Atlantic States Marine Fisheries Commission

ISFMP Policy Board

May 14, 2014
9:45 a.m. – 12:45 p.m.
Alexandria, Virginia

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 *(L. Daniel)*	9:45 a.m.
2. Board Consent *(L. Daniel)* • Approval of Agenda • Approval of Proceedings from February 2014	9:45 a.m.
3. Public Comment	9:50 a.m.
4. Management and Science Committee Report • Investigations of climate-induced shifts in stock distributions • Evaluation of state quota allocations (*M. Armstrong*)	10:00 a.m.
5. Consider Initiating Cancer Crab Fishery Management Plan (*T. Kerns*) **Action**	11:00 a.m.
6. American Lobster Stock Assessment Update (*G. Nesslage*)	11:30 a.m.
7. Assessment Science Committee Report (*G. Nesslage*) **Action** • Update to the stock assessment schedule	11:40 a.m.
8. Review and Consider Comments on NOAA Fisheries Stock Assessment Prioritization (*G. Nesslage*) **Action**	11:55 a.m.
9. Committee on Economics and Social Science Report (*S. Madsen*)	12:10 p.m.
10. Habitat and Artificial Reef Committee Reports (*M. Yuen*)	12:20 p.m.
11. Law Enforcement Committee Report (*M. Robson*)	12:30 p.m.
12. Other Business	12:35 p.m.
13. Adjourn	12:45 p.m.

The meeting will be held at the Crowne Plaza Hotel, 901 North Fairfax Street, Alexandria, Virginia; 703-683-6000

Atlantic States Marine Fisheries Commission

ISFMP Policy Board

May 15, 2014
2:15 – 2:45 p.m.
Alexandria, Virginia

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 *(L. Daniel)*	2:15 p.m.
2.	Board Consent *(L. Daniel)* • Approval of Agenda	2:15 p.m.
3.	Public Comment	2:20 p.m.
4.	Review of Non-compliance Findings (if necessary)	2:30 p.m.
5.	Other Business/Adjourn	2:45 p.m.

The meeting will be held at the Crowne Plaza Hotel, 901 North Fairfax Street, Alexandria, Virginia; 703-683-6000

MEETING OVERVIEW

ISFMP Policy Board Meeting
Wednesday, May 14, 2014
9:45 a.m. - 12:45 p.m.
Alexandria, Virginia

Chair: Louis Daniel (NC) Assumed Chairmanship: 10/13	Vice Chair: Doug Grout (NH)	Previous Board Meeting: February 5, 2014
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 February 5, 2014

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. Management and Science Committee Report (10:00 – 11:00 a.m.)

Background

- The Policy Board tasked MSC with investigating climate-induced shifts in stock distributions and possible re-evaluation of state quota allocations.
- MSC created a subcommittee to address the Board's task and developed a timeline of products to present to the Board during this ASMFC Spring Meeting 2014.
- MSC defined the focal species as summer flounder, black sea bass, and scup.
- MSC collaborated with NEFSC scientists to summarize the state of knowledge for focal species, define criteria for stock distribution shift, and demonstrate distribution shifts for stocks where it is occurring.
- MSC surveyed Commissioners to define the methods for adjusting state-by-state allocations and the frequency for re-evaluating stock distributions and allocations.

Presentations

- R. Bell (NEFSC) will provide a report on climate and stock distribution analyses (**Briefing Materials)**
- M. Armstrong will provide a report on Commissioner allocation survey results and MSC recommendations on reallocation options (**Briefing Materials)**

Board actions for consideration at this meeting

- Discussion of allocation options for shifting stocks
- Task TCs with exploring new allocation options for individual species

5. Consider Initiating Cancer Crab Fishery Management Plan (11:00-11:30 a.m.) Action

Background

- In August, the Policy Board requested staff prepare a white paper on cancer crab management and biology after a discussion of a Fishery Improvement Project (FIP) request.
- In October staff presented the Board a white paper on current cancer crab management and biology. The FIP has made progress on the Jonah crab work plan and have made management recommendations (**Briefing Materials**).

Presentations

- Overview of FIP management recommendations by T. Kerns.

Board actions for consideration at this meeting

- Consider initiation of a cancer crab fishery management plan

5. American Lobster Stock Assessment Update (11:30-11:40 a.m.)

Background

- The lobster stock assessment had previously been previous scheduled for peer review in the winter of 2014
- The stock assessment was delayed by approximately four months to allow time for errors in Massachusetts landings to be corrected and incorporated into analyses. Lead analysts and TC members were committed to other assessment workshops this summer, causing the next workshop to be delayed until September.
- The benchmark peer review will likely occur in late winter/early spring of 2015 in preparation for the Spring Meeting.

Presentations

- Overview lobster stock assessment progress by Dr. Nesslage

Board actions for consideration at this meeting

- None

6. Assessment Science Committee Report (11:40-11:55 a.m.) Action

Background

- The Assessment Science Committee and Management and Science Committee reviewed the assessment schedule during their Spring 2014 meetings (**Briefing Materials)**
- Black sea bass has a timeframe set, spot has been paired croaker assessment and a timeline has been set. Timing has changed for lobster, horseshoe crab, MSVPA, and Northern shrimp. Horseshoe crab has been changed from a benchmark assessment to an update due to data confidentiality issues.

Presentations

- P. Campfield will review schedule changes recommended by the committees (**Briefing Materials)**

Board actions for consideration at this meeting

- Approve the revised stock assessment schedule

7. Review and Consider Comment on NOAA Fisheries Stock Assessment Prioritization (11:55 a.m.-12:10 p.m.) Action

Background

- NOAA released a draft protocol for stock assessment prioritization and is seeking public comment (**Briefing Materials**)
- The ASC review and provided comments on the protocol in April (**Supplemental Materials)**

Presentations

- Overview of ASC comments by Dr. Nesslage

Board actions for consideration at this meeting

- Approve ASMFC comments to NOAA on the Stock Assessment Prioritization Protocol

8. Committee on Economics and Social Science Report (12:10-12:20 p.m.)

Background

- The Committee on Economics and Social Sciences (CESS) provided the Policy Board with options for socioeconomic analyses at the Annual Meeting
- The Policy Board directed CESS to conduct a case study on a Commission species, two suggestions were American eel or lobster.
- A request for economic study on allocations for menhaden was made by a Board member

Presentations

- S. Madsen will provide an overview of socioeconomic study options (menhaden, lobster, eel)

Board direction for consideration at this meeting

- Determine a focal species for a socioeconomic case study

9. Habitat and Artificial Reef Committee Reports (12:20-12:30 p.m.)

Background

- The Habitat Committee will meet on May 1, 2014.
- The Artificial Reef Committee met in February. In 2014 the Committee will be updating the Guidelines to Marine Artificial Reef Materials. The Committee is interested in conducting an economic analysis on the benefits of artificial reefs. The committee is investigating if there is sufficient information to conduct the analysis.

Presentations

- M. Yuen will provide an update of the committee's work

Board direction for consideration at this meeting

- none

10. Law Enforcement Committee Report (12:30-12:35 p.m.)

Background

- The Law Enforcement Committee will meet May 13 and 14.

Presentations

- M. Robson will provide an update of the committee's work

Board direction for consideration at this meeting

- none

10. Other Business

11. Adjourn

MEETING OVERVIEW

ISFMP Policy Board Meeting
Thursday, May 15, 2014
2:15-2:45 p.m.
Alexandria, Virginia

Chair: Louis Daniel (NC) Assumed Chairmanship: 10/13	Vice Chair: Doug Grout (NH)	Previous Board Meeting: February 5, 2014
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

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. Review Non-Compliance Recommendations (If Necessary) (2:30-2:45 p.m.)

Background

- Species management boards and sections review compliance on an on-going basis.
- If a board/section recommends that a state be found out of compliance, the Policy Board must review this finding prior to the Commission taking action.

Presentations

- Staff will provide background on any non-compliance recommendations

Board actions for consideration at this meeting

- Determine if a recommendation should be made for the Commission to notify the Secretaries of Interior and Commerce of a state's non-compliance

5. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

ISFMP POLICY BOARD

Crowne Plaza - Old Town
Alexandria, Virginia
February 5, 2014

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

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ATTENDANCE

Board Members

Terry Stockwell, ME, proxy for P. Keliher (AA)
Steve Train, ME (GA)
Rep. Walter Kumiega, ME (LA)
Doug Grout, NH (AA)
G. Ritchie White, NH (GA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Paul Diodati, MA (AA)
Bill Adler, MA (GA)
Robert Ballou, RI (AA)
David Borden, RI, proxy for B. McElroy (GA)
Rick Bellavance, RI, proxy for Sen. Sosnowski (LA)
David Simpson, CT (AA)
Dr. Lance Stewart, CT (GA)
James Gilmore, NY (AA)
Pat Augustine, NY (GA)
Brandon Muffley, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
Mitchell Feigenbaum, PA, proxy for Rep. Vereb (LA)
Loren Lustig, PA (GA)
Leroy Young, PA, proxy for J. Arway (AA)
David Saveikis, DE (AA)
Roy Miller, DE (GA)
Bernie Pankowski, DE, proxy for Sen.Venables (LA)
Tom O'Connell, MD (AA)
Bill Goldsborough, MD (GA)
Russell Dize, MD, proxy for Sen. Colburn (LA)
Rob O'Reilly, VA, proxy for J. Bull (AA)
Louis Daniel, NC (AA)
Bill Cole, NC (GA)
Robert Boyles, Jr., SC (AA)
Ross Self, SC, proxy for Sen. Cromer (LA)
Spud Woodward, GA (AA)
Patrick Geer, proxy for Rep. Burns (LA)
Jim Estes, FL, proxy for J. McCawley (AA)
Kelly Denit, NMFS
Bill Archambault, USFWS
Martin Gary, PRFC

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

Ex-Officio Members

Staff

Bob Beal
Toni Kerns
Kate Taylor

Guests

Mike Millard, USFWS
Michael Pentony, NMFS
Arnold Leo, E. Hampton, NY
Raymond Kane, CHOIR
Sally Campen, Global Guardian Trust
Derek Orner, NOAA
Charles Lynch, NOAA
Wilson Laney, USFWS
Kevin Chu, NOAA
Joe Grist, VMRC

The ISFMP Policy Board of the Atlantic States Marine Fisheries Commission convened in the Presidential Ballroom of the Crown Plaza Hotel Old Town, Alexandria, Virginia, February 5, 2014, and was called to order at 3:25 o'clock p.m. by Chairman Louis Daniel.

CALL TO ORDER

CHAIRMAN LOUIS B. DANIEL, III: All right, what I would like to do is we have some guests that have arrived. Our new NMFS folks, Eileen Sobeck, and I think Sam Rauch is with her; so if they would join me at the table, we will go ahead and move right into our Policy Board meeting.

MR. SAM RAUCH: Thank you, Louis, for allowing us to come up here and having a chance to speak. I have known many of you. I am Sam Rauch. I have always been the Deputy Director of the Fisheries Service for Regulatory Programs; at least for the last eight years or so, but for two years I've going through this difficult position where I held two jobs. I am very glad that I don't hold those anymore.

I am extremely pleased to be able introduce the new Director of the National Marine Fisheries Service, the Assistant Administrator, Eileen Sobeck. She has a long history. She started with NOAA. She worked at the Justice Department where she was, ironically, my first boss over there. She stayed there after I left to come over here.

She did a brief detour with Interior and we will forgive her for that. She is here now; and we were pleased that this opportunity arose to have an opportunity to get together and talk with you as our relationship with the states is very important. We want to make sure that conversation continues. Eileen.

REMARKS OF MS. EILEEN SOBECK, ASSISTANT ADMINISTRATOR FOR NOAA FISHERIES

MS. EILEEN SOBECK: Great, thank you very much, Sam. It is great to be here, Louis and Bob. I'm not going to speak very long. I'm here to listen and participate. I do think it is ironic that I gave Sam his first job and now I'm doing the job that – I'm learning the job that he has been doing for the last two years. It just proves what goes around comes around.

I have been involved in fisheries and natural resource issues in one form or another for a long time. I am a recovering lawyer just like Sam. I try not to be a lawyer anymore. I've learned my lesson that litigation and legal interpretations aren't necessarily the best way to solutions. I know that I'm not supposed to mention my time at Interior, that it is not very popular, but Interior is actually in a lot of realms very good at partnerships and recognizes the importance of states and has a lot of both regulatory and non-regulatory programs that involve partnerships.

I learned actually a lot there about the value of working with state and regional entities in solving common resource issues. This is sort of Day 8 into the job. I am humbly learning how much I don't know. I'm trying to remember that even things that I used to know something about 20 years ago have really changed a lot. Every day, again, I learn more and more about how little I do know and how much I have to learn.

One of the great things is that Sam and his team have made a priority for me to get out and meet people and rather than hearing your issues framed by the great NOAA Fisheries staff, I get to hear them you guys. I've had a couple of meetings already from a variety of stakeholders; and being able to sit in on one of your meetings and participate in this part of the program is going to be really valuable. At the break you can ask me anything you want.

At this point I have no answers to anything. I am only collecting questions. I just wanted to really say thank you to Sam. I have heard nothing but great things about his leadership. I'm really happy that he is not moving on somewhere else, that he is actually going back to what seems like the job he would prefer to do. It is making me extremely nervous how happy he is that I'm here. I feel like I have a great team in place. I don't have a personal agenda. My job is to carry forward the mission of the agency and

try to accomplish the goals that I think that we all share. Thank you.

CHAIRMAN DANIEL: We appreciate you being here; but we did think we were going to get some resolution on sturgeon and striped bass in the EEZ. (Laughter) No! Pat.

MR. PATRICK AUGUSTINE: Thank you, Mr. Chairman, and welcome, Eileen. We appreciate you taking on this big responsibility. I would be remiss if I did not congratulate and thank Sam for two hard years. I tease him every time he comes back or has come back. He always has a new title; and I think maybe they're going to allow you to have permanent ink on this card for maybe six months or a year. Sam, you've done an outstanding job.

I think you have been very open to the public. I know your blog or your piece in the Commercial Fishing News, for those people that get that document, have been very timely and upbeat; and you have driven the system. I think even without leadership at the time, where you took over what you had to do and made things happen, you're to be commended for a great job. You have got a great staff man there, Eileen, and we hope he doesn't go away for a while.

MR. ROBERT H. BOYLES, JR.: Mr. Chairman, I would just like to echo what Pat said. Eileen, welcome. We are thrilled that you are here. There are no easy answers anymore; there doesn't appear to be. We're looking forward to working with you and trying to find some of the solutions to these very, very difficult and complicated problems.

I especially would like to echo Pat's comments about thanking Sam for a thankless job and your willingness to step up to the conn there in the interim. I'm grateful for your leadership in the interim. Eileen, I'm looking forward to working with you and your leadership as well, so welcome to the commission. Thank you for what you will do for the states, and we're looking forward to working with you.

MS. SOBECK: Thanks; and I did want to say that I'm going to try to get out and about to as many of these meetings and as many of the things that Sam covered as I can; but I don't know that I'll need to or want to or that you will want me to be doing them all myself. I have a great team and Sam is number one on that team on a lot of these issues, and so he may well continue to have the leading role. We will discuss that with him and with you all. If he continues to have some of these roles it won't be because he is not keeping me informed but that he has been doing two jobs and now we're going to be splitting those jobs between us.

CHAIRMAN DANIEL: Well, I think you come in at a good time with a lot of issues facing this commission. We had a very good meeting last night with the Mid-Atlantic Council folks in trying to work out ways to collaborate, cooperate and work between the Mid and the Atlantic States. We talked a little bit about reaching out to the South Atlantic to try to do the same thing with Roy and Bob. I think they will be amenable to that.

You always have a good team here representing the Service on the commission. I hope it can be a very open and forthright relationship. It has been rocky in the past, but it hasn't been under Sam's leadership. We do hate to see him go but are glad to see somebody in the position now permanently and set; and so we'll look forward to working with you in the future.

MS. SOBECK: Well, I still have more hair than Sam does; so we're not exactly the same, but I think – well, Sam knows a lot more than I do about these issues, but I think one thing we do share is that I want you guys to be open with me, and I'm going to be open with you. As far as I can tell, Sam has been very – you know, not hiding the ball and being very forthright and not dancing around the issues, as some say.

I can't speak to the substance of any of the issues before this group at the moment, but I think you hit the nail on the head; there are no easy issues anymore in fisheries, if there ever were. I think there only ever were because it was a lot harder to communicate with each other so we didn't. Geography, you know, people in Florida didn't find out what was going on in

Alaska for a few weeks or months or whatever; but I just think that means the need to communicate, the need for transparency and to be honest and frank without being hostile is necessary.

CHAIRMAN DANIEL: It works better usually. All right, if there are no further questions or accolades for Sam – I think we all agree with those – I would like to take a ten-minute break to give some folks a chance to say hello; and then hopefully you will stick around in the audience and stick with us for another couple of hours as we go through our Policy Board.

(Whereupon, a recess was taken.)

EXECUTIVE COMMITTEE REPORT

CHAIRMAN DANIEL: All right, I'd like to get everybody back at the table to continue with our Policy Board meeting. I'm going to take care of one item of business right off while everybody is bright and bushy tailed and give you just a quick update on some discussions and issues that were dealt with at the executive committee this morning just so that everybody is aware of what we are recommending to the Policy Board.

We are still working on – I think we've got one more iteration of our draft plan for conflict of interest that we will be prepared to circulate soon. Bob is going to start passing out our declaration of interests forms. We would like for everybody to start taking a look at those and make sure that the plans that you have declared an interest on are still pertinent and up to date and that you are indeed involved in the plans that you think you are. If you're involved in plans that you didn't think you were, go ahead and remove yourself from that or however you deem it appropriate for your state.

We didn't do a motion for the board issues so I guess I'm just going to bring up our suggestion and hope for a motion. I guess that would be the way to handle it. A couple of issues came up; and you probably are all familiar with New Hampshire brought up an issue about being on the Black Sea Bass, Scup, Flounder Board, but really only have an interest in black sea bass. There may be other jurisdictions that only have an interest in summer flounder or scup or whatever. We talked a lot about how the South Atlantic Board works and how that has worked in the past. Generally speaking, that is Florida, Georgia, South Carolina and North Carolina, but then Virginia oftentimes is at the table. With black drum we had folks all the way up to I guess Delaware and maybe New York involved with the South Atlantic Board.

Generally, those states that have an interest in that individual species on that South Atlantic Board really don't participate or become involved in issues that don't really pertain to their state. What we thought would be a good idea is if folks would like to declare an interest in one or two of the three species in the Summer Flounder, Black Sea Bass, Scup Board, that we would agree to allow that to happen. Do you have a comment?

REPRESENTATIVE WALTER KUMIEGA, III: I do, Mr. Chair. We never did the approval of the agenda or proceedings or public comment as we went from one meeting to the other.

APPROVAL OF AGENDA

APPROVAL OF PROCEEDINGS

CHAIRMAN DANIEL: We sure didn't; thank you. Does anybody have any comments about the agenda or the proceedings for our October meeting? Seeing none; we will accept them by consensus and move on. Thank you. Okay, what we recommended was that the Policy Board consider allowing a state to declare an interest in one of those three species.

They would really not be involved in the deliberations on summer flounder and scup. There was a request I think from one of the states that if a state – that if they do that, have the black sea bass issues first on the agenda so that those poor folks don't have to sit through what we did yesterday on flounder. Does that adequately represent what we talked about this morning? Is there any objection to that suggestion; does somebody want to make a motion to that effect? We can just add it into

policy or we can have a motion to accept it or reject it if you don't like the idea. Pat.

MR. AUGUSTINE: Mr. Chairman, if there are no negative concerns around the table, I would suggest that you assume that we agree and just add it to the document.

CHAIRMAN DANIEL: Thank you, Pat; is that agreeable to everyone around the table? The other issue that we wanted to suggest to the board was splitting up the Coastal Shark and Spiny Dogfish Board. There is a lot of interest back and forth in doing that. The Coastal Shark Board really works more with the National Marine Fisheries Service and Highly Migratory Species; and so we thought it would be a service to both of those species groups if we had a Spiny Dogfish Board and a separate Coastal Sharks Board.

Smoothhounds, which I don't like the name "smoothhounds", but that is what they call them, would be in the Coastal Shark Plan because they're HMS, for whatever reason we still don't quite understand, but they are HMS species. The smoothhounds would be in the Coastal Sharks Board and spiny dogs would be a standalone. Likewise, is there any objection or concern around the table from splitting out up those two boards? Great!

CONTINUATION OF EXECUTIVE COMMITTEE REPORT

CHAIRMAN DANIEL: Mr. Vice-Chairman, did we have any other items at the executive committee?

MR. DOUGLAS E. GROUT: We formed a subgroup to help develop a workshop at the May meeting on Magnuson-Stevens Reauthorization, potentially getting the commission's input and wanting to make comment on the reauthorization plans.

CHAIRMAN DANIEL: Thank you; I did let that one slip. We've got a couple of versions of potential Magnuson Reauthorization Issues; and we felt it would be a good idea to convene a working session at the May meeting, have a workgroup to work out some of those details for our meeting if we want to come up with some specific recommendations on the Magnuson Reauthorization. We will be moving forward with that approach for the May meeting. Dennis.

MR. DENNIS ABBOTT: And also on the conflict of interest, there are some revisions that are going to be incorporated based on what was done this morning. At the May meeting, prior to the full commission meeting, there will be a meeting of the LGAs to go over those changes prior to final approval.

MR. WILLIAM A. ADLER: Mr. Chairman, that working group; do you have that established for the Magnuson?

CHAIRMAN DANIEL: We do. Tom.

MR. THOMAS FOTE: Since I wasn't at the executive committee, who are the members of the working group and is the working group going to – I'd like a little more information about what the working group is going to do.

CHAIRMAN DANIEL: Doug is going to be heading that up so I will let him speak to that.

MR. GROUT: The group will be Paul Diodati, Pat Keliher, Robert Boyles, but all we're doing is organizing a workshop that is going to be at the May meeting for the full commission to weigh in. Some of the concepts that we have is there is some draft Magnuson Reauthorization Plans that came out in the House and we want to put that out and explain that to people.

There may be some input from other people and other organizations that suggest changes to Magnuson that we may want to make the commissioners aware of and then get the commissioners' input on whether we can come to any kind of agreement or consensus on input. Clearly, if we don't have a consensus on an issue or agreement on an issue, I don't think we should go forward with any kind of comment on it. That is the plan.

