae and juveniles are also consumed by pinfish (Minello and Stunz 2001).

Part D. Adult Habitat

Along the Atlantic Coast adult red drum migrate north and inshore in the spring and migrate offshore and south in the fall. Overall, adults tend to spend more time in coastal waters after reaching sexual maturity. However, they do continue to frequent inshore waters on a seasonal basis. Less is known about the biology of red drum once they reach the adult stage and accordingly, there is a lack of information on habitat utilization by adult fish. The SAFMC's Habitat Plan (SAFMC 1998) cited high salinity surf zones and artificial reefs as essential fish habitat (EFH) for red drum in oceanic waters, which comprise the area from the beachfront seaward. In addition, nearshore and offshore hard/live bottom areas have been known to attract concentrations of red drum. The following description of these habitats was adapted from that provided in the SAFMC's Habitat Plan (1998b).

Geographic and Temporal Patterns of Migration

Adult red drum make seasonal migrations along the Atlantic coast. In the spring, adults move north and inshore but offshore and south in the fall. Overall, adults tend to spend more time in coastal waters after reaching sexual maturity. However, they do continue to frequent inshore waters on a seasonal basis. In the Indian River Lagoon, FL, limited seasonal migrations (Reyier et al. 2011) including some movement to coastal inlets in fall during the spawning season have been detected (Reyier et al. 2011). In Mosquito Lagoon (northern IRL), a portion of the adult population remain within the estuary where documented spawning occurs (Johnson and Funicelli 1991, Reyier et al. 2011).

Salinity

Adult red drum inhabit high salinity surf zones along the coast and adjacent offshore waters, at full marine salinity. Adults in some areas of their range (e.g. Indian River Lagoon, FL) can reside in estuarine waters year-round, where salinities are variable.

Substrate

In addition to natural hard/live bottom habitats, adult red drum also use artificial reefs and other natural benthic structures. Red drum were found from late November until the following May at both natural and artificial reefs along tide rips or associated with the plume of major rivers in Georgia (Nicholson and Jordan 1994). Data from this study suggests that adult red drum exhibit high seasonal site fidelity to these features. Fish tagged in fall along shoals and beaches were relocated 9 - 22 km offshore during winter and then found back at the original capture site in the spring. In summer, fish moved up the Altamaha River nearly 20 km to what the authors refer to as “pre-spawn staging areas” and then returned to the same shoal or beach again in the fall.

Temperature

Bottom water temperatures in deeper hard/live bottom areas range from approximately 11 °C - 27 °C whereas inshore areas typically exhibit cooler temperatures (SEAMAP's South Atlantic Bottom Mapping Work Group effort 1992).

Dissolved Oxygen

Large subadults and small adults were collected in waters of the Indian River Lagoon, FL where mean DO levels ranged from 5 ppm to 10 ppm (year round) (Tremain and Adams 1995).

Feeding Behavior

Red drum are opportunistic foragers and their prey varies with size and season (Scharf and Schlight 2000). Adults feed on a variety of crustaceans, mollusks, and fishes (Chao 2002). Common prey species of adult red drum of the coast of Texas are white shrimp, gulf menhaden, and swimming crabs (blue crabs and related species) (Scharf and Schlight 2000).

Competition and Predation

Predators of large adult red drum within nearshore and offshore habitats likely include an array of shark species. Blacktip sharks and sandbar sharks have been observed within and surrounding large red drum schools off the Atlantic coast of Florida.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

The SAFMC recognizes several habitats as EFH for red drum. These natural communities include tidal freshwater, estuarine emergent vegetated wetlands (flooded salt marsh, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (seagrass), oyster reefs and shell banks, unconsolidated bottom (soft sediment), high salinity surf zones, and artificial reefs (SAFMC 1998). The area covered ranges from Virginia through the Florida Keys, to a depth of 50 m offshore.

Identification of Habitat Areas of Particular Concern

For red drum, this includes the following habitats: tidal freshwater, estuarine emergent vegetated wetlands (flooded saltmarshes, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (sea grasses), oyster reefs and shell banks, unconsolidated bottom (soft sediments), ocean high salinity surf zones, and artificial reefs. The SAFMC, which has a similar designation for their HAPCs, has recognized HAPCs for red drum along the U.S. coast including all coastal inlets, all state-designated nursery habitats (i.e. Primary Nursery Areas in North Carolina), sites where spawning aggregations of red drum have been documented and spawning sites yet to be identified, and areas supporting submerged aquatic vegetation. The SAFMC (1998b) also cited barrier islands off the South Atlantic states as being of particular importance since they maintain the estuarine environment in which young red drum develop. Inlets between barrier islands are of concern because the productivity of the estuary depends on the slow mixing of fresh and seawater that occurs in these areas. Finally, inlets, channels, sounds and outer bars are of particular importance to red drum since spawning activity is known to occur in these areas throughout the South Atlantic. Moreover, subadult and adult red drum utilize these areas for feeding and daily movements.

A species' primary nursery areas are indisputably essential to its continuing existence. Primary nursery areas for red drum can be found throughout estuaries, usually in shallow waters of varying salinities that offer certain degree of protection. Such areas include coastal marshes, shallow tidal creeks, bays, tidal flats of varying substrate, tidal impoundments, and seagrass beds. Since red drum larvae and juveniles are ubiquitous in such environments, it is impossible to designate specific areas as deserving more protection than others. Moreover, these areas are not only primary nursery areas for red drum, but they fulfill the same role for numerous other resident and estuarine-dependent species of fish and invertebrates, especially other sciaenids.

Similarly, subadult red drum habitat extends over a broad geographic range and adheres to the criteria that define HAPCs. Subadult red drum are found throughout tidal creeks and channels of southeastern estuaries, in backwater areas behind barrier islands and in the front beaches during certain times of the year. Therefore, the estuarine system as a whole, from the lower salinity reaches of rivers to the mouth of inlets, is vital to the continuing existence of this species.

SAFMC HAPC Designations for Red Drum

Of the designated EFH, HPACs have been recognized for red drum by the SAFMC. Areas which meet the criteria for HAPC include all coastal inlets, all state-designated nursery habitats of particular importance to red drum, documented sites of spawning aggregations from North Carolina to Florida, other spawning areas identified in the future, and areas supporting submerged aquatic vegetation (SAFMC 1998). These HAPC include the most important habitats required during the life cycle of the species, including spawning areas and nursery grounds. Other areas of concern are barrier islands.

Present Condition of Habitat Areas of Particular Concern

Red drum populations along the Atlantic coast are managed through the Atlantic Coastal Fisheries Cooperative Management Act (Atlantic Coastal Act). Unlike the Magnuson-Stevens Fishery Conservation and Management Act which addresses fishery management by federal agencies, the Atlantic Coastal Act does not require the ASMFC to identify habitats that warrant special protection because of their value to fishery species. Nonetheless, the Commission believes this is a good practice so that appropriate regulatory, planning, and management agencies can consider this information during their deliberations.

A subset of red drum habitats, which the Commission refers to as Habitats of Concern (HOC), is especially important as spawning and nursery areas for red drum. HOC for red drum include all coastal inlets, submerged aquatic vegetation beds, the surf zone (including outer bars), and state-designated nursery habitats (e.g., Primary Nursery Areas in North Carolina; Outstanding Resource Waters in South Carolina's coastal counties; Aquatic Preserves along the Atlantic coast of Florida).

Coastal Spawning Habitat: Condition and Threat

The productivity and diversity of coastal spawning habitat can be compromised by the effects of industrial, residential, and recreational coastal development (Vernberg et al. 1999). Coastal development continues in all states and coastlines of the nation despite the increased protection afforded by federal and state environmental regulations. Threats to nearshore habitats in the south Atlantic that are documented spawning habitats for red drum or are suitable spawning habitats are described below.

Navigation and boating access development and maintenance activities, such as dredging and hazards from ports and marinas, are a threat to spawning habitats of red drum. According to the SAFMC (1998) and ASMFC (2002), navigation related activities can result in: removal or burial of organisms from dredging or disposal of dredged material, effects due to turbidity and siltation, release of contaminants and uptake in nutrients, metals and organics, release of oxygen-consuming substances, noise disturbance, and alteration of hydrodynamic regime and habitat characteristics. All listed effects have the potential to decrease the quality and quantity of red drum spawning habitat.

Ports also pose the threat of potential spills of hazardous materials. Cargo that arrives and departs from ports can contain highly toxic chemicals and petroleum products. The discharge of oil may have also altered migration patterns and food availability. Port discharge of marine debris, garbage, and organic waste into coastal waters is also a concern. While spills are rare, constant concern exists for extensive spans of estuarine and nearshore habitats proximal to ports are at risk of contamination. Even a small spill could result in a huge exposure of productive habitats. Oil releases such as the MC 282 or Deepwater Horizon oil release (2010) into the Gulf of Mexico has severely affected aquatic life, water quality, and habitat posing many threats such as mortality, disease, genetic damage, and immunity issues (Collier et al. 2010). Chemicals in crude oil can cause heart failure in developing fish embryos (Incardona et al. 2004, 2005, 2009). Chronic exposures for years after the Exxon Valdez oil spill were evident in fishes and other marine life, resulting in a higher pattern of mortality (Ballachey et al. 2003). Oiling of nearshore high-energy habitats along beaches of the Gulf of Mexico from Louisiana to Florida occurred for prolonged periods of time during the spring of 2010, and weathered oil products were found in offshore sediments where spawning red drum can occur.

Beach nourishment projects and development of wind and tidal energy could also alter red drum spawning and offshore adult habitat dynamics. Beach nourishment can result in removal of offshore sediments resulting in depressions and altering sediment characteristics along the shoreline (Wanless 2009). Sediments eroded from beaches after nourishment projects can also be transported offshore and bury hard bottoms, which can diminish spawning aggregation habitat for red drum. Beach nourishment projects can also alter forage species abundance, distribution, and species composition in the high-energy surf zone for a time, but this varies by species and timing of nourishment activities (Irlandi and Arnold 2008). Wind and tidal energy projects can create artificial structure in migration corridors and submarine cables may produce electrical fields that can affect red drum movement patterns and habitat use in affected areas (DONG 2006; OEER 2008; ASMFC-Habitat Committee 2012).

Use of certain types of fishing gear, such as trawls and bivalve dredges, can also adversely affect spawning habitat (Essential Fish Habitat Steering Committee 2002). Trawls and dredges remove structure-forming epifauna, alter sediment contours, redistribute reef aggregate materials (e.g. fractured rock outcroppings and boulders), and change infaunal and demersal organism abundance and community assemblages in fished areas. Fishing also reduces forage species abundance, which are common red drum prey, indirectly affecting spawning success through reduced foraging success. The most significant effect of this type of fishing gear is long-term changes in bottom structure and long-term changes in benthic trophic and ecosystem functions. These effects can be on the order of months to years in low energy environments, so alterations can have a long-term effect on red drum spawning habitat.

Spawning is optimal within a specific range of temperatures. Climate change and resulting temperature regime changes in spawning habitats could alter the timing of spawning and egg development, which may be detrimental in a specific habitat area of concern. Such alterations in phenology are recognized as such a threat to the survival of many species (USFWS 2011). Significant climate change could alter current patterns and significantly change water temperatures, affecting migration, spawning patterns, and larval survival (Hare and Able 2007; USFWS 2011).

Estuarine Spawning, Nursery, Juvenile and Subadult Habitat: Condition and Threats

Between 1986 and 1997, estuarine and marine wetlands nationwide experienced an estimated net loss of 10,400 acres (Dahl 2000). The majority of this loss was from urban and rural activities, which converted wetlands to other uses. Along the south Atlantic coast, Florida experienced the greatest loss due to urban or rural development (Dahl 2000). In Tampa Bay, 3,250 acres of seagrass have been recovered between 2008 and 2010 (EPA 2011b).

Reduced water quality can lead to increased susceptibility to pathogens, which can result in lesions, developmental issues, disease of major organs, and mortality in red drum and other fishes (Conway et al. 1991). Red drum may exhibit a higher tolerance to bacteria with age, and antibody response also increases as water temperature does (Evans et al. 1997). Atrazine, a widely used pesticide in the United States, reduced growth rates in red drum larvae by 7.9% - 9.8% (Alvarez and Fuiman 2005). Potentially toxic contaminants have been detected in red drum, including mercury (Adams and Onorato 2005) and persistant organic pollutants (Johnson-Restrepo et al. 2005).

Nutrient enrichment of estuarine waters is a major threat to water quality and habitat available to red drum. In the southeast, forestry practices significantly contribute to nutrient enrichment, as does pesticide use, fertilizers, and pollution runoff (ASMFC 2002; NSCEP 1993). Urban and suburban development are the most immediate threat to red drum habitat in the southeast. Port and marina expansion also impact the estuarine habitat important to red drum by pollution contributed from stormwater originating from altered uplands and through alterations to hydrodynamic flows and tidal currents. Watercraft operation can result in pollutant discharge, contributing to poor water quality conditions. Facilities supporting watercraft operations also result in the alteration and destruction of wetlands, shellfish and other bottom communities through construction activities. Motorized vehicles in

Class A (<16 ft) and Class 1 (16 - 25 ft) have seen major recreational growth in estuarine waterways (NMMA 2004). Operation of watercraft equipped with outboard and inboard engines and propellers over shallow seagrass communities can cause increased seagrass scarring (Sargent et al. 1995). Mining activities in nearby areas can also pose a threat with nutrient and contaminant runoff, dredging material deposition, and through alterations of the hydrology of the estuary.

Hydrologic modifications can negatively affect estuarine habitats. Aquaculture, mosquito control, wildlife management, flood control, agriculture, and silviculture activities can result in altered hydrology. Ditching, diking, draining, and impounding activities also qualify as hydrologic modifications that can impact estuarine environments (ASMFC 2011). Alteration of freshwater flows into estuarine areas may change temperature, salinity, and nutrient regimes as well as wetland coverage. Studies have shown that alteration in salinity and temperature can have profound effects in estuarine fishes (Serafy et al. 1997) and that salinity can dictate the abundance and distribution of organisms residing in estuaries (Holland et al. 1996). Construction of groins and jetties has altered hydrodynamic regimes and the transport of larvae of estuarine dependent organisms through inlets (Miller et al. 1984; Miller 1988).

Shoreline erosion patterns can also affect the hydrodynamics and transport of larvae to estuarine environments. Erosion has the potential to alter the freshwater flow into habitats essential for egg, larval, and juvenile survival. Whether erosion is human-induced or naturally occurring, nearshore habitats are consequently affected and eroded sediment is transported and deposited elsewhere (ASFMC 2010). Beach nourishment activities can result in sedimentation in estuaries, covering seagrass beds and other nearshore habitats, and causing water quality to deteriorate (Green 2002; DEP 2011). Along the Atlantic coast, living shorelines are becoming popular to control and minimize erosion (ASFMC 2010).

Trawl fisheries are a threat to estuarine habitat for red drum. In combination with the physical and biological effects identified in the Essential Fish Habitat Steering Committee workshop proceedings (2002), trawling activities and bivalve harvesting activities(oyster tonging, clam raking, clam kicking, etc.) can severely damage seagrass systems (Stephan et al. 2000). Such activities can reduce the productivity of estuarine red drum habitat, reduce forage species abundance, and alter movement patterns for red drum schools. Effects of these fishing gears can be mitigated through effective management strategies, such as exclusion of trawl fisheries from seagrass communities.

Climate change could result in faster erosion of certain nearshore areas and loss of shallow nursery habitats to inundation. Projections of global sea level rise are from 18 - 59 cm by the year 2100, with an additional contribution from ice sheets of up to 20 cm (IPCC 2007). In addition to sea level rise, climate change could alter the amount of freshwater delivery and salinity levels in estuarine areas (USFWS 2011). As temperature increases, the surface water in estuaries and marshes also increases, which reduces oxygen solubility (EPA 2011a) and can stress the environment. Estuarine waters are vulnerable to acidification, but seagrasses are particularly susceptible to changes in water column acidity (EPA 2011a), which is an important nursery habitat for larval and juvenile red drum.

Adult Habitat: Condition and Threats

While threats to adult red drum habitat exist, they are not as numerous as those faced by post-larvae, juveniles, and subadults in estuarine and coastal waters. According to the SAFMC (1998) and ASMFC (2002), threats to both nearshore and offshore habitats that adult red drum utilize in the south Atlantic include navigation management and related activities; dredging and dumping of dredged material; mining for sand or minerals; oil and gas drilling and transport; and commercial and industrial activities, and are similar to those for red drum coastal spawning habitat.

Currently, mineral mining activities in the south Atlantic are highly limited. Offshore mining has the potential to pose a threat to adult red drum habitat in the future. Mining activities could alter the hydrology, sediment landscape, and water quality of surrounding areas, affecting both fish and their habitat, by causing sediment plumes or releasing metallic substances into the water column (Halfar 2002).

A more immediate threat to red drum adult habitat is the mining of sand for beach nourishment projects. Associated risks include burial of hard bottoms near mining or disposal sites, contamination, and an increase in turbidity and hydrological alterations that could result in a diminished habitat (Green 2002; Peterson and Bishop 2005). Although adult red drum are euryhaline and eurythermal, drastic or sudden changes in salinity and/or temperature can result in mortality (Gunter 1941; Buckley 1984).

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Red Drum

Red Drum utilize all available estuarine and nearshore habitats throughout their life history. Although regional habitat types, such as mesohaline submerged aquatic vegetation communities, might be limited locally, red drum can use multiple habitat types at each stage of their development. There is no supporting evidence that habitat is currently limiting to populations of red drum throughout their range.

Oyster reefs are an important habitat to red drum at the juvenile and subadult life stages. In South Carolina, the abundance of red drum is not limited by the availability or health of oyster reef habitat, despite significant reductions of oyster reef habitat throughout the range of the red drum population. Creeks, tributaries, and estuaries are important habitats for red drum. Larval, juvenile, and subadult red drum are particularly sensitive to pollution contributed to watersheds by human activities. There is currently no evidence that chemical pollution is a limiting factor for juvenile and subadult red drum. However, changes in hydrology due to watershed activities that alter stormwater flow and sedimentation might restrict red drum larval recruitment both locally and regionally. Additionally, sediment accumulation may alter submerged aquatic vegetation abundance and circulation patterns resulting in lower recruitment into small creeks.

Unknowns and Uncertainties

Not much is known regarding the preferred ranges and physiological tolerances of red drum and how it changes during development. In the context of climate change, more information is needed to predict how different life stages of red drum will be impacted by increased temperatures, altered freshwater flow regimes, increased acidity, and decreased dissolved oxygen. In addition to direct physiological impacts of climate change on red drum, indirect effects on red drum also need to be examined (e.g., habitat degradation, reduced prey abundance, and increased disease susceptibility).

Larval and juvenile red drum are also known to use many different habitats as nurseries, although the relative contribution of a particular nursery to the adult population has not currently been assessed.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Amendment 2 to ASMFC's Interstate Fishery Management Plan for Red Drum (2002) states 15 habitat management recommendations for red drum.

1. Each state should implement identification and protection of red drum habitat within its jurisdiction, in order to ensure the sustainability of that portion of the spawning stock that either is produced or resides within its boundaries. Such efforts should inventory historical habitats through mark-recapture studies or other means as available, identify those habitats presently used for spawning or nursery areas (Section 3.8), specify those that are targeted for recovery, and impose or encourage measures to retain or increase the quantity and quality of red drum essential habitats.

2. Each state should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by red drum. Regulatory agencies should be advised of the types of threats to red drum populations and recommended measures which should be employed to avoid, minimize or 95 eliminated any threat to current habitat extent or quality.

3. Each state should establish Habitat Areas of Particular Concern (HAPCs) or similar designations appropriate for each state which hosts significant amounts of red drum spawning and nursery habitat. Each protected area should include sufficient amounts of necessary habitats for red drum, i.e., oyster reef, intertidal marsh or submerged rooted vascular vegetation, tidal creeks, intertidal flats, and adjacent deepwater estuarine to provide for individuals from age 0 to age 5 to reside therein. States may determine that such areas may warrant Marine Protected Area status and be closed to harvest either seasonally or permanently. It may be advantageous to locate such areas within existing special management areas such as National Wildlife Refuges, National Parks, including National Seashores, or state-designated areas such as Primary Nursery Areas (North Carolina).

4. Each state should establish freshwater inflow targets for estuaries documented as important red drum spawning, nursery or wintering habitat. Such targets should be derived where possible from flow data which predate significant hydrological alterations, and should mimic as closely as possible a natural hydrograph (defined as the pattern which predates significant anthropogenic alterations).

5. Where sufficient knowledge is available, states should seek to designate red drum essential habitats for special protection. These locations should be designated High Quality Waters or Outstanding Resource Waters and should be accompanied by requirements for non-degradation of habitat quality, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the are (via restrictions on National Pollutant Discharge Elimination system (NPDES) discharge permits for facilities in those areas).

6. State fishery regulatory agencies should develop protocols and schedules for providing input on water quality regulations to the responsible agency, to ensure to the extent possible that water quality needs for red drum are restored, met and maintained. Water quality criteria for red drum spawning and nursery areas should be established or existing criteria should be upgraded to levels which are sufficient to ensure successful reproduction. Any action taken should be consistent with federal Clean Water Act guidelines and specifications.

7. State marine fisheries agencies should work with permitting or planning agencies in each state to develop permit conditions and planning considerations to avoid or mitigate adverse impacts on HAPCs or other habitats necessary to sustain red drum. Standard permit conditions and model policies that contain mitigation protocols should be developed. The development of Memoranda of understanding (MOU) with other state agencies is recommended for joint review of projects and planning activities to ensure that habitat protections are adequately implemented.

8. Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known or suspected to accumulate in red drum tissue and which pose a threat to human health or red drum health.

9. Each state should establish windows of compatibility for activities known or suspected to adversely affect red drum life states and their habitats, such as navigational dredging, bridge construction and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

10. Projects involving water withdrawal from spawning or nursery habitats (e.g. power plants, irrigation, 96 water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal will not adversely impact red drum spawning stocks, including early life stages.

11. States should endeavor to ensure the proposed water diversions/withdrawals from rivers tributary to spawning and nursery habitats will not reduce or eliminate conditions favorable to red drum use of these habitats.

12. The use of any fishing gear or practice which is documented by management agencies to have an unacceptable impact on red drum (e.g. habitat damage, or bycatch mortality) should be prohibited within the affected essential habitats (e.g. trawling in spawning areas or primary nursery areas should be prohibited).

13. Each state should review existing literature and data sources to determine the historical extent of red drum occurrence and use within its jurisdiction. Further, an assessment should be conducted of areas historically but not presently used by red drum, for which restoration is feasible.

14. Every effort should be made to eliminate existing contaminants from red drum habitats where a documented adverse impact occurs.

15. States should work in concert with the U.S. Fish and Wildlife Service, Division of Fisheries Resources and Ecological Services, and the National Marine Fisheries Service, Office of Habitat Conservation, to identify hydropower dams and water supply reservoirs which pose significant threat to maintenance of appropriate freshwater flows to, or migration routes for, red drum

spawning areas and target them for appropriate recommendations during Federal Energy Regulatory Commission (FERC) relicensing evaluation.

Habitat Research Recommendations

Amendment 2 to ASMFC's Interstate Fishery Management Plan for Red Drum (2002) states seven research needs for red drum habitat, characterized as high (H), medium (M), and low (L) priority.

1. Identify spawning areas of red drum in each state from North Carolina to Florida so these areas may be protected from degradation and/or destruction. (H)

2. Identify changes in freshwater inflow on red drum nursery habitats. Quantify the relationship between freshwater inflows and red drum nursery/sub-adult habitats. (H)

3. Determine the impacts of dredging and beach renourishment on red drum spawning and early life history stages. (M)

4. Investigate the concept of estuarine reserves to increase the escapement rate of red drum along the Atlantic coast. (M)

5. Identify the effects of water quality degradation (changes in salinity, DO, turbidity, etc.) on the survival of red drum eggs, larvae, post-larvae, and juveniles. (M)

6. Quantify relationships between red drum production and habitat. (L)

7. Determine methods for restoring red drum habitat and/or improving existing environmental conditions that adversely affect red drum production. (L)

SAFMC's Habitat Plan for the South Atlantic Region (1998) and the National Marine Fisheries Service Habitat Research Plan (Thayer et al. 1996) outlines the following needs and recommendations for research.

1. Investigate the relationship between habitat and yield of red drum throughout its range, including seasonality and annual variability as well as the influence of chemical and physical fluxes on these relationships.

2. Identify and quantify limiting conditions to red drum production, particularly in HPACs.

3. Conduct cause-and-effect research to evaluate the response of red drum populations and HPACs to anthropogenic stresses including responses to alterations in upland areas and the role of buffer zones.

4. Encourage research in the development of bio- or photo-degradable plastic products to minimize impact of refuse on inshore, coastal and offshore habitats that red drum utilize at various stages of development.

5. Quantify the impacts of acid deposition on red drum estuarine habitats.

6. Conduct research on habitat restoration and clean-up techniques including the development of new approaches and rigorous evaluation protocols. Research should focus on such topics as contaminant sequestration, bio-remediation techniques, the role and size of buffer zones, and the role of habitat heterogeneity in the restoration process.

7. Conduct research to assess the impacts of oil, gas and mineral exploration, development or transportation on red drum and red drum HPACs

8. Determine impacts of dredging nearshore and offshore sandbars for beach renourishment on all life history stages of red drum, particularly spawning adults.

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CHAPTER 5: Spot

Populated with text from the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012)

Section I. General Description of Habitat

Spot are found in estuaries and coastal areas from the Gulf of Maine to the Bay of Campeche, Mexico, and are concentrated between the Chesapeake Bay and South Carolina (Phillips et al. 1989). Juvenile spot prefer shallow water areas, less than 8 m, over fine sediment and in tidal marshes (Phillips et al. 1989; Strickney and Cuenco 1982; Chesapeake Bay Program 1991). Juvenile spot are found in salinities ranging from 0 - 30 ppt and water temperatures from 5 °C – 30 °C (Stickney and Cuenco 1982; Phillips et al. 1989, ASMFC 1987), and therefore are found from polyhaline to freshwater nursery areas. Adult spot are more abundant in coastal waters and lower estuaries whereas juveniles are abundant in lower salinity areas.

Part A. Spawning Habitat

Data indicate that spot spawn further offshore and in deeper waters than other sciaenids. Spot typically migrate offshore and spawn in the relatively deep water of the outer continental shelf, though some evidently spawn in both nearshore waters and estuaries (Dawson 1958; Lewis and Judy 1983). Ripe adults aggregate off beaches in the fall and start migrating offshore to more southern waters (Pearson 1932). Spot may spawn repeatedly over several weeks (Hildebrand and Cable 1930), with some individuals remaining offshore after spawning (Pearson 1932; Wenner et al. 1979, 1980). Fall migrations of maturing spot to offshore waters were reported from Chesapeake Bay (Hildebrand and Schroeder 1928), North Carolina (Roelofs 1951), and South Carolina estuaries (Dawson 1958). Ripe spot were collected in depths up to 82 m off South Carolina (Dawson 1958) and 12.8-16.1 km off the Georgia coast (Hoese 1973). Smith (1907) stated that in North Carolina spot spawn in the sounds and inlets and Hildebrand and Cable (1930) suggested that spawning occurred in close proximity to passes off North Carolina; however, no evidence was offered to support these statements. Larval distributions of spot also indicate that spawning occurs more heavily offshore (26 - 128 m) than inshore (14.6 - 20.1 m; Lewis and Judy 1983; Warlen and Chester 1985).

Geographic and Temporal Patterns of Migration

By the fall, spot either remain in estuaries another year (after year 1) or migrate offshore. For those that remain nearshore, some adults may spawn on the inner continental shelf during the late fall, if water temperatures remain warm enough. For those that migrate to the outer continental shelf, spawning will occur if temperatures are suitable for spawning and egg development (17.5 °C – 25 °C) (Hettler and Powell 1981). Compared to other sciaenids, spawning spot are further offshore and in deeper waters. Ripe spot have been collected in depths up to 82 m off South Carolina (Dawson 1958) and shallower waters 8 - 10 mi off the Georgia coast (Hoese 1973). It is unknown what proportion of spent adults return inshore, or any other habits or behaviors they exhibit (other than the assumption that some proportion return to nearshore or estuarine waters).

Salinity

There is no evidence that spawning individuals experience anything less than full seawater based on their offshore location.

Substrate

While the behaviors of juvenile and adult spot likely center on feeding, and thus substrate, it is unknown to what degree substrate influences spawning individuals. Based on the time of year and the offshore habitats required for spawning, it is unlikely that substrate plays a prominent role in spot behavior. Additionally, spot eggs are pelagic and positively buoyant, so substrates likely does not influence their distribution.

Temperature

Temperature may be the strongest driver of spawning spot behavior. Maturing individuals move offshore in the fall, and if capable (probably based on size) spawn in the late fall if water temperatures are still >17.5 °C (Hettler and Powell 1981). If these two conditions are not met, which is likely true for most of the population, mature spot continue their migration offshore to the outer continental shelf habitats where higher winter temperatures can be found.

Dissolved Oxygen

Spawning adults likely experience normoxic conditions (>4.0 mg/L DO) offshore, and thus dissolved oxygen (DO) is not a limiting factor or strong influence on behavior.

Feeding Behavior

Spawning adult feeding behaviors are likely a continuation of adult feeding, which takes place in the substrate feeding on epifauna and benthic infauna (Chao and Musick 1977); however, it is unknown how much time or effort spawning individuals spend on feeding.

Competition and Predation

Because food and space are unlikely limited, environmental constraints (e.g., temperature) are probably greater factors than competition and predation. Offshore predation of spot is not well documented, but thought to be a continuation of the predation seen in lower estuary and nearshore habitats (e.g., sharks, sciaenids, flounders).

Part B. Egg Habitat

Geographic and Temporal Patterns of Migration

Offshore of the U.S. southeast Atlantic coast, spot eggs are spawned during the winter months, but spawning often extends from late fall to early spring (Flores-Coto and Warlen 1993). Exact locations of spawning are not documented, though based on spawning temperature requirements of 17.5 °C - 25 °C (Hettler and Powell 1981), eggs may be spawned in the inner continental shelf early in the spawning season before temperatures decrease. It is likely, however, that the majority of spot eggs are spawned after the fall on the outer continental shelf as this is the only offshore location supporting temperatures high enough for spawning (Warlen and Chester 1985). Detailed descriptions of the egg (and larval) inshore advection processes remain an active field of study, although the positively buoyant eggs are likely moved toward the coast by a combination of wind and warm water eddies, such as those from the Gulf Stream. For example, Govoni et al. (2013) found that spot larvae in warm water cyclonic eddies that both advance development (with warm water temperatures) and enhanced feeding opportunities for late larvae (supported by increased primary productivity).

Salinity
Because the egg stage of spot occurs entirely offshore, full seawater (approximately 35 ppt) is likely necessary for proper development and transport of eggs, though no studies have explicitly reported any tolerances or thresholds.

Substrate
Because the egg stage of spot occurs entirely offshore and the eggs are positively buoyant, substrate is not considered a critical aspect of spot egg habitat.

Temperature
Spawning adults and larvae (≤15 d old) are have relatively high temperature requirements (17.5 °C - 25 °C) (Hettler and Powell 1981; Warlen and Chester 1985), which suggests that spot egg temperature requirements are also between 17.5°C - 25 °C. Spot eggs hatched within 48 h under laboratory conditions at 20 °C, which is likely a realistic temperature based on empirical data (Powell and Gordy 1980).

Dissolved Oxygen
Because the egg stage of spot occurs entirely offshore, eggs are likely only ever exposed to normoxic waters (5 - 8 mg/L). It is not currently thought that DO is a limiting factor to survival of spot eggs.

Feeding Behavior
Spot eggs subsist entirely off the yolk sac prior to hatch.

Competition and Predation
Spot eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (temperature, salinity, and oxygen requirements largely met by the offshore conditions). Predation of eggs undoubtedly occurs but has not been well studied or reported. Although potentially large numbers of eggs are killed from predation, there is no reason to think that pelagic oceanic predators are targeting spot eggs over other, similar pelagic eggs.

Part C. Larval Habitat

Geographic and Migration Patterns
Powell and Gordy (1980) report that the yolk sac and oil globule were absorbed within 5 d of hatch, in a laboratory setting at 20 °C. Newly hatched larvae are likely still close to offshore spawning locations, which have been suggested to be up to or beyond 90 km offshore (Flores-Coto and Warlen 1993). Larvae cover (through a combination of passive and active migration or transport) perhaps the largest geographic distance of any life stage of spot, with the possible exception of adults migrating for spawning. As with the egg stage, larvae depend on wind and currents (e.g., warm water eddies) for transportation and complete their development over the continental shelf waters during the winter (Able and Fahay 2010). In the winter and through early spring, larval spot ingress into estuarine habitats and settle into upper regions of an estuary (Ribeiro et al. 2015).

Salinity
Corresponding with the range of habitats seen by larvae, a range of salinities is also experienced. Beginning offshore, full seawater (approximately 35 ppt) dominates until larvae enter coastal estuaries,

where salinities likely vary considerably. It is unknown what proportion of larvae settles in upper estuarine or oligohaline habitats.

Substrate

For the majority of the larval phase, spot are pelagic and not in contact with or preferring a particular type of substrate. During settlement, they will interact much more with the substrate, though it remains unclear what (if any) substrate preferences exist for post-settlement larvae.

Temperature

Govoni et al. (2013) reported the densest larval spot concentrations were found along the continental shelf, which ranged in temperature from 11 °C - 19 °C. Temperatures preferences for larvae may not be as high as for spawning adults and egg development since larvae must be transported through waters that are cooler than the offshore waters in which they were spawned. Additionally, spring estuarine water temperatures, particularly in the southeast U.S., may vary substantially based on atmospheric and terrestrial factors, and thus spot toward the end of their larval phase likely experience a wide range of temperatures. Perhaps the greatest temperature threat to larval spot comes from cold temperatures in estuaries. Hoss et al. (1988) reported a stress response to cold temperatures that resulted in an energy deficit at temperatures ≤10 °C.

Dissolved oxygen

DO demands are likely met offshore, as well as inshore after ingress. Both of these habitats typically do not experience hypoxic conditions in the winter and early spring, although no published studies have reported on any limitations.

Feeding Behavior

Larval spot are planktonic feeders. Copepods and ostracods are the primary food up to 25 mm SL (Hildebrand and Cable 1930). Spot larvae are also known to eat tintinnids, pteropods, pelecypods, ostracods, and the egg, naupliar, copepodid, and adult stages of copepods (Govoni et al. 1983). By settlement into nursery habitats (~20 mm SL), sediment is found in the stomachs suggesting that spot are foraging along the bottom (Deary 2015).

Competition and Predation

Spot larvae likely do not enter into any limiting ecological competition, as their habitat demands are basic—it is unknown whether larvae are limited spatially after settlement, and they are largely planktonic feeders. Predation of larvae undoubtedly occurs both offshore and inshore, yet these processes are difficult to quantify in a way meaningful to the overall population or abundance (i.e., at broad scales and not characterized by spatial or temporal effects of a single study). Similar to the early stages of many other pelagic fish larva, the early stages of spot are significantly predated upon by gelatinous zooplankton (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part D. Juvenile Habitat

Tidal salt marshes and larger estuaries are recognized primary nurseries for spot (Weinstein 1979; Currin et al. 1984), although juvenile spot have been frequently collected offshore on the inner continental shelf (Woodland et al. 2012). Due to the generally high productivity of estuaries, this habitat provides ample prey for spot, which feed mostly on small bottom dwelling worms and crustaceans (Chao and Musick 1977). Atlantic coast estuaries are often shallow and structurally complex, providing a physical refuge from predators. In addition, spot are well adapted to live in the physiologically stressful, low dissolved oxygen environment of small tidal creeks (Cochran 1994). Research in Rose Bay, North Carolina suggests that during their first summer, spot grow and disperse from shallow edges of the bay to all depths (Currin 1984). Although exceptions exist, this pattern is the generally observed for many coastal species.

Geographic and Temporal Patterns of Migration

Juveniles occupy a variety of estuarine habitats, although in the early spring they are abundant in seagrass habitats (Olney and Boehlert 1988). Young-of-year juvenile spot are abundant in shallow bay habitats and intertidal and subtidal creeks in the spring (Able et al. 2007; Able and Fahay 2010). By late summer, larger juveniles are common in intertidal and subtidal marsh habitats.

Salinity

Juvenile spot are found in salinities ranging from 0 to 30 ppt (polyhaline to freshwater) (Phillips et al. 1989; ASMFC 1987) in nursery areas. Ross (2003) noted spot occupy water with a wide salinity range. Even though spot are tolerant to salinity, juveniles are more abundant in less saline estuarine nursery habitats, suggesting these are preferred nurseries (Thomas 1971; Ross 2003; Able and Fahay 2010).

Substrate

Juvenile spot likely have a preference for a substrate type, such as mud (Bozeman and Dean 1980; Strickney and Cuenco 1982). However, a number of studies highlight the opportunistic aspect of spot with regard to habitat. Juvenile spot have been collected over shell, sponge, and peat substrates (Able and Fahay 1998; Able and Fahay 2010). Strickney and Cuenco (1982) report mud being the most suitable, but fine sand and coarse sand. Hettler (1989) concluded that up to 1/3 of juveniles might spend their time in Spartina (*Spartina alterniflora*) vegetation and Weinstein and Brooks (1983) reported spot use seagrass meadows. In many systems across the Atlantic distribution of spot, abundance may vary among substrate type, although spot are ubiquitous and a distribution-wide substrate preference has not been reported.

Temperature

The preferred temperature range of juvenile spot is 6 °C - 20 °C, with a tolerable temperature range extending from 1.2 °C - 35.5 °C (Parker 1971). Juvenile spot are susceptible to winter kills when estuarine temperatures drop suddenly; however, there is likely individual variation in the susceptibility to this source of mortality, and those later-spawned spot (which are smaller in size) likely have lower survival to low temperatures.

Dissolved Oxygen

Much work has been done in regard to spot DO tolerances. This work has been done largely in response to the growing number and size of hypoxic events in coastal rivers and estuaries (Breitburg et al. 2009) that spot inhabit. Originally, Ogren and Brusher (1977) reported DO preferences >5.0 mg L^{-1}, although they can tolerate DO as low as 0.8 mg L^{-1} with 95% survival (Burton et al. 1980). Mortality increases to 95% when DO drops below 0.8 mg L^{-1} (Burton et al. 1980). Though recent work has begun to show that spot actively avoid hypoxic areas and even inhabit the margins of these areas (Campbell and Rice 2014).

Feeding Behavior

Juvenile spot feed mostly on small bottom dwelling worms and crustaceans (Chao and Musick 1977; Deary 2015). Hales and Van Den Avyle (1989) noted the flexibility in juvenile diets, including insect larvae, polychaetes, harpacticoid copepods and other crustaceans. Several studies have reported that spot behavior is often driven more by feeding opportunities than by predation risk (Weinstein and Walters 1981; Miltner et al. 1995; Nemerson and Able 2004), which collectively suggests that prey availability and abundance many drive habitat associations to a greater degree than predators.

Competition and Predation
Density-dependence is often cited as the greatest competitive effect on juvenile spot (Craig et al. 2007), particularly as hypoxia limits available habitat and increases fish densities in suitable areas (Campbell and Rice 2014). Predators of spot include common estuarine predatory fish, such as sharks, seatrout (*Cynoscion spp*.), and flounders (*Paralichthys spp*.), among others (Rozas and Hackney 1984).

Part E. Adult Habitat

Adult spot are common in coastal waters during the spawning season and in estuaries and nearshore waters during the other parts of the year. They are typically found over sandy or muddy bottoms in waters up to approximately 60 m deep.

Geographic and Temporal Patterns of Migration
Designation of 'adult' is typically defined by the presence of mature reproductive tissue or after the production of viable gametes (Helfman et al. 2006). Under this designation, it is unknown exactly when spot become adults other than vaguely suggesting around ages-1 or 2 (Hales and Van Den Avyle 1989). Given this transition and the relatively short lifespan of most spot, here we refer to adult spot as those that have lived one year and moved to offshore habitats, which typically takes place around October or November, though in the Chesapeake Bay and estuaries to the south some young-of-year may overwinter in estuaries (Able and Fahay 2010). Adults distribute in the inner continental shelf in the fall, while individuals that are mature begin to move farther offshore to warmer waters.

Salinity
Adult spot are tolerant of salinities up to 60 ppt (ASMFC 1987; Phillips et al. 1989) and are more abundant in coastal waters and lower estuaries and less abundant in lower salinity areas, compared to juveniles.

Substrate
Adult spot are bottom-oriented, and require substrates to forage on epifauna and benthic infauna (Chao and Musick 1977). Adults likely prefer muddy substrates to sand or vegetated substrate, which has been reported for juveniles (see juvenile substrate section), although offshore adults will likely utilize sand substrates, which are more common outside of estuaries.

Temperature
As with other habitat variables, adult spot are likely tolerant to a wide range of temperatures, though specifics have not been reported. Despite any tolerances, however, lower temperatures drive migrations offshore in the fall (Pacheco 1962).

Dissolved Oxygen
As with juveniles, adults are likely tolerant of a wide range of DO, but prefer normoxic conditions (>4.0 mg L^{-1}; Chao and Musick 1977). Hypoxic conditions (<2.0mg L^{-1}) are less common offshore, and thus DO is probably less of a concern for adults than for juveniles.

Feeding Behavior
Adult feeding behaviors are a continuation of juvenile feeding, which takes place in the substrate foraging on epifauna and benthic infauna (Chao and Musick 1977). It is unknown whether adult feeding behaviors change offshore.

Competition and Predation
Density dependence may be less of a factor for adults than was for juvenile spot as there are fewer adults than juveniles because offshore habitats are likely less spatially limiting than smaller and highly-variable upper estuary environments. Holland et al. (1977) did report sharp mid-summer declines of benthic macroinvertebrates in the Chesapeake Bay, although this occurred largely in upper bay habitats where adults are less likely to inhabit. Predation of spot is dominated by sharks and other estuarine and nearshore predatory fishes, such as other sciaenids and flounders (Bowman et al. 2000).

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat
The South Atlantic Fishery Management Council's Essential Fish Habitat Plan identifies essential fish habitat for coastal migratory pelagic species as including sandy shoals of capes and offshore bars, high profile rocky bottom, and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum (SAFMC 1998). It further recognizes all coastal inlets and all state-designated nursery habitats as being of particular importance.

Identification of Habitat Areas of Particular Concern
Spot are strongly associated with the bottom as juveniles and adults and are seasonally dependent on estuaries. From Delaware to Florida, primary nursery habitat includes low salinity bays and tidal marsh creeks with mud and detrital bottoms. Juvenile spot are also found in eelgrass beds in the Chesapeake Bay and North Carolina. By late spring, juveniles are often more abundant in tidal creeks than in seagrass habitats. Estuaries, which are especially susceptible to alterations from human activities, are designated as Habitat Areas of Particular Concern (HAPCs) for spot.

Juvenile spot are associated with the estuarine or creek substrates (bottoms, which are often susceptible to degradation from human activities). Additionally, the loss of habitat due to hypoxia is a serious concern across the eastern U.S. (as well as globally), and numerous studies have reported the negative impacts on spot resulting from hypoxic events (Craig et al. 2007; Campbell and Rice 2014).

Present Condition of Habitat Areas of Particular Concern
A number of activities may affect the condition of the habitats utilized by spot. Estuaries are extremely sensitive to dredging, point and nonpoint source pollution, and destructive or unregulated practices in siliviculture, agriculture, or coastal development that contribute to increased turbidity. These activities may reduce the quantity and quality of spot habitat.

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Spot

For reasons outlined previously in this section, hypoxia is likely the greatest threat to juvenile spot. Spot tend to do well in warm waters, so increased temperatures from climate change are not of immediate concern; however, other impacts of climate change (e.g., changes in precipitation and subsequently salinity) (Schaffler et al. 2013) are not well understood or forecasted.

Unknowns and Uncertainties

The early stages of spot have a ubiquitous distribution throughout estuarine ecosystems using a variety of habitats. However, it is not known if certain nursery habitats contribute more individuals to adult populations. Studies determining preferred nurseries habitats would help managers identify and conserve critical nursery habitats. In addition, spot forage within and along the sediment of the benthos, which concentrates hydrophobic toxicants, potentially increasing their exposure to these contaminants. Previous research has examined the physiological impacts on adult spot (Middaugh et al. 1980; Roberts et al. 1989), however, no known research has examined the impacts of toxicant exposure on early stage spot, which may have developmental or reproductive implications.

Another consideration for spot is the in the early stages, density-dependence is a major competitive force. With the loss of nursery habitats through anthropogenic factors and climate change, competition is expected to increase and the influence of this competitive force on recruitment dynamics is not currently understood.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Spot eggs exist in offshore habitats for a short time in winter and likely have no interactions with other fishery activities. It is not currently thought that any management actions are needed to modify habitat or survival of spot eggs. The following management recommendations were highlighted by the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012):

1. To effectively maintain habitat health, habitat areas of particular concern should be accompanied by minimization of non-point source and storm water runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area. Water quality should be monitored to ensure that quality standards are being met.

2. States should minimize loss of wetlands to shoreline stabilization, and monitor navigational dredging, bridge construction, dredged material disposal, and other coastal projects to minimize impact on habitat areas of concern.

3. The use of any fishing gear that is determined by management agencies to have a negative impact on spot habitat should be prohibited within habitat areas of particular concern.

4. States should identify dams that threaten freshwater flows to nursery and spawning areas, and target them for appropriate recommendations during FERC re-licensing.

5. States should continue support for habitat restoration projects, including oyster shell recycling and oyster hatchery programs as well as seagrass restoration, to provide areas of enhanced or restored bottom habitat.

Habitat Research Recommendations

From the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASMFC 2012). Particular attention should be directed toward what these data may indicate regarding habitat utilization and habitat condition (environmental parameters). A list of existing state and federal programs generating environmental data such as sediment characterization, contaminant analysis, and habitat coverage (marsh grass, oyster beds, SAV) should also be produced and those programs polled on a similar basis. Habitats utilized by this suite of species range from the fresh water dividing line out to, and likely beyond, the shelf break. Thus, virtually any study generating environmental data from estuarine or coastal ocean systems could be of value.

1. Identify critical habitats at all life stages and assess threats by: habitat alteration, dredging and dredge spoil placement, destructive or unregultated agricultural or coastal development, recreational boating, point and nonpoint source pollution.

2. Egg Stage: Investigations into cyclonic eddies and other offshore distributional processes is an active area of fisheries research (Govoni and Spach 1999; Govoni et al. 2013). Although threats to spot eggs (and the eggs of other coastal species with offshore, winter-spawned stages) are likely minimal or non-existent, continued efforts into understanding these large-scale processes will likely be informative toward understanding the distribution of subsequent life stages.