MR. FOTE: That means if commissioners have ideas of what should be changed or what should be done in the Magnuson Act, they should be forwarding it to you, Doug?

MR. GROUT: Sure.

CHAIRMAN DANIEL: And I will tell you that I have been in contact with Dr. Brian Rothschild and several other folks. He has put together some information that is very similar to the Hastings Draft that has some very good information. We're trying to put together all the information that we have between now and the May meeting so that we can have an informed discussion on that issue. Robert.

MR. BOYLES: Mr. Chairman, I think we've got a little miscommunication here. My understanding is we're going to have a workshop for all commissioners at the May meeting. The subgroup is simply to organize how do we do that. Tom, I think the direction of your comments were if you've got ideas on what we would recommend about Magnuson, give them to Doug.

I believe maybe the more appropriate place would be to let all of us at the workshop have the benefit of that. In other words, the subgroup is not coming up with the commission's position on Magnuson Reauthorization. The subgroup is simply putting the mechanics together of what the workshop would look like. Did I misunderstand the discussion, Mr. Chairman?

CHAIRMAN DANIEL: I think that was a good pick up, Robert. I think there was some confusion there. Tom.

MR. FOTE: Well, I'm wondering then if we do have some position papers that we've already written and do you want to do that before we basically come to the May meeting so we have some ideas from commissioners that already have some ideas. Who do we get them to and should we circulate them before the meeting so we have a base to start working on like public comment?

CHAIRMAN DANIEL: That would be helpful; yes.

MR. FOTE: So who do I send those ideas to and is Doug the person to send those ideas?

CHAIRMAN DANIEL: Doug and copy to Bob, please. Roy.

MR. ROY MILLER: Mr. Chairman, I have a question on your previous item, if I could come back to that when you're done with this discussion.

CHAIRMAN DANIEL: Is there any further discussion on that issue? If not, Roy.

MR. MILLER: Thinking about the previous agenda item regarding declared interest in a species or species subgroup, Mr. Chairman, do we have a general policy with regard to, say for an example, implementation of minimum size limits for spotted seatrout?

Even though states to the north of Maryland haven't declared an interest in spotted seatrout, is that species plan specific what the states who do not have a declared interest would be required to do with regard to species and seasons and that kind of thing? Thank you.

MS. TONI KERNS: I'm going to try to answer it; and if I answer it incorrectly, I think Bob will correct me. Each FMP states what states are within the management board, and those are your declared interest. Those states have a declared interest make up that management range and you then abide by the rules within the FMP.

You can have exceptions under de minimis criteria, et cetera; but if you are not a part of the FMP or have declared interest, then you are not obligated to follow the FMP. For example, current New Hampshire is not a part of the Black Sea Bass FMP but they do have black sea bass in their waters and they are not required to put any management measures in place.

MR. MILLER: A brief followup; that may be a change in emphasis on where we were years

ago. I remember when the South Atlantic Board proposed spotted seatrout minimum size limits, for instance. Just about every state implemented minimum size limits – even Delaware did so and we had no spotted seatrout to speak of – so it hasn't always been that way; but what you're saying is that is how we will proceed?

CHAIRMAN DANIEL: I'm not totally sure, Roy. Bob.

EXECUTIVE DIRECTOR ROBERT E. BEAL: I think the South Atlantic Board is somewhat unique and there have been examples where states have been asked to implement size limits. I think New York was asked to implement a red drum size limit or something fairly recently that they followed through on.

They're not really full participants on the board, but there was concern by the states to the south that a lack of a size limit in those states may create a loophole of some sort, and they were asked to implement very minimal management measures. It has usually been more of a request that they do it than a compliance criteria. I think it has generally worked out.

It is again one of those things that we talked about at the executive committee this morning as kind of more of a practice of a way of doing business than an actual requirement within the Charter or any other guiding documents. It is just kind of how it has been working. Part of this whole discussion is do we need to solidify those practices in some sort of guidance document.

MR. FOTE: If I remember right, if you had a fish in your area, even though you weren't part of the board, you would have to do the minimum that was put in. You couldn't skirt the issue. I think that's where we were many years ago, and I never knew that it had changed. We do that with all the South Atlantic species even though we don't see them or see them very occasionally.

If you're seeing any species on a regular basis and you have an opportunity to catch them, then you really are compelled to go into the regulations and the minimum regulations need to be put in place. You might not have to do reporting or anything else, but you need to put the regulations in place. That is how we've always operated. I don't see change there. Unless we're going to change that, I guess that is going to be a change then.

CHAIRMAN DANIEL: Well, I think from my understanding everybody that has limits on, for example, speckled trout or red drum had a declared interest in that fishery. Now, there may be one or two that didn't, but from my understanding most have had a declared interest.

MR. FOTE: That's not true.

CHAIRMAN DANIEL: Okay. Well, then we'll do a workshop on that the next meeting. I'm kidding! I'm not totally sure, Tom. What I do know is that in the discussion this morning, New Hampshire falls outside of what we thought was the range of black sea bass. Two years ago they started seeing black sea bass and waited for a year to see if it was just an anomaly and it wasn't.

They saw them again; so what they did was preemptively go in and set some minimum size limits and regulations in order to prevent there being a loophole in New Hampshire and causing problems for other New England states. Now the question is New Hampshire believes it should be a member of the black sea bass part of the Black Sea Bass, Scup and Flounder Board. They don't want to sit through the scup stuff and the summer flounder stuff nor do they believe it is appropriate for them to be discussing and deliberating on the scup stuff and the summer flounder stuff. What they're asking for is the opportunity to sit on the black sea bass part of the board.

I'm not aware of any other issue that we have right this minute other than that one; and certainly I'm unaware of any nefarious intent to shirk responsibilities or anything like that. That is one of the reasons why we're going to send around the list of declared interest, and that way we'll know and have a better – because I think

we're still listed as having an interest in lobster and I'm going to take that one off.

I don't have any regulations on lobster and don't anticipate implementing any regulations on lobster. Just take a close look at those. This is all subject to change, but we just felt like I was an appropriate discussion for the policy board to make sure that everybody was comfortable with it. Is that a fair characterization?

MR. BILL COLE: Mr. Chairman, I believe Tom is right. Historically – and I think it comes from the Charter that the board, once the Policy Board agrees to do a plan, that the board will define the scope of the range and ask each state or each entity if they have an interest in the species and want to be included on the board.

Now, if a state has the species and doesn't show an interest, then the board can do a plan, but that plan is applicable to that state because the plan applies to the range of the species. So it is smart business if you've got some in your state, you probably should declare interest in that board's activities rather than suffer other consequences.

Now, that is the reason that we have this de minimis and so forth and so on for those states who have so little of those species, but to keep them inclusive if we can within the range of the species. Now, I will stand corrected but I believe that is in the Charter and in the Operating Procedures. Certainly in my long-time experience with the commission, it has been the operating experience.

CHAIRMAN DANIEL: Well, we've got the spreadsheet of declared interests for all the states if anybody is interested in looking at that. Dave.

MR. DAVID SIMPSON: Bill pretty well summarized my point that you can envision boards seeing a need for a state or jurisdiction to participate in their management. Whether or not they want to participate in the development of that management might be a different question. I think that is where we end up in coastal sharks.

Because of the federal management to have seamless enforcement and implementation of their plans, they need Connecticut to do that and so that is our involvement. Withdrawing from the Coastal Sharks Board as much as I might want to, I don't think would relieve me of Connecticut's responsibility – relieve the state of the responsibility to implement the plan.

CHAIRMAN DANIEL: Okay, anything else on that issue? If not, the final issue that was discussed – and this is why we were making fun of workshops because it looks like the next meeting is going to have several workshops in it – one of the things we discussed was we had a discussion on how states are going to be implementing the Marine Recreational Information Program and felt like it would be a good idea to have that discussion in May so we can see all the various aspects of how that is going to be implemented from states that are very involved and active in implementing MRIP to those that aren't so involved or active, and maybe bring in some of our project coordinators to come in and provide presentations on how that is being done and get a sense of what we need to do in order to have more consistent maybe implementation of the MRIP Program. Dave.

MR. SIMPSON: Yes, I think it's a great idea and I'd also like to hear from NOAA. This is one that it struck me that it seemed like it came from below and came up. I would have thought that if NOAA wanted to partner with the state of Connecticut they would have contacted me or my bosses and said let's get together and have a discussion about whether we want to engage in this.

Instead it's sort of hallway discussions with the technical committee staff that, oh, by the way, you know, there is a change and NOAA wants ACCSP to do all this now and we will be part of it. It would be good to hear what the thought is for why they would like to see this partnership and what the benefits and liabilities are associated with it.

CHAIRMAN DANIEL: Yes, we felt like that would be I think a good discussion for everybody to be involved in around the table. Rob.

MR. ROB O'REILLY: I just wanted to follow up on part of the discussion this morning that it also included the idea that there could be a management board – the South Atlantic has multiple species, summer flounder, scup and black sea bass. I understand the issue about the range and that makes senses as far as inclusion and then the commitment of the state would be recommended but not mandatory to be on the board.

The inference about the black sea bass situation in New Hampshire, I thought we also discussed the idea that if New Hampshire or anyone else, for that matter, who was in a position where only one of the multiple species were of interest, then they certainly could be part of the discussion about those other species. That was also a component of today's discussion and I didn't want to let that go. I just want to put that on the record.

CHAIRMAN DANIEL: Thanks for that clarification. All just, there was just a lot going on this morning in the executive committee and we wanted to bring those issues forward to the Policy Board and make sure everybody was in the loop and comfortable with the suggestions and recommendations that we were making. Thank you for your indulgence on that.

OTHER BUSINESS ADDED TO AGENDA

CHAIRMAN DANIEL: I'll go back to the approval of the agenda. I forgot to add a piece of other business. There was a request from the Winter Flounder Board that we will take up as an item of other business before we adjourn.

NOAA MARINE DEBRIS PROGRAM DERELICT GEAR ASSESSMENT

CHAIRMAN DANIEL: Nancy, welcome back, good to see you.

MS. NANCY WALLACE: Thank you, Louis, I'm very happy to be back. I am Nancy Wallace and I'm the Director of NOAA's Marine Debris Program. As some of you may know, I started my career as a fishery management plan coordinator here at ASMFC. I think it is seven and a half years later, and it is nice to see how many familiar faces are still here. It is really nice to see all these smiling faces, and I love the conversation. I was having memories of my menhaden days.

But now instead of focusing on fish everyday, I focus on trash. I am the Director of the Marine Debris Program. We sit in NOAA within the National Ocean Service; so we are partnering very, very closely with our friends at NMFS, but we are in a different line office. And as such, just to start us off, we are non-regulatory so everything that we do is through partnerships and incentives and education.

We do not make any rules or regulations, but we do provide a lot of good information that can potentially lead into those types of management actions. Today I'm here just to really share information about the program and make sure you're all aware of it, because we do have a lot of crossover with fishing gear. I will go ahead and get started.

We are a fairly new program within the government world. We were established in 2005, officially signed into law in 2006 and then actually reauthorized – the only NOAA Program to be reauthorized in the last Congress in 2012; and we were not given a sunset date, so we don't have to go through that process again and we're very happy about that.

Our vision is that the global ocean and its coasts are free of the impacts of marine debris, and we do that through a variety of ways. What is marine debris? It is important to know what the definition of marine debris is. It is any solid manmade material that is in the marine environment that shouldn't be there.

We don't focus on oil although my division, the Marine Debris Division, sits in the same office with our Emergency Response and Oil Division, but we focus on solid materials. It is not animal carcasses and it is not leaves or trees, so it has to be in the definition for us to be able to work on it. It actually goes everything from the smallest pieces of plastic all the way up to derelict fishing gear or plastic bags, plastic bottles and through

very large abandoned vessels; so it can be any of those things.

Our program has a number of pillars on how we address the issue. For and foremost is through removal. We give out about a million dollars a year in removal grants that go out throughout the entire country. They are community-based removal grants administered by the National Marine Fisheries Service Restoration Center.

The idea is to remove big, accumulated debris; so a lot of times that is the abandoned vessels or large amounts of fishing gear. It tends not to be the smaller cleanups but we do support those in other ways. We try to do a lot through prevention because the number one thing we want to do is to prevent the debris from coming into the marine environment in the first place.

We do that through a different set of grants through communities. We work with aquariums and zoos and universities to share information about behavior change and how each individual person can actually have an impact on this issue. We do a lot about research. We try to look at what the impacts of marine debris is; so things like micro-plastics and fishing gear and vessels, what are they doing to the natural resources, to the habitat; looking at transport models of marine debris to try to locate where the debris will be coming so we can have that or prevention methods as well.

In the past few years we've become a lot more engaged in the emergency response aspect of marine debris, all the way from Hurricane Katrina, the Japan tsunami in 2011 and now Super Storm Sandy in 2012. All of those different efforts we have been very engaged in; because unfortunately anytime there is a severe event like that, there is a lot of destruction and with destruction comes debris; and especially in coastal areas that debris ends up in the marine environment.

The way that we accomplish a lot of our goals is through regional coordination. We recognize that there are different challenges and different solutions in different parts of the country. This is a national program. We are focused from Guam to the Ocean Islands, the Gulf of Mexico, the Caribbean, up to Maine and everything in between, including the Great Lakes.

We have to tailor our responses to the different areas and what is happening there. Our program mandates; one of the mandates in our Act is to address fishing gear; and that is why I'm here today. The language itself is to undertake efforts to reduce adverse impacts of lost and discarded fishing gear on living marine resources and navigational safety.

In the Act it gives us three ways to do that; by researching and developing alternatives to gear that pose threats; developing methods for marking gear to enhance tracking, recovery and identification; and developing non-regulatory measures and incentives to reduce the volume of lost and discarded fishing gear.

Here is a sample of our regional folks. These are the different folks all over the country. We have folks in Alaska; Pacific Northwest; Hawaii; Mobile, Alabama; Ohio. We do have a new person, a new Northeast Regional Coordinator who sits in the Northeast Regional Office in Gloucester. Then we have our Southeast and Caribbean Coordinator who sits here in Silver Spring. We have recently hired a Sandy Coordinator with some of our supplemental funds, so he is leading the charge on the debris removal for Sandy.

Why do we do this work? I don't have to tell all of you; I'm sure you know way better than I do what the impacts of lost and discarded fishing gear are. The reasons we're concerned about this is because of entanglement of animals, the ghost fishing, habitat destruction, destruction to active fishing gear and vessels and then, of course, the economic impact that is associated with that.

In terms of entanglement, one of the concerns that we have especially on the east coast is the North Atlantic Right Whale. In 2010 there were ten new right whale entanglements that were recorded. This is a concern. As you all know, there are only 400 of those whales left. It is an endangered species; so what we want to try to do

is mitigate the amount of debris that could be in the environment that would be affecting those animals.

In terms of ghost fishing, fishermen are great at developing gear. It is going to continue to fish for a long time whether it is pulled out or if it is not pulled out. This is something we're concerned about because the amount of critters that are left in that gear is quite a lot. One of the things we're doing is trying to look at what those impacts are, how expodential is it?

I will talk a little bit more in a few minutes, but we've provided some funding to the Virginia Institute of Marine Science, different groups in the Chesapeake Bay, actually all over in Alaska, Puget Sound to really start to quantify what the impacts are in terms of how many species are being caught. Another area that our program really focuses on is the plastics, microplastics in particular, so much of the marine debris that we come across is made up of plastic, whether it be the plastic bag or the plastic bottle. A lot of fishing gear has plastics in it or just the toys and toothbrushes and the amount of things that we find on the beaches. One of the real concerns is that plastic breaks down, but it never breaks down all the way so the pieces get smaller and smaller.

Unfortunately, there is a lot of pollution in the ocean environment. There are toxins. A lot of those toxins are hydrophobic; so if there is a piece of plastic that that pollutant can absorb to, it will; and so that happens. We are sure of that. Then what happens – and we're sure of this, too – is that those plastics are ingested by fish, by birds, by turtles.

What we don't know is what the transfer is then; so are those pollutants then releasing into the tissue of those fish. If so, what is the chain through the bio-accumulation, through the trophic chain, there are potentially some human health impacts? We don't but we are starting to do a lot of research on the science behind that; because unfortunately this plastic is just pervasive throughout the marine environment.

To give you a couple of project highlights of what we've done in our career since 2005, since the program started. We have funded over a hundred different derelict gear fishing projects nationwide. A lot of that is removal; some of it is research. But just to give you a couple of examples of what type of work we've done within the program, we've funded the Virginia Institute of Marine Science to look at biodegradable crab pot cull rings to see how long it takes for the cords to degrade.

We've worked with the Gulf of Maine and Maine Lobster Foundation to actually go out and collect derelict gear and look at the assessment of where that gear is ending up. We worked with fishermen in New Jersey, with the Richard Stockton College, to do derelict gear removal. We have also done some pilot projects in North Carolina to look at recycling derelict crab pots into oyster reefs.

One of the main things we've really tried to do is to employ the fishermen to do this work because they know the area best and they know the gear the best. For research, I mentioned this before, but we did do some pretty comprehensive work in the Chesapeake Bay. We funded a contractor, Versar, to work in the Maryland portion, and then we've also partnered with VIMS in Virginia's section to be able to see how many pots are out there and what they're catching.

In the Versar Study in Maryland they estimated that more than 84,000 traps were collected in the Chesapeake Bay. They did 285 side-scan sonar transects and found that there were 20 dead crabs per trap per year that were being caught; so that is a pretty significant number. The Virginia Institute of Marine Science did a study from 2009 through 2012 and their results are actually – I think they became public today.

I wasn't going to come and share their results because I didn't want to scoop them on their study. As I was leaving I saw the e-mail that it came out, but you can follow up and look at that, but it is pretty significant the amount that they were finding in the Bay. In terms of removal, some of the projects that we funded are with the

Provincetown Center for Coastal Studies, going out and doing – this is a side-scan sonar track to be able to locate where the debris is. With this program, we employed four different fishing vessels; and the lobster boats were on the water for 32 days. They actually collected over 40 tons of gear in that time. It is pretty substantial. Another program that some of you may be familiar with is our Fishing for Energy Program. In 2008 and prior to that we did a lot of workshops with fishermen and said we're finding a lot of derelict gear; can you help us understand why we might be able to find that gear? We've heard that there are a lot of reasons. There are storms; there are propellers that cut off the buoys that are lost; there is accidental loss.

But one of the other things we heard is that disposing of derelict gear is costly, it is expensive; and so we worked with our partners at the National Fish and Wildlife Foundation, with Covanta Energy and at Schnitzer Steel. We were able to say how can we provide a free or no-cost option for fishermen to be able to dispose of their gear and then do something with it?

What we were able to do is that we have bins set up at ports where fishermen can go throw either their old derelict gear in the bins that they're not going to be able to use anymore or if they're out at sea and they find gear on the beach that they can get rid of; that is a free place for them to put that, too.

Schnitzer Steel takes the metals out, recycles the metal, and then Covanta Energy takes it to their waste energy facilities and it is incinerated and it is put back into the grid. We're really excited about this because it is a win-win situation. So far we have collected over 2.2 million pounds of nets at 41 different bins across the country; and more than 250 tons of gear has been removed by fishermen through grants.

We do a Fishing for Energy Grant Program as well that NOAA helps provide support for. These are our bin locations. As you can see, the majority of the bins are in New England. We've had great success especially in Massachusetts where we've heard from the fishermen that they're really excited about this.

What we hear more and more from fishermen is that they would love to see more bins in more locations. We would love that, too. We are trying to think about how to make these more self-sustaining so to be able to provide seed money to new ports and then have those ports kind of self-sustain over time so we can expand the program.

I wanted to show just one slide on our work related to Super Storm Sandy since it does affect many of the states that you all are from. We received about $5 million in the Sandy Supplemental. That was to survey and assess debris that was generated. We want to be able to do a little bit more than just survey and assess. We want to give money to the states to actually remove that debris.

NOAA through our Office of Coast Survey and some of our other offices are able to do a lot of that now mapping. We're taking that information and, we're providing it to our state partners. Rhode Island, Connecticut, New York, New Jersey and Delaware are the five that we're focusing on right now.

We're developing agreements and we're going to be transferring money to those states to be able to actually go out and remove the debris. All of the funding will be transferred by September 30th of this year, hopefully much sooner, and a lot of the work will be done by that time. For Fiscal Year 2014 we just recently got our budget. It is not the final number, but luckily things are looking okay.

We are taking a new approach to our research this year. We've funded, as I mentioned, a hundred different derelict fishing gear studies all across the country in the last seven or eight years. What we want to do now is instead of kind of putting a little bit of money into a lot of different projects; this year we're going to put as much as we can into one big project.

We are going to try to look at the comprehensive impacts of derelict fishing gear in the

Chesapeake Bay. We chose the Chesapeake Bay because there is a lot of data that has already been collected there. There are a lot of great partnerships with the watermen there. We did look at other areas of the country; and after a lot of discussions and research, we focused in on the Bay.

What we're going to be doing is looking at kind of the amount, the abundance, the location, the impacts from an economic standpoint as well as a natural resource and habitat standpoint and come up with a final answer. We're going to be doing that through an external contract. We have a Statement of Work ready to go; and as soon as we get the final okay on our budget, we're going to send it out the door.

We are hopeful that the contractor will work with the different groups that have been doing this work already. We're pretty excited. Now, as I said, we're not regulatory so we're not going to be suggesting any changes, but what we can do is provide the information to you. What I'm hopeful is that through this study we'll also be able to really hone in on why this derelict gear is happening and to look for solutions to prevent it from occurring in the first place.

As I mentioned, we're a small program; and the partnerships that we work on are really important, and we would not be able to do any of the work that we do without our partnerships. The non-profits; the state, local and federal agencies that do a lot of this work; the fishermen and other industries that we work for; and our researchers and the academic community have been critical to the success of the program to date. We are thankful for that.

This is my last slide and I just wanted to say thank you very much for the time and sharing what we do. I have a different turtle for every region I'm in. This is the east coast turtle; the Maryland, the diamondback terrapin. I don't know how we're doing on time; but if there is time and you have any questions, I'd be happy to answer them; or if you have any interest after, I can always be reached to follow up.

CHAIRMAN DANIEL: Thank you, Nancy. Are there questions for Nancy? Rob.

MR. O'REILLY: Hello, Nancy; and I wish you had mentioned Atlantic croaker, which you were so much involved with for its first SEDAR; but that's okay. What I wanted to ask was I wasn't sure what NOAA is doing dovetails with something coming up very soon, which is a Virginia Marine Debris Reduction Plan, which spun off I guess last year. At the marine aquarium, there was a Marine Debris Summit, which I didn't get to attend but one of our staff did; and I was wondering how those were linked and is that in turn linked somehow back to the initiative for the Chesapeake Bay.

MS. WALLACE: That is a great point. Yes; we are very engaged in the Virginia effort. I have to say Virginia I think is taking the lead on developing a regional plan. NOAA provided funds through the Coastal Zone Management Program to the state of Virginia. Virginia said marine debris is an issue and we want to work on it. They have developed a working group to develop an action plan. I actually was on the phone yesterday with Katie Register. She interviewed me to kind of cull down on some of the main issues

They're doing that with I think 20 different partners. Our east coast coordinator has attended all of those meetings and is very linked. One of the things that we have been able to do as a program is help facilitate the development of regional action plans. We have a Hawaii Marine Debris Action Plan; there is a West Coast Plan. We're going to finalize a Great Lakes Plan in the next few weeks.

What we don't have is any east coast or Gulf of Mexico plans. I have to say I have been really impressed by Virginia especially because they are the first state to come out and say we want to do our own plan without NOAA kind of prodding and facilitating. What we're able to do then is provide funding through our grants' process to help implement the actions that are in these regional plans.

Now that we have a northeast coordinator, we're going to try to develop some sort of northeast regional plan and continue down. We have a workshop scheduled in Florida in May and one in South Carolina in June that will be addressing North Carolina, South Carolina and Georgia issues for a plan. That is a great point; and, yes, we will absolutely be linking those efforts with the Chesapeake Bay Research Study. Our coordinator is kind of the connecting piece between all of that.

MR. LOREN W. LUSTIG: Thank you for a very, very interesting report. I really support what you're doing. I was very interested when you were speaking about derelict gear being used to enhance an oyster reef I believe in the Chesapeake. Can you comment about the use of derelict vessels that might be used and the cost thereof for cleanup and the like to actually sink those vessels and make them into an artificial reef. About five years ago I went on coast guard vessel that was moored at Key West, Florida, from World War II and was interested to find out about six months later that it was actually sunk off of Sarasota, Florida; so I know the opportunity is there. Thank you.

MS. WALLACE: That's a great question because marine debris is abandoned vessels, but we have worked closely with the state historic preservations offices. There are a lot of historic wrecks that we would never ever touch. We don't consider those the same type of debris. I know in the Gulf of Mexico and Florida there are a lot of rigs – not rigs.

There is a Rigs to Reef Program in the Gulf of Mexico but vessels as well that are sunk. From our standpoint, we try to keep things out of the marine environment that shouldn't be in the marine environment; but anytime there is an artificial reef developed, there is quite an extensive permitting process.

We work with the EPA; with the states; NOAA is involved; and so there is a lot of assessment to see if there will be benefit to those types of – you know, will the habitat that is being created be more important than perhaps putting the debris in the ocean in the first place; and so in some cases that is acceptable. In other cases, I can tell you one of the programs that we're working on and that we're funding right now is in Broward County, Florida, where in the seventies there was a decision to put a ton tires down on the habitat, on the benthic habitat to develop reef.

Now the tires are completely breaking up; the reef was never – this one was in Broward County, Florida, and so now we're spending a lot of money to try to remove it. There is always kind of the give and take of any of these decisions and the long-term sustainability of anything we're putting in the ocean. The oyster one was in North Carolina; the oyster pots; the habitat, yes.

CHAIRMAN DANIEL: Yes; after every hurricane, sometimes we'll have as many as 5,000 tires wash up on our beaches and we've got to go pick them up; thanks to really an idea back in the mid-eighties to put them out there. Are there further questions for Nancy? She will be available afterwards, right, Nancy?

MS. WALLACE: Absolutely, yes.

CHAIRMAN DANIEL: Okay; it was great to see you and thank you very much for an excellent presentation. Next is we have Mike Pentony for a review of the proposed rulemaking on Special Management Zones for five artificial reefs off the coast of Delaware.

REVIEW OF THE PROPOSED RULEMAKING ON SPECIAL MANAGEMENT ZONES FOR FIVE ARTIFICIAL REEFS OFF THE COAST OF DELAWARE

MR. MICHAEL PENTONY: My purpose here today is just to give the commission a brief update and background on an action that we are currently considering. We're in the process of developing a proposed rule; but we have not published a rule yet. We intend to continue to consult with the commission throughout our process before we make a final decision on these proposed special management zones.

Those of you on the Mid-Atlantic Council may recall this has been developing for the last several years. In 2011 the state of Delaware petitioned the Mid-Atlantic Council to consider requesting that NMFS designate five artificial reefs off the coast of Delaware as special management zones.

That is a term of art that appears in the Summer Flounder, Scup and Black Sea Bass Fishery Management Plan that authorizes the Mid-Atlantic Council to request the agency to designate artificial reefs as SMZs and essentially create gear-restricted areas within those special management zones to facilitate recreational fishing or really to facilitate or address and remedy gear conflicts that can occur on some of these reefs.

As I mentioned, in 2011 the state of Delaware requested the council to consider this. The council undertook the process that is required in the regulations under the Black Sea Bass FMP. They appointed a team to review the information, develop a proposal for the council to consider, and held a series of public hearings on the issue.

In June of 2013, just last year, or actually February of last year – it has been about a year – the Mid-Atlantic Council formally requested that the agency consider designating these five areas that you have up on the map there as these SMZs under the authority that we have in the Black Sea Bass FMP.

As I mentioned, we are reviewing that request and developing a proposed rule. We are developing an environmental assessment under NEPA to go along with that proposed rule. I expect that we will have a proposed rule out in the next two to three months. We will probably have an extended comment period, maybe 60 days, because of the unique aspects of this issue.

What the council has requested and that we are entertaining is that the areas there would be restricted to hook-and-line fishing and hand harvest. There would be a 500 yard buffer around each reef; so those would essentially become gear-restricted areas where pot fishing and mobile gear fishing would be restricted from those areas.

I do want to point out that the interpretation or what we're hearing is people are perceiving this as a recreational versus commercial fishing action. The council did not request and we are not considering prohibiting all commercial fishing from these areas. We are simply proposing or intend to propose that the areas be restricted to hook-and-line fishing be it recreational or commercial.

The primary intent of this is to reduce gear conflicts that the state of Delaware and others have heard have been occurring on these reefs. It also, as you probably know or may not know, is an attempt to by the state of Delaware to ensure that it does not lose any sources of funding under the Sportfish Restoration Act the Fish and Wildlife Service administers.

New Jersey, as you know or may know, lost access to some funding for its reef program because the state did not have any mechanism to address gear conflicts on those reefs; and so this is an attempt and effort by the state of Delaware to ensure that it can continue to be eligible for funding under that program in order to maintain and enhance those reefs. Unless there are any questions, I'll stop there and see if there are any questions that you may have.

MR. BOYLES: Mr. Chairman, no question and just a comment just for the board's edification. The state of South Carolina has requested similar actions from the South Atlantic Council, and that has been the case. Our reefs have been designated special management zones for a number of years.

Most recently the state requested and the council approved and NMFS subsequently implemented regulations to prohibit of species in snapper grouper and coastal migratory pelagics in excess of the personal bag limit. For what it is worth, I support this effort and think it is a good step and a good move for the state of Delaware to do this, recognizing that we're going to have more and more gear conflicts as habitats become further constrained. For what it's worth, I'd just offer

moral support. I'm not sure you're looking for a position from this body, Mr. Chairman, but I certainly support the effort.

CHAIRMAN DANIEL: I may be completely off here, but as I recall the South Carolina SMZs were granted or the council agreed to the recommendations from the state of South Carolina. One of the reasons was because all of your reefs were constructed by Wallop/Breaux funds and were not funded by taxpayer dollars.

I guess that would be my question of the Delaware reefs is are those fully funded by recreational dollars or they taxpayer dollars, because that is where we ran into a problem in North Carolina where we had Wallop/Breaux money, but we also had appropriated state dollars that went into building those reefs. That created a problem for us when we went in that direction, and I don't know if you've run into the same issue with Delaware or not.

MR. PENTONY: I can't answer that question directly, but it is something that we're looking at.

MR. DAVID E. SAVEIKIS: Yes; Delaware's program is funded exclusively with Wallop-Breaux funds and matching state recreational license money.

CHAIRMAN DANIEL: You shouldn't run into a problem, then. Robert.

MR. BOYLES: Mr. Chairman, initially, not to put too fine a point on it, but I think our initial issue in South Carolina was bangsticks. It started out as a gear conflict issue; and only in the last several years when we started getting gear conflicts and user conflicts did we pursue this effort to limit possession to the personal bag limit. Again, that is something that has been implemented by a lot of discussion at the council level. Again, I support the effort.

CHAIRMAN DANIEL: Yes; if it is all recreational money and they are actually going to allow a commercial hook-and-line fishery on those reefs, I would be hard pressed to find an objection for what Delaware is trying to accomplish. There may be others that feel differently, but that would be my general sense. Tom.

MR. FOTE: What are bangsticks; I never heard that phrase?

CHAIRMAN DANIEL: Sticks that go "bang". They're exploding spears. They are actually a shotgun shell on a stick and you pop the fish with them and it explodes and kills them.

MR. FOTE: We used them for shark fishing. They used to use them for shark fishing; but I thought you had some other gear that was called a bangstick. I understand what a bangstick is.

CHAIRMAN DANIEL: Yes; they created quite a stir in the South Atlantic eight or nine years ago down in Jekyll Island. That was a very interesting meeting. Dave Simpson.

MR. SIMPSON: I just wondered if someone from Delaware could just give us the like one-minute lowdown on what the reefs are made of and how this came about and all that.

MR. MILLER: Dave, the Delaware Reefs are derelict vessels, the most recent one. Particularly the most recent one is a fairly large derelict vessel that is about 20 miles offshore. Other reefs are made of materials of opportunity, including New York subway cars, concrete culverts, that type of material. Was that good enough, Dave?

CHAIRMAN DANIEL: Is there anything else on this issue? If not, thank you very much. Next on our agenda is Toni is going to review the survey results from our 2013 Commissioner Survey that I know everyone filled out and submitted in a timely way.

ASMFC 2013 COMMISSIONER SURVEY RESULTS

MS. KERNS: Well, if everyone you mean 27 commissioners, yes, everyone. The survey is included as part of our 2014 Action Plan. The purpose of the survey is to measure the progress towards the commission's goals. As I just said,

27 out of 45 commissioners responded, which is up from last year.

I think we had 24 so we're moving in the right direction and maybe next year I'll provide a free incentive for those of you that fill out the survey and actually tell me that you filled out the survey. I think we only had about 15 people tell us they filled out the survey. The survey asked for your input on responses of a scale from one to ten. It has five topics, 20 questions.

You range your answers on not supportive all the way to very supportive. There are five open-ended questions to finish up the survey. Overall there seems to be increased satisfactions from commissioners. Almost all responses are at a six or above. I'm just going to go through a couple. I'm not going to go through each question.

The results of the survey were in the supplemental materials. The graph just shows you how our responses have been over time since 2010 when we started this survey. It seems like folks have had an increased confidence that we can achieve the commission's vision as well as we're fairly satisfied with the cooperation between commissioners to achieve our vision.

We're moving in the right direction towards cooperation with our federal partners, which in the past two years had gone down, so I'm glad to see that we're doing a better job there. One of the areas where we had a slight declining trend is the satisfaction with our efforts to describe progress to the public and stakeholders as well as showing transparency in the commission decision-making process.

The other two areas where we had declining downward trends which were similar in scale here was how comfortable we are with the performance in reacting to new information and adapting accordingly to our commission goals as well as due to our limited scope of authority how comfortable are you with the commission spends the appropriate amount of time or appropriate amount of resources on issues within its control. There was also a slight downward trend there.

To the open-ended questions, there were a lot of responses so I just pulled out some that seemed to have a little bit of repetition in those responses from what is the most significant problem the commission could and should solve: improve stakeholder transparency; depleted and overfished commission fisheries; time in responsive management decisions; equity and allocation of our resources; multi-species and adaptive management in light of the changing environments; and having a high level of confidence in monitoring, research and stock assessments.

What is the most important challenge the commission could make to improve results: have meaningful and effective reform of the recreational catch and effort data collection systems; making hard decisions; have more staff resources and commission staff to conduct stock assessments; have adaptive management to changing resource distribution and abundance; and rebuild and restore fisheries.

The open question is what is biggest obstacle to commission success: lack of resources – those were about funding – having political pressure from stakeholder, states and other areas; the Endangered Species Act; environmental changes and limited control over those – there is a consistent message that we could only manage our fisheries and we have no control over habitat and other such areas – as well as data collection.

Then is the commission using the appropriate metrics to measure progress; and in general it sounds like, yes, we are; that we may want to start looking into ecosystem approaches. They should not change according to the status of the stock, so our current metrics do change sometimes in an FMP according to the status of the stock and that they shouldn't. We are shortsighted to look at success just on a rebuild status and that we should be looking at the bigger picture more and have an emphasis on fishery mortality metrics over biomass.

Then with the additional comments that we received, we have a lot of accolades to the staff and our leadership here at the commission; that

we should use the cut-off button less at board meetings and that we should have equitable allocation of restored fisheries. Based on the results of the survey; does the commission want to react to these survey results; and if so, what are they? Secondly, is the survey an effective tool and is it something that you want us to keep doing in the future?

CHAIRMAN DANIEL: Are there questions for Toni? Do you want to keep doing this? All right, I think it is a good pulse measure. I really don't think there is a whole lot we can discuss about it other than please fill out the daggone thing. It doesn't take any time, really, so it would be helpful. Everybody that didn't fill it out, I want you to raise your hand. Dennis.

MR. DENNIS ABBOTT: Looking at the trend charts, I don't think you can rely much on those because you really don't know who is filling out the survey every year due to attrition or people's choice in filling them out or not. I don't think it shows you a whole lot that you can rely on. You really need some way of knowing who is filling out the survey.

MS. KERNS: One of the things that we can do in Survey Monkey I believe is say "fill in your name". We haven't done in the past to allow you all to be anonymous and be comfortable about saying whatever you want in the survey; but if you would like us to have you put your name in the Survey Monkey Survey, we can do that so we know who is filling it out for sure. Right now you're supposed to e-mail me or Deke. There were several people that filled out the survey that did not tell us.

MR. O'REILLY: I'm not sure it is significant that there are changes in those who fill out the surveys or even if 27 out of 45 filled them out, although it would help for much better. It may be important to know something about the downward trends regardless of what is causing them. On a couple of figures where you see that there is less transparency, for example, is one of them, it might be good to know something about that. I don't know how you would do that. I don't think anyone is going to tell us right now why they think that or maybe they would, but that is something worth paying attention to.

CHAIRMAN DANIEL: Absolutely, especially that one. Jim.

MR. JAMES GILMORE: Just as suggestion, if we don't want to go to actually putting names down, maybe the number of years you have been sitting as a commissioner. I think the first couple of years I filled it out, I had very different responses than I have now. You could tweak that a little bit and people that have been sitting five or longer years may have a different perspective.

REPRESENTATIVE KUMIEGA: Anything over 50 percent is a pretty good return on a survey. I don't think the variations in those trends are significant enough given that 50-something percent or 60 percent response to be worried about. I think the responses to the open-ended questions are probably more useful to us. I don't who has an issue with the cut-off button, though.

CHAIRMAN DANIEL: I can't imagine because it is used very infrequently and it is usually on Pat. (Laughter) Did you fill out the survey, Pat? Tom.

MR. FOTE: Yes, 50 percent is really great on a survey. In order to get even close to that, we used to have to give away a $500 prize for filling out the survey. Maybe if you gave out a prize, you would get more survey responses just by telling people that they did it.

CHAIRMAN DANIEL: When you've got a group of 45 people that are dedicated to this cause, I would hope that we would have much higher than 50 percent. I realize 50 percent is great in like a mail-out survey or surveying the public; but when you're surveying the commission, I would expect to see 45 responses out of 45 people. Then we don't have to wonder, Dennis, if the results are meaningful or not. Rob.

MR. O'REILLY: I can't help but saying it is really 60 percent so we've already progressed quite nicely.

CHAIRMAN DANIEL: It sounds like weakfish. Is there any further comment on the survey?

MS. KELLY DENIT: I appreciate the slight uptick in the survey responses that relates to the engagement with the feds, but I would greatly appreciate any additional comments that you all want to provide that are suggestions for way that we can continue to improve that. Whether that is as part of this discussion right now or over a beer at the bar, I think we are very interested in moving that up much higher than it is right now and so suggestions on how to do that would be greatly appreciated.

DISCUSSION OF DEFINITIONS FOR THE ANNUAL FISHERIES PERFORMANCE OVERVIEW

CHAIRMAN DANIEL: Is there anything else on the survey? All right, discussion definitions for the Annual Fisheries Performance Overview. This sounds like an exercise in wordsmithing again.

MS. KERNS: It could be an exercise in wordsmithing. Back in August we went over the annual performance of the stocks. Just to remind everybody, the purpose of that is to support the Policy Board's review of the stock rebuilding performance and management board actions and to provide direction to management boards for our action plan each year.

We want to validate the status or rate of progress; and if it is an acceptable versus non-acceptable; and if not acceptable, identify appropriate corrective action. That document has a lot of words in there that we did not define. The Policy Board asked me to go back and get some definitions for the categories that are in the document.

I've put together a white paper that was in your supplemental materials that suggests adding some language in there as part of the annual performance of the stock that describes the five categories that we use for each of the stocks and those definitions. We would also include those definitions as a part of our stock status overview, which is the one-pager that has the up/down for each of our species that you see often in the back of the table that we take to tradeshows, et cetera.

We have six categories in the performance document. The first is rebuilt; rebuilt is biomass is equal to or above the biomass level set by the FMP. Rebuilding is biomass is approaching the target level established by the FMP to ensure population sustainability. Overfished; biomass falls below the threshold set by the FMP. It reduces the stock reproductive capacity to replace fish removed through harvest.

Depleted reflects low levels of abundance though it is unclear whether fishing mortality is the primary cause for the reduced stock status. That is where the difference between overfished and depleted is that we don't know where that mortality is coming from.

Concerned is stocks that are developing emerging issues prior to the completion of a stock assessment. This is going to range the scope of stocks that we're looking at. It will only be those stocks that we have assessments that are ongoing are right about to be upcoming and there seems to be some hot-button issues that we want to look at. Unknown is stocks that have no accept stock assessments. That's all.

CHAIRMAN DANIEL: Very good. Can you go back to the first two? Dave.

MR. SIMPSON: I have a sheet that Toni gave me and it doesn't have the concerned one on it; but I think that could be a really useful addition.

MS. KERNS: The concerned in the paragraph language; it is not in the table. We can add it to the table. The table we were just going to use in the quick overview; and I don't believe we actually have concerned as a category on that. If it is, I'll add it in; but if it's not, I didn't think that we would want to throw it in there because then I thought it would add confusion.

MR. SIMPSON: So for overfished, we might want to expand that definition to include or reduce the stock's capacity to produce optimum yield. If you just added "or produce optimum yield" I think that would cover both the textbook definition of growth overfishing and recruitment overfishing.

I wanted to ask if it was intentional to say "significantly reducing". In other words, right now if the target biomass is a hundred and we're at ninety-nine, we say we're overfished. Is the intention here to say, well, we wouldn't call it overfished if at ninety-nine but some other level? Was that the intention of that?

MS. KERNS: I'm going to ask Katie Drew to come to the microphone because she and I worked on these together as a team effort from the Science Department to make sure we were on the same board here.

MR. SIMPSON: I guess that's where I was thinking concerned might fall in; that in between overfished and not overfished, it would provide that little area of, okay, we're a little below where our target is, but we're not prepared to call it overfished.

DR. KATIE DREW: Part of the reason that we include sort of a biological component to these definitions here is to make this more I think accessible and transparent so that overfished isn't just crossing a line. It is not just about what is in management. It is that management has a scientific purpose behind these designations; and so we wanted this definition to explain you're crossing this line, but this is bad because there the scientific reason is not an arbitrary threshold.

I think species of concern is more in the unknown section. If we wanted to create a category for species that are somewhere between the target and the threshold or whatever in terms of trying to explain that we have concerns about that; I think that would be a separate designation from what this structure has already created.

MR. SIMPSON: Okay, I appreciate the transparency thing, but this would be the interpretation guide for performance on our FMPs, and those do have definitions and do kind of have lines that if you're one inch to the left of the line, then you're overfished in some of our FMPs, right?

DR. DREW: Yes.

MR. SIMPSON: So are we looking to change that?

MS. KERNS: No.

CHAIRMAN DANIEL: Let me try here. If you're below the threshold, you're overfished whether it is one inch or twenty-four inches. If the biomass falls below the threshold or when you do the assessment and you determine in an unknown stock – let's say you do the assessment and it comes out you're at 0.99 and trying to get to 1, you're still overfished. Your goal is the target, so you've got it up above the threshold in order to start rebuilding towards the target. I don't know if that gets to your concern or not.

MR. SIMPSON: I think it would if all of our plans have thresholds and targets. Do we like for tautog; I don't remember a threshold, for example?

MS. KERNS: All the plans do not have thresholds and targets.

CHAIRMAN DANIEL: Then that is a problem.

DR. DREW: In that case then we would be more in the unknown because if we don't have it, it is usually because there is no assessment or that part of the assessment did not pass peer review; so the status would be unknown in terms of overfished versus overfishing.

CHAIRMAN DANIEL: Yes; that makes sense.

MR. SIMPSON: Well, I don't want to belabor it because I think this is great. Toni gave me a definition of depleted, so I really should leave here happy today; and I will. But, still with tautog, because we don't have a threshold, the latest status is still overfished and that is kind of that line in the sand with no gray between

threshold and target; so maybe as we amend plans, we want to incorporate more of that zone of good, warning and bad.

MR. PENTONY: Toni, I just have a quick question for you on the rebuilt and rebuilding. What do you call a stock that has never been overfished or depleted and is above its biomass target?

MS. KERNS: Unique; we don't have any of those.

MR. PENTONY: Well, I raised this because we deal with this sometimes in the agency that if it is not under a formal rebuilding program and it has not ever been declared overfished, its biomass is going to vary around your target. It doesn't go from rebuilt to rebuilding and rebuilt to rebuilding, you know, flip-flop back year and year. It is what it is; and so I'm just wondering if these are terms meant to apply only to stocks that have at one point been overfished or they're meant to be terms of general applicability to clarify that they may not – do you see what I'm saying?