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CHAPTER 6: Spotted seatrout

Updated research for life stages. Populated with text from the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012)

Section I. General Description of Habitat

Overall, one issue with spotted seatrout is that the species is comprised of unique spatial populations, generally associated with an estuary. Little mixing goes on outside of adjacent estuaries. This means that it is not always safe to project the findings of one subpopulation onto the whole species, and this concern is amplified by the number of studies in the Gulf of Mexico or areas not comparable to the U.S. southeast Atlantic. For example, Powell (2003) presents good information on inferred spawning habitat and egg and larval distribution of spotted seatrout in Florida Bay (Powell et al. 2004). Florida Bay is a shallow, subtropical, oligohaline estuary without lunar tides, and considering that the spotted seatrout inhabiting this area are a unique subpopulation, it makes sense to limit the inference from a population like this onto both a distinct genetic and morphological stock in the Carolinas that inhabits a very different type of estuary (reiterated by Smith et al. 2008, which found growth differences among subpopulations). Research suggests salinity tolerances are genetic and that caution should be used when applying research to other populations.

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Many age-1 spotted seatrout are mature (L_{50}=292 for females; Ihde 2000) and all are mature by age-2. Consistent with the other life stages, spotted seatrout are generally restricted to their natal estuary (Kucera et al. 2002) and for spawning adults this means that spawning takes place often in the lower reaches of the estuary or nearshore just outside inlets.

Spawning seasons vary throughout the species range, and tend to lengthen as a function of warmer water. For example, spawning in Florida Bay has been reported to run from March to October (Powell 2003), while spawning in South Carolina is restricted from late April to early September (Roumillat and Brouwer 2004), and may not begin until May in North Carolina (Luczkovich et al. 2008) and the Chesapeake Bay (Smith et al. 2008). Adult Spotted Seatrout begin to spawn in March or April in southwest and west-central Florida estuaries (e.g., Tampa Bay and Charlotte Harbor; McMichael and Peters 1989) and in April or May in the more northerly Florida estuaries (e.g., northern Indian River Lagoon (Tabb 1961; Crabtree and Adams 1998). Specific estuarine spawning locations are not well documented, especially in Atlantic estuaries, although Luczkovich et al. (2008) recorded more spawning-associated calls near Bay River (western Pamlico Sound) than near Ocracoke Inlet (eastern Pamlico Sound). It is also worth mentioning that many of the environmental variables reported by Luczkovich et al. (2008) are in contrast with spawning habitat descriptions reported by Holt and others working in the Gulf of Mexico.

Salinity

Based on work in the Gulf of Mexico, Kucera et al. (2002) found differing egg characteristics from different Texas bays. Decreasing salinity resulted in increasing size and wet weight of eggs with the opposite true for increasing salinity. Eggs from spawners native to high salinity estuaries spawned at 20 ppt were not positively buoyant and died. Although it is difficult to generalize anything broadly applicable from this study, it does suggest that spawning salinity may be a locally-adapted trait.

Less work has reported on spawning salinities in the Atlantic, though Luczkovich et al. (2008) report spotted seatrout spawning-related drumming to take place in bottom salinities averaging 11.8 ppt (range 7.1 - 26.9 ppt), which is considerably less saline than reports from the Gulf of Mexico, but may also reflect the habitats investigated and not a uniform distribution of available salinities.

Substrate

It is unclear if spawning habitats are shared with adult habitats, and if so, what substrate preferences are. However, as eggs are pelagic, it is likely that substrate is less important than other environmental variables (such as temperature, salinity, tide, etc.).

Temperature

Spawning temperatures appear to be consistently high among all reports. For example, Louisiana spawning aggregations were highly associated with temperature 29.7 ± 0.31 °C (2 standard errors; Saucier and Baltz 1993), with Brown-Peterson et al. (1988) proposing a critical minimum spawning temperature of 23 °C. Others have suggested minima of 25.6 °C (Tabb 1966) and 26.3 °C (Rutherford et al. 1989). Similarly in the Atlantic, spotted seatrout did not drum below 23 °C (but one outlier), with most drumming occurring between 25 - 30 °C (Luczkovich et al. 2008). Hatch dates in the Chesapeake Bay have been dated to early May, yet it remains unclear if this northern distributional population has a lower spawning temperature tolerance.

Dissolved Oxygen

As with other life stages, dissolved oxygen (DO) has not been widely investigated or reported for spawning adults. Despite this paucity of data, the hydroacoustic results suggests that hypoxia did not limit spotted seatrout sound production; drumming has been recorded at DO levels as low as 0.05 mg L^{-1} (mean 6.1 mg L^{-1}, range 0.05 - 9.73 mg L^{-1}; Luczkovich et al. 2008)

Feeding Behavior

The protracted spawning season of spotted seatrout suggests that they do feed during the spawning season, and feeding patterns likely reflect the same as adult spotted seatrout.

Competition and Predation

No studies of competition or predation of spotted seatrout were found. Spotted seatrout are top predators in estuarine systems and are consumed by larger predatory fishes, ospreys, and other predatory birds.

Part B. Egg Habitat

Spotted Seatrout larvae use tidal flows to migrate into and within estuaries (Perret et al. 1980) where they settle in seagrass beds, shallow bays, and backwater creeks (McMichael and Peters 1989).

Geographic and Temporal Patterns of Migration

Along the Atlantic coast, spotted seatrout likely spawn in a variety of estuarine habitats. Spawning habitats are often located by identifying regions where spotted seatrout are drumming, a behavior characteristic of spawning. In a review of spotted seatrout, Johnson and Seaman (1986) report spawning habitat (and thus egg habitats) to range from non-tidal portions of estuarine tributaries, to outside of estuaries. Because eggs hatch 16 - 22 h after fertilization between (25 - 27 °C; Holt et al. 1985), the egg phase is relatively short in duration.

Salinity

Preferred salinities of spotted seatrout eggs are unknown but likely varies by spawning habitat. For example, Taniguchi (1981) reported from lab work an optimum salinity for hatching at 28.1 ppt. Gray et al. (1991) reported hatching success in treatments of 30 – 50 ppt but the highest hatching success was observed at 30 ppt and no hatching observed after 50 ppt.

Substrate

Due to the relatively short duration of the spotted seatrout egg phase and the neutral buoyancy needed to move eggs and provide oxygen, substrate is likely not an important habitat characteristic for this species at this stage.

Temperature

Preferred temperatures of spotted seatrout eggs vary. Using eggs from Texas fish, Fable et al. (1976) reared eggs at 25 °C that hatched 16 - 20 h after fertilization Taniguchi (1981) reported optimum temperature for hatching to be 28°C. While general trends may be applied to Atlantic stocks of spotted seatrout, these results should be used cautiously as they are based not only on artificial conditions (controlled laboratories), but using genetically different stocks that have adapted to different temperature and salinity regimes that exists in the Gulf of Mexico.

Dissolved Oxygen

No work has been conducted or reported having to do with DO and spotted seatrout eggs. Because eggs spawned in low salinities become demersal and die, it is thought that minimally normoxic conditions are required for adequate egg development.

Feeding Behavior

Spotted Seatrout eggs subsist entirely off the yolk sac prior to hatch.

Competition and Predation

Spotted Seatrout eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the oceanic or estuarine conditions). Predation of eggs undoubtedly occurs by a variety of oceanic and estuarine consumers, particularly gelatinous zooplankton (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part C. Larval Habitat

Geographic and Temporal Patterns of Migration

In the Gulf of Mexico, Holt and Holt (2000) found the most fish along the bottom during the day and similar numbers on bottom and surface at night, suggesting vertical migration. However, Lyczkowski-Schultz and Steen (1991) observed a reverse vertical behavior. Likely both studies are an accurate reflection of what the authors sampled, but that patterns of vertical distribution may be influenced by spatial or temporal effects not included in the studies. In the Chesapeake Bay, post-settlement, late larvae are obligate seagrass residents in meso- and polyhaline areas (Dorval et al. 2007; Jones 2013).

Salinity

Spotted Seatrout are among the more euryhaline of larval sciaenid, as Rutherford et al. (1989) could only collect spotted seatrout from 8 - 40 ppt (mean 33.2 ± 1.7 ppt), which, along with other work (Banks et al. 1991) establishes high tolerances of salinity and high mortality at lower salinities. Tabb (1966) particularly notes that while the overall tolerance range may be wide but abrupt changes in salinity, such are from freshwater inflow resulting from precipitation, renders fish vulnerable. In the Gulf of Mexico, larvae have been collected in salinities ranging from 15 – 50 ppt, but most are collected at salinities >24 ppt. Low salinities reduce survival of larval spotted seatrout (Holt and Holt 2003).

Substrate

Spotted Seatrout larvae settle on a variety of substrates, though they prefer seagrass habitats when available (Dorval et al. 2005; Dorval et al. 2007; Jones 2013). In estuaries and areas lacking submerged aquatic vegetation, such as much of South Carolina, Georgia, and parts of North Carolina, larval spotted seatrout have been collected in shallow marsh habitats (Wenner et al. 1990).

Temperature

Larval spotted seatrout likely tolerate a wide range of temperatures but optimum temperatures from South Florida are 23 - 33 °C (Taniguchi 1981). In Florida Bay, most larvae were found in temperatures between temperatures 26 - 33 °C (Powell 2003).

Dissolved Oxygen

To date, no studies of DO requirements for larval spotted seatrout have been reported.

Feeding Behavior

The overall pattern of feeding is likely an effect of prey availability in specific estuaries, but larval diet is dominated by plankton, specifically copepods. From wild spotted seatrout larvae in Texas waters, calanoid copepods and bivalve larvae were the most important food items (Holt and Holt 2000).

Competition and Predation

Explicit studies of competitors and predators is lacking; however, larvae of other sciaenids and estuarine species likely compete for similar planktonic prey items. And consistent with other predators of larval sciaenids, gelatinous predators and larger fish are likely the dominant predators of larval spotted seatrout (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

Part D. Juvenile Habitat

Geographic and Temporal Patterns of Migration

Throughout their range, juvenile spotted seatrout are most often associated with seagrass habitats or submerged aquatic vegetation. This is certainly true in the Gulf of Mexico (Rooker et al. 1998) and in Florida Bay, where spotted seatrout abundance and distribution has been linked to seagrass communities (Chester and Thayer 1990). In the Florida Bay study, temperature and salinity were relatively constant among sampled areas and spotted seatrout are captured in basins more than channels. In Mississippi waters, spotted seatrout have high site fidelity (Comyns et al. 2008).

In the Atlantic, seagrass beds are likely important (Jones 2013), but surprisingly few studies report on this habitat type, and many are of short duration, limited temporally, or of only a single species. In the Chesapeake Bay, juvenile spotted seatrout are obligate seagrass residents in meso- and polyhaline areas (Dorval et al. 2005; Dorval et al. 2007; Jones 2013). Seagrass beds of Chesapeake Bay provide different growth conditions depending on precipitation and freshwater flow into the bay with higher salinities support faster growth (Smith et al. 2008).

Salinity

The majority of studies involving juvenile spotted seatrout provide varying ranges of tolerated salinities, typically with mean values between 15 - 25 ppt. Spotted seatrout were the only one of five common coastal fish that grew slower during high river discharge years in Florida (Purtlebaugh and Allen 2010). In the Chesapeake Bay, drought years have been linked to increases in growth (Smith et al. 2008).

Substrate

Juvenile spotted seatrout prefer seagrass (submerged aquatic vegetation) but use shallow tidal salt marsh habitats when submerged aquatic vegetation is unavailable. In Florida Bay, juvenile spotted seatrout were most often captured where seagrass density and species diversity was highest (Chester and Thayer 1990).

Temperature

Temperature requirements, particularly minimum temperatures in the northern distributional limits of the species, are similar throughout their range. Based on work in South Carolina, temperatures <5 °C are cause for concern as mortality begins to become a serious threat (Anweiler et al. 2014). In North Carolina, spotted seatrout experience approximately 86% mortality after being exposed to 5°C after 10 days (Ellis 2014). In North Carolina, 3.0 °C was determined to be a lethal threshold whereas 5°C represents a lethal limit if the exposure persists (Ellis 2014).

Dissolved Oxygen

To date, no studies of DO requirements for larval spotted seatrout have been reported.

Feeding Behavior

Juvenile spotted seatrout eat mysids and caridean shrimp whereas larger juveniles eat penaeid shrimp and fishes (Johnson and Seaman 1986; Able and Fahay 2010).

Competition and Predation

Studies of competitors and predators are lacking; however, juvenile spotted seatrout and other juvenile sciaenids compete for space in upper-estuary habitats, and food in years of limited prey production. However, these are generalities and not based on specific studies of spotted seatrout. Juvenile spotted seatrout are preyed upon by larger fishes, such as striped bass (*Morone saxatilis*), Atlantic croaker (*Micropogonias undulatus*), Atlantic tarpon (*Megalops atlanticus*), and barracuda (*Sphyraena barracuda*) (Mercer 1984; Able and Fahay 2010).

Part E. Adult Habitat

Adult and juvenile spotted seatrout occupy similar habitats (i.e., seagrass beds) but they do partition their foraging habitats through ontogenetic diet shifts (Deary 2015). As adult spotted seatrout increase in size, pelagic fishes and penaeid shrimp become increasingly important in their diet (Lorio and Schafer

1966; ASMFC 1984; Mercer 1984; Daniel 1988). Diet analysis of spotted seatrout in the lower Cape Fear River, North Carolina, revealed that spotted seatrout are mainly piscivorous after reaching age 1 (Tayloe and Scharf 2006).

Geographic and Temporal Patterns of Migration

Most individuals of adult spotted seatrout have high site fidelity and display limited movement. In Florida's Gulf of Mexico waters 9 - 72 cm TL fish were tagged and 95% of recaptures were found within 48.3 km of the original tagging site (Iversen and Tabb 1962). More recently, Hendon et al. (2002) reported similar findings in that 92% of recaptured spotted seatrout moved <10 km, 82% moved <3 km.

In the Atlantic, Music (1981) observed the vast majority of recaptures within the estuary of capture with a mean distance traveled of 8.9 km. In addition, genetic studies corroborate the findings of tagging studies with significant genetic differentiation among estuaries along the Atlantic coast (O'Donnell et al. 2014). There was some evidence of movement in and out of open sounds from creeks and rivers in fall and winter, and to beach habitat in spring and summer (Music 1981). While movement in and out of an estuary is reported range-wide in association with feeding, spawning, and avoidance of specific temperature or salinity conditions (Lorio and Perrett 1980; Johnson and Seaman 1986), seasonal movements out of Chesapeake Bay may be the only example of a true migration by any subpopulations of spotted seatrout (Mercer 1984; Wiley and Chapman 2003).

Salinity

Adult spotted seatrout are likely tolerant of seawater but less tolerant of freshwater.

Substrate

Adult spotted seatrout likely use a range of habitats including lower-estuary and nearshore beaches. However, adult substrate preferences have not been reported and throughout their range estuarine habitats likely vary (e.g., presence or absence of submerged aquatic vegetation) making a universal substrate designation unlikely. As with juveniles, submerged aquatic vegetation is likely preferred, but limiting in many estuaries.

Temperature

Experimental work on minimum temperatures in juvenile spotted seatrout are similar for adults (Anweiler et al. 2014), and as with other environmental parameters, estuarine or region specific preferences and tolerances should not be assumed to apply throughout the range.

Dissolved Oxygen

To date, no studies of DO requirements for adult spotted seatrout have been reported.

Feeding Behavior

Tabb (1961) reported Indian River, Florida spotted seatrout switching prey throughout the year based on prey availability, and consumed fishes include many common estuarine species (anchovies, pinfish, silverside, mullet, croaker, and others) (Johnson and Seaman 1986).

Competition and Predation

No studies of competition or predation of spotted seatrout were found.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

Spotted seatrout are an estuarine fish, which relies heavily on submerged aquatic vegetation throughout all life stages. They also utilize shallow, soft bottom estuarine habitats as nurseries and as foraging and refuge habitats. Spotted seatrout are also known to use marine soft bottom habitat during summer and winter estuarine temperature extremes (ASMFC 2012).

Identification of Habitat Areas of Particular Concern

The ASMFC lists submerged aquatic vegetation as a HAPC for spotted seatrout (ASMFC 1984). Spotted seatrout are commonly found in submerged aquatic vegetation, but it is yet to be determined whether it is an EFH.

Environmental conditions in spawning areas may affect growth and mortality of egg and larvae, as sudden salinity reductions cause spotted seatrout eggs to sink, thus reducing dispersal and survival (Holt and Holt 2003).

Winter water temperature dynamics are of particular importance to habitat quality for spotted seatrout. Generally, spotted seatrout overwinter in estuaries, only moving to deeper channels or to nearshore ocean habitats in response to water temperatures below 10 °C (Tabb 1966; ASMFC 1984). Sudden cold snaps have been found to stun and kill large numbers of spotted seatrout in estuarine habitats during winter (Tabb 1966; Perret et al. 1980; ASMFC 1984; Mercer 1984). These large mortality events are often associated with rapid declines (less than 12 h) in temperature, which numb fish before they can escape to warmer waters (Tabb 1958, 1966). It should be noted that cold stun events appear to have a large influence on spotted seatrout population dynamics and that cumulative degree day, which characterizes temperatures across time, are potentially more appropriate predictor of cold stress over large spatial scales (Ellis 2014). Periodic increases in mortality associated with cold stuns should be considered when implementing management measures as they are likely to continue to occur on a periodic basis and are largely unpredictable (NCDMF 2010).

Present Condition of Habitat Areas of Particular Concern

By nature, the extent of submerged aquatic vegetation coverage tends to fluctuate on a scale of days to decades, depending on species, physical conditions, and location (Fonseca et al. 1998). Globally, submerged aquatic vegetation habitat is declining. Rapid, large-scale submerged aquatic vegetation losses have been observed in the European Mediterranean, Japan, Chesapeake Bay, Florida Bay, and Australia (Orth et al. 2006). While threats to the stability of submerged aquatic vegetation health and distribution are many, water quality degradation, including nutrient enrichment and sediment loading, is the greatest threat (Orth et al. 2006). The impacts of nutrient enrichment and sediment loading, such as increased turbidity, increased epiphytic loads, and sedimentation, and increased concentrations of toxic hydrogen sulfide directly reduce submerged aquatic vegetation growth, survival, and production (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998). The effects of eutrophication are most severe in sheltered, low flow areas with concentrated nutrient loads and large temperature fluctuations (Burkholder et al. 1994).

Once submerged aquatic vegetation habitat is lost, the associated sediments are destabilized, which can result in accelerated shoreline erosion and turbidity. These are conditions that are not favorable to vegetation recolonization and expansion in the affected area. Submerged aquatic vegetation in adjacent areas may also be impacted by the resulting increase of turbidity in surrounding habitats, increasing the total area affected (Durako 1994; Fonseca 1996). Losses of submerged aquatic vegetation on much larger scales are particularly problematic because the rate of recovery though propagation, recolonization, etc. is often much slower than the rate of loss (Fonseca et al. 1998). Nevertheless, recovery of submerged aquatic vegetation habitat may be possible with improvements to water quality as evidenced by the net gain of submerged aquatic vegetation acreage in Tampa Bay, Florida and Hervey Bay, Australia following strict water quality standards (Orth et al. 2006).

Dredging for navigational purposes, marinas, or infrastructure can directly impact submerged aquatic vegetation through large-scale removal or destruction of existing grass beds. Docks constructed over submerged aquatic vegetation and the associated shading can lead to the gradual loss of seagrass both beneath and adjacent to the structure (Loflin 1995; Shafer 1999; Florida Department of Environmental Protection, unpublished data). In addition to the impacts of shoreline development and dredging on submerged aquatic vegetation, the associated increase in boating activity can lead to increased prop scarring through vegetated areas. The propeller cuts leaves, shoots, and roots structures and makes a trench through the sediment. Recovery of submerged aquatic vegetation from prop scarring can take in upwards of 10 years, depending on species and local conditions (Zieman 1976). Wakes associated with increased in boating can lead to the destabilization of sediments, which, in turn, can increase turbidity and impact growth potential.

Use of bottom disturbing fishing gears also have the potential to damage or destroy vegetation. Although the damage from each gear varies in severity, shearing of leaves and stems, and uprooting whole plants are the most common impacts of bottom disturbing gears (ASMFC 2000). Shearing of leaves and stems does not necessarily result in mortality of seagrass, but in general, productivity is reduced (ASMFC 2000). Gears that result in below-ground disturbance may cause total loss of submerged aquatic vegetation and require months to years for the affected area to recover.

A newly emerging threat to submerged aquatic vegetation is the potential impacts of global climate change on this sensitive habitat. While climate change has occurred throughout history, the rate at which sea surface temperature, sea-level, and CO_2 concentrations are increasing is much faster than experienced in the last 100 million years (Orth et al. 2006). These changes may be occurring at a rate too fast to allow seagrass species to adapt. This leads to the potential for further large-scale losses of habitat globally. If submerged aquatic vegetation is indeed able to adapt to the pace of climate change, shoreline stabilization projects in many coastal areas impede the shoreward migration necessitated by rising sea-level (Orth et al. 2006). Additionally, the increased frequency and intensity of coastal storms and hurricanes, and the associated delivery of freshwater, nutrients, and sediments threaten to further degrade water quality in estuaries and coastal rivers, reducing the health and potential extent of submerged aquatic vegetation (Scavia et al. 2002; Orth et al. 2006).

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Spotted Seatrout

Though largely estuarine, spotted seatrout may move into marine environments during summer and winter estuarine temperature extremes (ASMFC 2012). Another concern for the conservation of this species is the loss of seagrasses, which are a primary habitat for spotted seatrout and can affect their distribution within estuaries.

Unknowns and Uncertainties

The physiological tolerances of spotted seatrout to environmental variables (e.g., dissolved oxygen, temperature, salinity) have not been investigated throughout their range or at different life history stages. Without these data, it is difficult to predict the impact of environmental perturbations on spotted seatrout, which are necessary to sustainably manage this species. Unlike other sciaenids that are mobile, spotted seatrout have high site fidelity. In addition, not much data is available regarding inter- and intra-specific competition, which will become an increasingly common problem as the extent of seagrasses declines (Orth et al. 2006). Future habitat loss is associated with anthropogenic factors (i.e., nutrient enrichment, boating, dredging, etc.) as well as climatic drivers (sea level rise, warming, acidification), which will increase environmental stressors on spotted seatrout populations. Pollution, including mercury, may have negative health effects on spotted seatrout (Adams et al. 2010), and an array of contaminants have been detected in this species (Johnson-Restrepo 2005; Adams et al. 2003; Adams and Paperno 2012).

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

As with spot, management recommendations for spotted seatrout have been highlighted by the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012):

1. To effectively maintain habitat health, habitat areas of particular concern should be accompanied by minimization of non-point source and storm water runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area. Water quality should be monitored to ensure that quality standards are being met.

2. States should minimize loss of wetlands to shoreline stabilization, and monitor navigational dredging, bridge construction, dredged material disposal, and other coastal projects to minimize impact on habitat areas of concern.

3. The use of any fishing gear that is determined by management agencies to have a negative impact on spotted seatrout habitat should be prohibited within habitat areas of particular concern.

4. States should identify dams that threaten freshwater flows to nursery and spawning areas, and target them for appropriate recommendations during FERC re-licensing.

5. States should continue support for habitat restoration projects, including oyster shell recycling and oyster hatchery programs as well as seagrass restoration, to provide areas of enhanced or restored bottom habitat.

Habitat Research Recommendations

The following research needs were recommended by the Omnibus Amendment to the ISFMP for Spanish Mackerel, Spot, and Spotted Seatrout (ASFMC 2012):

1. Identify essential habitat requirements.

2. Identify unique spawning location.

3. Evaluate the role of SAV on the spawning success of spotted seatrout.

4. Develop water quality criteria for spawning and nursery areas.
5. Evaluate the role of shell hash and shell bottom in spotted seatrout recruitment, particularly where SAV is absent.

6. Expand nursery sampling to include critical habitat (SAV) sampling in high and low salinity areas during the months of July through September.

7. Investigate the relationship between temperature and mortality of adults and juveniles.

8. Define overwintering habitat requirements.

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CHAPTER 7: Weakfish

Populated from Amendment 4 to the Weakfish FMP (2002)

Section I. General Description of Habitat

Weakfish are another sciaenid species that uses a variety of coastal and estuarine habitats throughout their life. Although spawning may take place closer to estuaries or in lower estuaries (as opposed to offshore), larval weakfish recruit to upper estuarine habitats but move down the estuary as they grow. Much work has been done on juvenile weakfish, particularly with respect to hypoxia, and like other sciaenids, weakfish exhibit a complex relationship with dissolved oxygen concentrations. Adults often move out of estuaries and spawn in nearshore habitats. Unlike other sciaenids, weakfish exhibit natal homing behaviors.

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

The vast majority of age-1 weakfish are mature (Lowerre-Barbieri et al. 1996a; Nye and Targett 2008) and begin spawning in late winter in the south and progressively later in the spring in northern estuaries. Spawning typically peaks in May and June, and ends in the late summer, though temporal variability in eggs and larvae have been observed that suggest either multiple spawning peaks (Goshorn and Epifanio 1991) or an annual shift in peaks (Lowerre-Barbieri et al. 1996b). Regardless of the variability, weakfish are considered to have a protracted spawning period consisting of several months in most locations, with multiple reports of spawning (inferred from drumming) taking place in the evening (Connaughton and Taylor 1995; Luczkovich et al. 2008).

Spawning activities occur near the coast or within estuaries, many of which are natal estuaries (or adjacent estuaries) (Thorrold et al. 1998; 2001). In Delaware Bay, inshore, midwater, and offshore sites (all <6 km from shore) have reported spawning-associated drumming from mid-May to late-July (Connaughton and Taylor 1995). The drumming suggests the presence of large spawning aggregations in shallow waters earlier in the spawning season, with midwater and offshore drumming activity increasing later in the spawning season. It was hypothesized that the spawning aggregates were not just moving as a function of time, but as a function of increasing inshore temperatures, and that spawning may have continued past July in deeper waters than the study examined.

The spawning period in North Carolina is longer and begins in March and continues to September (Merriner 1976). This has led to clinal variability in life histories and reproduction (Shepherd and Grimes 1984). Weakfish that spawn in southern locations live shorter lives and reproduce at smaller sizes compared to weakfish living in northern locations. Shepherd and Grimes (1984) interpret this as 'bet hedging' (Stearns 1976) against cold spring waters that prevent weakfish egg from hatching. That is, northern weakfish have longer lives and more annual reproductive events because northern bays are more temperature variable, whereas southern bays are warm enough to ensure hatching. Unique spatial life histories combined with the strong evidence for natal homing suggests that while habitat for spawning and other life stages may be variable, spatial structuring exists, and estuary-specific habitat use and preference may be more important population-level structuring.

Salinity
Lower estuary and coastal spawning habitats experience moderate to high salinities. No studies have explicitly investigated salinity in relation to spawning habitat; however some studies have reported salinity values during inferred spawning events. Luczkovich et al. (1999) reported mean salinity to be 28.8 ppt (range 15.1 - 34.7 ppt). Another study found that weakfish were commonly heard in higher salinity habitats (mean 15.4 ppt, range 7.8 - 28.3 ppt).

Substrate
Although depth is considered an important spawning habitat variable (Luczkovich et al. 2008), no studies report on spawning habitat substrate. Additionally, weakfish eggs are pelagic and thus substrate and bottom features are considered minimally important during and after spawning.

Temperature
Photoperiod and temperature are thought to drive seasonal maturation (Epifanio et al. 1988), along with the hypothesized avoidance of cooler spring temperatures that pose a mortality threat to larval and juvenile weakfish (Shepherd and Grimes 1984). Luczkovich et al. (1999) reported weakfish drumming in a mean temperature of 20.7 °C (range 19.1 - 22.6 °C); another study reported bottom temperatures associated with weakfish drumming to average 25.3 °C (range 17 – 31 °C) (Luczkovich et al. 2008).

Dissolved Oxygen
Dissolved oxygen (DO) is not well reported in adult and spawning weakfish, and based on spawning locations (deep estuaries and nearshore) low DO and hypoxic conditions are likely rare. Luczkovich et al. (2008) did measure bottom and surface DO and reported means of 7.9 and 7.6 mg L^{-1}, respectively. In the same study, only one sonobuoy reported any drumming noises at <4.0 mg L^{-1} DO, although other sciaenids (spotted seatrout and silver perch) both exhibited spawning-associated noises at low DO, even hypoxic conditions.

Feeding Behavior
No studies have reported the feeding habits of spawning weakfish, though it might be safely inferred that adult feeding habits apply to spawners, particularly because the duration of the spawning season suggests that spawning is integrated into their adult lives, rather than a small, discrete period of time that may necessitate a different foraging strategy.

Competition and Predation
No studies have examined competition or predation on spawning weakfish, though it might be inferred that adult competition and predation descriptions apply to spawning adults. Adults are commonly preyed on by bluefish and other estuarine predatory fishes.

Part B. Egg Habitat

Nursery habitats are those areas in which larval weakfish reside or migrate after hatching until they reach sexual maturity (90% by age 1, 100% by age 2). These areas include the nearshore waters as well as the bays, estuaries, and sounds to which they are transported by currents and hatch.

Geographic and Temporal Patterns of Migration

Mature weakfish spawn in the nearshore ocean and lower reaches of large east coast estuaries. Egg hatching occurs about 36 - 40 h post-fertilization (Welsh and Breder 1923) at 20 - 21 °C. Spawning begins in the southern region of the distribution (e.g., North Carolina) early in the spring (March; Merriner 1976) and later in northern bays and estuaries. Because spawning can continue into the summer (July in the Mid Atlantic Bight) (Berrien and Sibunka 1999) and there are reports of two peaks in spawning (Delaware Bay: Thomas 1971; Goshorn and Epifanio 1991), it is likely that weakfish eggs experience a range of conditions and that local adaptation may influence differences in latitudinal environments. Additionally, Berrien et al. (1978) report weakfish larvae occurring from nearshore waters to 70 km offshore, suggesting that eggs may be found over a wide geographic area that extends away from the coast.

Salinity

Olney (1983) noted a distinct polyhaline distribution of sciaenid eggs, with high concentrations at the mouth of the Chesapeake Bay. Although he was not able to identify the eggs to the species level, the large number of eggs collected and the timing of collection strongly suggest that weakfish eggs were present, if not a substantial percentage of the sample. Olney (1983) reported that sampling across a range of salinities (11 - 31 ppt) resulted in 84% of sciaenid eggs collected in salinities >26 ppt. The Chesapeake Bay Weakfish and Spotted Seatrout Fishery Management Plan (Chesapeake Bay Program 1990) reports fertilized eggs collected between 12.1 and 31.3 ppt.

Substrate

Like many marine fish eggs, weakfish eggs are buoyant and the entire egg phase takes place in the pelagic zone of nearshore or lower estuarine waters, and thus substrate is not likely encountered.

Temperature

Minimum temperature is likely the main driver of weakfish reproduction and thus a necessary condition for egg development. Harmic (1958) reported a range of 12 - 16 °C necessary for successful hatching; however, weakfish eggs have been collected across a range of temperatures (17 - 26.5 °C) (Chesapeake Bay Program 1990), which likely reflects their broad geographic occurrence.

Dissolved Oxygen

DO is probably not an issue for short-lived weakfish eggs that remain buoyant and pelagic, and thus out of hypoxic and anoxic bottom waters. However, Harmic (1958) reported reduced hatching success at DO <4.3 mg L^{-1}.

Feeding Behavior

Weakfish eggs subsist entirely off the yolk sac prior to hatch.

Competition and Predation

Weakfish eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the offshore conditions). Predation of eggs undoubtedly occurs and is likely dominated by gelatinous zooplankton (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992). Although potentially large numbers of eggs are killed from predation, there is no initial reason to think that pelagic oceanic predators are targeting weakfish eggs over other, similar pelagic eggs.

Part C. Larval Habitat

Nursery habitats are those areas in which larval weakfish reside or migrate after hatching until they reach sexual maturity (90% by age 1, 100% by age 2). These areas include the nearshore waters as well as the bays, estuaries, and sounds to which they are transported by currents or in which they hatch.

Geographic and Temporal Patterns of Migration

Weakfish larvae are widely distributed and have been reported from nearshore waters to 70 km offshore (Berrien et al. 1978), as well as throughout estuaries. Wherever eggs hatch, larvae spend approximately 3 weeks moving toward or up estuaries. In both Delaware and Chesapeake Bays, larvae have been sampled throughout the estuary, suggesting relatively quick and even post-hatch dispersal, or substantial within-estuary reproduction. Additionally, the protracted spawning season, taking place over months in many locations, provides a constant source of larvae to estuarine habitats. Olney (1983) found weakfish larvae distributed throughout the lower Chesapeake Bay. Ribeiro et al. (2015) identified weakfish as a component of the summer larval fish assemblage in the York River estuary of the Chesapeake Bay.

Larval weakfish migration has been an active area of research. Rowe and Epifanio (1994a) report that in Delaware Bay larvae were more abundant at depth (2 and 7 m off the bottom) than at surface. They report no effect of tidal stage on yolk sac larvae, but greater abundance of post-yolk sac larvae during flood tide, suggesting that post-yolk sac may use selective tidal stream transport to migrate into upper estuarine regions. Rowe and Epifanio (1994b) report mean larval flux to be greater during flood phase for all early and late stage larvae, but not for yolk sac larvae. Together, these studies suggest that while yolk sac larvae are passively transported as part of general sub-tidal circulation, post-yolk sac larvae use selective tidal stream transport to migrate up estuaries.

Salinity

Owing to the wide distribution of weakfish larvae, a range of salinities is likely tolerated. In the lower Chesapeake Bay, Olney (1983) reported salinities during larval weakfish sampling to range from 11.2 to 31.5 ppt. Rowe and Epifanio (1994a) report salinities of migrating larvae to be 20.1 - 27.8 ppt.

Substrate

Larval weakfish are planktonic (Welsh and Breder 1923) and thus do not come in contact with the substrate over which they are dispersed.

Temperature

As with salinity, both Olney (1983) and Rowe and Epifanio (1994a) provide similar temperature ranges for larval weakfish, with a range of 18.1 - 28.1 °C and 16.8 - 22.9 °C, respectively.

Dissolved Oxygen

Due to the relatively short larval duration, the pelagic habitat, and the migratory behaviors of weakfish larvae, it is unlikely that they encounter any habitats in which DO imposes a limitation or threat currently.

Feeding Behavior

A number of studies have investigated the feeding behaviors of larval weakfish, both in laboratory settings as well as in the field. Goshorn and Epifanio (1991) found that larval weakfish began exogenous feeding 2 days post hatch at 20 °C and that invertebrate eggs and tintinnids were important prey (larvae <.5 mm notochord length, NL). Polycheate larvae were important for all size classes and dominant in weakfish >3.55 mm NL. Small copepods (*Acartia tonsa*) were also important for all weakfish larvae, but dominant at sizes >7.55 mm NL.

Competition and Predation

Little work has looked at competition and predation of larval weakfish. Some competition likely takes place when a high-density larval patch settles on limited habitat; however, the wide range of settled habitats and protracted spawning season suggest that widespread competition is unlikely. Furthermore, work on natal homing (Thorrold et al. 1998; 2001) suggests that adult weakfish return to natal estuaries to spawn, adding a level of population structure to mitigate against widespread competition.

No studies have explicitly reported on predation of larval weakfish, although larvae are likely subject to predation by a range of estuarine predators. Cowan et al. (1992) examined hydromedusa (*Nemopsis bachei*) and ctenphore (*Mnemiopsis leidyi*) predation on Black Drum (and Duffy and Epifanio 1994 reference gelatinous predators), suggesting that high densities of hydrozoans could impact larval weakfish abundance.

Part C. Juvenile Habitat

Juvenile weakfish inhabit deeper waters of bays, estuaries, and sounds, including their tributary rivers. They also use the nearshore Atlantic Ocean as nursery areas. In North Carolina and other states, juveniles are associated with sand or sand/seagreass bottom. They feed initially on zooplankton, switching to mysid shrimp and anchovies as they grow. In Chesapeake and Delaware Bays, they migrate to the Atlantic Ocean by December.

Geographic and Temporal Patterns of Migration

The general pattern of habitat use by juvenile weakfish is estuarine-wide, but often beginning in late spring and early summer in upper estuarine habitats (or even freshwater) (Massman 1954) and moving down estuary during the fall to nearshore habitats.

Able et al. (2001) found high abundance of weakfish in June throughout Delaware Bay tidal creeks, and the large numbers of fish were attributed somewhat to high recruitment and that higher abundances were observed in upper bay sites over lower bay sites. Paperno et al. (2000) also reported that juvenile weakfish recruited to all parts of Delaware Bay, but higher abundances were observed in lower salinities. Higher temperature and lowers salinity habitats are preferred by juveniles early in the season or for earlier cohorts (Lankford and Targett 1994).

In the York River, Virginia, juveniles were caught in spring and summer, to which Chao and Musick (1977) attributed water temperature and DO as the most important factor driving distribution. Weakfish were abundant in late summer and fall with age 1 fish returning in the spring but young-of-year individuals absent until late summer. Inshore and nearshore of the Chesapeake Bay, a pattern of similar habitat use in early and late summer was discovered when comparing inner continental shelf and estuarine habitats, with an expected strong shift to inner continental shelf habitat use over estuary by fall (Woodland et al. 2012). Growth rates between habitats were similar, suggesting no growth advantage in either habitat, but in late summer larger fish were concentrated in the inner continental shelf while smaller fish were in estuary. Pincin et al. (2014) examined weakfish abundance in coastal Maryland bays and found no effect of seagrass and Olney and Boehlert (1988) observed that larval weakfish are rare in seagrass sites.

Salinity
Juvenile weakfish salinity preferences likely increase with size and age and is broad since weakfish use oligohaline to polyhaline habitats throughout the first year of life. Lankford and Targett (1994) found salinity effects on specific growth rates and gross growth efficiencies were optimal 20 ppt for 40 – 50 mm fish. Feeding rate was significantly higher at 5 ppt than at 19 ppt salinity.

Substrate
Weakfish are pelagic predators (Chao and Musick 1977; Horodysky et al. 2008) that are not expected to interact with the benthos so substrate type is not an ecologically important environmental variable for weakfish.

Temperature
Juvenile weakfish likely tolerate a wide range of temperatures, though temperature is considered to be an important variable driving their distribution. Although temperature has been documented in a number of descriptive studies, Lankford and Targett (1994) examined temperature effects on specific growth rates and gross growth efficiencies, and found significant effects at 27 and 29 °C treatments. Overall, mean feeding rates increased with increasing temperature (from experimental treatments of 20 - 28 °C).

Dissolved Oxygen
A relatively large body of research has been done on the effects of DO levels on juvenile weakfish. Tyler and Targett (2007) reported low weakfish densities in early morning (during diurnal hypoxic conditions) but relatively high weakfish densities later in the day and an avoidance threshold of 2.0 mg L^{-1}. A lower threshold of avoidance (<1.4 mg L^{-1} DO) was reported for hypoxia-acclimated fish (Brady and Targett 2013), supporting the idea that not only are these fish less inclined to swim to avoid hypoxia, but they can tolerate lower levels than fish that have never been exposed to hypoxia. Stierhoff et al. 2009 reported avoidance of low DO (≤1 mg L^{-1}), but no preference to DO levels > 2.0mg/L, suggesting weakfish are tolerant of low DO conditions.

Feeding Behavior
Juvenile weakfish experience ontogenetic diet shifts (Chao and Musick 1977; Nemerson and Able 2004; Deary 2015). In the Delaware Bay, mysid shrimp (*Neomysis americana*) dominated the diet (Grecay and Targett 1996a). Larger juvenile weakfish (67 - 183mm) in the Chesapeake Bay consumed bay anchovy (*Anchoa mitchilli*) and mysid shrimp (*N. americana*) (Chao and Musick 1977), which highlights the transition from mysids to fish (piscivory) around 60 mm TL (Thomas 1971).

Competition and Predation
Due to the wide spatial distribution and extended temporal period of recruiting juvenile weakfish, it is unlikely that any large-scale competitive factors drive the population. Annual fluctuations in recruitment and micro-scale habitat and foraging competition probably result in patches of competition. Forage items are typically not limited, though in years of low prey abundance (and high turbidity) (Grecay and Targett 1996b) competition may result in decreased growth rates for less fit individuals.

Juvenile weakfish are likely preyed upon opportunistically by a range of estuarine and nearshore predators (fishes); however, Mancini and Able (2005) report silver perch and bluefish as the main documented predators. Large predators are typically less abundant or absent in oligotrophic, upper estuarine areas, yet as temperatures increase in summer, the interactions of temperature and salinity result in a suboptimal physicochemical environment (Lankford and Targett 1994; Lankford and Targett 1997).

Part D. Adult Habitat

Adult weakfish reside in estuarine and nearshore Atlantic Ocean habitats. Warming of coastal waters in the spring cues inshore migration and northward from the wintering grounds to bays, estuaries, and sounds. Larger fish move inshore first and tend to congregate in the northern part of the range. Catch data from commercial fisheries in Chesapeake and Delaware Bays and Pamlico Sound indicate that the larger fish are followed by smaller weakfish in summer. Shortly after their initial spring appearance, weakfish return to the larger bays and nearshore ocean to spawn. In northern areas, a greater portion of the adults spend the summer in the ocean rather than estuaries.

Weakfish form aggregations and move offshore as temperatures decline in the fall. They move generally offshore and southward. The continental shelf from Chesapeake Bay to Cape Lookout, North Carolina appears to be the major wintering ground at depths of 18 - 55 m. Some weakfish remain in inshore waters from North Carolina southward.

Geographic and Temporal Patterns of Migration

After juvenile weakfish overwinter in offshore environments, the vast majority (>90%) mature during their second year of life (age-1). The general pattern of adult habitat use is considered to be seasonal migrations south (toward Cape Hatteras, North Carolina) and offshore in fall and winter, and north and inshore during spring and summer (Able and Fahay 2010). Summer inshore habitats are shallow, averaging around 17 m, while offshore winter habitats average 59 m, but include depths up to 159 m (Able and Fahay 2010).

Off the New Jersey coast in the summer, weakfish occurred primarily inshore in shallow strata in coastal New Jersey (the Navesink River) during the summer. Tagged weakfish left the estuary when temperatures were above 28 °C and when freshwater discharge was low ($<2\ m^3\ s^{-1}$). Smaller weakfish were more like to have longer overall residence times, although even large individuals (>400 mm TL) demonstrated estuarine habitat use ≥40 d (with some >60 d residence). These tagged weakfish were also found to leave the estuary when temperatures decreased below 23 °C. Thorrold et al. (1998; 2001) concluded that 60 - 81% of weakfish exhibit estuarine fidelity as adults, despite the fact that the same fish from across the eastern U.S. were genetically panmictic.

Salinity

Adult weakfish occur primarily in nearshore or lower estuarine habitats where salinities are near full seawater. In a review of weakfish, Mercer (1989) report that adults were collected in salinities ranging from 6.6 - 32.3 ppt. Adult weakfish prefer higher salinities when inhabitating estuaries in the summer; Rountree and Able (1992) sampled adults in 22 - 32 ppt shallow sub- and intertidal marsh creeks in New Jersey. As with other habitat variables, salinity is probably tolerated at variable levels reflected in the variety of inshore and nearshore habitats populated by adult weakfish.

Substrate

In accordance with the variety of habitats used by adults, specific habitat use or habitat preference in adult weakfish has not been reported. Able and Fahay (2010) report the use of sandy or muddy substrates by adults in bays and estuaries, but substrates used are likely as variable as the overall habitats in which adult weakfish are found. In addition, weakfish are pelagic, open water foragers (Chao and Musick 1977; Horodysky et al. 2008), therefore substrate in not a significant environment variable.

Temperature

Temperature is likely a major driving in development of reproductive tissue and spawning behaviors in weakfish, though it is still an important habitat factor among resting (not reproductively active) adults. Weakfish have been captured in a wide range of temperatures (Mercer 1989). Contemporary studies of weakfish temperature occurrence or preference are lacking, likely due to their wide distribution, inferred tolerance for a range of temperatures, and the relatively high effort put into studying juvenile weakfish habitat. Temperatures above 28 °C but below 23 °C resulted in the egress of adult weakfish from coastal estuaries (Wuenschel et al. 2014).

Dissolved Oxygen

Adult weakfish likely experience normoxic conditions, as they typically avoid the upper estuary reaches inhabited by juvenile weakfish where hypoxia is most commonly reported. Without any explicit studies of adult weakfish DO tolerances or preferences, such values might be estimated from the extensive body of work conducted on juvenile weakfish. Later stage juvenile weakfish may have physiologies (and subsequent tolerances) similar to adults.

Feeding Behavior

Adult weakfish feed primarily between dawn and dusk on clupeid species, anchovies, blue crabs, and spot (Mercer 1989). More recent work has supported piscivory as the main adult weakfish feeding mode, but also note crustaceans, mollusks, shrimp, squid, and other common estuarine prey (Able and Fahay 2010). Overall diets vary in proportion to available prey but adult diets are relatively stable from June to October (Wuenschel et al. 2013).

Competition and Predation

Competition among adult weakfish is not well known. Silver perch and bluefish are commonly cited as the primary predators (Mancini and Able 2005), though predation of larger adults likely decreases with size and may include occasional larger coastal predators. Weakfish were consumed by summer flounder, bluefish, and other weakfish (Wuenschel et al. 2013). The same study noted that by October, summer flounder and bluefish predation was extensive (~25%).

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

Habitats used by weakfish include spawning sites in coastal bays, sounds, and the nearshore Atlantic ocean, as well as nursery areas including the upper and lower portions of the rivers and their associated bays and estuaries (ASMFC 2002).

Identification of Habitat Areas of Particular Concern

There is no HAPC designation for weakfish.

Present Condition of Habitat Areas of Particular Concern

The quality of weakfish habitats has been compromised largely by impacts resulting from human activities. It is generally assumed that weakfish habitats have undergone some degree of loss and degradation; however, few studies quantify the impacts in terms of the area of habitat lost or degraded.

Loss due to water quality degradation is evident in the northeast Atlantic coast estuaries. The New York Bight is one example of an area that has regularly received deposits of contaminated dredged material, sewage sludge, and industrial wastes. These deposits have contributed to oxygen depletion and the creation of large masses of anoxic waters during the summer months.

Some losses have likely occurred due to the intense coastal development that has taken place during the last several decades, although no quantification has been done. Losses have likely resulted from dredging and filling activities that have eliminated shallow water nursery habitat.

Further functional losses have likely occurred due to water quality degradation from point and non-point source discharges. Intensive conversion of coastal wetlands to agricultural use also contributed to the functional loss of weakfish nursery area habitat. Other functional loss of riverine and estuarine areas may have resulted from changes in water discharge patterns due to withdrawals or flow regulation. Estuarine nursery areas for weakfish, as well as adult spawning and pre-spawning staging areas, may be affected by prolonged extreme conditions from inland water management practices.

Power plant cooling facilities continue to impact weakfish populations. The EPA estimates the number of weakfish age 1 lost as a result of entrainment at all transition zone cooling water intake structures in the Delaware Bay is over 2.2 million individuals. Other threats stem from the continued alteration of freshwater flows and discharge patterns to spawning, nursery, and adult habitats in rivers and estuaries. Additional threats arise from placement of additional municipal water intakes in spawning and nursery areas, although the impacts may be mitigated to some degree with proper screening (ASMFC 2002).