MS. KERNS: Yes; I see what you're saying and I don't think we have any fisheries that actually fall into that category.

CHAIRMAN DANIEL: I understand what you're saying, though, and I think the way we do it at home is our rebuilt category is actually called "viable"; and then that is a stock that is producing sustainable harvest and it may have met this rebuilding trajectory; but I think rebuilt and viable from my perspective are kind of interchangeable in this context.

MR. PENTONY: Yes; and that is helpful. I would point out summer flounder. We declared that rebuilt a few years ago. It is no longer above the biomass target; so you can't call it technically rebuilt this year, but I wouldn't call it rebuilding because it is not under a rebuilding program. We're just varying around the biomass target and "viable" sounds like a good term for something like that.

CHAIRMAN DANIEL: I understand what you're saying.

MS. KERNS: I guess my question would be summer flounder is categorized as rebuilt by the Service as well, right?

MR. PENTONY: Well, it is categorized as rebuilt because we had a formal rebuilding plan and we rebuilt the stock; but that doesn't mean that the biomass is going to always stay above the biomass target. In fact, it is not above the biomass target this year. It is not overfished; it is not under a rebuilding plan; so we can't really call it rebuilding. That is why I'm raising this. There is this gray area that trips us up sometimes.

MS. KERNS: We can create a seventh category if that is the will of the commissioners.

CHAIRMAN DANIEL: We found "viable" to work in North Carolina because we started with "healthy" and then there started to be some connotations towards public health. The mercury and all that stuff came up and then that is when we went back to "viable". I think we can work on a "viable" definition. I'm not going to take the time to wordsmith it right now, but I think it would probably behoove us to have that to address that gray area.

I did have one comment. We ran into some problems with this at home. We have the same category of rebuilding; and biomass doesn't necessarily have to be approaching the target, because a lot of people misinterpret what does "approaching" mean? That means you're really close, that is what some people think; but you might have a stock – I don't know; I don't want to use an example – that is progressing towards the target.

I would suggest changing that to biomass is progressing towards the target and not necessarily approaching it. That gives you that flexibility because some of these rebuilding plans might be ten, fifteen or twenty years; and they might be in a rebuilding situation for a long period of time. That was just hopefully to be a clarifying statement. Rob.

MR. O'REILLY: I guess we're looking for – is the word "transparency" that I'm hearing a lot, but consistency is what grabs me. With these particular definitions, the rebuilding and also the rebuilt, I think they're tied together, obviously, and so I don't know why we wouldn't say the biomass target – instead of the word "level" use the word "target" in the top definition; and instead of the word "level" use the word "target biomass" in the part of that. I think that is a little clearer. I think everyone recognizes about targets. Once we start talking about levels, we're losing the consistency there.

I wanted to comment just briefly on the summer flounder example. That is a tough one because it was rebuilt but each year it is treated as if it really still is rebuilt or there wouldn't be efforts to have the full ACL assume to be taken; and also when the SSC has the risk policy, you know, everything we're doing while we're falling behind by 39 percent since 2011 is because it is treated as rebuilt still in a way. It is not a clear-cut situation, that's for sure, because it is not as if the council or us or the SSC are just saying, well, we'll just go forward and we won't worry about the fact that it was just recently rebuilt. It is almost being treated as if it is still rebuilt.

REPRESENTATIVE KUMIEGA: I hope we do get a definition. I don't know if "viable" is the right word, but I can't think of a better one so we will go with that. Like lobster in the Gulf of Maine is in good shape and we don't want to be making people think that it isn't or that it wasn't; so I don't think we want to use "rebuilt" for it because it has never been overfished. Well, by some definitions it has.

MR. ROBERT BALLOU: Mr. Chairman, I would just note with interest that in Dr. Rothschild's paper that he wrote that I read in preparation for the executive committee meeting on Magnuson Reauthorization issues; if I'm not mistaken, he is suggesting replacing in Magnuson "overfishing" with "depleted" because of the pejorative nature of overfishing and the notion that a stock's maximum biomass may be lower than its target due to factors other than fishing.

I just thought it was interesting to see the two side by each on I guess it is the next slide meaning we're continuing forward with the two terms; the second one being I guess where you really don't know what is causing the depletion; and I guess overfished being – I guess I'm just sort of stuck on he has peaked my interest in this issue of whether it is fairer and more appropriate to use the word "depleted" versus "overfished". I just offer that up for comment and consideration.

MS. KERNS: Bob, I actually had read through the House Bill on Magnuson and saw that they were replacing it. The rationale that we used for leaving both definitions there is that we have a couple of stock assessments where our technical committees are pretty adamant that those stocks are depleted in the sense that they really aren't clear what is causing the downward trend in the biomass. There are other assessments where it is much more clear of what is going on; and we wanted to be able to have a distinguishing category between those two. That was the rationale for having both there and the unknown of what would come out of Magnuson.

MR. BALLOU: If I could follow up; so is it implied or should we make it explicit that by overfished we are in fact referring to fishing mortality and fishing pressure being the result that the maximum biomass is not being achieved. I think I heard you just say that; that is essentially why we want to keep the two terms. In some cases we know or we think we know that we aren't achieving our biomass targets based on fishing pressure; therefore, we need to reduce it; versus a depleted status, in which case we just don't know what is causing it.

MS. KERNS: Or where we think the major source of pressure is coming from fishing. It may not be all, but –

CHAIRMAN DANIEL: I don't know how comfortable I feel leaving this discussion. I don't want to keep saying the way we do it, but we have one definition that is depleted and indicate in the definition of "depleted" that it may be due to fishing, it may be due to other

things, it may be due to a combination of those things; but we really don't know.

I mean ecological variability and recruitment success is a factor that can lead to a depleted status as can overfishing. It is not going to be one or other. I'm almost rather work with you to take another look at this and bring it back in May if there is not an objection especially from our vice-chairman. Doug.

MR. GROUT: Well, you said you're not comfortable leaving this discussion so I'm going to discuss it some more. I appreciate the way Toni went forward with this because there is a new term in Magnuson or at least in the draft of "depleted"; and I think it is good that we try and put a definition to it.

We have also in some of our management; we've had some concern northern shrimp that we're calling it overfished when there is some pretty strong evidence that it is temperature that is driving it right now. There has been a call on some part of our commissioners to have a depleted status for them because of that.

I think the gray area here where we have overfished, which is primarily but not totally the result of overfishing, and then a depleted where it can either be primarily the result of some other factor, although we recognize there may be some overfishing that occurred at some point; or, as was mentioned, something that was unknown.

We don't know for sure whether it is because of fishing or because of other factors. There is no way you're ever going to have a black-and-white definition of both of them; but I think it is clear that we need two definitions; and it seems like there is some potential other people feel that we need to have some second definition for something that isn't directly and primarily caused by overfishing.

MR. STEPHEN R. TRAIN: Mr. Chairman, I was one of the people that Doug spoke about at the shrimp meeting that has a problem with some of the terminology; and I'm glad that we're looking at "depleted". Even with the definition of overfished we have and if we continue to use it, the problem I have with the term is it blames the wrong people.

It has the connotation that it is the fishermen's fault; and it is the managers' fault if something is overfished, but people target the people that are fishing the resource. If we allow it to continue to be harvested beyond its capacity, that is our fault and probably it should be mismanaged and not overfished.

CHAIRMAN DANIEL: What was that one comment, we don't know that we don't know that we are overfished. "Depleted"; depleted stocks are those stocks where the spawning stock abundance is below a predetermined threshold or where low stock abundance precludes an active fishery. Factors than can contribute to depleted status included but are not limited to fishing, predation, competition, water quality, habitat loss, recruitment variability, disease or a combination of these factors. Determination is based on approved stock assessments.

That covers everything and then you don't have that negative connotation of overfishing being suggestive that is the sole factor because of the decline. We can work on these definitions and come back with some additional options; and I will work with Toni on that. We will get something out to you. Is there anything further on our definitions?

DISCUSSION OF CANCER CRAB FISHERY IMPROVEMENT PROJECT

CHAIRMAN DANIEL: Next is cancer crabs from Toni.

MS. KERNS: We have been discussing the possibility of conducting a Cancer Crab Fishery Management Plan based on the recommendation from a Fishery Improvement Project that has been coming out of the New England states that has been I guess moderated by the Gulf of Maine Research Institute.

We were hoping that they would have a set of recommendations for us in time for this meeting;

but we do not and so therefore we will put off this discussion until the May meeting. Between now and May we will be putting together our 2014 Budget based on the Action Plan and the newly approved Strategic Plan. I am asking the Policy Board if you want me to go ahead and put a placeholder in that budget for meetings for an FMP if we went ahead and did do one. It can be easily removed from the budget if the board decides not to initiate an FMP.

CHAIRMAN DANIEL: Is everybody comfortable with that approach? Okay. Steve.

MR. TRAIN: Mr. Chair, I fully expect to have what we expected to have this month at the next meeting. The members of the Fisheries Improvement Project did not feel that the information that we had assimilated had a proper review and had time to get here in time for everybody to review that; so we want to hold off. We didn't want to give a half-done request.

CHAIRMAN DANIEL: But you're comfortable with this approach?

MR. TRAIN: Yes.

MR. DAVID BORDEN: Mr. Chairman, I'm also a participant in that process with Steve; and I'm very comfortable with the strategy. The documentation that has been put together I think is fairly comprehensive. It is about 45 pages long. It lays out everything that is known about Jonah crabs. There are a couple of sections that are still being worked on.

These include the minimum size, size at sexual maturity information, a characterization of the processing industry and how much it is worth. I think of significance is the fact that my understanding is the National Marine Fisheries Service in the next couple of weeks will announce the S-K grants. Massachusetts DMF put in a proposal to do research on Jonah crabs, and it will be very helpful to know whether or not they actually get that grant. I think that will lend a lot of credibility to the information that comes out of this group. I support the delay; and I think you will get a much better product as a result of it. Thank you.

CHAIRMAN DANIEL: Thank you, Dave. Is there anything further on the cancer crab issue? If not, I'm going to move into other business and call on Ritchie White.

OTHER BUSINESS

MR. G. RITCHIE WHITE: The Winter Flounder Board has requested the Policy Board to task the commission leadership to work with the New England Fishery Management Council leadership for more inclusive winter flounder management at the NRCC Meeting this spring.

EXECUTIVE DIRECTOR BEAL: Ritchie, was that a motion or just seeking consensus of the Policy Board?

MR. WHITE: Seeking consensus. We can do a motion but I figured if there was consensus, we wouldn't need a motion.

EXECUTIVE DIRECTOR BEAL: Is there any objection to the proposal that Ritchie has put forward on behalf of the Winter Flounder Board to seek greater cooperation with the New England Council and the commission on winter flounder management? I wouldn't think there would be any.

All right, we will take that forward to the NRCC Meeting in the spring and talk with the representatives from the New England Council. Terry Stockwell is one of them, who is their chair, so I think the communication has already started so we're in good shape. Is there any other business before the Policy Board? I do not think there was any on the agenda. Rob.

MR. O'REILLY: Mine is very quick. In the document handed out, the one-page document for the declaration of interest, I see future planning activity, blue crab; and I guess I was just wondering what that is all about.

EXECUTIVE DIRECTOR BEAL: Are you volunteering to write the FMP, Rob?

MR. O'REILLY: No.

EXECUTIVE DIRECTOR BEAL: That is a list that has been sort of a carryover for at least a decade. Black drum used to be on the list and now it is moved on to the completed list. There is blue crab and smelt and a number of other things on there, but there is really no priority of intention to initiate any of those FMPs right now. Those are just ones that have come up in the past as something the commission may want to consider in the future, but there are no plans right now. Bob Ballou.

MR. BALLOU: Mine will also be quick. At the annual meeting this Policy Board supported the writing of a letter to the Mid and to the Service, I believe, regarding black sea bass. I'm wondering if we've received any response. Thank you.

EXECUTIVE DIRECTOR BEAL: Toni can handle that one.

MS. KERNS: We did write a letter and we have not received a response.

EXECUTIVE DIRECTOR BEAL: Is there anything else? We will follow up on that, Bob, to get a response. Is there anything else for the Policy Board? Mr. Chairman, anything else?

CHAIRMAN DANIEL: No.

ADJOURNMENT

EXECUTIVE DIRECTOR BEAL: All right; this Policy Board stands adjourned.

(Whereupon, the meeting was adjourned at 5:25 o'clock p.m., February 5, 2014.)

Disentangling the effects of climate, abundance and size on the distribution of marine fish: an example based on four stocks from the Northeast U.S. Shelf

Richard J. Bell[*,1], David Richardson[1], Jonathan Hare[1] and Patrick Lynch[2]

[1]Northeast Fisheries Science Center, National Marine Fisheries Service, Narragansett, RI 02882

[2]NOAA Fisheries Service Headquarters, National Marine Fisheries Service, Silver Spring, MD 20910

[*]Corresponding author
E-mail: rich.bell@noaa.gov

Abstract

Climate change and fishing can have major impacts on the distribution of natural marine resources. Climate change alters the distribution of suitable habitat forcing organisms to shift their range or attempt to survive under suboptimal conditions. Fishing reduces the abundance of marine populations and truncates their age structure leading to range contractions or shifts. Along the east coast of the United States there have been major changes in fish populations due to the impacts of fishing and subsequent regulations as well as changes in the climate. Black sea bass, scup, summer flounder and winter flounder are important commercial and recreational species which utilize inshore and offshore waters on the north east shelf. We examined the distribution of the four species with the NEFSC trawl surveys to determine if the along shelf center of biomass had changed over time and if the change was attributed to changes in temperature or fishing pressure through changes in abundance and length structure. Black sea bass, scup and summer flounder exhibited a significant poleward shift in distribution in at least one season while the SNE/MAB stock of winter flounder did not shift. Generalized additive modelling indicated that the northerly shift for black sea bass and scup in the spring was related to climate, while the change in distribution of summer flounder was largely attributed to a decrease in fishing pressure and an expansion of the length/age structure. While the increase in ocean temperatures will have major impacts on the distribution of marine taxa, the effects

of fishing can be of equivalent magnitude and on a more immediate time scale. It is important for management to take all factors into consideration when developing regulations for natural marine resources.

Introduction

Increasing global temperatures can have major impacts on marine organisms including shifts in distributions and changes in abundance (Walther et al., 2002; Hare et al., 2010; Pinsky and Fogarty, 2012). Recent studies have shown that with the poleward shift in ocean temperature isotherms (Burrows et al., 2011) there has been a subsequent poleward shift in marine taxa (Poloczanska et al., 2013). Organisms increase their overall survival and fecundity by occupying, to the extent possible, their optimal habitat (Anderson et al., 2013). Individuals within their optimal habitat maximize their overall fitness and minimize their mortality risks. Climate change however, can affect certain aspects of an organisms habitat. The physical structure or photoperiod may remain constant at a given location or latitude, but other habitat components such as temperature, salinity, dissolved oxygen, and advection may be altered (Anderson et al., 2013). Shifts in distribution are then the result of individuals attempting to remain within the best conditions possible through migration or declines in abundance in suboptimal environments while expanding in better suited environments, if they exist.

In addition to climate mediated changes in distribution, range shifts may

also be caused by simple changes in overall abundance. MacCall's Basin model suggests that when populations are low they occupy the highest quality habitat available. As the population density increases individuals move out into formerly inferior habitat where intraspecific competition is lower (MacCall, 1990; Quinn and Deriso, 1999). Habitat quality is rarely isotropic so the areal expansion of the population along a habitat gradient with increasing abundance could result in a shift in distribution.

Changes in abundance due to increases in mortality can also affect distribution through changes in the length/age-structure of a population. Within many species there is a tendency for individuals to be distributed by size with the largest members closest to the poles (Bergman's Rule) (Mayr, 1956). This has been found for marine taxa (Chapelle and Peck, 1999) including fish (Lindsey, 1966) and is a major structuring component of stocks such as the Pacific hake stock on the west coast of North America (Nelson and Dark, 1985; Smith et al., 1992). Pacific hake increases moving north from California to Canada.

Along the Northeast Shelf of the United States there have been major shifts in the distribution of marine taxa (Nye et al., 2009; Lucey and Nye, 2010; Howell and Auster, 2012; Pinsky and Fogarty, 2012). Changes in the species assemblages due to the shifts can have major impacts on ecosystem goods and services. The distribution shifts are particularly important because the catch quota for a number of stocks and therefore peoples livelihoods, are allocated based on the species' distributions in previous decades

(ASMFC, 2004). Understanding the mechanisms which regulate distribution must be taken into account as part of any potential change to the quota allocation system.

On the Northeast shelf there is evidence of warming water temperatures (Nixon et al., 2004; Friedland and Hare, 2007; Belkin, 2009) and large changes in the abundance of fish species due to fishing and recovery (Fogarty and Murawski, 1998; Terceiro, 2012b). Many of the studies on species distribution shifts have implicated increasing temperature as a major driver. However, changes in size- and age-structure (Radlinski et al., 2013) and changes in abundance (Hare et al., 2010) have also been implicated in distribution shifts in the ecosystem.

We examined four species in the Southern New England/Mid-Atlantic Bight (SNE/MAB) region of the Northeast shelf in detail to determine if there had been a shift in their distribution and if so, could one of the three hypotheses account for the change 1. Climate change - Species shift to remain within their optimal habitat. 2. Basin model - Changes in abundance result in a change in the occupied habitat area. and 3. Bergman's rule - Changes in the length structure of the population changes the latitudinal range occupied.

Black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), summer flounder (*Paralichthys dentatus*) and winter flounder (*Pseudopleuronectes americanus*) are important commercial and recreational species along the east coast of the United States that have varied in abundance over the last forty years. All four species utilize nearshore habitat during both early de-

velopment and adult stages and their latitudinal ranges are believed to be influenced by their upper or lower thermal tolerance in the SNE/MAB (Collette and Klein-MacPhee, 2002). All four have also experienced heavy fishing pressure at times over the last forty-years. We examined the distribution of the four species to see if the along shelf center of biomass had changed over time and if the change was attributed to changes in the physical environment or fishing pressure through changes in abundance and length structure.

Methods

We determined the center of biomass for each species and tested if there had been a significant change in distribution over the time series. The three hypotheses were examined by fitting a generalized additive model to the center of biomass data with three independent variables related to the hypotheses: 1. water temperature (climate change), 2. abundance (Basin model), and 3. length (Bergman's rule).

As an additional test of the Basin model, the difference between the seventy-fifth and twenty-fifth percentiles of each species' range was assessed for an expanding or contracting occupied area over time and a relationship with abundance. The empirical along shelf distributions of different length classes were calculated for each species to further examine Bergman's rule of size distribution with latitude.

Annual Center of Biomass

We calculated the seasonal center of biomass for the four species based on the stratified weighted mean biomass from the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The methods were similar to Nye et al. (2009) except for three factors. 1. Biomass was used instead of ln(biomass+1). 2. Biomass was estimated from length based on the equation $w = aL^b$, where the parameters (a and b) were obtained from the NOAA fisheries age/length/weight website (NEFSC Fisheries Biology Program, 2013) (Table 1). 3. To account for the stratified random sampling design, each tow was weighted by $\frac{\text{stratum area}}{\text{num of tows}}$ so that differences in the annual allocation of stations to each stratum would not affect the center of biomass. Because the east coast of the United States runs in a northeast direction and not directly north-south, the center of biomass was measured as changes along the continental shelf (Figure 1). Following Nye et al. (2009) the distance along the shelf was calculated for each tow at the 100 m depth contour.

Sampling strata for the NEFSC trawl survey have changed over the years (Sosebee and Cadrin, 2006). While some strata have been continuously sampled since 1963, sampling began on the more inshore areas in 1972. Sampling of the two most inshore depth zones ceased in 2009. We restricted our analysis to the years 1972 - 2008 in order to be able to include all depth strata in all years.

Black sea bass, scup, and summer flounder are considered one continu-

ous stock from Cape Hatteras north to the Canadian border (NEFSC, 2012; Shepherd, 2012; Terceiro, 2012a,b). The majority of the individuals are in the SNE/MAB region with some fish on Georges Bank. Relatively few individuals are caught north of Cape Cod (Gulf of Maine). We restricted the analysis to strata in the SNE/MAB and Georges Bank region. Winter flounder is divided into three stocks (NEFSC, 2011). We focused only on species in SNE/MAB and therefore only included the SNE/MAB stock of winter flounder. All winter flounder individuals south and west of the Great South Channel were included in the analysis of distribution. None of the winter flounder on Georges Bank or in the Gulf of Maine were included.

The young-of-the-year (YOY) of each species were not fully accessible to the fall trawl survey and were excluded from all analyses. All four species reproduce in nearshore areas and all except winter flounder move offshore at the end of their first summer (Collette and Klein-MacPhee, 2002). YOY in more northerly latitudes move offshore into the survey area earlier than those further south, while the southern area is sampled prior to the northern area. The northern YOY are then accessible to the survey while the southern portion is not accessible. This may not be true for all species in all years, but to create a consistent dataset, all individuals below the YOY length threshold in the fall were excluded. The YOY length threshold was taken from the NOAA fisheries age/length/weight website (NEFSC Fisheries Biology Program, 2013) (Table 1). All size classes were included in the spring analyses.

The stratified weighted center of biomass each year (COB_{yr}) was:

$$COB_{yr} = \frac{\sum_{st} W_{lgth,st,yr} \cdot \text{Along}_{lgth,st,yr} \cdot \frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}}{\sum_{st} W_{lgth,st,yr} \cdot \frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}} \quad (1)$$

where $W_{lgth,st,yr}$ is the calculated biomass of each length bin at each station (each station is one tow) in each stratum in each year. The along shelf location of each station within each stratum, each year was $\text{Along}_{lgth,st,yr}$ and $\frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}$ was the area of each stratum divided by the number of tows in each stratum each year.

Changes in the distribution of the four species over time were examined with linear models to determine if the along shelf centers of biomass exhibited significant trends over time. To account for potential autocorrelation in the time series the residuals of the linear models were tested with the Durbin-Watson statistic. If the models exhibited autocorrelation in the residuals they were refit with generalized least squares regression which included an autoregressive correlation structure to account for autocorrelation. We examined trends along the full time series from 1972 to 2008 for all species.

Generalized Additive Models

Generalized additive modelling (GAM) was used to examine potential factors driving changes in the along shelf centers of biomass. GAMs are extensions of linear models in which the dependent variable is the sum of smooth func-

tions of the independent variables (Wood, 2006). Our analyses were conducted with the freeware software R cran with the GAM package (mgcv) (Wood, 2006). We examined the change in distribution relative to the three hypotheses as implemented by the change in the mean length of the population, temperature and abundance.

In the model for each species in each season, the along shelf center of biomass (COB_{yr}) was an additive function of the smooth terms mean length ($\overline{L}_{yr}$); temperature ($Temp_{yr}$); and abundance (N_{yr}).

$$COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr}) \tag{2}$$

The stratified weighted abundance each year (N_{yr}) was:

$$N_{yr} = \frac{\sum\limits_{st} N_{lgth,st,yr} \cdot \frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}}{\sum\limits_{str} \text{Str area}_{str}} \tag{3}$$

where $N_{lgth,st,yr}$ was the abundance in each length class at each station (each station is one tow) in each stratum in each year. The stratified weighted mean length of the population ($\overline{L}_{yr}$) was:

$$\overline{L}_{yr} = \frac{\sum\limits_{st} N_{lgth,st,yr} \cdot L_{lgth,st,yr} \cdot \frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}}{\sum\limits_{st} N_{lgth,st,yr} \cdot \frac{\text{Str area}_{str}}{\text{tows}_{str,yr}}} \tag{4}$$

where $L_{lgth,st,yr}$ was the actual length of each length class at each station in each stratum in each year.

The temperature term was the mean of five weekly estuary time series covering the range of the four species stocks. The five estuaries were the Chesapeake Bay, Delaware Bay, Long Island Sound, Narragansett Bay and Buzzards Bay. The temperature was averaged over the twelve week period prior to the mean date of the spring and fall trawl survey. The mean date of the spring trawl survey over all years was week 13 of the year (the second week of April). The spring temperature term was the mean of the weekly estuary temperature from week 2 to week 13 (early Jan to early April). The mean date of the fall trawl survey over all years was week 40 of the year (the second week of October). The fall temperature term was the mean of the weekly estuary temperature from week 29 to week 40 (early July to early October).

Basin Model - Range Expansion

We examined if potential changes in distribution were due to changes in abundance which resulted in the expansion or contraction of a species range (hypothesis two). The frequency histogram of the along shelf position of all individuals of a species each season/year was expressed as a cumulative density function. The difference between the seventy-fifth percentile of the along shelf location cumulative density function and twenty-fifth percentile was calculated to determine the annual distance occupied. A linear regression was fit to the annual distance occupied, accounting for autocorrelation in the residuals as indicated above, to determine if there was a significant expansion

or contraction of each species' range. The annual distance occupied was then regressed against the stratified weighted abundance to determine if the total occupied range expanded and contracted in relations to the number of individuals.

Bergman's Rule - Empirical Data

The along shelf distributions of different sized individuals of each stock were examined to determine if different length classes occupied different along shelf ranges (hypothesis three). We divided the survey data into length classes based on the length distribution of each species. The annual along shelf center of biomass for each length class was determined along with the along shelf position of the 25%, 50% and 75% in the same manner as described in the sections above. The overall mean position was the mean of the annual along shelf center of abundance for each percentile. The proportion of total stratified mean abundance in each size class, each year was also calculated. The YOY data from the fall survey were included in the calculations for demonstration purposes.

Results

Along Shelf Center of Biomass

The changes in the annual center of biomass varied among species and seasons (Figure 2). Black sea bass and scup had significant northerly trends in the spring that were not present in the fall (Figure 3). Summer flounder had a significant northward trend in the fall, but no change in distribution in the spring. The pattern was similar between the two seasons however, with the distribution further north in the 1970s and 1980s, shifting south in the early 1990s and then moving poleward into the 2000s. The SNE/MAB stock of winter flounder varied over time, but showed no change in distribution over the time series during either season.

Generalized Additive Models

The GAMs fit to the changes in the center of biomass produced a range of results (Table 2 & Figure 4). Over the course of the time series the spring and fall temperatures increased (Figure 5), while abundance and mean length varied (see supplemental material). Different seasons and species had different significant parameters and the total amount of deviance explained varied considerably. The increase in the along shelf center of biomass for black sea bass and scup in the spring had a significant positive relationship with temperature. Changes in length structure and the total population did not exhibit a relationship. As the temperature increased, black sea bass

and scup shifted north and may have been able to take advantage of new habitat. The GAMs explain 22% & 38% of the total deviance indicating that there are additional factors affecting the changes in distribution. The GAMs suggest hypothesis one (climate change) as an important mechanism for distribution shifts in these two species in the spring. In the fall, the temperature along the Northeast shelf is within the suitable range for black sea bass and scup and the physical environment was not significantly related to shifts in distribution. The mean length was the only significant term for both species with the center of biomass further north when larger fish made up a greater proportion of total abundance (Figures A.6 & A.10).

The changes in the along shelf center of biomass for summer flounder in both seasons showed a significant relationship with changes in mean length, but not with temperature or abundance. Larger fish occupy habitat further north and as the proportion of larger fish in the population has increased the stock has shifted north. The increase in temperature was not a significant term in the model suggesting it had little influence on the change in distribution. The shift is particularly dramatic since the early 1990s when the population was severely depleted and the length structure truncated. A change in the length/age structure (hypothesis three - Bergman's rule) is the main driver of shifts in summer flounder distribution.

The center of biomass of winter flounder varied without a trend and had a significant relationship with temperature in the fall, but not the spring. The GAM found that the center of biomass shifted south with increasing

temperatures. This is in direct contrast to the life history and ecology of winter flounder (Collette and Klein-MacPhee, 2002) suggesting that the relationship was a spurious correlation and not informative in explaining the distribution of winter flounder. There was little support for any of the hypotheses concerning winter flounder. Abundance was not significant in any of the GAMs for any species providing no evidence for changes in abundance impacting distribution (hypothesis two - basin model).

Basin Model - Range Expansion

None of the species exhibited a significant change in the along shelf distance occupied (Table 3). The annual range occupied varied, but the difference between the seventy-fifth and twenty-fifth percentile of the along shelf position did not expand or contract consistently over the course of the time series (Figures A.1 & A.2). As an example the spring trawl survey data indicates that black sea bass is moving north, but the total occupied range does not exhibit a trend (Figure 6).

The annual occupied range was not significantly related to the stratified weighted abundance except for summer flounder in the spring (Table 4). In general, at the scale of the NEFSC trawl survey, the occupied range was not a function of abundance suggesting that changes in distribution were not related to the total population.

Bergman's Rule - Empirical Data

Among the four fish species, larger individuals were generally found further north or there was no pattern between size and distribution (Figure 7 & supplemental material). In the spring, scup and summer flounder segregated by size with the largest fish caught the furthest north. Black sea bass and winter flounder exhibited relatively little size segregation with all sizes distributed relatively similarly along the coast. The size distribution of summer flounder and winter flounder in the fall, was similar to that in the spring. Smaller summer flounder were further south while larger individuals were further north (Figure 7a) and the different size classes of winter flounder were generally centered around 550 - 650 km. As indicated in the methods section, the YOY of black sea bass and scup (The two smallest size classes) were predominately collected in the north (Figures A.4 & A.8). In many years the YOY were not encountered in the southern stations, because they had not yet moved offshore when the fall trawl survey occurred and were therefore not represented in the data. The next largest size class were caught in the most southerly locations. The individuals larger than the YOY size classes exhibited a relatively smooth distributional pattern.

Summer flounder and winter flounder did not exhibit the same strong YOY distribution pattern as black sea bass and scup. Summer flounder however, move offshore around the same time in the fall as black sea bass and scup and thus could also be incompletely sampled. There is the potential that the YOY data for all species could be inadequate and both as a precaution

and to be consistent, all YOY data in the fall was removed. The removal of the YOY data did not alter any of the major conclusions of the study. Overall there was evidence for Bergman's rule for summer flounder (both seasons) and black sea bass and scup (fall). The SNE/MAB stock of winter flounder exhibited weak to no evidence for increasing size with latitude.

The proportion of different size classes constituting total abundance was relatively similar between the two seasons for summer flounder and winter flounder, but not for black sea bass and scup. The proportion of larger summer flounder varied during the time series and was lowest in the late 1980s - early 1990s. The proportion of larger fish then increased during the late 1990s and 2000s in both seasons (Figures 7b & A.12c). The proportion of different size classes of winter flounder varied over the time series with a slight increase in larger fish during the 2000s, but was similar in both seasons. The proportions of different size classes for black sea bass and scup were different between the two seasons with substantially more juveniles present in the fall (fish $\sim$<15 cm) The fall trawl survey catches a large proportion of age-0 and age-1 fish moving offshore as the temperature declines, but the majority of these fish are from the more northerly areas of the stock range.

Discussion

Changes in environmental conditions and changes in fishing mortality are important mechanisms which affect the distribution of marine taxa (Engel-

hard et al., 2011). It is clear from the analyses that all species can not be assumed to move poleward with increasing temperatures and that all range shifts can not simply be attributed to climate change. Of the four species examined in detail, black sea bass and scup moved north with an increase in temperature, summer flounder moved north with a reduction in fishing mortality and the distribution of winter flounder did not shift.

Increasing temperatures due to climate change (hypothesis one) have shifted the thermal habitat of many natural marine resources further north. Thermal habitat is often limiting during the winter when temperature is considered one of the major constraints on survival (Hurst, 2007). Winter conditions reduce the suitable habitat and limit the ranges of fish species. Along the northeast shelf, the northern range of many species such as croaker are limited by winter temperatures (Hare and Able, 2007). Their ranges contract during cooler periods and expand during warmer periods.

During the winter, black sea bass and scup are typically concentrated on the shelf in water above seven degrees (Neville and Talbot, 1964; Drohan et al., 2007; Moser and Shepherd, 2009). In the early part of the 1900s the restricted thermal habitat during severe winters enabled good catches with limited effort for the winter fishery (Neville and Talbot, 1964). Despite the thermal constraints, the two species are moving north and have shifted their center of biomass by 150 - 200 kilometers over the past four decades. The generalized additive models attribute the shifts to increasing temperatures on the shelf (Friedland and Hare, 2007; Belkin, 2009) which has shifted the

seven degree isotherm further north enabling the two species to survive at higher latitudes and occupy new habitat. The full population of black sea bass and scup, from YOY to adults, are offshore in March and April when the spring trawl survey occurs making this survey a good sample of the two stocks distributions.

During the warmer months the lower thermal constraints are reduced and other factors such as the magnitude of seasonal movement are typically more important in regulating a species range. Larger fish can generally migrate further than smaller individuals and move further from their offshore, over-wintering grounds. The fall trawl survey however, does not provide a good sample of the full population for the two species as it largely catches age-0 and age-1 individuals (NEFSC, 2012; Shepherd, 2012; Terceiro, 2012a). Due to the biased catch, the fall along shelf center of biomass does not provide a good measure of the distribution for the entire population, but largely reflects the proportion of juveniles. Black sea bass and scup are spatially segregated by length in the fall with larger individuals further north. The center of biomass is further south when the number of juveniles is high and further north when the number of juveniles is low. This is reflected in the significant mean length term in the fall generalized additive models.

The summer flounder stock declined in the 1980s under intense fishing pressure, but rebounded in the late l990s as management regulations came into effect. The stock is currently above the management target for biomass (B_{msy}) (Terceiro, 2012b). Based on the analyses, summer flounder is a species

that supports Bergman's rule. They are spatially distributed by size with larger individuals further north. As the population declined with fishing, the larger, older individuals were depleted, and the proportion of smaller fish increased constituting the bulk of the summer flounder stock. Smaller fish live at lower latitudes and the center of biomass shifted south. Fishing regulations in the 1990s reduced mortality leading to an increase in the population and an expansion of the length/age structure. The proportion of larger fish (> 43 cm) is currently as high or higher than it has been during the entire time series. The larger, older individuals repopulated areas in which they historically resided and as their numbers increased, they pulled the center of biomass north.

Temperature is not an important driver in this analysis, which corroborates with previous findings that it is not currently a major driver affecting summer flounder (Bell et al., in review). Laboratory studies suggest that summer flounder recruitment should vary inversely with winter temperatures because larvae overwinter in nearshore areas and experience mortality below 2 - 4 C° (Malloy and Targett, 1991, 1994; Szedlmayer et al., 1992). Despite large changes in summer flounder abundance over the last three decades, recruitment has been relatively stable and exhibited no relationship with winter temperatures. Changes in the abundance of summer flounder and thus the size structure and distribution are governed by changes in the mortality of older age classes through fishing and not by changes in the natural mortality due to temperature during the early life stages.

Fishing was the primary driver of changes in distribution with the level of fishing mortality determining the proportion of different size classes in the population. This implicates hypothesis three - Bergman's rule, because it explains how the effects of fishing would impact the distribution. Summer flounder were not moving to remain in shifting optimal habitat, but the different size classes experienced different levels of mortality which altered the abundance of different ages and subsequently shifted the center of biomass north or south.

Temperature could still be important however, because one of the explanations of Bergman's rule is that larger body individuals have a greater tolerance for colder conditions through a lower surface to volume ratio or some other means (Mayr, 1956). The different size classes of summer flounder may still be following suitable habitat and shifting their distribution north with the increase in temperature, but the current impact of fishing is far greater, overwhelming any temperature signal. Potential effects of climate change may only be noticeable after the population equilibrates with the fishing mortality and a stable age structure is achieved. Future changes in fishing mortality with different management regulations however, have the potential to quickly alter the length distribution of the population and shift the distribution independent of any temperature increase.

The SNE/MAB stock of winter flounder exhibited no change in the along shelf center of biomass over the time series. Previous work has suggested that the range of winter flounder has shifted north, but included the SNE/MAB

and Georges Bank stocks as one unit (Nye et al., 2009). Partitioning the species at the Great South Channel agrees with the current understanding of the stock structure (NEFSC, 2011), but may impose a historical boundary that is superseded by the habitat needs of the population. Winter flounder is a cold water species which is potentially susceptible to increases in temperature (Rose, 2005). There may be movement across the Great South Channel onto Georges Bank or a decline in the SNE/MAB stock and an increase in the Georges Bank stock. Within the SNE/MAB region however, there is no evidence of a shift north or a decline in the occupied along shelf distance. The significant temperature term in the GAM exhibits a negative relationship which does not agree with the biology of the organism and is most likely a spurious correlation.

SNE/MAB winter flounder abundance has declined since the 1980s with a slight increase in the 2000s (NEFSC, 2011). Their range however has not shifted or contracted suggesting that winter flounder still occupy the same area, but their total density within that area is greatly reduced. The lack of a range shift may be due to their life history. Adult winter flounder exhibit a moderate to high level of homing and spawn each winter in their natal estuary (Collette and Klein-MacPhee, 2002). The productivity of the stock has declined with warming conditions leading to lower recruitment with increasing temperatures (Bell et al., in review). Because they show site fidelity, it appears that individuals are not shifting north with their suitable habitat, but return to their natal estuary where conditions are suboptimal.

Their total fitness is reduced potentially leading to a continued decline in abundance, but a stable range contrary to what might be expected with the Basin model. The abundance and not the distribution would exhibit a relationship with climate change which explains the lack of significant terms and low deviance explained in the generalized additive models. The reduced number of individuals occupying the same range could also lead to extremely low densities within individual estuaries and the potential for inbreeding which has already been documented in New York (O'Leary et al., 2013).

The along shelf center of biomass for three of the four species has shifted north during recent decades. While many studies have found a relationship between the environment, typically temperature, and distribution shifts (Perry et al., 2005; Nye et al., 2009; Pinsky and Fogarty, 2012) a more species-specific analysis indicated that multiple factors regulate changes in distribution. The working hypotheses provided mechanisms to understand how different factors such as shifting habitat or anthropogenic depletions impact species distribution.

Climate change alters the physical environment in which an individual lives and has a direct influence on its overall fitness and reproductive output. As conditions change around the globe the optimal habitat for many species has shifted poleward and will continue to shift. Species must either migrate to remain within suitable habitat or suffer the consequences. The exact mechanism enabling the shift is not always clear and is different for different types of organisms. For large migratory species, individuals may have the

ability to move with changing conditions and remain within suitable habitat. For demersal species however, such as those along the Northeast shelf, lower recruitment success and a decline in nursery conditions at the southern extent of their range and better recruitment and higher quality nursery conditions in the northern extent of their range are considered to be important mechanisms shifting their distribution (Rijnsdorp et al., 2009). For species which exhibit spawning site fidelity such as winter flounder or salmon, shifting conditions could be particularly challenging. As suitable conditions move past a species historic range, species may not be able to alter their behaviour or adapt quick enough to shift with it leading to major declines in abundance.

Fishing can have major impacts on the distribution of marine organisms by altering their abundance. It can function directly by removing all the individuals from a given area changing the occupied range of that species. Fishing can also reduce diversity and alter bottom habitat making organisms more susceptible to climate change which could result in distributional shifts (Rijnsdorp et al., 2009). For species which segregate by size however, fishing reduces the population and changes the age/length structure. As is clear from summer flounder, high fishing mortality rapidly removed the largest members of the population and shifted the center of biomass south. The reduction in fishing pressure and recovery of the age structure then shifted the center of biomass north almost 250 km in just under two decades.

Understanding these regulating factors enables management to develop policies on how range shifts affect stocks and how catch quota allocations

can be implemented across state and national boundaries. For transboundary, size segregated species such as summer flounder and Pacific hake these factors can be major issues. Changes in fishing pressure due to management decisions could rapidly shift species across state or national lines. These considerations will only become more important for stocks with divided catch allocations. Many natural marine resources will shift poleward or decline in the coming decades (Walther et al., 2002; Burrows et al., 2011; Poloczanska et al., 2013), however the impacts of fishing and other factors can have major and more immediate impacts on distribution. Accounting for all these drivers is essential for proper management because they affect the sustainability of fish stocks and directly impact livelihoods.

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Tables & Figures

Species	a	b	YOY
Black Sea Bass	1.598691e-05	2.91	$<$ 15 cm
Scup	1.410615e-05	3.19	$<$ 10 cm
Summer Flounder	7.478006e-06	3.18	$<$ 14 cm
Winter flounder	1.36979e-05	2.97	$<$ 16.5 cm

Table 1: Variables for the length to weight conversions for each species $w = aL^b$, and the young-of-the-year (YOY) length thresholds.

Species	M.lgth	Temp	N	Dev Exp
B.Seabass - Spr	3.9931	1.6366 *	0	0.38
B.Seabass - Fall	0.9315 *	0.6995	0.0589	0.43
Scup - Spr	0	0.6601 *	1.6859	0.22
Scup - Fall	1.999 *	4.2072	0	0.83
Sumfl - Spr	1.3781 *	0	0.3232	0.39
Sumfl - Fall	1.0286 *	0.6931	0.8879	0.58
Wfl - Spr	0.9037	0	1.5483	0.16
Wfl - Fall	0.7421	0.9489 *	3.13	0.34

Table 2: The estimated degrees of freedom for each species and season from the generalized additive models. The proportion of the deviance explained (Dev Exp) is with all three terms included. The * denotes significant terms.

Species	Slope	p-value
B.Seabass - Spr	1.73	0.21
B.Seabass - Fall	2.11	0.41
Scup - Spr	-3.11	0.16
Scup - Fall	-2.61	0.27
Sumfl - Spr	-0.17	0.92
Sumfl - Fall	1.89	0.15
Wfl - Spr	1.11	0.10
Wfl - Fall	-1.86	0.11

Table 3: The slope of the difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of biomass for each species over time.

Species	N	p-value	R^2
B.Seabass - Spr	9.99E-06	0.916	0.0004
B.Seabass - Fall	-1.43E-04	0.196	0.0517
Scup - Spr	-6.49E-06	0.454	0.0161
Scup - Fall	-5.92E-06	0.067	0.0927
Sumfl - Spr	4.39E-04	0.035	0.1211
Sumfl - Fall	2.42E-04	0.162	0.0550
Wfl - Spr	-4.51E-05	0.173	0.0524
Wfl - Fall	-7.88E-05	0.327	0.0275

Table 4: The slope of the difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of biomass for each species and abundance.

Figure 1: The along shelf center of biomass on the east coast of North America. The individual survey strata are in light grey.

Figure 2: The along shelf center of biomass for each species in each season. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

Figure 3: The slope in kilometers per year of the annual along shelf center of biomass for each species in each season with 95% confidence intervals.

Figure 4: The significance of each term in the generalized additive model for the dependent variable along shelf center of biomass for each species in each season.

Figure 5: The mean spring and fall estuary temperature.

Figure 6: A. The twenty-fifth and seventy-fifth percentile of the along shelf center of abundance for black sea bass in the spring. B. The difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of abundance as a measure of range expansion/contraction.

Figure 7: A set of four sub-floats.]The along shelf 25 - 75 % range of each of the length classes (a) of summer flounder over the years 1972 - 2008 and the proportion of each length class each year (b) in the fall.

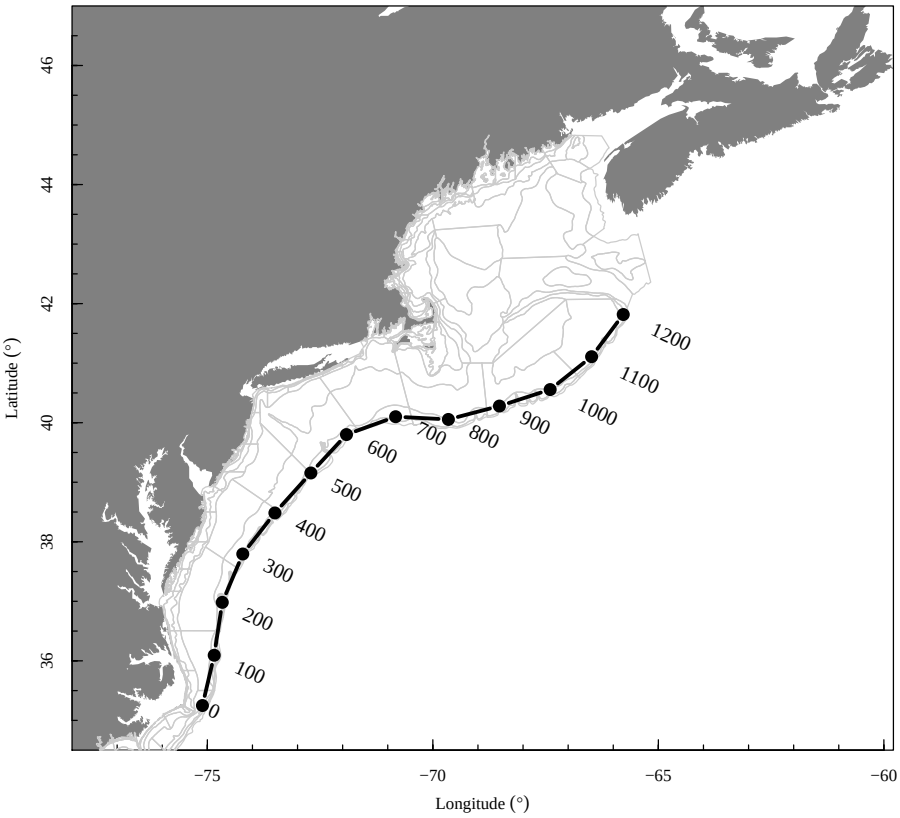


Figure 1: The along shelf center of biomass on the east coast of North America. The individual survey strata are in light grey.