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of Weakfish

The following is taken from Amendment 4 to the Weakfish FMP, Section 1.4.2:

Habitat loss due to water quality degradation is evident in the northeast Atlantic coast estuaries. For example, the New York Bight has regularly received deposits of contaminated dredged material, sewage sludge, and industrial wastes, which has led to oxygen depletion and large masses of anoxic waters during the summer months. Some losses have likely occurred due to the intense coastal development in the last several decades, including dredging and filling activities in shallow nursery habitats, point and non-point source discharges, and intensive conversion of coastal wetlands for agricultural use (ASMFC 2002).

Flow regulation may have also contributed to functional loss of riverine and estuarine areas due to possible changes in water discharge patterns. Estuarine pre-spawning staging areas, spawning, and nursery areas may be affected by prolonged extreme conditions resulting from inland water management practices. Power plant cooling facilities continue to impact weakfish populations through the entrainment of larvae and juveniles.

Unknowns and Uncertainties

Weakfish are pelagic fishes in estuarine systems and more common in the main channel of bays, sounds, and tributaries (Chao and Musick 1977). Therefore, perturbations to substrate and seagrass habitats through dredging, coastal development, and boating are not going to impact weakfish as much as benthic sciaenids. However, weakfish are visual predators (Horodysky et al. 2008) and human activities (e.g., dredging, eutrophication, sediment runoff) that increase turbidity are likely to reduce foraging efficiency for weakfish at all life stages. In addition, individuals are attracted to spawning aggregations through drumming but humans are increasing underwater noise pollution in coastal estuaries, which can increase stress and reduce the effectiveness of acoustic calls needed to initiate spawning (Slabbekoorn et al. 2010). It is not known how weakfish respond to increasing noise pollution and particular attention is needed in regards to the impacts of noise pollution on spawning adults as well as estimates of egg production.

Although weakfish are tolerant of low dissolved oxygen conditions (Stierhoff et al. 2009), other environmental variables are changing due to climate change. For weakfish, increasing acidification may be the more significant than other climate driven environmental changes since reduced pH decrease responsiveness to sensory cues, which can reduce foraging efficiency and predator avoidance (Dixson et al. 2010). Additional work, needs to be conducted to understand how ocean acidification may impact weakfish in estuarine systems at different life history stages.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

The following research recommendations are from Amendment 4 to the Weakfish FMP, Section 6.1.1 and ranked by high priority (H), medium priority (M), and low priority (L):

1. Collect catch and effort data including size and age composition of the catch, determine stock mortality throughout the range, and define gear characteristics. In particular, increase length-frequency sampling, particularly in fisheries from Maryland and further north. (H)

2. Derive estimates of discard mortality rates and the magnitude of discards for all commercial gear types from both directed and non-directed fisheries. In particular, quantify trawl bycatch, refine estimates of mortality for below minimum size fish, and focus on factors such as distance from shore and geographical differences. (H)

3. Update the scale – otolith comparison for weakfish. (H)

4. Define reproductive biology of weakfish, including size at sexual maturity, maturity schedules, fecundity, and spawning periodicity. Continue research on female spawning patterns: what is the seasonal and geographical extent of "batch" spawning; do females exhibit spawning site fidelity? (M)

5. Conduct hydrophonic studies to delineate weakfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat. (M)

6. Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent. (M)

7. Identify stocks and determine coastal movements and the extent of stock mixing, including characterization of stocks in overwintering grounds (e.g. tagging). (L)

8. Biological studies should be conducted to better understand migratory aspects and how this relates to observed trends in weight at age. (L)

9. Document the impact of power plants and other water intakes on larval, post larval and juvenile weakfish mortality in spawning and nursery areas, and calculate the resultant impact to adult sock size. (L)

10. Define restrictions necessary for implementation of projects in spawning and overwintering areas and develop policies on limiting development projects seasonally or spatially. (L)

11. Develop a coastwide tagging database. (L)

12. Develop a spawner recruit relationship and examine the relationships between parental stock size and environmental factors on year-class strength. (L)

Habitat Research Recommendations

The following research recommendations are from Amendment 4 to the Weakfish FMP, Section 6.1.4:

1. Conduct hydrophonic studies to delineate weakfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat.

2. Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent.

3. Document the impact of power plants and other water intakes on larval, post larval and juvenile weakfish mortality in spawning and nursery areas, and calculate the resulting impacts on adult stock size.

4. Define restrictions necessary for implementation of projects in spawning and overwintering areas and develop policies on limiting development projects seasonally or spatially.

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CHAPTER 8: Northern kingfish

Section I. General Description of Habitat

Northern kingfish are found in estuaries and coastal areas from Maine to the Yucatan, Mexico (Irwin 1971) and are more common in the Mid Atlantic Bight than in the South Atlantic Bight (Hildebrand and Schroeder 1928; Schaefer 1965; Ralph 1982). Northern kingfish prefer habitats in close proximity to inlets and in the ocean to depths up to 20 meters (Welsh and Breder 1923; Bearden 1963; Irwin 1971; Ralph 1982). Juvenile northern kingfish inhabit shallower waters than the adult northern kingfish and were typically found in the surfzone and rivers (Bearden 1963; Ralph 1982).

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Northern Kingfish are thought to migrate inshore and northward from their overwintering habitats during the spring and summer while spawning is occurring (Hildebrand and Cable 1934). Fish in spawning condition have been observed from March through September based on macroscopic inspection of gonads for fish in North Carolina (Collier in prep) and from June through August based on the size distribution of young of the year fish (Welsh and Breder 1923; Schaefer 1965; Miller et al. 2002). Spawning is thought to occur in the nearshore-ocean or within inlets in deep channels (Irwin 1971; Ralph 1982).

Salinity

Adult northern kingfish are thought to spawn in lower estuary and coastal habitats with moderate to high salinities (Ralph 1982). Spawning is occurs along the bottom (Ralph 1982).

Substrate

The spawning habitat has not been described for northern kingfish but they are typically found over sandy bottoms (Welsh and Breder 1923; Hildebrand and Cable 1934; Bearden 1963) with some reports of northern kingfish around oysters and hard bottom (Irwin 1971). It is expected that northern kingfish spawn over sandy or muddy bottoms in the ocean and in deeper channels.

Temperature

Northern Kingfish migrate based on temperature and will remain in the lower estuary and nearshore ocean during the spawning season. Spawning adults have been observed in temperatures ranging from 7.8 - 35.8 °C (Irwin 1971). The temperature range is likely to vary with latitude with northern kingfish from the Mid-Atlantic experiencing lower temperatures than fish inhabiting the South Atlantic and Gulf of Mexico.

Dissolved Oxygen

Preferences for dissolved oxygen (DO) have not been reported for adult and spawning northern kingfish. Based on suspected spawning locations (deep estuaries and nearshore) low DO and hypoxic conditions are likely rare.

Feeding Behavior

Diets of northern kingfish were reported during the summer months, which includes the spawning season. The diet of northern kingfish is comprised of penaeid shrimp, polycheate worms, and amphipods in the South Atlantic Bight (Welsh and Breder 1923; Bearden 1963) and shrimp, crabs, and squids in northern latitudes (Irwin 1971).

Competition and Predation

Competitors of northern kingfish include other sciaenids including its congeners, southern and gulf kingfishes, spot, Atlantic croaker, red drum, and black drum, due to diet and habitat overlap (Ralph 1982). No studies have reported on competition or predation of spawning northern kingfish, though it might be safely inferred that adult competition and predation descriptions apply to spawners, particularly because the duration spawning season suggests that spawning is integrated into their adult lives, rather than a small, discrete period that may necessitate a different behavioral strategy.

Part B. Egg and Larval Habitat

The eggs of northern kingfish are buoyant and the water column is the primary habitat. Eggs have been reported in the water column of the nearshore-ocean and in estuaries. Larvae are defined as kingfish <25 mm SL although the size of transition is not clearly defined (Welsh and Breder 1923). It is likely the nursery habitats for northern kingfish extend from the nearshore ocean into upper reaches of estuaries due to tidal transport. The greatest concentration of larvae northern kingfish occur in the nearshore ocean and lower estuaries (Irwin 1971; Ralph 1982).

Geographic and Temporal Patterns of Migration

Mature northern kingfish spawn in the nearshore ocean and lower reaches of deep estuaries. Egg hatching occurs about 46-50 hours post-fertilization at 20 -21 °C (Welsh and Breder 1923). Spawning begins in the southern region of the distribution (e.g., North Carolina) early in the spring and likely begins later in the spring in northern latitudes (Irwin 1971). Eggs are likely subjected to a variety of environmental conditions due to a protracted spawning season and broad geographic distribution from Florida to Maine in euryhaline areas similar to Southern Kingfish (Bearden 1963).

Northern kingfish larvae are widely distributed and have been reported in nearshore ocean waters and throughout estuaries (Bearden 1963; Irwin 1971; Ralph 1982). It is likely the larval transport of northern kingfish is similar to the larval transport of other sciaenids using tidal stream transport (e.g., weakfish, souther kingfish) given the general overlap in spawning season and location.

Salinity

Although salinity has not been reported, eggs and larvae of kingfishes (some studies do not differentiate among species) are concentrated near ocean near inlets and the lower parts of estuaries where salinities are higher (Ralph 1982; Flores-Coto et al. 1999; Reiss and McConaugha 1999).

Northern kingfish larvae likely tolerate a wide range of salinities based on their wide distribution but are most common in waters with salinities greater than 20 ppt, similar to southern kingfish (Bearden 1963). As northern kingfish grow, they are found in higher salinity waters (Ralph 1982). Although northern kingfish larvae are distributed over a range of salinities, it is not known if rapid changes in salinity impact survival.

Substrate

Like many marine fish eggs, northern kingfish eggs are spherical, buoyant, and have a relatively short phase. In addition, the entire egg phase takes place in the pelagic zone of nearshore or lower estuarine waters, and thus substrate is not likely encountered (Welsh and Breder 1923).

Temperature
Minimum temperature is likely the main driver of northern kingfish reproduction and thus a necessary condition for egg development. Welsh and Breder (1923) spawned northern kingfish at 20 - 21 °C and based on average ocean temperatures for months listed as spawning times, northern kingfish likely spawn at temperatures between 18 - 27 °C.

Dissolved Oxygen
DO is probably not an issue for short-lived northern kingfish eggs that remain buoyant and pelagic, and thus out of hypoxic and anoxic zones.

Feeding Behavior
Northern kingfish eggs subsist entirely off the yolk sac prior to hatch. The feeding behaviors of larval northern kingfish have not been described. However, they likely consume zooplankton prey, such as copepods, decapods, and polychaetes (Able and Fahay 2010), similar to other sciaenids.

Competition and Predation
Northern Kingfish eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the offshore conditions). Predation of eggs undoubtedly occurs but has not been well studied or reported. Although potentially large numbers of eggs are killed from predation, there is no initial reason to think that pelagic oceanic predators are targeting northern kingfish eggs and larvae over other species. In the early stages (eggs and larvae), gelatinous zooplankton are likely the main predators of northern kingfish (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

No study has looked at competition and predation of larval northern kingfish but the larvae likely compete with gulf and southern kingfishes and other sciaenids including spot, Atlantic croaker, red drum, and black drum (Ralph 1982) as well as Florida pompano and silversides in the surfzone (Bearden 1963). Some competition likely takes place when a high-density larval patch settles on limited habitat; however, the wide range of settled habitats and protracted spawning season suggest that widespread competition is unlikely.

Part C. Juvenile Habitat

Juvenile northern kingfish are between 25 and 150 or 230 mm SL. The upper size varies between sexes due to the differential size at maturity. Juvenile northern kingfish inhabit the nearshore ocean and surfzone and the deeper waters of bays, estuaries, and sounds, including their tributary rivers. Northern kingfish are summer estuarine residents of estuarine beaches (Miller et al. 2002).

Geographic and Temporal Patterns of Migration
The general pattern of habitat use by juvenile northern kingfish is estuarine-wide beginning in late spring and early summer in lower estuarine and nearshore habitats. Juveniles move to deeper, more saline waters in the fall (Ralph 1982; Miller et al. 2002). Northern kingfish tend to remain in localized areas throughout the summer (Miller et al. 2002).

Salinity
Juvenile northern kingfish migrate to deeper more saline waters as they get larger. By the fall most northern kingfishes migrate out of the shallow estuarine and nearshore oceanic habitats to the deeper ocean habitats to overwinter (Bearden 1963; Ralph 1982; Miller et al. 2002). Growth rates were compared among different habitats and no significant differences were detected indicating that salinity does not impact growth rates Miller et al. 2002). The fish tended to leave the estuarine beaches at smaller sizes than at oceanic beaches (165 total length (TL) vs. 230 TL).

Substrate
Juvenile northern kingfish are typically observed over sandy sediment in shallow estuarine and surfzone environments and can be found over mud environments (Welsh and Breder 1923; Irwin 1971; Ralph 1982). There are reports of northern kingfish being caught over hard substrate including oyster shell (Irwin 1971; Ralph 1982).

Temperature
Juvenile northern kingfish likely tolerate a wide range of temperatures and it is considered to be an important variable driving their distribution. They are rarely seen in temperatures below 20 °C and migrate out of shallow waters in September and October (Ralph 1982; Miller et al. 2002). In a tank experiment, they avoided temperatures above 30 °C.

Dissolved Oxygen
Little has been reported on the impact of DO levels on juvenile northern kingfish. The lower estuary and surfzone environments may have fewer occurrences of hypoxic and anoxic events compared to upper estuarine habitats. However, northern kingfish do have a relatively fast growth rate (1.8 - 2.4 mm d^{-1} as juveniles) (Miller et al. 2002), which could be attributed to the elevated metabolic rate of the species (Horodysky 2011).

Feeding Behavior
Juvenile northern kingfish are benthic foragers (Chao and Musick 1977). They use their single barbel to detect prey. The juvenile diet consists of nematodes, polychaete worms, mysid shrimp, penaeid shrimp, isopods, amphipods, copepods, fishes, and detritus (Ralph 1982).

Competition and Predation
No study has looked at competition and predation of juvenile northern kingfish but the juveniles likely compete with gulf and southern kingfishes, other benthic foraging sciaenids (spot, Atlantic croaker, red drum, and black drum) (Ralph 1982), and Florida pompano and silversides in the surfzone (Bearden 1963).

Part D. Adult Habitat

Adult northern kingfish are schooling fish that reside in both estuarine and nearshore Atlantic Ocean habitats. Adult are found over clean sandy sediment with some reports of northern kingfish around hard substrate. Warming of coastal waters in the spring is a cue for a migration inshore and northward from the wintering grounds to nearshore ocean, bays, estuaries, and sounds. Northern kingfish migrate offshore and southward as temperatures decline in the fall.

Geographic and Temporal Patterns of Migration

Most northern kingfish mature after their first winter (Schaefer 1965; Collier et al. in prep). The general pattern of adult habitat use includes a seasonal migrations south and offshore in fall and winter and north and inshore during spring and summer (Irwin 1971; Ralph 1982; Miller et al. 2002). Summer inshore habitats extend from the estuaries to continental shelf in depths less than 18 m (Ralph 1982). Although it is not clear the depth where overwintering occurs, northern kingfish have been captured in depths of 36 m in the late fall off North Carolina with the deepest record being 128 m (Irwin 1971).

Salinity

Adult northern kingfish occur primarily in nearshore-ocean or lower estuarine habitats where salinities are at or near full seawater.

Substrate

In accordance with the variety of habitats used by adults, specific habitat use or habitat preference in adult northern kingfish has not been reported. Northern kingfish are typically found over sandy or muddy-sand substrates in the ocean, bays, and estuaries, but substrates used are likely as variable as the overall habitats in which adults are found. Some reports indicate that northern kingfish are found among hard substrate (Irwin 1971; Ralph 1982) and, anecdotally, fishermen indicated catches of northern kingfish are typically higher in close proximity to hard substrates.

Temperature

Temperature appears is driving factor in the movement of northern kingfish. They have reported temperature tolerances of 7.8 - 35.8 °C. In areas south of Cape Hatteras, northern kingfish are rarely seen in temperatures <20 °C. Adults have been reported dying due to cold stun in the northern part of their range (Irwin 1971). They have an upper thermal limit of 35 °C and avoid temperatures >31 °C (Ralph 1982).

Dissolved Oxygen

Adult northern kingfish likely experience normoxic conditions, as they typically are found in lower estuary or nearshore ocean. Without any explicit studies of adult northern kingfish DO tolerances or preferences, values can be inferred from other sciaenids that have overlapping habitat occurrences. It should be noted that the metabolic rate for northern kingfish was significantly higher than spot and Atlantic croaker (Horodysky et al. 2011), which suggests that northern kingfish may be more sensitive to hypoxia than other sciaenids.

Feeding Behavior

Adult northern kingfish are benthic feeders and use single barbel on the chin to detect the prey. Northern kingfish have been observed to consume shrimp, amphipods, mysids, and polychaete worms (Welsh and Breder 1923; Woodland et al. 2011).

Competition and Predation

Competition among adults is not well known. As with other life stages, northern kingfish overlap in their distribution with southern and gulf kingfishes, suggesting a potential for competition among these species. However, the diet on gulf kingfish appears to be more specialized than the other two species and the diets of southern and northern kingfishes indicated niche segregation (Woodland et al. 2011). Other potential competitors include other sciaenids and Florida pompano.

Kingfish spp. otoliths have been observed in the stomachs of cetaceans (Tyner 2004) and likely predators include larger sciaenids and coastal sharks.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

Northern kingfish use a variety of habitats in lower reaches of estuaries and nearshore oceanic habitats. They are observed over sand and mud substrate in nearshore ocean, bays, estuaries, and sounds. Some studies have reported around hard substrate (Welsh and Breder 1923; Irwin 1971; Ralph 1982).

Identification of Habitat Areas of Particular Concern

There is no HAPC designation for northern kingfish.

Present Condition of Habitat Areas of Particular Concern

The quality of northern kingfish habitats has been compromised largely by impacts from human activities. It is generally assumed that these habitats have undergone some degree of loss and degradation; however, few studies quantify the impacts in terms of the area of habitat lost or degraded.

Habitat loss due to water quality degradation is evident in the northeast Atlantic coast estuaries. The New York Bight, for example, has regularly received deposits of contaminated dredged material, sewage sludge, and industrial wastes. These deposits have contributed to oxygen depletion and the creation of large masses of anoxic waters during the summer months.

Some losses have likely occurred due to the intense coastal development that has occurred during the last several decades, although no quantification has been done. Losses have likely resulted from dredging and filling activities that have eliminated shallow water nursery habitats. Further functional losses have likely occurred due to water quality degradation from point and non-point sources. Intensive conversion of coastal wetlands to agricultural use also is likely to have contributed to functional loss of northern kingfish nursery area habitat, particularly estuarine beaches.

Other functional loss of riverine and estuarine areas may have resulted from changes in water discharge patterns resulting from withdrawals or flow regulation. Estuarine nursery areas for northern kingfish, as well as adult spawning and pre-spawning areas, may be affected by prolonged exposure to extreme conditions from inland water management practices.

Beach renourishment projects are likely to have an impact on northern kingfish. Kingfishes utilize the surfzone to different degrees as they develop. Juveniles are residents of the surfzone and lower estuaries (Miller et al. 2002). Northern kingfish densities were highest during a beach renourishment project, suggesting that individuals were attracted to the bioturbated region (Wilber et al. 2003). Short-term and long-term monitoring on the effects of beach renourishment is needed to better understand the impacts on kingfish.

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of northern kingfish

The timing of seasonal and spawning migrations appear to be linked to temperature, as well as their overall distribution within estuarine and coastal ecosystems. As temperatures cool in the fall, northern kingfish move south and offshore to deeper water that is more stable in temperature. They return to northern, inshore habitats as temperatures increase again in the spring and summer (Irwin 1971; Ralph 1982; Miller et al. 2002). In the summer, individuals use sand and mud bottomed habitats in lower estuaries and along the continental shelf in depths less than 18 m (Ralph 1982).

Unknowns and Uncertainties

Little research has been conducted on northern kingfish at any life stage and a comprehensive coastwide study that covers their geographic range is needed. The impacts of dredge and fill projects including renourishment projects cannot be fully assessed without additional research to understand habitats that are essential fish habitat.

In addition, it is often difficult to distinguish the early stages of kingfish spp., which adds confusion when investigating and determining physiological tolerances to environmental conditions. More research is required in the biology and life history of northern kingfish following a revision of the diagnostic characters used to identify northern kingfish in larval and juvenile collections.

Another consideration for northern kingfish is that they forage within and along the sediment of the benthos, which concentrates hydrophobic toxicants, potentially increasing their exposure to these contaminants. No known research has examined the impacts of toxicant exposure on early stage northern kingfish, which may have developmental or reproductive implications.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Currently, northern kingfish is not managed through the Interstate Fisheries Management Program (ASMFC 2014). The following recommendations are based on recommendations made in NCDMF 2007 and FMPs for other sciaenids:

1. Protect known nursery areas from activities likely to negatively impact northern kingfish.

2. Integrate beach and inlet management plans into a coastwide plan that minimizes impacts to the habitat of kingfishes and other estuarine fishes.

3. Require beach renourishment and dredge and fill projects adhere to state, regional, or national policies and require robust monitoring before and after dredge, renourishment, and fill activities.

4. Modify stormwater rules or policies to more effectively reduce the volume and pollutant loading of stormwater runoff entering coastal waters.

5. Minimize contamination of bottom sediments through protection and enhancement of wetlands utilizing regulatory and non-regulatory measures, such as land use planning, land acquisition, vegetated buffers, and permitting regulations.

6. Implement and enforce sediment compatibility criteria for beach nourishment projects.

Habitat Research Recommendations

Currently, northern kingfish is not managed through the Interstate Fisheries Management Program (ASMFC 2014). The following recommendations are based on recommendations made in NCDMF 2007 and FMPs for other sciaenids to improve our understanding of the biology, habitat use, and potential stressors of northern kingfish.

1. Conduct studies to delineate northern kingfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat.

2. Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent.

3. Define restrictions necessary for implementation of projects in spawning and overwintering areas and develop policies on limiting development projects seasonally or spatially.

4. Recommend BACI studies for beach renourishment projects to describe the impact/benefit of renourishment.

5. Develop consistent methods for studying impact of beach renourishment to allow for comparison spatially and temporally.

6. Determine impact of beach stormwater outfalls on kingfish populations.

7. Determine impact of bottom disturbing gear on kingfish spawning, nursery, and feeding habitats.

8. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.

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CHAPTER 9: Southern kingfish

Section I. General Description of Habitat

Southern kingfish are found in estuaries and coastal areas from Long Island, New York to Buenos Aires, Argentina (Irwin 1971) and are more common in the South Atlantic Bight than Mid Atlantic Bight (Hildebrand and Schroeder 1928; Smith and Wenner 1985). Southern kingfish prefer habitats close to inlets and in the ocean at depths ranging from 5 - 27 m (Bearden 1963; Harding and Chittenden 1987). Juvenile southern kingfish inhabit shallower waters than the adult southern kingfish and were found in waters less than 16 m whereas adults are found in waters less than 23 m (Bearden 1963; Crowe 1984; Harding and Chittenden 1987).

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Southern Kingfish are thought to migrate southward during the winter and northward prior to the spawning season (Hildebrand and Cable 1934; Smith and Wenner 1985; Beresoff and Schoolfield 2002).

Salinity

Adult southern kingfish are spawn in lower estuarine and coastal habitats in waters that have moderate to high salinities (Bearden 1963; Irwin 1971; Dahlberg 1972; Smith and Wenner 1985). They are found in higher salinity waters than juveniles (>20 ppt) (Bearden 1963; Irwin 1971; Crowe 1984).

Substrate

The spawning habitat has not been described for southern kingfish but they are typically found over sandy and muddy bottoms in the ocean or in deeper channels (Welsh and Breder 1923; Hildebrand and Cable 1934; Bearden 1963).

Temperature

Southern Kingfish migrate based on temperature and will remain in the lower estuary and nearshore ocean during the spawning season. They have been observed in temperatures from 8 - 37 °C (Crowe 1984). The temperature range is likely to vary with latitude with southern kingfish from the Mid Atlantic experiencing lower temperatures than fish inhabiting the South Atlantic and Gulf of Mexico.

Dissolved Oxygen

Preferences for dissolved oxygen (DO) have not been reported for adult and spawning southern kingfish. Based on suspected spawning locations (deep estuaries and nearshore ocean) low DO and hypoxic conditions are likely rare.

Feeding Behavior

Diets of southern kingfish were typically reported during the summer months, which include the spawning season. The diet varied and was often comprised of fished (including silversides, anchovies, star drum, and tonguefish), *Squilla*, *Crangon*, penaeid shrimp, mysids, polycheate worms, and copepods in the South Atlantic Bight (Irwin 1971; Woodland et al. 2011).

Competition and Predation

Competitors of southern kingfish likely include other sciaenids (northern kingfish, gulf kingfish, spot, Atlantic croaker, red drum, and black drum) due to diet and habitat overlap. One study reported dietary overlap between southern kingfish, Clearnose Skate, and Smooth Dogfish (Woodland et al. 2011). Few studies have reported on competition or predation of spawning southern kingfish, though it might be safely inferred that adult competition and predation descriptions apply to spawners, particularly because the prolonged spawning season, which suggests that spawning is integrated into the ecology of adults.

Part B. Egg and Larval Habitat

The eggs of southern kingfish are buoyant and the water column is the primary habitat. Eggs have been reported in the water column of the nearshore ocean and in estuaries.

Larvae of southern kingfish are defined as kingfish <25 mm SL although the size of transition is not clearly defined (Welsh and Breder 1923). It is likely the nursery habitats for southern kingfish extend from the nearshore ocean into upper reaches of estuaries due to tidal transport. The greatest concentration of larvae southern kingfish occur in the nearshore ocean and lower estuaries (Irwin 1971; Ralph 1982; Flores-Coto et al. 1999; Reiss and McConaugha 1999; Markovsky 2009).

Geographic and Temporal Patterns of Migration

Mature southern kingfish spawn in the nearshore ocean and lower reaches of deep estuaries (NCDMF 2007). Spawning begins in the southern region of the distribution (e.g., Florida) early in the spring and likely begins later in the spring at northern latitudes (Irwin 1971). Eggs are likely subjected to a variety of environmental conditions due to the protracted spawning season and broad geographic distribution from Florida to Maine in euryhaline areas (Bearden 1963).

Southern Kingfish larvae are widely distributed and have been reported in nearshore ocean waters and throughout estuaries (Bearden 1963; Irwin 1971; Crowe 1984). This wide distribution is driven by the use of currents to migrate into nurseries.

Salinity

Salinity has not been reported but eggs and larvae of kingfishes (some studies do not differentiate) indicate they are concentrated in the ocean near inlets and the lower parts of estuaries where salinities are higher (Flores-Coto et al. 1999; Reiss and McConaugha 1999; Markovsky 2009).

Southern Kingfish larvae likely tolerate a wide range of salinities based on their wide distribution but are most common in waters with salinities >20 ppt (Bearden 1963). As southern kingfish grow, they are increasing found in higher salinity waters (Bearden 1963; Crowe 1984).

Substrate

Like many marine fish eggs, southern kingfish eggs are buoyant, and have a relatively short phase (compared to other life stages) with the entire egg phase taking place in the pelagic zone of nearshore or lower estuarine waters, and thus substrate is not likely encountered.

Larval southern kingfish are likely planktonic and then benthic after settlement (Hildebrand and Cable 1934). The likely substrates include sandy, muddy, and shell substrate in shallow estuarine and surfzone environments (Hildebrand and Cable 1934).

Temperature
Minimum temperature is likely the main driver of southern kingfish reproduction and thus a necessary condition for egg development. Based on observations for larvae, southern kingfish were observed in temperatures from 24 - 30 °C in the Gulf of Mexico (Crowe 1984). This range of temperatures might be narrower than the temperature tolerance in the Atlantic based on reported months of spawning from March to September (20 - 30 °C).

Dissolved Oxygen
Due to a likely short larval duration similar to southern kingfish and the pelagic habitat, it is unlikely that they encounter any habitats in which DO imposes a limitation or threat.

Feeding Behavior
Southern kingfish eggs subsist entirely off the yolk sac prior to hatch. The feeding behaviors of larval southern kingfish has been described as more general than adults in that the early stages are consuming planktonic prey (Chao and Musick 1977).

Competition and Predation
Southern Kingfish eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the offshore conditions). Predation of eggs undoubtedly occurs but has not been well studied or reported. Although potentially large numbers of eggs are killed from predation, there is no initial reason to think that pelagic oceanic predators are targeting weakfish eggs over other, similar pelagic eggs. As with other marine fishes, eggs and larvae are susceptible to predation by gelatinous zooplankton (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

No study has looked at competition and predation of larval southern kingfish but they likely compete with gulf and northern kingfishes and other members of the sciaenid family including spot, Atlantic croaker, weakfish, red drum, and black drum (Ralph 1982) as well as Florida pompano and silversides in the surfzone (Bearden 1963). Some competition likely takes place when a high-density larval patch settles on limited habitat; however, the wide range of settled habitats and protracted spawning season suggest that widespread competition is unlikely.

Part C. Juvenile Habitat

Juvenile southern kingfish are generally between the sizes of 25 and 120 or 180 mm SL, due to different size at maturing between the sexes. Juvenile southern kingfish inhabit the nearshore ocean and surfzone and the deeper waters of bays, estuaries, and sounds, including their tributary rivers.

Geographic and Temporal Patterns of Migration
The general pattern of habitat use by juveniles is estuarine-wide and begins in late spring and early summer in lower estuarine and nearshore habitats. In the fall, juveniles move to deeper, more saline waters (Crowe 1984). Southern kingfish are summer residents of the surfzone and estuaries (Dahlberg 1972; Crowe 1984).

Salinity

Juvenile southern kingfish migrate to deeper more saline waters as size increases. By the fall most southern kingfish migrate out of the shallow estuarine and nearshore ocean environment to the deeper ocean habitats to overwinter (Bearden 1963; Harding and Chittenden 1987). The fish tended to leave the estuarine beaches at smaller sizes than oceanic beaches (160 mm TL vs. 200 mm TL) (Harding and Chittenden 1987). It is not known if salinities impact growth rates.

Substrate

Juveniles are observed over sandy, muddy, and shell substrates in shallow estuarine and surfzone environments (Bearden 1963; Irwin 1971; Harding and Chittenden 1987). In the fall, the most juvenile southern kingfish will migrate into the ocean (Hildebrand and Cable 1934; Smith and Wenner 1985; Harding and Chittenden 1987). However, some individuals will remain in the estuary throughout the winter (Bearden 1963).

Temperature

Juvenile southern kingfish tolerate a wide range of temperatures. They are rarely seen in temperatures below 15 °C and migrate out of shallow waters in September and October (Crowe 1984; Harding and Chittenden 1987).

Dissolved Oxygen

Little has been reported on the impact of DO levels on juvenile southern kingfish. The lower estuary and surfzone environments may have fewer occurrences of hypoxic and anoxic events compared to upper estuarine habitats. However, southern kingfish do have a relatively fast growth rate (Hildebrand and Cable 1934; Bearden 1963; Crowe 1984) and likely contributes to the elevated metabolic rate (Horodysky et al. 2011) and increased oxygen consumption.

Feeding Behavior

Juveniles are benthic foragers and use a single barbel to detect prey. The juvenile diet consists of nematodes, polychaete worms, mysid shrimp, penaeid shrimp, isopods, amphipods, copepods, fishes, and detritus (Welsh and Breder 1923; Bearden 1963).

Competition and Predation

No study has looked at competition and predation of juvenile southern kingfish but the juveniles likely compete with gulf and northern kingfishes and other sciaenids (spot, Atlantic croaker, red drum, and black drum) (Ralph 1982) as well as Florida pompano and silversides in the surfzone (Bearden 1963).

Part D. Adult Habitat

Adults are schooling fish that reside in both estuarine and nearshore Atlantic Ocean habitats. Adult southern kingfish are typically found over clean, sandy sediment with some reports of southern kingfish found over muddy and shell bottoms. Warming of coastal waters in the spring keys migration northward from the wintering grounds (Smith and Wenner 1985). Southern kingfish migrate generally southward as temperatures decline in the fall (Smith and Wenner 1985).

Geographic and Temporal Patterns of Migration

Most southern kingfish mature after their first winter (Smith and Wenner 1985; Collier et al. in prep). Adults undertake seasonal migrations south and offshore in fall and winter and north and inshore during spring and summer (Irwin 1971; Smith and Wenner 1985; Beresoff and Schoolfield 2002). Summer inshore habitats are from the estuary to continental shelf in depths between <5 - 30 m (Harding and Chittenden 1987). Although it is not clear at which depth overwintering occurs, southern kingfish have been captured in depths up to 54 m in the late fall (Bearden 1963).

Salinity
Adult southern kingfish occur primarily in nearshore ocean or lower estuarine habitats and salinities are near full seawater.

Substrate
Southern kingfish are typically found over sandy or muddy-sand substrates in the ocean, bays, and estuaries (Irwin 1971; Harding and Chittenden 1987).

Temperature
Temperature appears to be a driving factor in the movement of southern kingfish. They have reported temperature tolerances of 7 - 33 °C (Irwin 1971; Crowe 1984). In areas south of Cape Hatteras, southern kingfish are more commonly seen in temperatures >15 °C (Irwin 1971).

Dissolved Oxygen
Adults likely experience normoxic conditions, as they typically are found in lower estuary or nearshore ocean. Without any explicit studies of adult southern kingfish DO tolerances or preferences, DO requirements might be inferred from other sciaenids with overlapping habitat occurrences southern kingfish have high metabolic rates (Horodysky et al. 2011) and may be more sensitive to low DO conditions.

Feeding Behavior
Adult southern kingfish are benthic feeders that consume fishes (including silversides, anchovies, star drum, and tonguefish), *Squilla*, *Crangon*, Penaeid shrimp, mysids, polycheate worms, and copepods in the South Atlantic Bight (Irwin 1971; Woodland et al. 2011).

Competition and Predation
Competition among adults is not well known. Based on reports, southern kingfish overlap their distribution with northern and gulf kingfishes; however the diet of gulf kingfish appears to be much more specialized. The diet of southern and northern kingfishes indicate niche segregation is present. However, southern kingfish diets did overlap with smooth dogfish and clearnose skates (Woodland et al. 2011). Other potential competitors include other members of the sciaenid family and Florida pompano.

Kingfish spp. otoliths have been observed in the stomachs of cetaceans (Tyner 2004) and likely predators include larger sciaenids and coastal sharks.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat
Unlike northern kingfish, southern kingfish are more abundant in the South Atlantic Bight in slightly deeper waters (27 m vs. 20 m for northern kingfish) (Welsh and Breder 1923; Bearden 1963; Schaefer 1965; Harding and Chittenden 1987; Miller et al. 2002). However, both species are found near inlets and

nearshore ocean habitats, although the peak range of abundance is spatially separated, there is a high degree of habitat overlap between northern and southern kingfishes.

Southern kingfish use a variety of habitats in lower reaches of estuaries and nearshore oceanic habitats. They are observed over sand, mud, and shell substrates in the surfzone, nearshore ocean, bays, estuaries, and sounds (Bearden 1963; Harding and Chittenden 1987).

Identification of Habitat Areas of Particular Concern

There is no HAPC designation for southern kingfish.

Present Condition of Habitat Areas of Particular Concern

The quality of southern kingfish habitats has been compromised largely by impacts resulting from human activities. It is generally assumed that these habitats have undergone some degree of loss and degradation; however, few studies quantify the magnitude of habitat lost or degradation.

Loss due to water quality degradation is evident in the northeast Atlantic coast estuaries. The New York Bight, for example, has regularly received deposits of contaminated dredged material, sewage sludge and industrial wastes. These deposits have contributed to oxygen depletion and the formation of large masses of anoxic waters during the summer months, which may reduce the habitat available to southern kingfish.

Some losses have likely occurred due to the intense coastal development that has occurred during the last several decades, although no quantification has been done. Losses have likely resulted from dredging and filling activities that have eliminated shallow water nursery habitat. Further functional losses have likely occurred due to water quality degradation resulting from point and non-point discharge sources. Intensive conversion of coastal wetlands to agricultural use also is likely to have contributed to functional loss of southern kingfish nursery area habitat. Other functional loss of riverine and estuarine areas may have resulted from changes in water discharge patterns resulting from withdrawals or flow regulation. Estuarine nursery areas for southern kingfish, as well as adult spawning and pre-spawning areas, may be affected by prolonged exposure to extreme conditions from inland water management practices.

Beach renourishment projects are likely to have an impact on southern kingfish. Kingfish utilize the surfzone to different degrees as they progress through their life stages. Juveniles are localized-residents of the surfzone and lower estuaries (Miller et al. 2002). Southern kingfish were observed to increase in density during a beach renourishment project, potentially attracted to the bioturbation (Wilber et al. 2003). Short-term and long-term monitoring on the effects of beach renourishment is needed to better understand the impacts on kingfish.

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Schroeder 1928; Bearden 1963; Smith and Wenner 1985; Harding and Chittenden 1987). In the summer, individuals use deeper habitats than northern kingfish over sand, mud, and shell bottomed habitats in lower estuaries and along the continental shelf in depths less than 27 m (Bearden 1963; Harding and Chittenden 1987).

Unknowns and Uncertainties

Little research has been conducted on southern kingfish at any life stage and a comprehensive coastwide study that covers their geographic range is needed. The impacts of dredge and fill projects including renourishment projects cannot be fully assessed without additional research to understand habitats that are essential fish habitat.

In addition, it is often difficult to distinguish the early stages of kingfish spp., which adds confusion when investigating and determining physiological tolerances to environmental conditions. Slight differences in diet and habitat have been described among kingfishes but more work is needed to fully resolve these ecological differences so that they can be implemented into a management perspective.

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4. Modify stormwater rules or policies to more effectively reduce the volume and pollutant loading of stormwater runoff entering coastal waters.

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CHAPTER 10: Gulf kingfish

Section I. General Description of Habitat

Gulf kingfish are found in coastal areas from Chincoteague, Virginia to Rio Grande, Brazil and is most common south of Cape Hatteras and in the Gulf of Mexico (Irwin 1971). This species prefers surfzone habitats and oceanic habitats <10 m deep (Welsh and Breder 1923; Bearden 1963; Irwin 1971). Gulf kingfish are rarely found in habitats other than the nearshore-ocean unlike southern and northern kingfishes which utilize estuarine habitats along with the nearshore ocean.

Part A. Spawning Habitat

Geographic and Temporal Patterns of Migration

Gulf kingfish are thought to migrate inshore and northward from their overwintering habitats during the spring and summer while spawning is occurring (Hildebrand and Cable 1934). Fish in spawning condition have been observed from April through September in North Carolina (Collier in prep; Hildebrand and Cable 1934; Bearden 1963; Modde 1980). Spawning occurs in the shallow nearshore ocean (Irwin 1971; Braun and Fontoura 2004).

Salinity

Adult gulf kingfish spawn in the nearshore-ocean where the waters are at full salinity (Braun and Fontoura 2004).

Substrate

The spawning habitat has not been described for gulf kingfish but spawners are typically found over sandy bottoms (Hildebrand and Cable 1934; Bearden 1963).

Temperature

Gulf Kingfish migrate based on temperature and nearshore ocean during the spawning season. They have been observed in temperatures from 10 - 31 °C (Irwin 1971). Little research has been conducted on temperature preferences for spawning gulf kingfish but based on the temperatures where juveniles are observed spawning likely occurs between 18 and 30 °C.

Dissolved Oxygen

Preferences for dissolved oxygen (DO) have not been reported for adult and spawning gulf kingfish. Based on suspected spawning locations, low DO and hypoxic conditions are likely rare.

Feeding Behavior

Diets were described during the summer months, which includes the spawning season. The diet of gulf kingfish is more specialized than northern and southern kingfishes likely due to their more limited habitat range and molar-like pharnygeal teeth. Gulf kingfish diet includes mole crabs, *Donax*, polychaetes, brachyurans, stomatopod, *Squilla*, and fishes (Bearden 1963; McMichael and Ross 1987).

Competition and Predation

Competitors likely include other members of sciaenid family, especially other benthic sciaenids (southern and northern kingfishes, spot, Atlantic croaker, red drum, and black drum) based on diet and habitat overlap. No studies have reported on competition or predation of spawning gulf kingfish, though adult competition and predation descriptions apply to spawners, particularly because the long spawning season.

Part B. Egg and Larval Habitat

The eggs of gulf kingfish are likely buoyant and water column is the primary habitat. Research has not been conducted on egg and larval development.

Larvae of gulf kingfish are defined as kingfish <25 mm SL although the size of transition is not clearly defined (Hildebrand and Cable 1934). It is likely the nursery habitats for gulf kingfish extend from the nearshore ocean to the surfzone since the greatest concentration of larvae occur in the these areas (Bearden 1963; Irwin 1971; Modde 1980).

Geographic and Temporal Patterns of Migration

Mature gulf kingfish spawn in the nearshore ocean (Braun and Fontoura 2004). Eggs are likely subjected to a variety of environmental conditions due to the protracted spawning season and broad geographic distribution from Florida to Virginia (Bearden 1963).

Gulf kingfish larvae are widely distributed in nearshore-ocean waters and surfzone (Bearden 1963; Irwin 1971). It is likely the larval transport of gulf kingfish is through longshore currents.

Salinity

Salinity preferences/tolerances have not been reported for gulf kingfish eggs but larvae and juveniles of gulf kingfish are rarely reported in areas other than nearshore ocean and surfzone. It is not known if eggs can tolerate salinities less than full strength seawater, but larvae and juvenile gulf kingfish are rare in lower salinity estuarine systems. Larvae likely tolerate a narrow range of salinities based on their primarily oceanic distribution (Bearden 1963).

Substrate

Like many marine fish eggs, gulf kingfish eggs are pelagic and found in nearshore or lower estuarine waters, and thus substrate is not likely encountered. When larvae are planktonic, the larvae would not come in contact with the substrate over which they are dispersed but when larvae settle, they likely settle on sand substrate similar to the substrate used by juveniles.

Temperature

Minimum temperature is likely the main driver of gulf kingfish reproduction and thus a necessary condition for egg development. Gulf kingfish are uncommon under 20°C (Bearden 1963) in the nearshore ocean, which is the spawning location (Braun and Fontoura 2004). Based on average ocean temperatures for months listed as spawning times, gulf kingfish likely spawn at temperatures between 18 - 27 °C, which is the likely preferred temperature range for eggs and larvae.

Dissolved Oxygen

DO is probably not an issue for short-lived gulf kingfish eggs that likely remain buoyant and pelagic, and thus out of hypoxic and anoxic zones. Due to the likely short larval duration and oceanic habitat, it is unlikely that they encounter any habitats in which DO imposes a limitation or threat.

Feeding Behavior
Gulf Kingfish eggs subsist entirely off the yolk sac prior to hatching. The feeding behaviors of larvae have not been described. Additional research is needed, but the behaviors are likely similar to other sciaenids in that they feed on planktonic organisms, primarily copepods.

Competition and Predation
Gulf Kingfish eggs likely do not enter into any meaningful ecological competition, as their habitat demands are basic (and largely met by the offshore conditions). Predation of eggs undoubtedly occurs but has not been well studied or reported. Although potentially large numbers of eggs are killed from predation, there is no initial reason to think that pelagic oceanic predators are targeting gulf kingfish eggs over other, similar pelagic eggs. Gelatinous zooplankton are the likely predators of gulf kingfish eggs and larvae (Purcell 1985; Olney and Boehlert 1988; Cowan et al. 1992).

No study has examined competition and predation of larval gulf kingfish but the larval probably compete with northern and southern kingfishes (McMichael and Ross 1987) and other sciaenids including spot, Atlantic croaker, red drum, and black drum (Ralph 1982) as well as Florida pompano and silversides in the surfzone (Bearden 1963). Some competition likely takes place when a high-density larval patch settles on limited habitat; however, the wide range of settled habitats and protracted spawning season suggest that widespread competition is unlikely.

Part C. Juvenile Habitat
Juveniles are between the sizes of 25 and 150 or 230 mm SL (upper size varies between sexes). Juvenile gulf kingfish inhabit the nearshore ocean and surfzone. Gulf kingfish are summer residents of the surfzone (Ross and Lancaster 2002; Felix et al. 2007; Branson 2009).

Geographic and Temporal Patterns of Migration
Juvenile gulf kingfish use the surfzone in late spring and early summer and move to deeper waters as temperatures cool (Braun and Fontoura 2004). Gulf kingfish tend to remain in localized areas throughout the summer (Ross and Lancaster 2002; Felix et al. 2007; Branson 2009).

Salinity
Juveniles migrate to deeper waters as they get larger (Braun and Fontoura 2004). By the fall most gulf kingfish migrate out of the nearshore ocean environment to the deeper ocean habitats to overwinter (Bearden 1963) and therefore remain at full marine salinity. There are also few reports of gulf kingfish being caught in estuaries (Bearden 1963; Irwin 1971; Branson 2009).

Substrate
Juveniles are typically observed over sandy sediment in surfzone environments (Hildebrand and Cable 1934; Irwin 1971; Ross and Lancaster 2002).

Temperature
Juvenile gulf kingfish tolerate a wide range of temperatures. Juvenils are rarely found in temperatures below 20 °C and migrate out of shallow waters in September and October (Bearden 1963; Modde 1980).

Dissolved Oxygen

Little has been reported on the impact of DO levels on juvenile gulf kingfish. The surfzone environment may have fewer occurrences of hypoxic and anoxic events compared to estuarine habitats.

Feeding Behavior

Juvenile gulf kingfish are typically described as benthic foragers. They use their barbel to detect prey and their molar-like pharyngeal teeth to crush shells. The juvenile diet consists of bivalve siphon tips, cumaceans, copepods, mysids, and amphipods, and polychaetes (Bearden 1963; McMichael and Ross 1987). Juveniles appear to atrophy their swimbladder at smaller size than other kingfishes and likely switch to a more benthic diet at smaller sizes.

Competition and Predation

No study has looked at competition and predation of juvenile gulf kingfish but the juveniles compete with northern and southern kingfishes (McMichael and Ross 1987) and other sciaenids such as spot, Atlantic croaker, red drum, and black drum (Ralph 1982) as well as Florida pompano and silversides in the surfzone (Bearden 1963).

Part D. Adult Habitat

Adult gulf kingfish reside in nearshore Atlantic Ocean habitats. Adults are typically found over clean sandy sediment with few reports of gulf kingfish found in estuarine habitats. Most gulf kingfish mature after their first winter (Collier et al. in prep). Warming of coastal waters in the spring keys migration inshore and northward from the wintering grounds. Adults migrate generally offshore and southward as temperatures decline in the fall.

Geographic and Temporal Patterns of Migration

Adults undergo seasonal migrations south and offshore in fall and winter and north and inshore during spring and summer (Irwin 1971). Although it is not clear the depth at which overwintering occurs, gulf kingfish have been captured in depths of 27 m in the Gulf of Mexico during the winter (Irwin 1971). Adults migrate inshore from deeper habitats for spawning (Braun and Fontoura 2004).

Salinity

Adult gulf kingfish occur primarily in nearshore ocean habitats where salinities are near full seawater.

Substrate

Gulf Kingfish are typically found over sandy substrates in the nearshore ocean and surfzone.