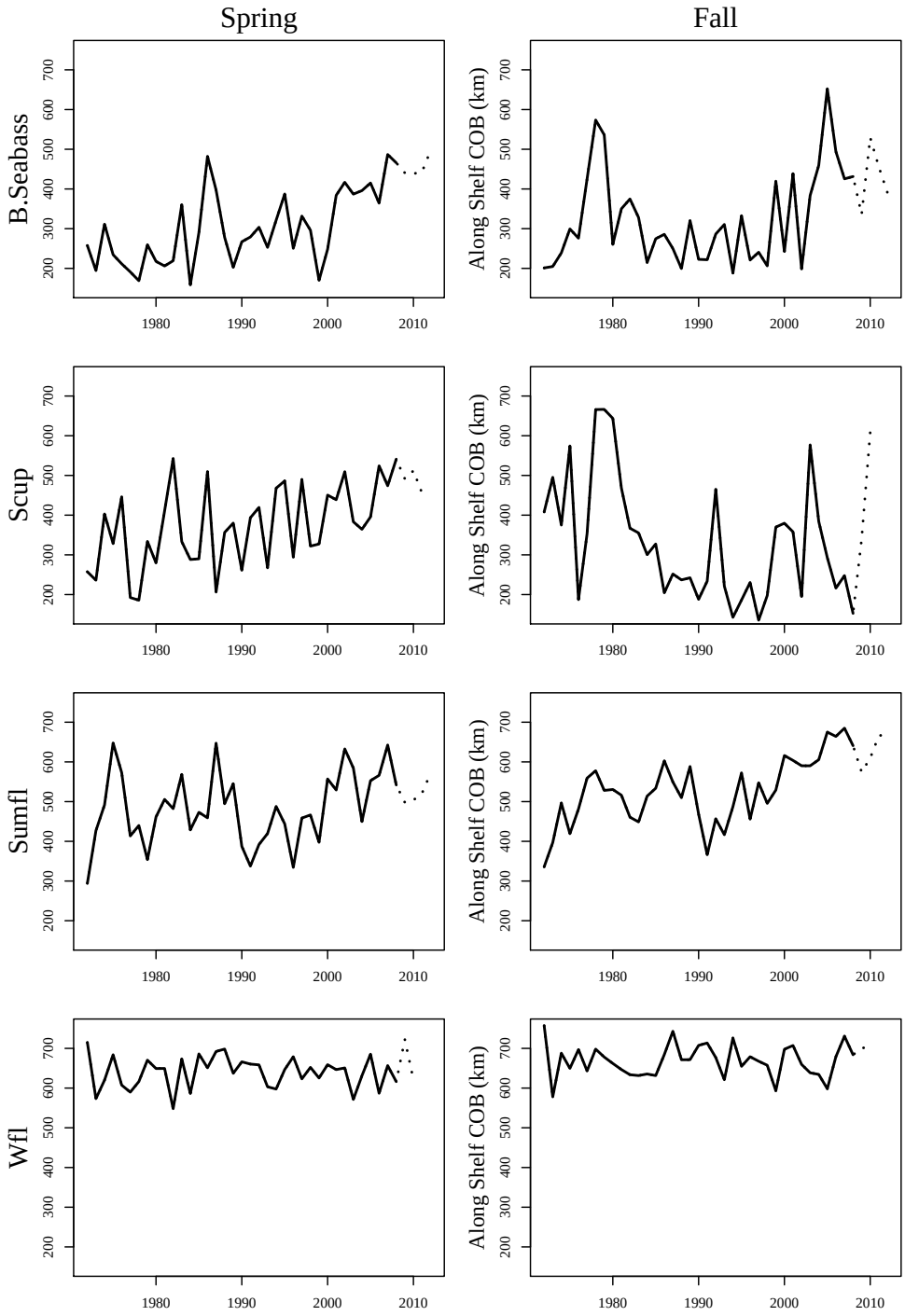
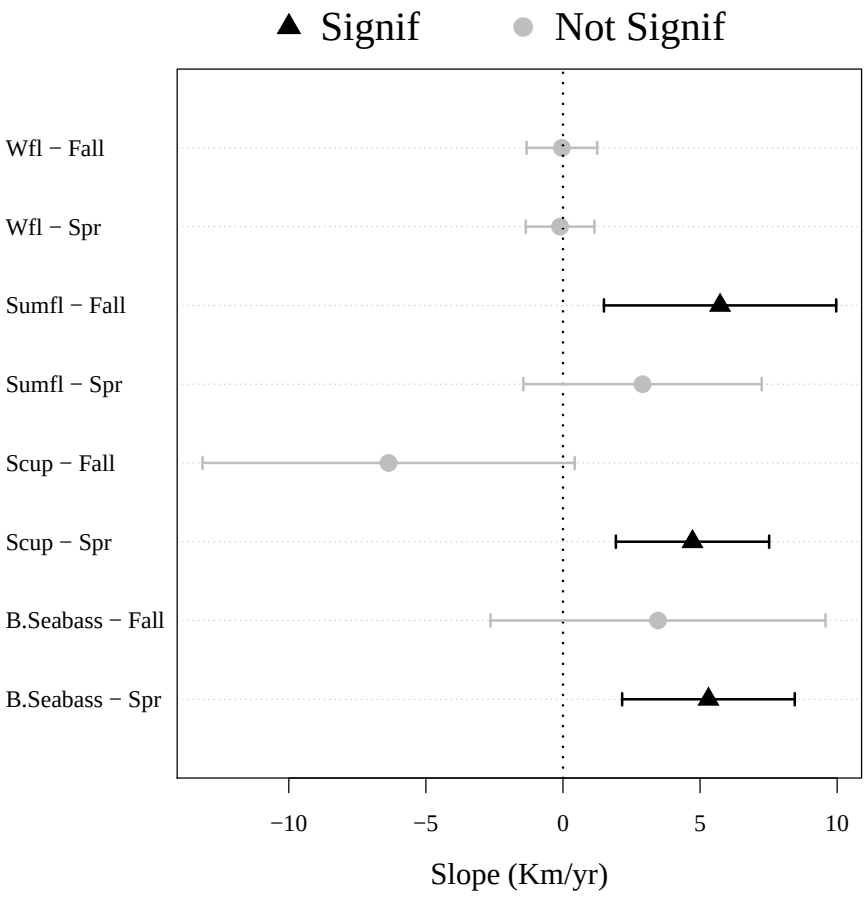


Figure 2: The along shelf center of biomass for each species in each season. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.



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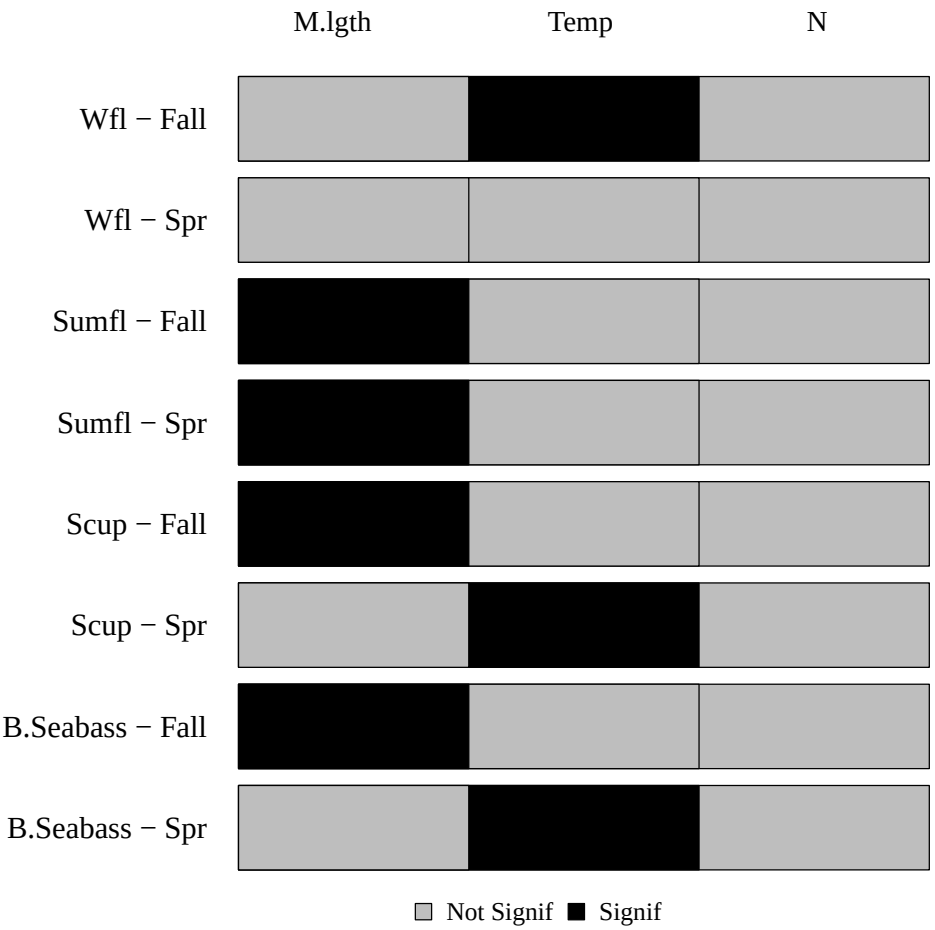


Figure 4: The significance of each term in the generalized additive model for the dependent variable along shelf center of biomass for each species in each season.

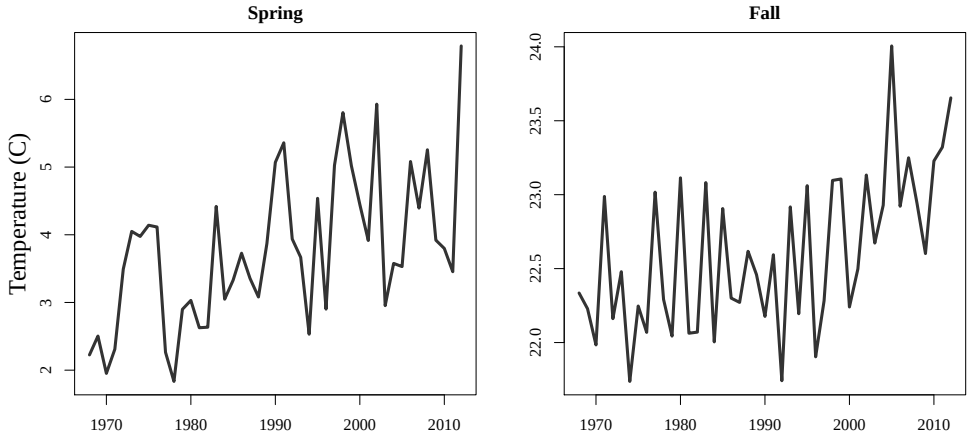


Figure 5: The mean spring and fall estuary temperature.

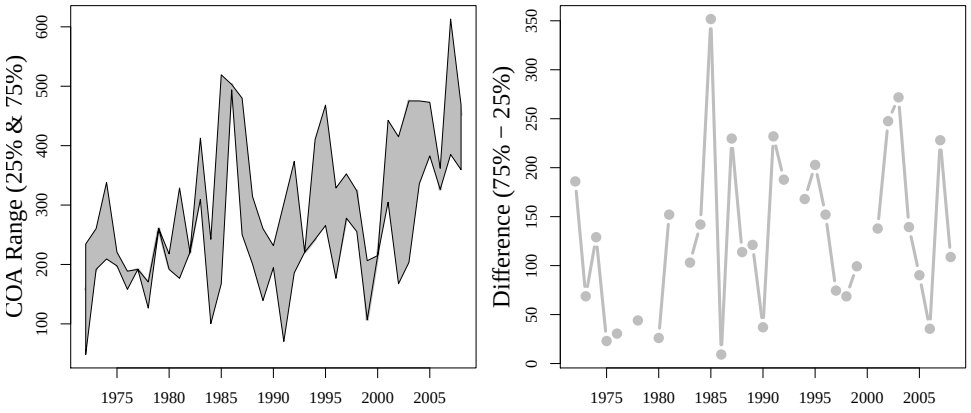
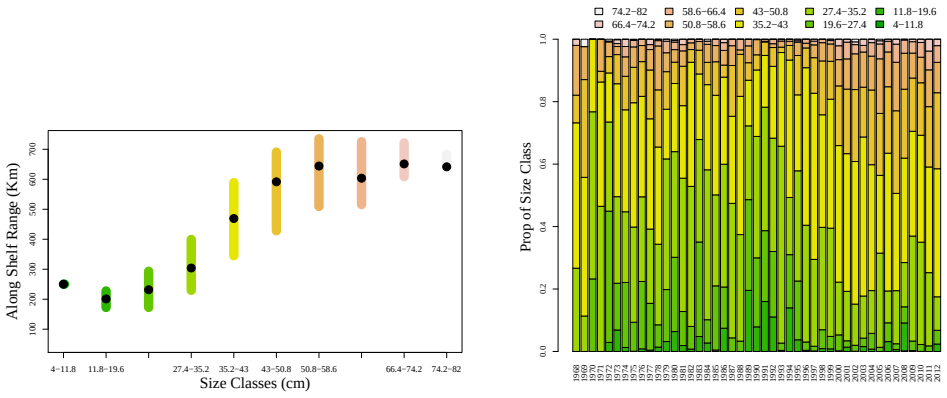


Figure 6: A. The twenty-fifth and seventy-fifth percentile of the along shelf center of abundance for black sea bass in the spring. B. The difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of abundance as a measure of range expansion/contraction.



(a) **(b)**

Figure 7: The along shelf 25 - 75 % range of each of the length classes (a) of summer flounder over the years 1972 - 2008 and the proportion of each length class each year (b) in the fall.

A Supplemental material

Figure A.1: Left column. The twenty-fifth and seventy-fifth percentile of the along shelf center of abundance for each species in the spring. Right column. The difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of abundance to determine if the range is expanding or contrasting.

Figure A.2: Left column. The twenty-fifth and seventy-fifth percentile of the along shelf center of abundance for each species in the fall. Right column. The difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of abundance to determine if the range is expanding or contrasting.

Figure A.3: The stratified mean abundance and mean length for black sea bass in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

Figure A.4: A set of four sub-floats.]The along shelf 25 - 75 % range of each of the length classes (a) & (b) of black sea bass over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

Figure A.5: The smoothed terms for black sea bass in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.6: The smoothed terms for black sea bass in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.7: The stratified mean abundance and mean length for Scup in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

Figure A.8: A set of four sub-floats.]The along shelf 25 - 75 % range of each of the length classes (a) & (b) of scup over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

Figure A.9: The smoothed terms for scup in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.10: The smoothed terms for scup in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.11: The stratified mean abundance and mean length for summer flounder in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

Figure A.12: A set of four sub-floats.]The along shelf 25 - 75 % range of each of the length classes (a) & (b) of summer flounder over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

Figure A.13: The smoothed terms for summer flounder in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.14: The smoothed terms for summer flounder in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

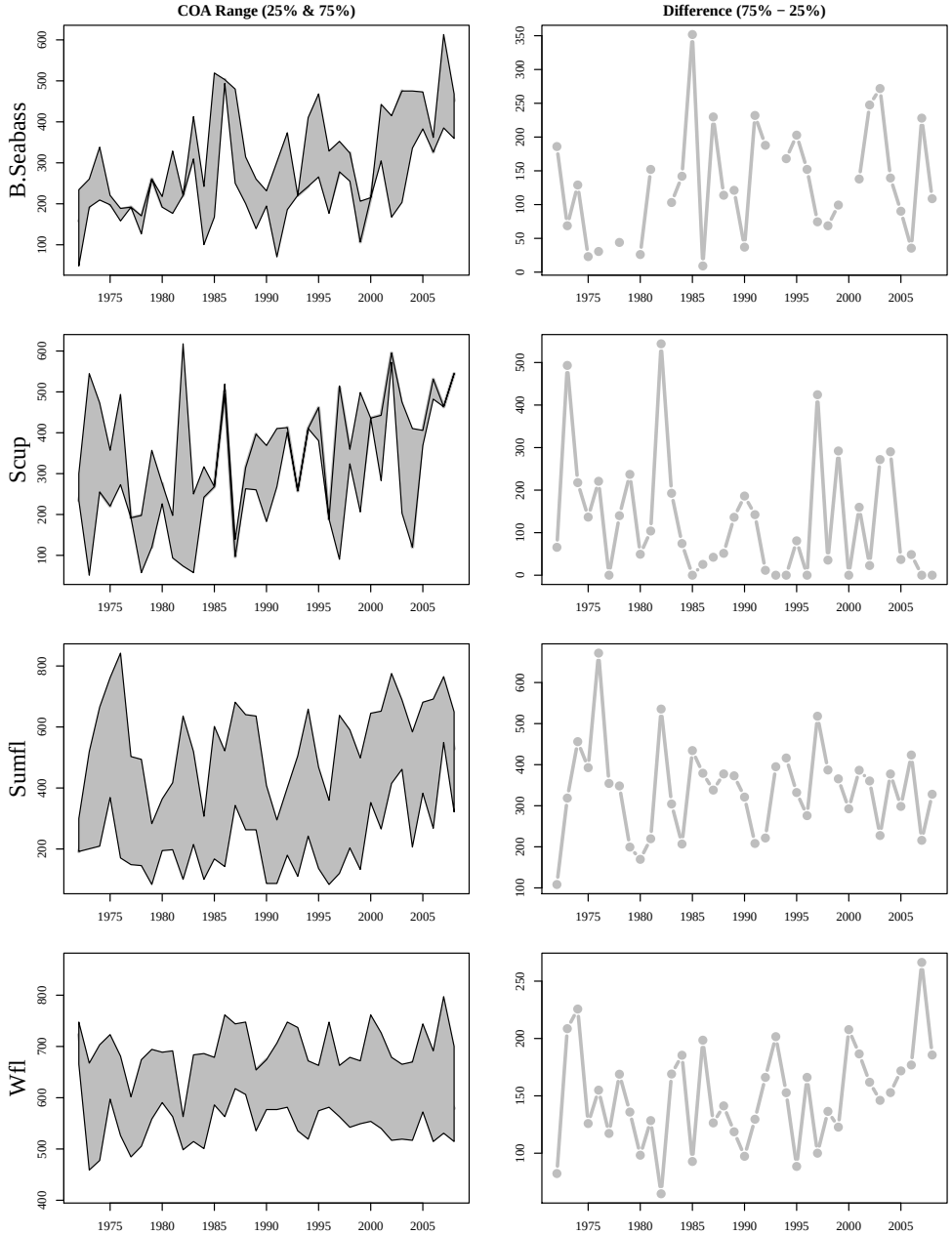
Figure A.15: The stratified mean abundance and mean length for winter

flounder in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

Figure A.16: A set of four sub-floats.]The along shelf 25 - 75 % range of each of the length classes (a) & (b) of winter flounder over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

Figure A.17: The smoothed terms for winter flounder in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Figure A.18: The smoothed terms for winter flounder in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.



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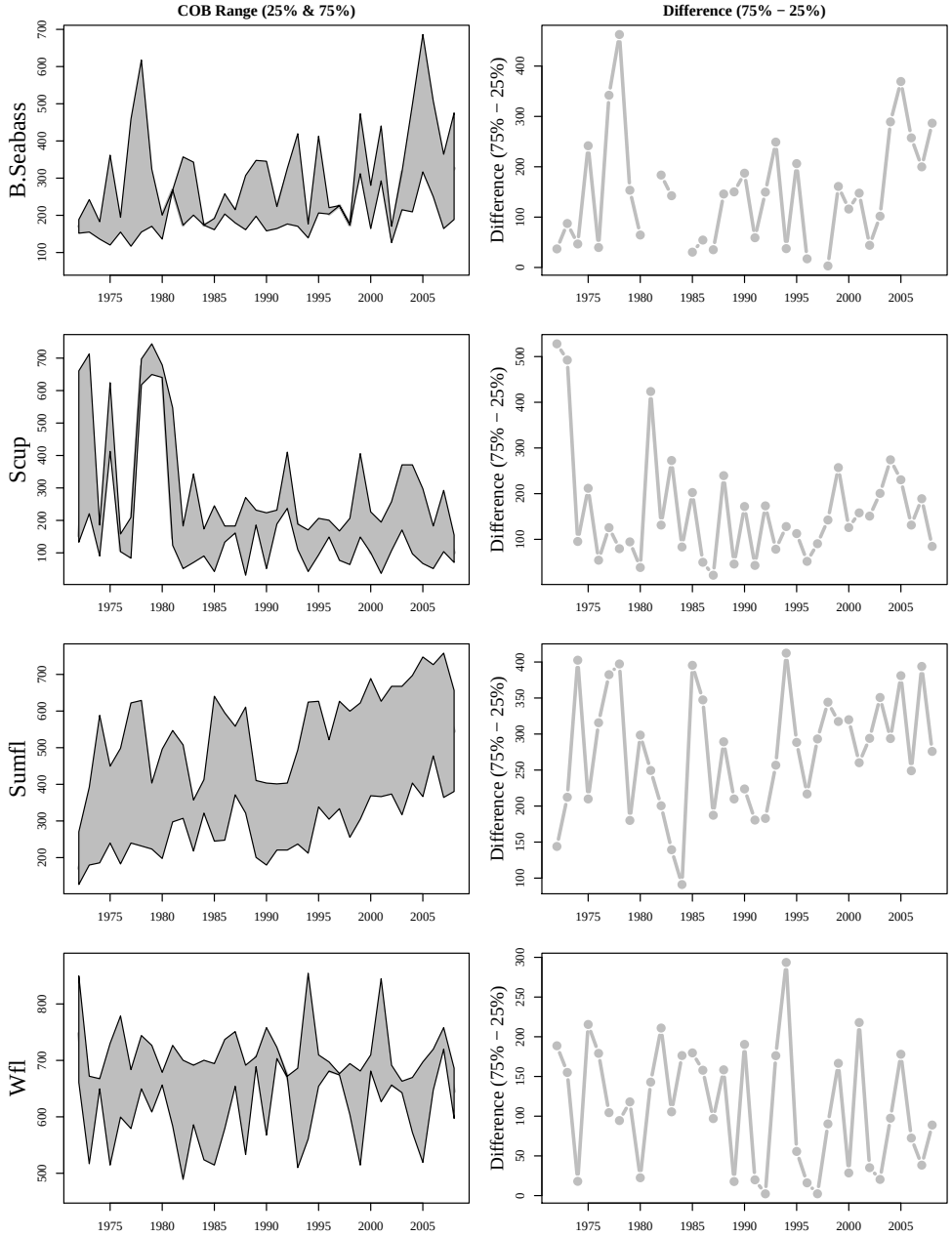


Figure A.2: Left column. The twenty-fifth and seventy-fifth percentile of the along shelf center of abundance for each species in the fall. Right column. The difference between the seventy-fifth and twenty-fifth percentile of the along shelf center of abundance to determine if the range is expanding or contrasting.