Temperature

Temperature appears to be a driving factor in the movement of gulf kingfish. Gulf kingfish have reported temperature tolerances of 10 - 31 °C (Irwin 1971) and are rarely observed in temperatures <20 °C (Bearden 1963).

Dissolved Oxygen

Adults likely experience normoxic conditions, as they are found in the nearshore ocean. Without any explicit studies of adult gulf kingfish DO tolerances or preferences, values might be inferred from other sciaenids that have overlapping habitat occurrences. Like other kingfishes, gulf kingfish have high metabolic rates (Horodysky et al. 2011), which suggests that they are more sensitive to low DO than other sciaenids.

Feeding Behavior

The diet has been reported to include: whole *Donax*, polychaetes, *Emerita*, brachyurans, *Squilla*, and fishes (Bearden 1963; McMichael and Ross 1987).

Competition and Predation

Competition among adult gulf kingfish is not well known. Based on reports, gulf kingfish overlap their distribution with southern and northern kingfishes (McMichael and Ross 1987); however the diet of gulf kingfish appears to be much more specialized than the other kingfishes. Other potential competitors include other members of the sciaenid family and Florida pompano. Kingfish spp. otoliths have been observed in the stomachs of cetaceans (Tyner 2004) and likely predators include larger sciaenids and coastal sharks.

Section II. Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitat

Unlike northern and southern kingfishes, gulf kingfish are more abundant in surfzone habitats and rarely venture into the lower reaches of estuaries in depths less than 10 m (Welsh and Breder 1923; Bearden 1963; Irwin 1971). Gulf kingfish are observed over sand substrates almost exclusively in the surfzone (Hildebrand and Cable 1934; Irwin 1971; Branson 2009).

Identification of Habitat Areas of Particular Concern

There is no HAPC designation for gulf kingfish.

Present Condition of Habitat Areas of Particular Concern

The quality of gulf kingfish habitats has been compromised largely by impacts resulting from human activities. It is generally assumed that these habitats have undergone some degree of loss and degradation; however, few studies quantify the impacts of habitat loss or degradation.

Some losses have occurred due to the intense coastal development that has occurred during the last several decades, although this has not been quantified. Losses have resulted from dredging and filling activities that have eliminated shallow water nursery habitats. Further functional losses have occurred due to water quality degradation due to discharges from point and non-point sources.

Beach renourishment projects are likely to have an impact on gulf kingfish. Kingfishes utilize the surfzone to different degrees as they progress through their life stages. Juveniles are localized-residents of the surfzone (Ross and Lancaster 2002; Felix et al. 2007) and are found in few other habitats. Short-term and long-term monitoring on the effects of beach renourishment is needed to better understand the impacts on kingfish.

Section III. Threats and Uncertainties

Significant Environmental, Temporal, and Spatial Factors Affecting Distribution of gulf kingfish

The timing of seasonal and spawning migrations appear to be linked to temperature. As temperatures cool in the fall, gulf kingfish move south and offshore to deeper water that is more stable in temperature. They return to northern, inshore habitats as temperatures increase again in the spring and summer (Irwin 1971). When gulf kinfish are nearshore, they remain in the coastal surfzone full marine salinity and rarely move into estuarine environments (Bearden 1963; Irwin 1971). Gulf kingfish prefer sandy substrates (Irwin 1971; Ross and Lancaster 2002).

Unknowns and Uncertainties

Little research has been conducted on gulf kingfish at any life stage and a comprehensive coastwide study that covers their geographic range is needed. The impacts of dredge and fill projects including renourishment projects cannot be fully assessed without additional research to understand which habitats are essential fish habitat.

In addition, it is often difficult to distinguish the early stages of kingfish spp., which adds confusion when investigating and determining physiological tolerances to environmental conditions. Slight differences in diet and habitat have been described among kingfishes but more work is needed to fully resolve these ecological differences so that they can be implemented into a management perspective.

Another consideration for gulf kingfish is that they forage within and along the sediment of the benthos, which concentrates hydrophobic toxicants, potentially increasing their exposure to these contaminants. No known research has examined the impacts of toxicant exposure on early stage gulf kingfish, which may have developmental or reproductive implications.

Section IV. Recommendations for Habitat Management and Research

Habitat Management Recommendations

Currently, gulf kingfish is not managed through the Interstate Fisheries Management Program (ASMFC 2014). The following recommendations are based on recommendations made in NCDMF 2007 and FMPs for other sciaenids:

1. Protect known nursery areas from activities likely to negatively impact gulf kingfish.

2. Integrate beach and inlet management plans into a coastwide plan that minimizes impacts to the habitat of kingfishes and other estuarine fishes.

3. Require beach renourishment and dredge and fill projects adhere to state, regional, or national policies and require robust monitoring before and after dredge, renourishment, and fill activities.

4. Modify stormwater rules or policies to more effectively reduce the volume and pollutant loading of stormwater runoff entering coastal waters.

5. Minimize contamination of bottom sediments through protection and enhancement of wetlands utilizing regulatory and non-regulatory measures, such as land use planning, land acquisition, vegetated buffers, and permitting regulations.

6. Implement and enforce sediment compatibility criteria for beach nourishment projects.

Habitat Research Recommendations

Currently, gulf kingfish is not managed through the Interstate Fisheries Management Program (ASMFC 2014). The following recommendations are based on recommendations made in NCDMF 2007 and FMPs for other sciaenids to improve our understanding of the biology, habitat use, and potential stressors of gulf kingfish.

1. Conduct studies to delineate gulf kingfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat.

2. Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent.

3. Define restrictions necessary for implementation of projects in spawning and overwintering areas and develop policies on limiting development projects seasonally or spatially.

4. Recommend BACI studies for beach renourishment projects to describe the impact/benefit of renourishment.

5. Develop consistent methods for studying impact of beach renourishment to allow for comparison spatially and temporally.

6. Determine impact of beach stormwater outfalls on kingfish populations.

7. Determine impact of bottom disturbing gear on kingfish spawning, nursery, and feeding habitats.

8. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.

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Chapter 11: Threats to Atlantic Sciaenid Habitats

Section I. Identification of Threats

The habitat threats that are outlined below pertain to the Atlantic sciaenids outlined in this document, although certain species and life stages may be more impacted than others. All of the Atlantic sciaenids have life stages that are estuarine-dependent, as nurseries or seasonal foraging areas (Murdy and Musick 2013; Deary and Hilton 2016).

Threat 1: Beach renourishment

Source of Threat: Human activities to contribute more sediment to recreational beaches and provide material for infill. The threats of beach renourishment on sciaenids is from removal of preferred substrate (particularly sediment size), burial of individuals and potential prey, changes in prey community (Irlandi and Arnold 2008), increased turbidity (Green 2002; Peterson and Bishop 2005), and release of toxicants buried in sediments. Although beach renourishment can impact all sciaenids through increased turbidity, which can decrease the visual abilities of sciaenids, but renourishment projects probably affect benthic associated sciaenids (red drum, spot, Atlantic croaker, kingfishes, black drum) since they spend most of their lives associated with the benthos.

Rank of Threat (ex. Low, Medium, High): According to the ASMFC's Interstate Fishery Management Plan for Red Drum (2002), the impacts of beach renourishments were ranked as **Medium**.

Threat 2: Degradation of water quality (Pollutants, nutrient enrichment, sediment loading, hypoxia)

Source of Threat: Human activities in many cases are the sources of water quality degradation. Industrial waste accumulates in bottom sediments and can be disturbed during dredging and beach renourishment projects (Riggs et al. 1991). Many coastal estuarine systems due to their proximity to industrial areas and sediment characteristics are susceptible to toxicant contamination (Street et al. 2005). In Atlantic croaker, toxicants have been noted to significantly reduce growth rates and condition (Burke et al. 1993), which are likely to be observed in other sciaenids exposed to toxicants. In larval fishes, certain toxicants are known to result in heart failure in developing embryos (Ballachey et al. 2003).

Pollutants and nutrient enrichment can originate from point and non-point discharge sources. Nutrient enrichment is a major threat to estuarine ecosystems, particularly forestry practices, agriculture, pesticides, and fertilizers (ASMFC 2002; NSCEP 1993). In polluted areas, pathogens can start proliferating and cause disease in red drum and other estuarine fishes (Conway et al. 1991). Nutrient enrichment can also reduce the extent and species diversity of submerged aquatic vegetation (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998). The effects of nutrient enrichment are also most pronounced in sheltered, low flow areas susceptible to large temperature fluctuations (Burkholder et al. 1994). Sediment loading can also reduce the coverage of submerged aquatic vegetation through reduced light penetration in shallow, estuarine systems (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998).

Eutrophication can also lead to depleted bottom oxygen conditions (Street et al. 2005). Many sciaenids are mobile and able to move out of hypoxic conditions, which can increase densities in shallow habitats and subsequent competition and density-dependence in these habitats (Craig et al. 2007; Campbell and Rice 2014). For example, under hypoxic conditions, Atlantic croaker will move out of these areas to shallower areas (Eby and Crowder 2002).

Rank of Threat (ex. Low, Medium, High): According to the ASMFC's Interstate Fishery Management Plan for Red Drum (2002), water quality degradation was ranked as **Medium**.

Threat 3: Coastal Development (Altered shorelines, urbanization, altered hydrology, habitat loss)

Source of Threat: Coastal development and the infrastructure needed to support human inhabitation of coastal ecosystem have greatly altered aquatic ecosystems through altered flow regimes (damming, increased runoff), channelization, port and marina construction, and boating. In many cases, these alterations to aquatic ecosystems have led to declines in coastal and estuarine habitats that serve as nurseries and foraging grounds for sciaenids, as well as other fishes.

Channelized streams have reduced species diversity, decreasing productivity in these systems (Tarplee et al. 1971; Hawkins 1980; Schoof 1980). The construction of docks and marinas perturb shallow, nearshore habitats and for example reduce the number of Atlantic croaker in these disturbed habitats (Peterson et al. 2000). Shoreline stabilization projects can alter local hydrology and change the physical processes the transport larvae into estuarine systems (Miller et al. 1984; Miller 1988). Activities associated with urbanization can alter freshwater flows and subsequently increase the exposure of fishes to sudden salinity changes (Sefray et al. 1997), which can influence the abundance and distribution of organisms within estuarine ecosystems (Holland et al. 1996).

Increased boating activity leads to increases in underwater noise pollution, seagrass scarring, and increased marina and dock construction. Together, boating can increase stress on fishes and lead to habitat loss seagrass beds that can take at least a decade for recovery to occur (Zieman 1976).

Rank of Threat (ex. Low, Medium, High): **High**

Threat 4: Navigation and Dredging

Source of Threat: Dredging activities are associated with the construction and maintenance of ports and marinas. Many of the impacts of dredging related activities are from the direct removal of sediment, which degrades many different habitats including soft and hard substrates and submerged aquatic vegetation (SAFMC 1998; ASMFC 2002). Dredging activities also resuspend sediments, which increases local turbidity and exposure to contaminants. In addition, dredging activities can initiate hypoxic events as well as bury organisms (ASMFC 2002).

Rank of Threat (ex. Low, Medium, High): According to the ASMFC's Interstate Fishery Management Plan for Red Drum (2002), the impacts of navigation and dredging were ranked as **Medium.**

Threat 5: Fishing

Source of Threat: In addition to losses of abundance as target and bycatch, some fishing gears, particularly dredges and trawls, can impact sciaenid habitats (Essential Fish Habitat Steering Committee

2002). These gears remove epifauna, alter bathymetry, reef distribute substrates, and change organism assemblages. Habitat loss by fishing gears can take months to years to recover.

Rank of Threat (ex. Low, Medium, High): **Medium**

Threat 6: Climate change

Source of Threat: Climate change involves a complex set of factors such as increasing temperature, sea level rise, increasing carbon dioxide levels, and changing precipitation regimes. Warming of oceanic temperatures can result in fishes spawning earlier than previously reported (USFWS 2011). Increasing temperatures can also expand species ranges, increasing competition in estuarine ecosystems. Rising sea level can flood shallow nursery habitat and accelerate the loss of submerged aquatic vegetation (Orth et al. 2006; IPCC 2007). Altered precipitation can also change the delivery of freshwater to aquatic ecosystems and can rapidly change salinity in estuarine areas (USFWS 2011).

Rank of Threat (ex. Low, Medium, High): **High**

Section II. Effects of Habitat Degradation on Sciaenid Populations

The above mentioned threats are expected to decrease the spawning and nursery habitats required for sciaenid populations to persist. Disturbed habitats reduce growth likely through increased competition, reduced shelter, and reduced prey availability. In addition, disturbed habitats and increased stress can increase the susceptibility of sciaenids to disease. Since sciaenids are estuarine-dependent fishes (Murdy and Musick 2013), many of their habitats have been disturbed and are in close proximity to urbanized regions.

Section III. Recommendations to Mitigate Threats to Sciaenid Habitats

The following recommendations to mitigate threats to sciaenid habitats have been collated from the Habitat Management Recommendations section found in each species profile within this report (ASMFC 2002, 2012) and the North Carolina Coastal Protection Plan (NCDEQ 2015). In many instances, common recommendations were identified among species.

1. HAPCs locations should be accompanied by requirements that limit degradation of habitat, including minimization of non-point source and specifically storm water runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area.

2. States should coordinate and enhance the monitoring of water quality and habitat from tributaries to the nearshore ocean. Part of this monitoring should also assess the effectiveness of already established rules that protect these coastal habitats in each state.

3. States should minimize loss of wetlands to shoreline stabilization by using the best available information, incorporating erosion rates, and promoting incentives for use of alternatives to vertical shoreline stabilization measures (e.g., sea walls), commonly referred to as living shorelines projects.

4. Each State should establish windows of compatibility for activities known or suspected to adversely affect sciaenid life stages and their habitats, with particular emphasis to avoid spawning season. Activities may include, but are not limited to, navigational dredging, bridge construction, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

5. The use of any fishing gear that is determined by management agencies to have a negative impact on sciaenid habitat should be prohibited within HAPCs. Further, states should protect vulnerable habitat from other types of non-fishing disturbance as well.

6. States should conduct research to evaluate the role of submerged aquatic vegetation and habitats in the spawning success, survival, growth, and abundance of sciaenids. This research could include regular mapping of the bottom habitat in identified areas of concern, as well as systematic mapping of this habitat where it occurs in estuarine and marine waters of the states.

7. Restoration efforts should be enacted to restore critical habitats of sciaenids including oyster reefs, riparian wetlands, submerged aquatic vegetation habitats, barrier island systems, and soft bottom areas.

8. Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known or suspected to accumulate in sciaenid tissues and which pose a threat to human or sciaenid health.

9. Each state should establish windows of compatibility for activities known or suspected to adversely affect sciaenid life states and their habitats, such as navigational dredging, bridge construction and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

10. States should identify dams that threaten freshwater flows to nursery and spawning areas, and target them for appropriate recommendations during FERC re-licensing.

11. States need to expand education and outreach activities that explain management measures in place for sciaenids to stress the value of sciaenids and their critical habitats for their sustainability. Emphasis should be used to describe threats from land use and other challenges that sciaenid species face in each state.

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Chapter 12: Future Habitat Research Information Needs for Sciaenid Species

Section I: General Research Needs for Atlantic Sciaenids

Many of the research needs for Atlantic sciaenids revolve around understanding changes in habitat use through development. For example, black drum use a variety of habitats as larvae and juveniles, which may buffer them from the effects of habitat degradation, but it is unknown if certain habitats are more critical for black drum (i.e., enhanced growth, decreased mortality) and contribute more to the adult population. In addition, not much is known about the effects of habitat degradation on early life history stages (egg through juveniles), which are often the life stages that are most sensitive to perturbations. Individual research needs for each sciaenid species are outlined in the next section. Research needs for Atlantic sciaenids includes:

1. More research needs to identify the location and habitat characteristics of spawning grounds.

2. Determine the physiological tolerances and preferences to environmental variables (temperature, salinity, dissolved oxygen) for each life stage that maximize hatching success, growth, and survival. With these data, predict regions, species, and life stages that will be most susceptible to climate change.

3. Asses the impacts of perturbations to environmental variables on each life stage to understand how water quality degradation may affect spawning, hatching success, growth, and survival. With these data, determine acceptable and unacceptable water quality parameters for spawning and essential habitats.

4. Assess population connectivity along the coast to determine if local extirpation is an issue and if so, identify the species that are most susceptible.

5. Identify essential habitats as well as habitat requirements for each life stage to prioritize areas for conservation.

6. Examine the impacts of toxicant exposure and harmful algal blooms.

7. Assess impacts of habitat alterations from coastal development (urbanization, shoreline armoring, beach renourishment, and dredging) on Atlantic sciaenids at all life stages, particularly examining the effects of increased turbidity, burial, prey availability, and contaminant release on the health, growth, and survival of all life history stages.

Section II: Species-Specific Research Needs

Atlantic croaker

1. Assess the impact of hypoxia on the foraging and overall health

Black drum

1. Expand the temporal and spatial coverage of fishery independent surveys to include black drum habitats.

2. Conduct otolith microchemistry studies to identify recruitment contributions of various regions and habitats.

Red drum

1. Quantify relationships between red drum productivity and habitat at all life stages.

2. Assess the impact of alter freshwater flow regimes on red drum nursery and other essential larval and juvenile habitats.

Spot

1. Examine potential offshore, pelagic nursery habitats (eddies) and physics the influence the hatching success and distribution of larvae.

Spotted seatrout

1. Quantify the relationship between submerged aquatic vegetation and spawning success. In areas where submerged aquatic vegetation is sparse or absent, identify alternative spawning and nursery habitats.

2. Define overwintering habitat requirements of early stages and adults since this species exhibits high site fidelity.

Weakfish

1. Examine the impact of water intakes on larval and juvenile mortality in spawning and nursery areas.

2. Quantify the relationship between weakfish productivity and spawning habitat.

Northern kingfish

1. Determine life history characteristics and diagnostic characters to distinguish among the kingfishes in the early stages in order to determine environmental preferences for each essential habitat from field collections.

2. Monitor the impacts of beach renourishment on northern kingfish at all life stages.

3. Assess competition among kingfishes and other benthic sciaenids.

Southern kingfish

1. Determine life history characteristics and diagnostic characters to distinguish among the kingfishes in the early stages in order to determine environmental preferences for each essential habitat from field collections.

2. Monitor the impacts of beach renourishment on southern kingfish at all life stages.

3. Assess competition among kingfishes and other benthic sciaenids.

Gulf kingfish

1. Determine life history characteristics and diagnostic characters to distinguish among the kingfishes in the early stages in order to determine environmental preferences for each essential habitat from field collections.

2. Monitor the impacts of beach renourishment on gulf kingfish at all life stages.

3. Assess competition among kingfishes and other benthic sciaenids.

State Coastal Regulatory Plans in Response to Climate Change Report

Background

The Atlantic States Marine Fisheries Commission's (Commission) Habitat Committee (Committee), a branch of the Interstate Fisheries Management Program, was developed to identify, enhance, and cooperatively manage vital fish habitat for conservation, restoration, and protection, and support the cooperative management of the Commission and jointly managed species. In 2016 the Committee has been focused on Goal 4 of the current Commission Action Plan: to 'Protect and enhance fish habitat and ecosystem health through partnerships and education.'

This document addresses a task identified in the 2016 Action Plan to identify ongoing practices in the state coastal regulatory planning that address climate change impacts. It contains information on climate change initiatives, as well as links to documents and websites, as reported by each within the Commission's boundaries. This information is the first step towards identifying gaps and making recommendations for improving coastal preparedness and resiliency to climate change.

Maine

In 2013, the State of Maine established the Environmental and Energy Resources Working Group to identify administrative and strategic opportunities to improve Maine's ability to respond and adapt to changing physical conditions in the environment due to climatic influence. The Working Group was led by the Commissioner of the Department of Environmental Protection, and included the Director of the Governor's Energy Office, and the Commissioners of the Departments of Transportation; Marine Resources; Agriculture Conservation and Forestry; and Inland Fisheries and Wildlife. The report, Monitoring, Mapping, Modeling, Mitigation and Messaging: Maine Prepares for Climate Change, presents current programs and activities and contains 32 recommendations. In general, the recommendations are to continue the interdepartmental cooperation; as well as current monitoring, mapping, modeling, and mitigation activities.

The Department of Environmental Protection's Sustainability Division is developing mechanisms for cross agency partnerships, information sharing, efficiencies, and streamlining. These efforts will provide specific and identifiable tools to assist decision-makers. The Adaptation Toolkit, in development, will aid climate adaptation efforts by providing a centralized source for information needed to design and implement resiliency practices, as well as information on important regulations and standards to integrate into project or planning process, and opportunities to connect with state and other engaged practitioners for technical expertise.

In 2015, the Maine Department of Inland Fisheries and Wildlife collaborated with over 150 public and non-profit Conservation Partner groups (including private landowners, conservation organizations, sporting groups, scientists, and governmental agencies) to draft Maine's 2015 Wildlife Action Plan. The Action Plan addresses the full array of Maine's wildlife across all taxa groups and habitats, as well as identifies 378 Species of Greatest Conservation Need and provides species-specific and habitat-based actions to help prevent further species declines over the next ten years. In an effort to understand which of Maine's species and habitats are most vulnerable to climate change impacts, the Department of Inland Fisheries and Wildlife collaborated with the Manomet Center for Conservation Science and other partners on a climate change vulnerability assessment. The report, Climate Change and Biodiversity in Maine: Vulnerability of Habitats and Priority Species, classifies the vulnerability of the species and habitats to climate change.

The Maine Stream Connectivity Work Group and Maine's Aquatic Resources Management Strategy are working to minimize the impacts of road crossings on Maine's aquatic systems, which are becoming stressed by more frequent and severe storms.

The Department of Marine Resources continues to implement a wide range of fisheries research monitoring activities for stock assessments; however, the time series will also be useful for understanding changing environmental conditions.

The Department of Marine Resources has maintained an Environmental Monitoring Program in Boothbay Harbor for over a century. The observations began in March 1905 and constitutes one of the longest running, continuous series of sea temperature observations for any point on the North American Atlantic Coast. Currently, observations of air temperature, barometric pressure, sea surface temperature, relative humidity, wind speed, and wind direction are recorded at daily intervals.

New Hampshire

The New Hampshire Fish and Game Department is addressing climate change through four different avenues: planning, science, outreach, and communication.

The 2015 Wildlife Action Plan Update specifically recognized climate change as a risk factor for both habitats and species. Because of this, species and habitat profiles include their sensitivity to climate change-related parameters, and the weighted risk of those species and habitats in regards to impacts such as sea level rise (SLR), changes in precipitation, increased storm activity, changes to air and sea temperature, and more.

The Great Bay National Estuarine Research Reserve (part of New Hampshire Fish and Game Department) continuously monitors salt marsh distribution and condition along with information about the salinity of pore water and marsh elevation. Over time, this information will help inform if and how SLR is impacting salt marsh health at three sites around Great Bay.

New Hampshire Fish and Game Department also has detailed habitat maps for Great Bay (and will have them for the whole coastal region by next fall). These maps are considered baselines from which to compare future changes. The National Estuarine Research Reserve is also installing a tide gauge in the southern reach of Great Bay to monitor water level over time. The Sea Level Affecting Marsh Migration Model was run for all of coastal New Hampshire as a part of the Wildlife Action Plan, predicting how salt marsh distribution is likely to change under different SLR scenarios and where there is potential for migration. This information was combined with current condition information to determine where the highest quality marsh is likely to migrate, and where restoration opportunities are likely to be valuable in light of potential SLR.

A National Estuarine Research Reserve representative serves as co-chair of the Coastal Adaptation Workgroup – a group of outreach professionals that coordinate to bring local communities the best climate-related science. Much of this revolves around wise planning to protect both natural and built assets. The National Estuarine Research Reserve hosts a Climate Summit each spring (topics this year included: living shorelines, presentations about the Wildlife Action Plan, fisheries impacts in the Gulf of Maine, impacts on groundwater along the coast, culvert assessment work, dune restoration, city planning case studies, etc.). New Hampshire Fish and Game Department is also incorporating climate-related messages into our K-12 and teacher education programs. This summer they will host a teacher training workshop focused on how protected places can be observed to determine climate-related impacts over time; and the department will be hosting an intern who will be developing a volunteer phenology program for the center.

New Hampshire Fish and Game Department has two representatives on the Coastal Risks and Hazards Commission, a state-wide legislatively-directed commission that was charged with providing guidance and consistent information to state agencies and municipalities on how to assess and prepare for coastal storms, SLR, and increased precipitation. A draft report and recommendations on "Preparing New Hampshire for Projected Storm Surge, Sea-level Rise, and Extreme Precipitation" has been prepared. Because of the recommendations from the report, each state agency is going to be asked to review its rules and regulations in light of the science and recommendations provided by the commission. The legislation is pending now, and if passed would likely go into effect next year.

Additional Links:
The State of New Hampshire website: http://www.nh.gov/climate/
The New Hampshire Department of Environmental Services:
http://des.nh.gov/organization/divisions/air/tsb/tps/climate/

Massachusetts

In 2008 Massachusetts passed a global warming solutions act to reduce emissions, increase green infrastructure, and to analyze strategies for adapting to predicted changes in climate. The Massachusetts Climate Change Adaptation Report released in September 2011 by the Executive

Office of Energy and Environmental Affairs includes an overview of anticipated impacts and key adaptation strategies to increase resilience and preparedness.

Regarding fisheries, Massachusetts sits on the boundary of two biogeographic provinces, the Gulf of Maine and the Mid-Atlantic Bight. The state is already seeing shifts in species range distributions (black sea bass, American lobster, northern shrimp). The Division of Marine Fisheries collects bottom temperature data, every two hours at 60-70 sites across the state. Bottom temperature data is stored in an in-house database containing over 2 million readings dating back as far as 1986 for some sites. The Division of Marine Fisheries also has trawl data back to the 1970's.

In 2007 the mayor of Boston passed an Executive Order Relative to Climate Action, which called for a plan every three years. The first update was produced in 2014 (summary here: http://www.cityofboston.gov/images_documents/Greenovate%20Boston%202014%20CAP%20Update_Summary_tcm3-49733.pdf), and includes a variety of proposals, addressing open space, education, renewable energy, etc.

Rhode Island

In July 2014, the Rhode Island General Assembly approved the Resilient RI Act (RIGL §42-6.2), which formally established the Executive Climate Change Coordinating Council, as well as set specific greenhouse gas reduction targets, and incorporated consideration of climate change impacts into the powers and duties of all state agencies. The Coordinating Council is comprised of Directors and Commissioners from nine state agencies/offices and is supported by an Advisory Board and Science and Technical Advisory Board. It is charged with leading and coordinating state agencies in responding to the challenges posed by climate change in a timely and effective manner, focusing in particular on:

- assessing, integrating and coordinating efforts throughout state agencies to reduce greenhouse gas emissions, strengthen the resilience of communities, and prepare for the impacts of climate change;
- improving our understanding of the effects climate change will have in RI;
- working in partnerships to identify, develop and implement strategies to be better prepared, and reduce risk and losses.

There are several projects underway that will provide information to support future Coordinating Council recommendations. A few coastal related projects include the following. As first step in helping to reduce Rhode Island's greenhouse gas emissions is the completion of the 30 Megawatt Block Island Offshore Wind Project. This will be the first offshore wind project in the country. Located approximately three miles southeast of Block Island, the system is expected to be commercially operational by the end of 2016. The spatial planning and fisheries-related research and monitoring used to guide this work may provide a blueprint for other states and coastal communities.

To assess the effects climate change in Rhode Island the Executive Council's Science and Technical Advisory Board prepared a brief synopsis of the state of knowledge of the following manifestations of climate change: SLR, warming air temperatures, warming water (marine and fresh) temperatures, storm frequency and intensity, biodiversity (changes in species and habitats), and precipitation and inland flooding. The information summarized in this report will assist state agencies, decision-makers, and the public in understanding the real impacts RI is already experiencing due to a changing climate.

The Coastal Resources Management Council continues work on the Shoreline Change Special Area Management Plan, developing scientifically-based data and tools to aid in coastal hazard adaptation planning. The Management Council has completed revised Shoreline Change Maps for the south shore communities, showing how Rhode Island's shoreline has changed over time due to erosion, and how we might expect it to change in the future. Additional tools and other key resources are available from the website to aid the state and municipalities in supporting sound policy decisions which address coastal erosion, SLR, and storm surge inundation problems.

The Department of Environmental Management has also addressed considerations related to climate change throughout the recently updated State Wildlife Action Plan. In short, the Wildlife Action Plan reviewed vulnerability assessments for several species of great concern, identified threats to species and their habitats, and proposed actions to reduce these threats. In addition, the Division of Fish and Wildlife's Marine Fisheries Section continues to conduct long-term monitoring programs and collaborate on several local and regional research projects investigating the effects of climate change on managed species and the state's marine resources. State Wildlife Action Plans also have to specifically take into account climate change adaptation. Climate change is primarily in Chapters 1 (species), 2 (habitats), 3 (threats), and 4 (actions to abate threats to species and habitats).

In October 2015, the State Planning Council voted to adopt Rhode Island's new State Energy Plan "Energy 2035" as an element of the State Guide Plan, codifying the Plan as the state's formal long-term, comprehensive energy strategy. The Plan, produced by the Office of Energy Resources in collaboration with the Division of Planning, represents Rhode Island's first data-driven energy planning and policy document. Its vision is to provide energy services across all sectors—electricity, thermal, and transportation—using a secure, cost-effective, and sustainable energy system

In early 2016, OER launched the state's first ever electric vehicle rebate program to support adoption of electric vehicles by Ocean State drivers: Driving RI to Vehicle Electrification (DRIVE). The program made $200,000 available for qualified RI residents interested in purchasing or leasing an electric vehicle to apply for a financial rebate of up to $2,500, based upon vehicle battery capacity. Modeled closely on existing rebate programs offered in other states, DRIVE offers the potential to increase the total number of EVs on RI roadways by 20-35%.

Connecticut

The Connecticut Climate Change Action Plan was initiated in 2005 with the goal of reducing greenhouse gas emissions to achieve regional goals set by the New England Governors/Eastern Canadian Premiers. The Action Plan addresses quantification of benefits and costs of greenhouse gas reductions using existing analytical measures and a new desktop modeling tool developed under the direction of the Environmental Protection Agency (EPA). As the first state to utilize this new tool, Connecticut was able to identify benefits previously not quantified. To successfully meet the requirements of the Action Plan, a Governor's Steering Committee established working committees at both the agency head and staff level to develop, implement, and track progress on recommended actions.

Additional legislation passed in following years, and complementary to the Action Plan, Connecticut adopted California emissions standards; promoted hybrid fuel cars through tax incentives; set efficiency standards for products and appliances; and promoted the purchase of "Connecticut Grown" foods. A Governor's Executive Order requires the state to purchase renewable energy in increasing amounts, leading to 100% clean energy by 2050. Legislation also simplified the permitting process in ways that encourage implementation of 'living shorelines' in place of shoreline armoring.

Additional monitoring programs include:

Long Island Sound Study Sentinel Monitoring for Climate Change: A multidisciplinary scientific approach to provide early warning of climate change impacts to Long Island Sound ecosystems. This program is conducted jointly by EPA Regions 1 & 2, Connecticut Department of Energy and Environmental Protection, New York Department of Environmental Conservation, and several academic institutions.

Connecticut Institute for Resilience and Climate Adaptation: Established in 2013 under the direction of the Department of Energy and Environmental Protection and the University of Connecticut to conduct research, outreach, and education projects as well as guide the development of technologies and regulatory provisions that increase the protection of ecosystems, coastal properties, other lands, and attributes of the state that are subject to the effects of rising sea level.

New York

New York has an Office of Climate Change within the New York Department of Environmental Conservation (DEC) that coordinates efforts relating to climate change. The New York State Energy Research and Development Authority developed the Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State report that includes the impacts of climate change and recommendations.

New York developed a Sea Level Rise Task Force Report in 2009, which includes impacts and recommendations. The report led to the 2014 Community Risk and Resiliency Act. This Act:

1) Incorporates state-adopted SLR projections as regulation by Jan. 1, 2016 (DEC) and establishes a new New York Community Risk and Resiliency (Part 490), Projected Sea-level Rise (Part 490). Part 490 will establish projections of SLR in three specified geographic regions over various time intervals, but will not impose any requirements.

2) Adds mitigation of SLR, storm surge, and flooding to Smart Growth Public Infrastructure Policy Act criteria and guidance by Jan. 1, 2017 (DEC, Department of State).

3) Models local laws to enhance resiliency by Jan. 1, 2017 DEC, Department of State).

4) Considers SLR, storm surge, and flooding in 19 programs (facility-siting regulations, permits and funding) by Jan. 1, 2017 (DEC, Department of State), including a checklist on how to consider SLR, storm surge, and flooding in permitting decisions.

5) Requires guidance on implementation of the Community Risk and Resiliency Act and the use of natural resiliency measures to reduce risk by Jan. 1, 2017 (DEC, Department of State), while considering the ability of natural resiliency measures to provide for storm-related and other benefits.

New York also has guidance on flood risk management standards, culvert sizing, living shorelines, nature-based shorelines, and wetland migration. The Office of Climate Change also has a greenhouse gas emissions initiative, which develops caps, performance standards for CO_2 emissions, Climate Smart Communities programs – certifying communities for climate-friendly actions, greenhouse gas emissions targets, and grants to assist in implementation.

The New York State Energy Research and Development Authority conducts environmental research and analysis and provides technical expertise and support to New Yorkers in order to increase renewable energy usage and efficiency. They are currently studying atmospheric deposition and impacts on natural resources. New York also has a Climate Change Science Clearinghouse, which provides New York State-related climate change data and information to inform decision making.

New York is involved in National Estuary Programs and National Estuarine Research Reserve sites, which conduct research monitoring, the results of which are integrated in all climate change management plans and state wildlife action plans, ultimately affecting how we manage resources. Vulnerability assessments are being conducted – these assess at-risk natural resources and infrastructure, develop adaptation strategies, support low impact development and green infrastructure, and include wetland migration pathway modeling to advise management decisions.

Finally, New York also has monitoring networks (climate sentinel monitoring projects, sediment elevation tables, water quality, is developing wetland rapid assessments, and conducting marsh loss trend assessments). Restoration efforts support habitat connectivity, large scale wetland restoration, and focus on managing threats to trust species.

New Jersey

There are many efforts underway in New Jersey to mitigate and respond to the impacts of climate change including: substantial investment in clean energy initiatives such as renewable energy production from solar, wind, and geothermal sources; improving energy efficiency; and reducing overall energy use and intensity. In addition, the State of New Jersey has taken significant steps in creating climate change-related community preparedness programs with a focus on resiliency and adaptation efforts at the local and state level. These programs involve strong interaction with local governments at the land use planning level as well as efforts to protect critical infrastructure and ecosystems, and new suites of regulations related to the design of buildings, roads, and bridges (www.globalchange.gov).

Following Superstorm Sandy, New Jersey State Departments and Agencies have incorporated resiliency strategy and planning into every aspect of the recovery process in an effort to rebuild better and more resilient than before. Many of these initiatives will serve to make New Jersey more resilient to the adverse effects of future climate change. Among the initiatives are: beach and dune projects, acquisition of properties in repetitive flood loss areas, energy resilience at critical facilities throughout the State, and actions to address emergency fuel – highlighted during Superstorm Sandy by building resilience in fuel supply and distribution. As part of the long-term recovery strategy, New Jersey has committed to rebuilding by focusing on implementing *resilient* infrastructure projects and mitigation opportunities to prevent future damage, and utilizing construction techniques and materials that will better withstand future weather events. The State will continue to leverage existing federal and state resources to pursue these long-term strategic priorities and empower local governments to revitalize their communities. New Jersey has also focused its efforts on future emergency response programs. For more detailed information, please visit the Governor's Office of Recovery and Rebuilding website at http://nj.gov/gorr/.

The continued development of a long-term comprehensive statewide adaptation plan needs to involve the input and action of many parties, including federal, state and local governments; non-governmental organizations; academia; private industry; and the citizens of New Jersey. Safeguarding New Jersey's residents, its built and natural environment, and ensuring that the State continues to grow in a manner that is both sustainable and resilient to the adverse effects of climate change will require adaptation planning. More information on New Jersey's Adapting to a Changing Environment Program is available at http://www.nj.gov/dep/aqes/adapting.html.

Additionally, Rutgers University formed the New Jersey Climate Adaptation Alliance in 2011 (http://njadapt.rutgers.edu). The Climate Adaptation Alliance is described as *"a network of policymakers, public and private sector practitioners, academics, and NGO and business leaders designed to build climate change preparedness capacity in New Jersey…The Alliance is focused* *on climate change preparedness in key impacted sectors (public health; watersheds; rivers and coastal communities; built infrastructure; agriculture; and natural resources)."* The ultimate goal of this initiative is to assess climate vulnerability and preparedness needs for critical sectors in New Jersey and to develop capacity for response implementation in New Jersey. One of the important products of the Climate Adaptation Alliance was the development of the New Jersey Climate Adaptation Directory. According to the Climate Adaptation Alliance, *"the directory was created to provide resources that assist in guiding practitioners in New Jersey through the adaptation planning process. This directory brings together geographic data, tools, reports, model policies and ordinances, case studies, and current projects focused on evaluating vulnerabilities and developing and implementing climate change adaptation plans and strategies. The resources included are aimed at professionals in a range of fields, including but not limited to infrastructure, public health, emergency management, hazard mitigation, natural resources, economic development, agriculture, and land use planning."* This resource can be found here: http://njadapt.rutgers.edu/resources/climate-adaptation-directory#.

Pennsylvania

The Pennsylvania Climate Change Act of 2008 required the Department of Environmental Protection to produce a report on the anticipated climate change impacts in Pennsylvania and also a Climate Change Adaptation Strategy. Both are to be updated every three years. The original reports were produced in 2009 and have both been updated in 2013 and 2015 (http://www.dep.pa.gov/Business/Air/BAQ/AdvisoryGroups/CCAC/Pages/default.aspx#.VyJQWYLD-po). The report addresses freshwater tidal waterfront on page 197. From the report: Pennsylvania has approximately 56 miles of coastline on the Delaware Estuary that is largely freshwater and home to diverse flora and fauna. This includes approximately 1200 acres of freshwater tidal wetlands. Impacts to these habitats include decreased dissolved oxygen concentrations, SLR, and salinity intrusion. The potential for loss of these wetlands is high if accretion rates do not keep up with SLR. There is a low potential for wetland migration due to development. Further discussion on typical climate change impacts and strategies is extensive in these documents.

The Department of Conservation and Natural Resources has developed the DCNR and Climate Change: Planning for the Future document describing climate change's current and projected impacts on the state parks and forests, and their approach to adapt to these impacts.
The 2015-2025 Pennsylvania Wildlife Action Plan offers a review of threats posed by climate change. This plan includes species with declining or imperiled populations, or with secure populations, but substantial environmental threats, and their habitats. Among the primary climate change information sources in this plan include the Northeast Climate Science Center (Staudinger et al. 2015), and state documents produced by the Department of Environmental Protection. Climate change is identified as a threat to 29.5% (196 species of a total 664) of the Species of Greatest Conservation Need in the plan, which also discusses vulnerability and associated risk of those species and habitats to climate change (2015-2025 Pennsylvania Wildlife Action Plan, Chapter 3, pp. 29-70 and 95-107). The Plan (Chapter 4, pp 85-101) also

includes conservation actions to address climate change, including regional (Staudinger et al. 2015) and national adaptation strategies (National Fish Wildlife Plants Climate Adaptation Partnership 2012).

Maryland

Maryland has developed the Climate Change Maryland website to educate citizens about climate change and the actions that the state is taking to reduce its carbon footprint. This program includes participation from over 12 states agencies. It contains information on the Greenhouse Gas Reduction Plan, which was written in 2012 (and updated in 2015) to address the 2009 Greenhouse Gas Emissions Reduction Act. The Greenhouse Gas Reduction Plan's goals are to reduce greenhouse gas emissions by 25% by 2020 by reducing all sectors' (energy, transportation, agriculture, etc.) carbon footprint. It has more than 150 programs and initiatives to address carbon emissions related to energy, construction, fisheries, forestry, etc.

The state also has a two phase plan to reducing Maryland's vulnerability to climate change. Phase I was published in 2008 and addresses SLR and coastal storms. Phase II was completed in 2011 and focuses on building societal, economic, and ecological resilience.

In 2012 the Climate Change and CoastSmart Construction Executive Order was signed to ensure all new and reconstructed state structures have minimal to no flood risk based on improved planning and construction.

Virginia

The Governor's Commission on Climate Change published A Climate Change Action Plan in 2008, which includes the effects of climate change (on the built environment, insurance, natural systems, etc.), recommendations, and commission deliberations. In December of 2014, the state published Virginia Accomplishments Since the 2008 Climate Action Plan Release. According to the executive summary, Virginia has taken many mitigation and adaptation actions in regards to climate change, but these changes were not necessarily in response to particular recommendations or carried out in a coordinated manner. One year later, in December 2015, the Governor Terence R. McAuliffe's Climate Change and Resiliency Update Commission published the Report and Final Recommendations to the Governor, which includes the top five recommendations to address climate change in the state. These include: i.) establishing a climate change and resilience resource center, ii.) creating a new Virginia bank for energy and resiliency, iii.) establishing a renewable energy procurement target for Commonwealth agencies, iv.) adopting a zero emission vehicle program, and v.) leveraging federal funding to make coastal communities more resilient. During the 2016 legislative session Virginia created the Commonwealth Center for Recurrent Flooding Resiliency, a joint venture of Old Dominion University, the College of William & Mary and the Virginia Institute of Marine Science. With an initial budget allocation of $2 million in state support these institutions will work together to provide critical research, policy, and outreach resources to protect natural resources and create resilient communities across the Commonwealth.

North Carolina

In 2015, the North Carolina Coastal Resource Commission Science Panel completed their five-year update of their 2010 Report and the 2012 Addendum as mandated by the General Assembly in Session Law 2012-202. This update incorporated the most recent science and uses a 30-year projection for SLR. The report emphasized the different rates of SLR across the coast of North Carolina. These differences were attributed to subsidence and the effects of water movements within the ocean itself. The panel recommended that the report continue to be updated every five years.

The 2016 update of North Carolina's Coastal Habitat Protection Plan addresses SLR and climatic changes in several locations with recommendations specifically to the protection of wetlands and buffers to help offset the expected rise. The Source Document for the Coastal Habitat Protection Plan, and the Plan itself, can be accessed at: http://portal.ncdenr.org/web/mf/habitat/chpp/downloads.

The Albemarle-Pamlico National Estuary Partnership, through its 2012-2022 Comprehensive Conservation and Management Plan incorporates climatic impacts throughout, but has three actions focused on climate change and SLR. Two actions address the impacts of SLR and climate change on the regional ecosystem as well as supporting research on adapting to those impacts. The third action supports engaging state, regional, and local governments and assisting them with incorporating SLR and climate change into their planning processes.

Both the North Carolina National Estuarine Research Reserve and the U.S. Fish and Wildlife Service have incorporated significant aspects of SLR and climate change research into their strategic plans. With several extensive National Wildlife Refuge systems on North Carolina's coast and four National Estuarine Research Reserve sites in eastern North Carolina, significant research is being done in those locations. Much of the research deals with hydrologic restoration and the study of wetlands and their mitigating impacts on SLR.

South Carolina

In 2013, the South Carolina Department of Natural Resources compiled a report titled "Climate Change Impacts to Natural Resources in South Carolina." The following two sentences from the report highlight the goal the agency had in writing it: "The Department of Natural Resources is taking a lead role among South Carolina state agencies to advance the scientific understanding of the vulnerability of South Carolina's vital natural resources during an era of changing climate. This will enable the agency, its partners, constituents, and all Palmetto State citizens to avoid or minimize the anticipated impacts while protecting South Carolina's natural resources." The report identifies a number of concerns for the state's natural resources including SLR, ocean acidification, and temperature rise effects. The state has a high proportion of the coastline that is comprised of marshes, barrier islands, and hammock islands. Many of these lands are owned by state and federal entities. The document has various strategies for research and for developing and protecting land to provide for migration.

Other scientists, such as Dr. James Morris from the University of South Carolina, are conducting research evaluating the fate of marshes due to potential SLR. The recent thousand-year rain event in the state and King Tides are raising public awareness of what SLR will probably entail.

Georgia

In Georgia, most of the authority for responding to climate change rests with the local governments. There is not a statewide plan or regulatory measures in place. The State Wildlife Action Plan, however, does address climate change. With that in mind, there aren't any vulnerability assessments regarding fisheries. NOAA Fisheries Science Centers are working on assessing climate vulnerabilities for many species at the federal level.

Georgia is home to Gray's Reef National Marine Sanctuary, and NOAA is taking a three-pronged approach to address climate change: they are using Gray's Reef as a sentinel site, responding to change through adaptive management, and increasing climate change communication. Climate change links for Gray's Reef and other National Marine Sanctuaries include:
http://sanctuaries.noaa.gov/science/sentinel-site-program/climate-change-ocean-acidification.html
http://marineprotectedareas.noaa.gov/sciencestewardship/climatechangeimpacts/
http://sanctuaries.noaa.gov/science/sentinel-site-program/grays-reef/climate-change-ocean-acidification.html

Florida

The Florida Fish and Wildlife Commission led a stakeholder summit on Climate Change in 2008. A report was generated in 2009 from this summit entitled "Florida's Wildlife: On the front line of climate change." As a result of this summit and due to the resulting recommendations, the Fish and Wildlife Commission established a Climate Change Oversight Team and developed adaptive strategies to address identified climate change threats to fish and wildlife and their habitats. Climate change considerations have been integrated into Florida's State Wildlife Action Plan, and funding has been provided to aquatic habitat projects supporting climate change adaptive strategies, such as living shoreline projects and regional climate change effects mitigation planning efforts. Funding opportunities for aquatic habitat restoration and enhancement projects supported by the Fish and Wildlife Commission ensure evaluation of climate change adaptation in all project proposals submitted. The state follows guidance in Adapting to Climate Change: A Planning Guide for State Coastal Managers, a 2010 report from NOAA.

The Florida Oceans and Coastal Council published The Effects of Climate Change on Florida's Ocean and Coastal Resources in 2009, and updated the report in December 2010. These reports were written for the Florida Energy and Climate Commission and the residents of Florida. The original report included information on the 2007 Intergovernmental Panel on Climate Change Report, the impacts of climate change on Florida's infrastructure, human health, and economy, the effects of the 'drivers' of climate change, and research priorities, while the update focused on SLR effects and research priorities.

Florida has also worked with partner organizations, such as The Nature Conservancy, to implement projects addressing resiliency and plan for coastal climate change. This has been a key focus of south Florida, which is generally recognized as being one of the most vulnerable regions in the Commission management region to SLR. Partners have developed shoreline resiliency and coral reef teams including the Shoreline Resiliency Working Group and Southeast Florida Coral Reef Initiative, which are focused on assessing and addressing the effects of climate change on coastal habitats. The Governor's South Atlantic Alliance recently sponsored (April 2016) a southeast U.S. Living Shorelines Summit in Jacksonville, Florida, which specifically addressed coastal habitat resiliency in the face of accelerated SLR. This effort has resulted in the development of a number of different regional resources, including a living shoreline training academy, which provides managers and the public with a certification in living shoreline design and implementation.