Black Sea Bass

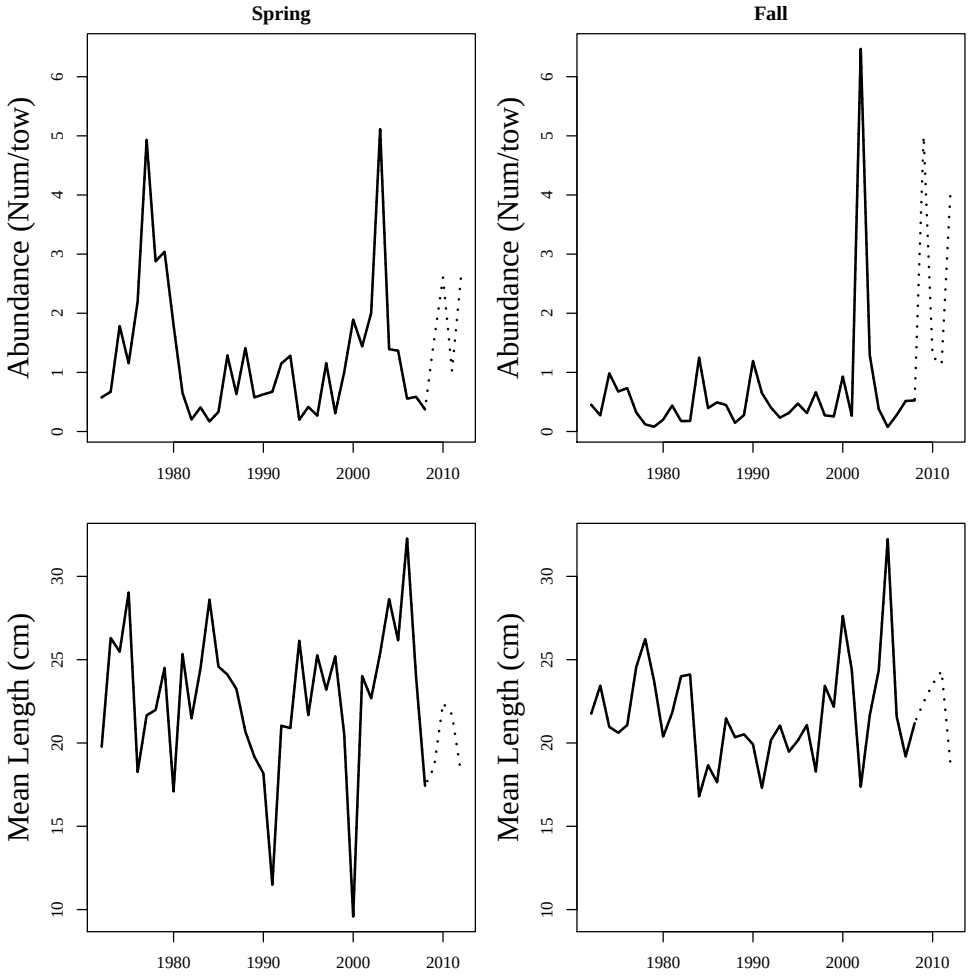
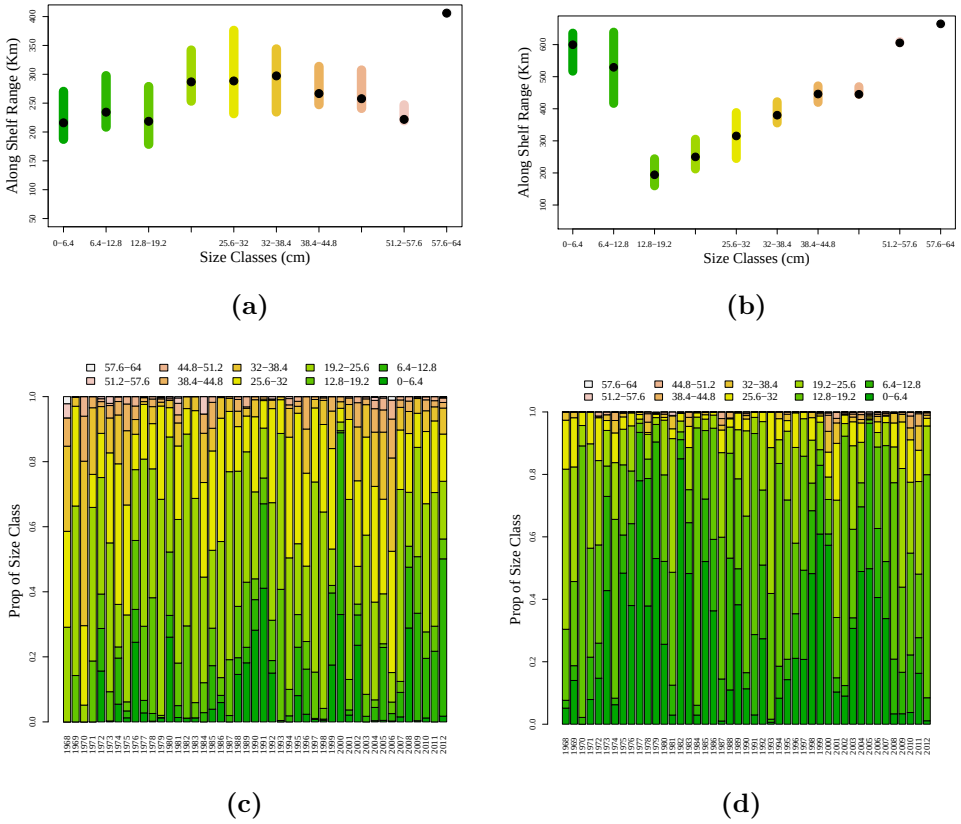


Figure A.3: The stratified mean abundance and mean length for black sea bass in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.



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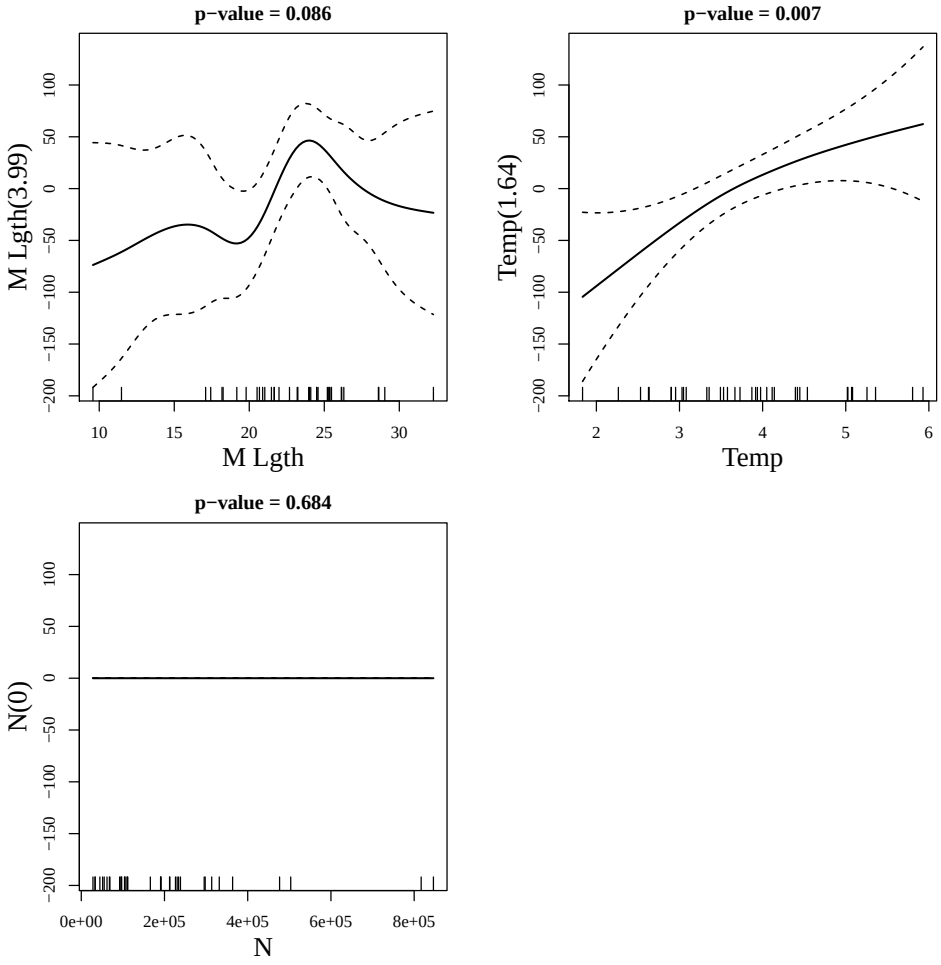

Figure A.5: The smoothed terms for black sea bass in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

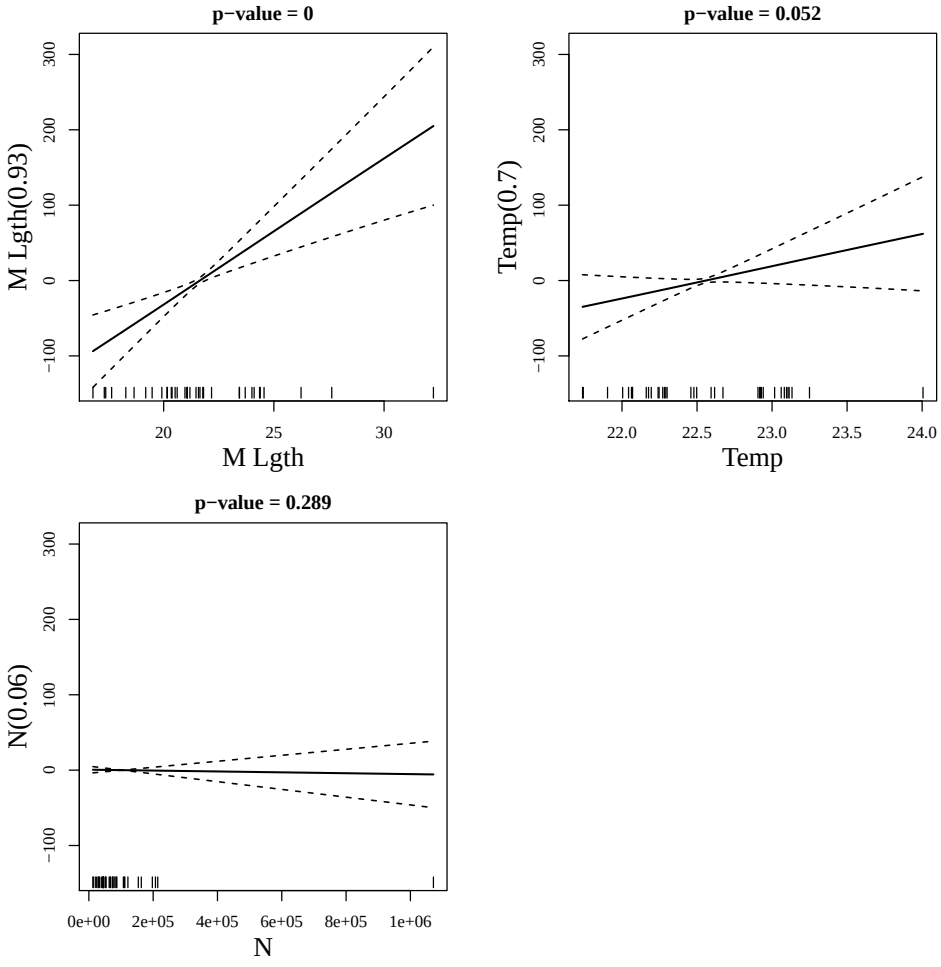

Figure A.6: The smoothed terms for black sea bass in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Scup

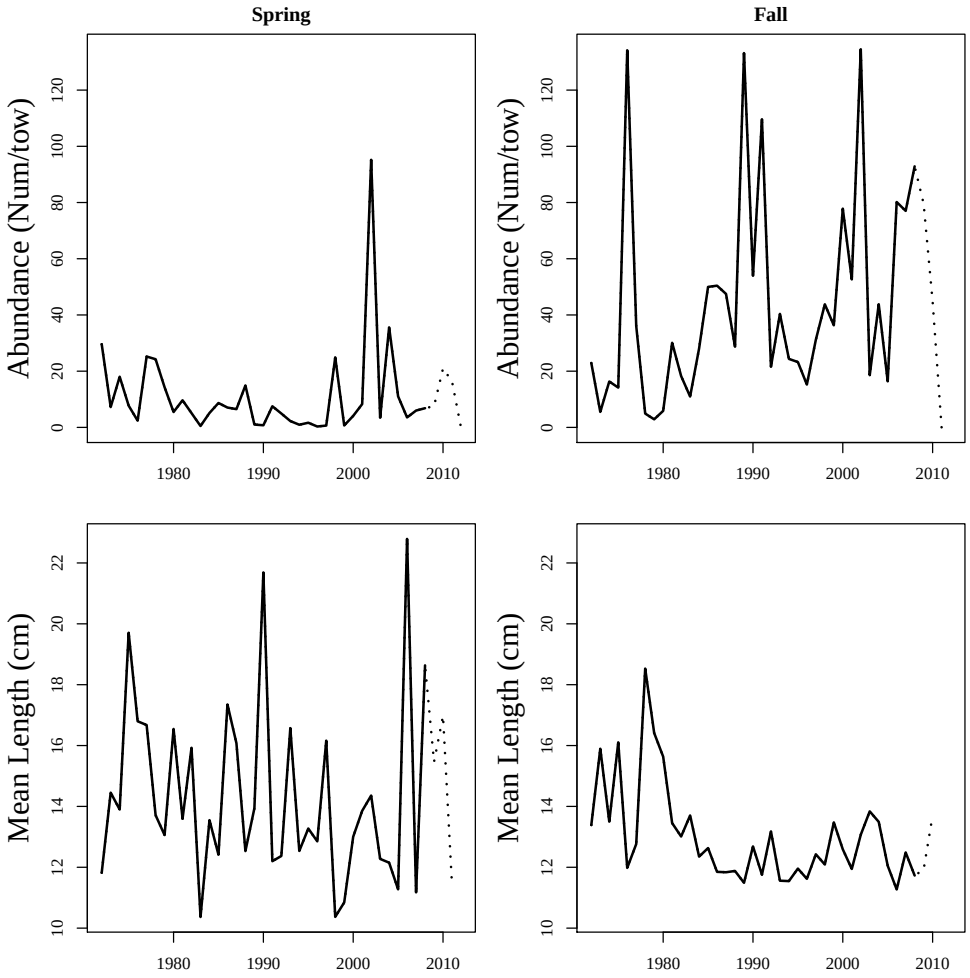

Figure A.7: The stratified mean abundance and mean length for scup in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

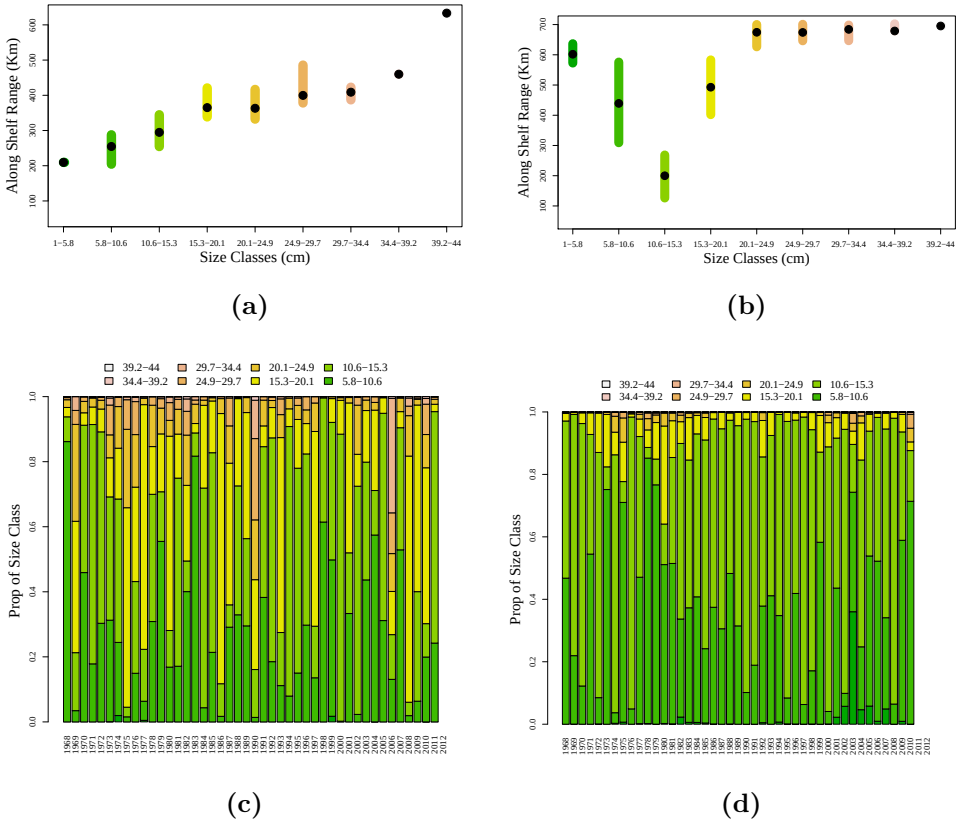

Figure A.8: The along shelf 25 - 75 % range of each of the length classes (a) & (b) of scup over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

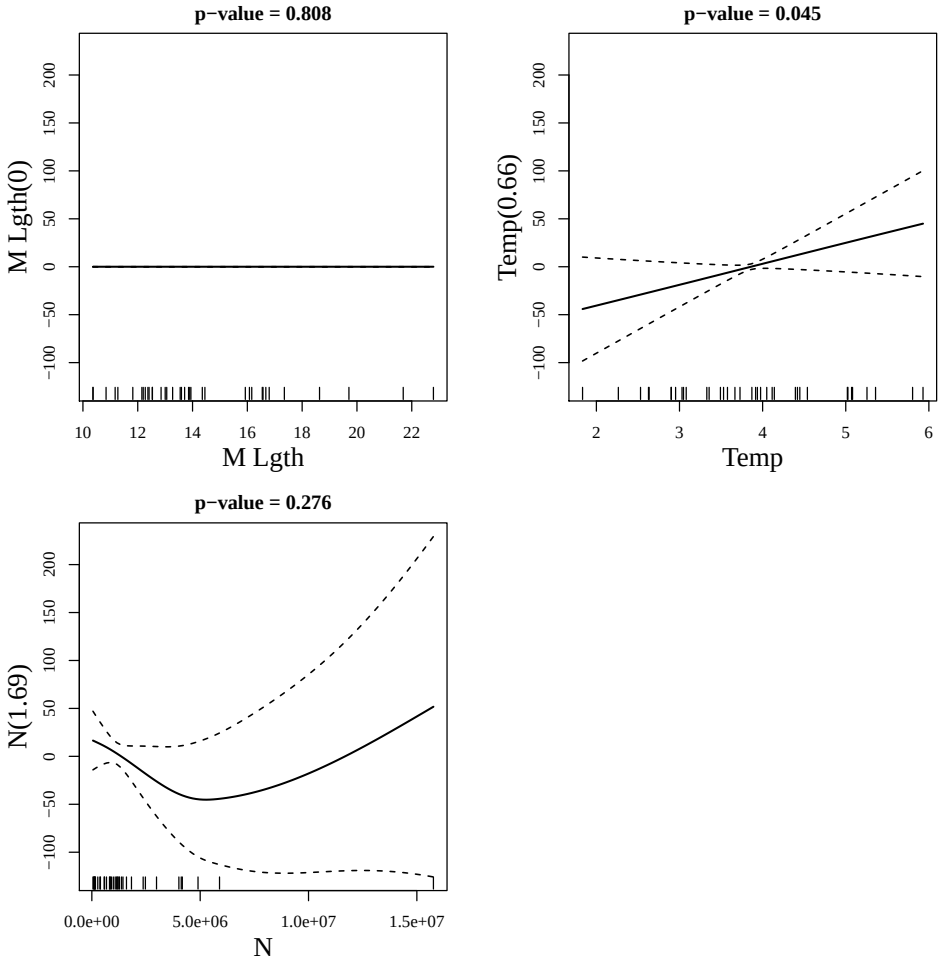

Figure A.9: The smoothed terms for scup in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

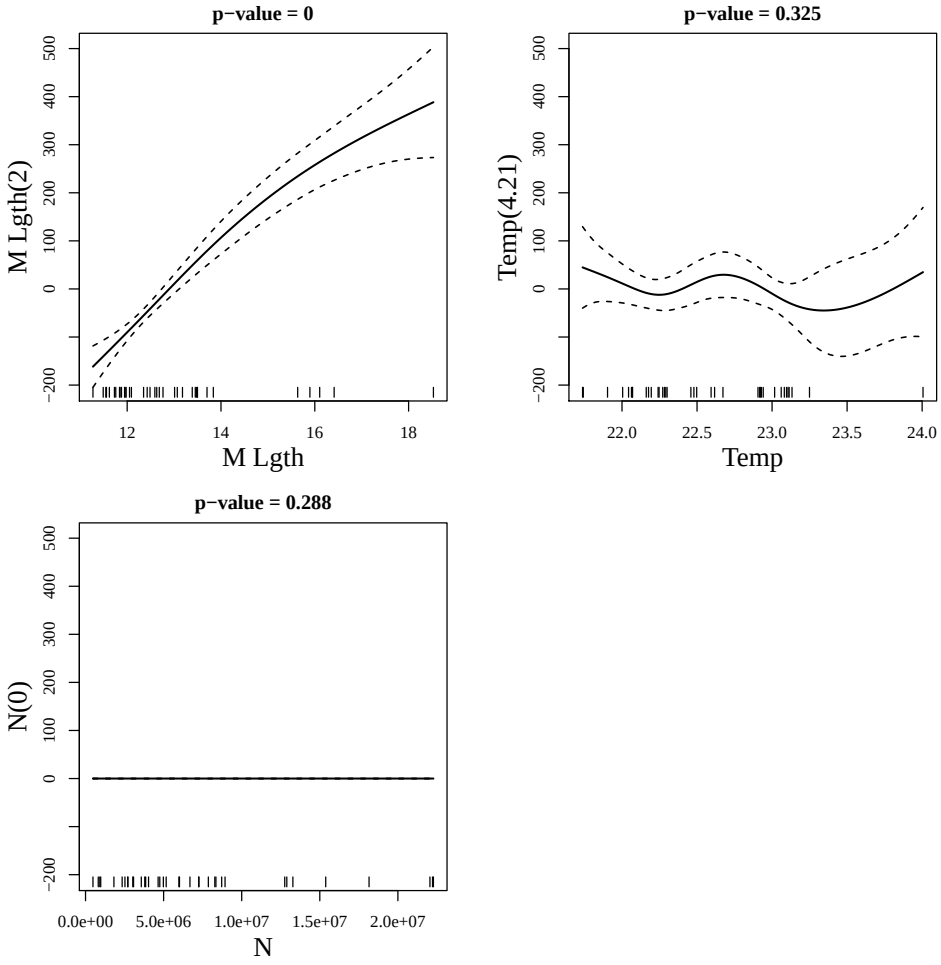

Figure A.10: The smoothed terms for scup in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Summer Flounder

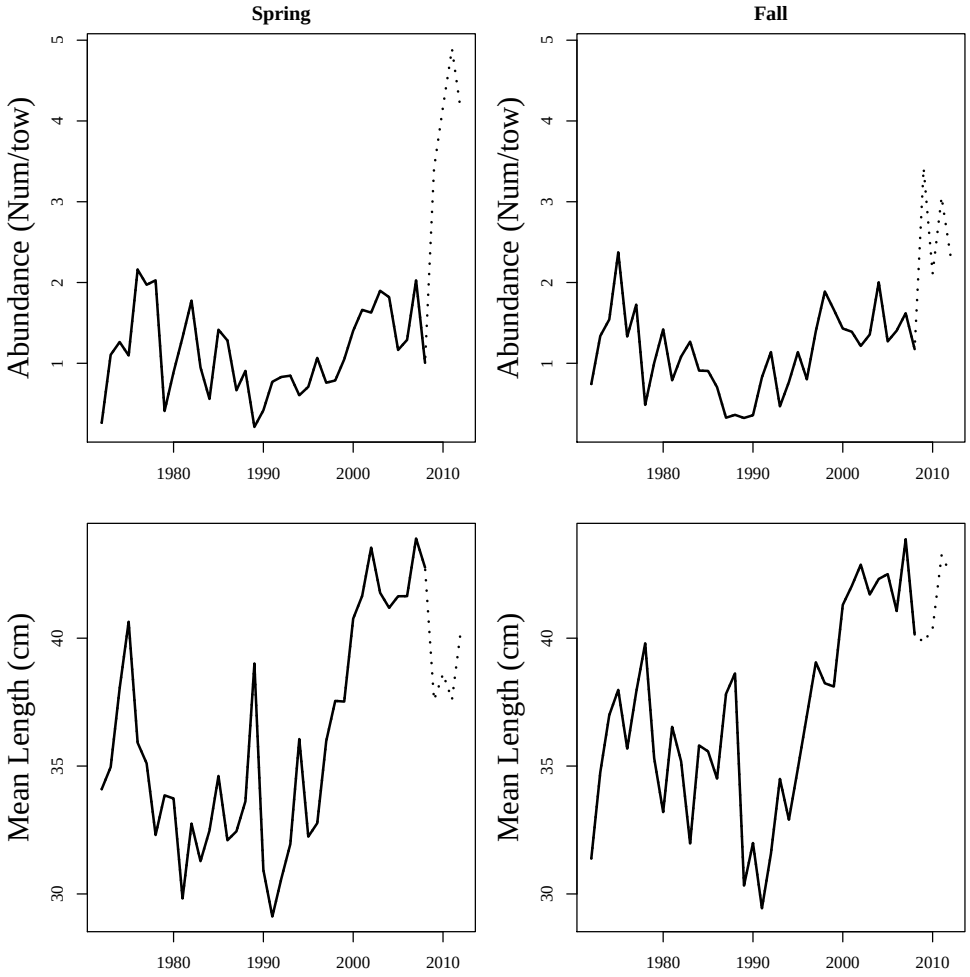

Figure A.11: The stratified mean abundance and mean length for summer flounder in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

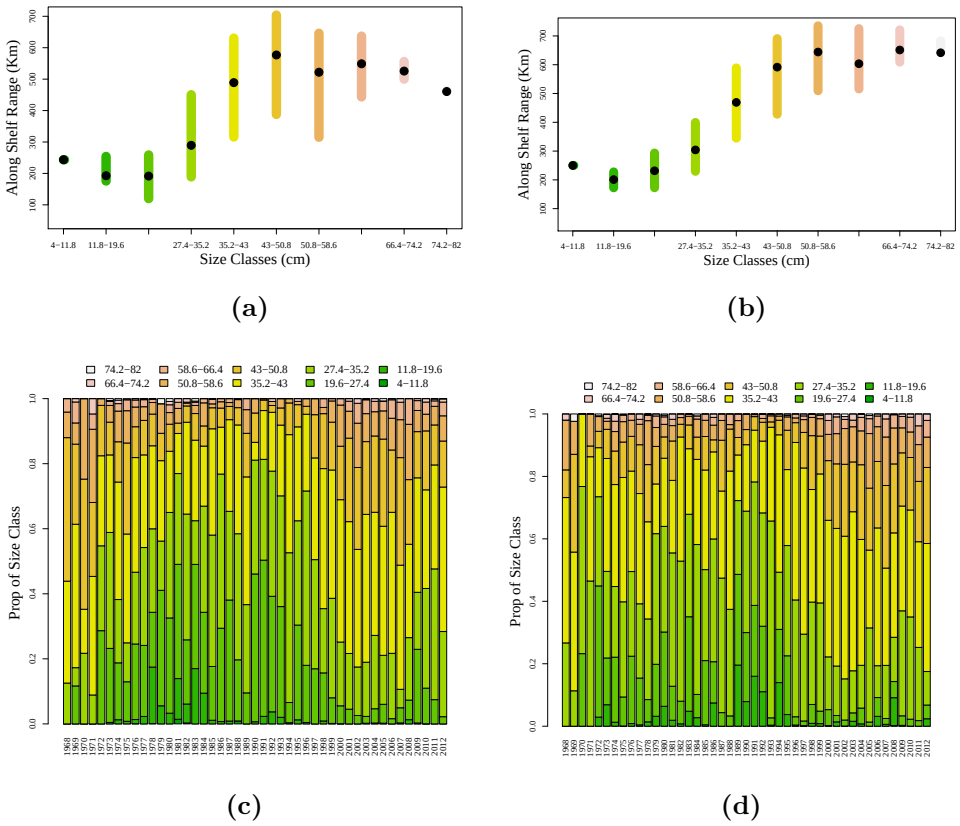

Figure A.12: The along shelf 25 - 75 % range of each of the length classes (a) & (b) of summer flounder over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

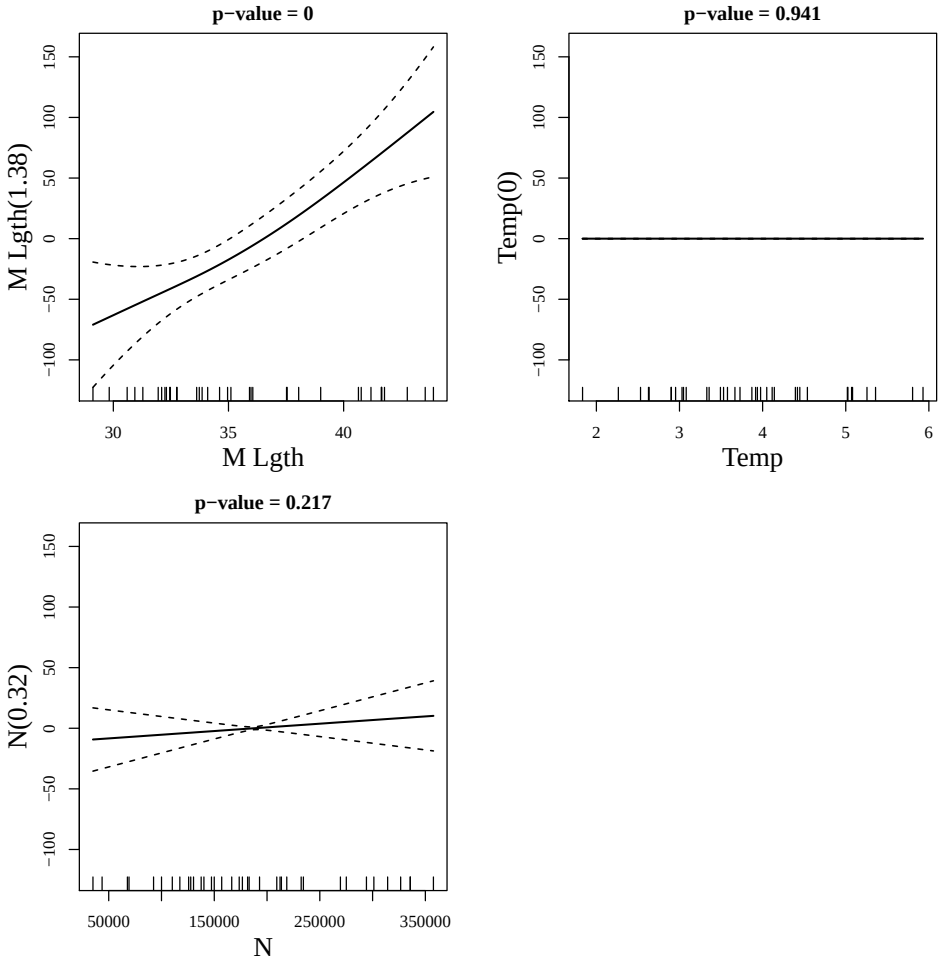

Figure A.13: The smoothed terms for summer flounder in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

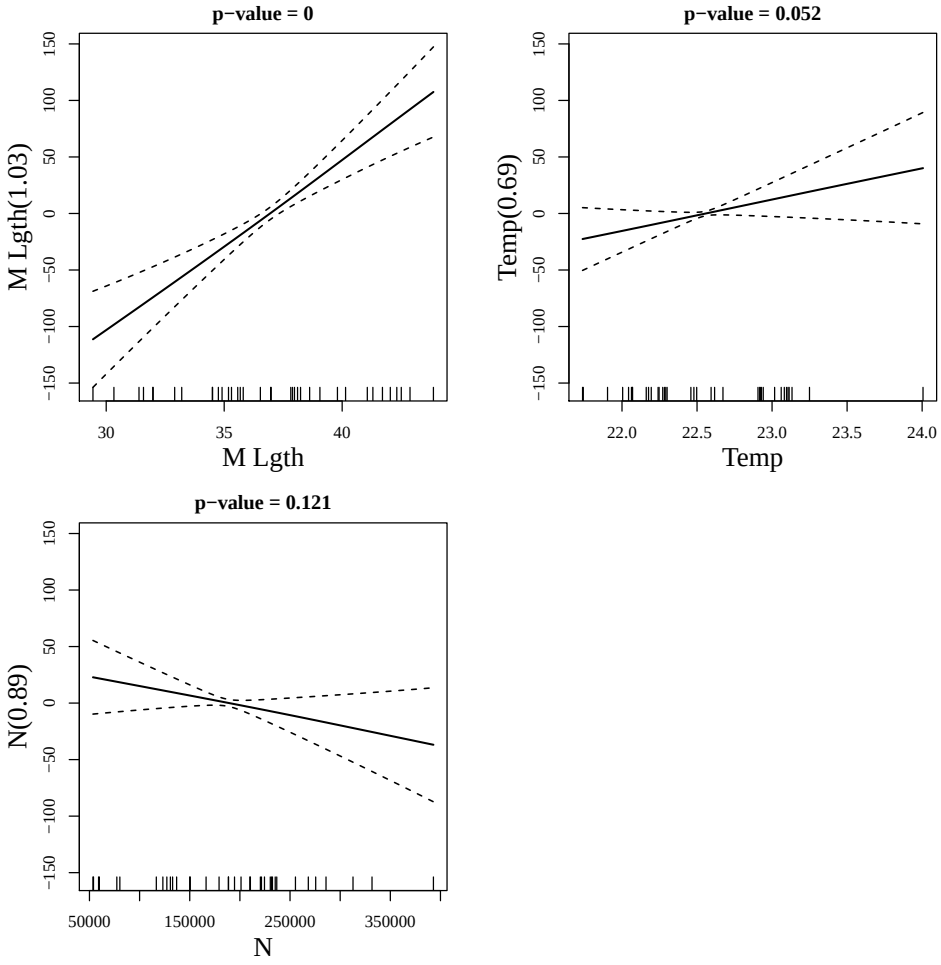

Figure A.14: The smoothed terms for summer flounder in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

Winter Flounder

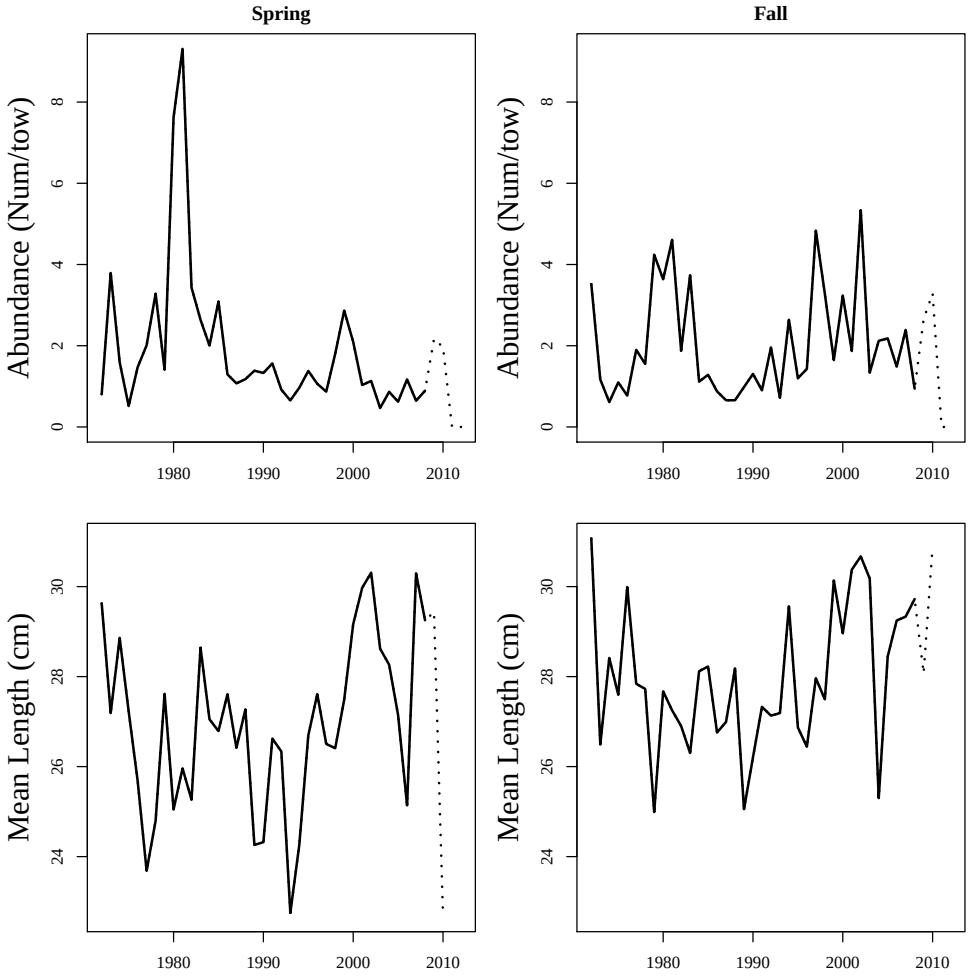

Figure A.15: The stratified mean abundance and mean length for winter flounder in the spring and fall from the NEFSC trawl survey data. The solid line covers the period 1972 - 2008. The dotted line extends from 2009 - 2012.

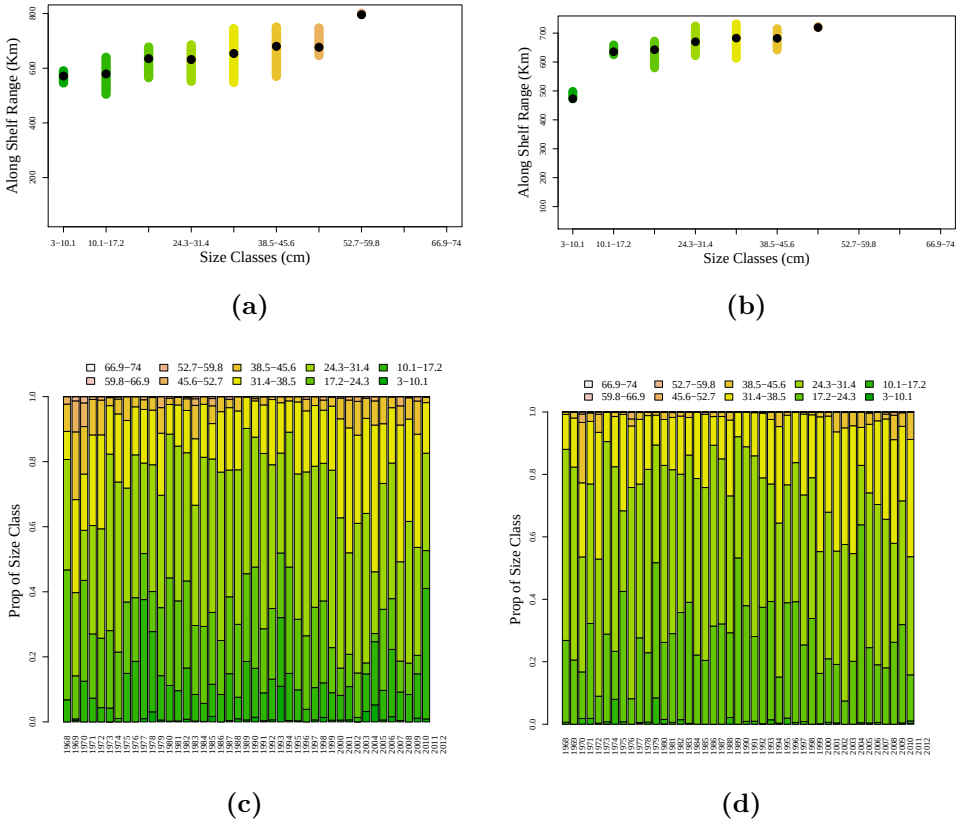

Figure A.16: The along shelf 25 - 75 % range of each of the length classes (a) & (b) of winter flounder over the years 1972 - 2008 and the proportion of each length class each year (c) & (d) for both seasons. Spring (a) & (c) and fall (b) & (d).

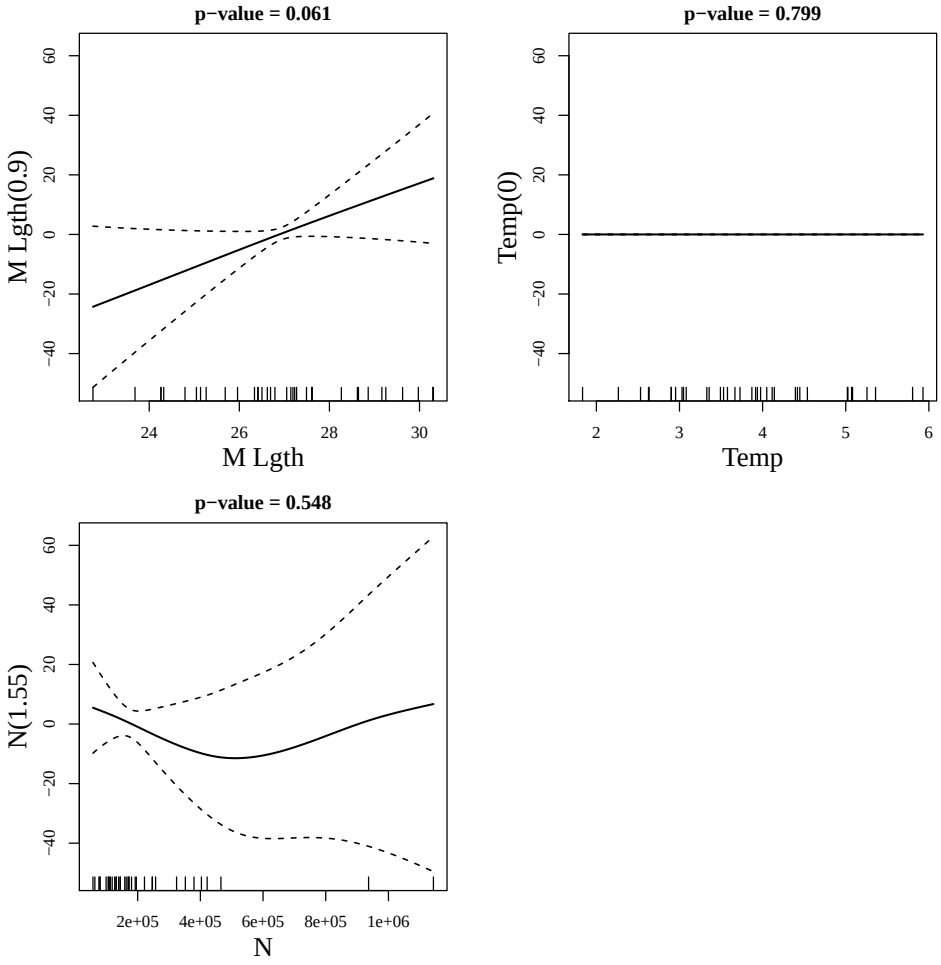

Figure A.17: The smoothed terms for winter flounder in the spring from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

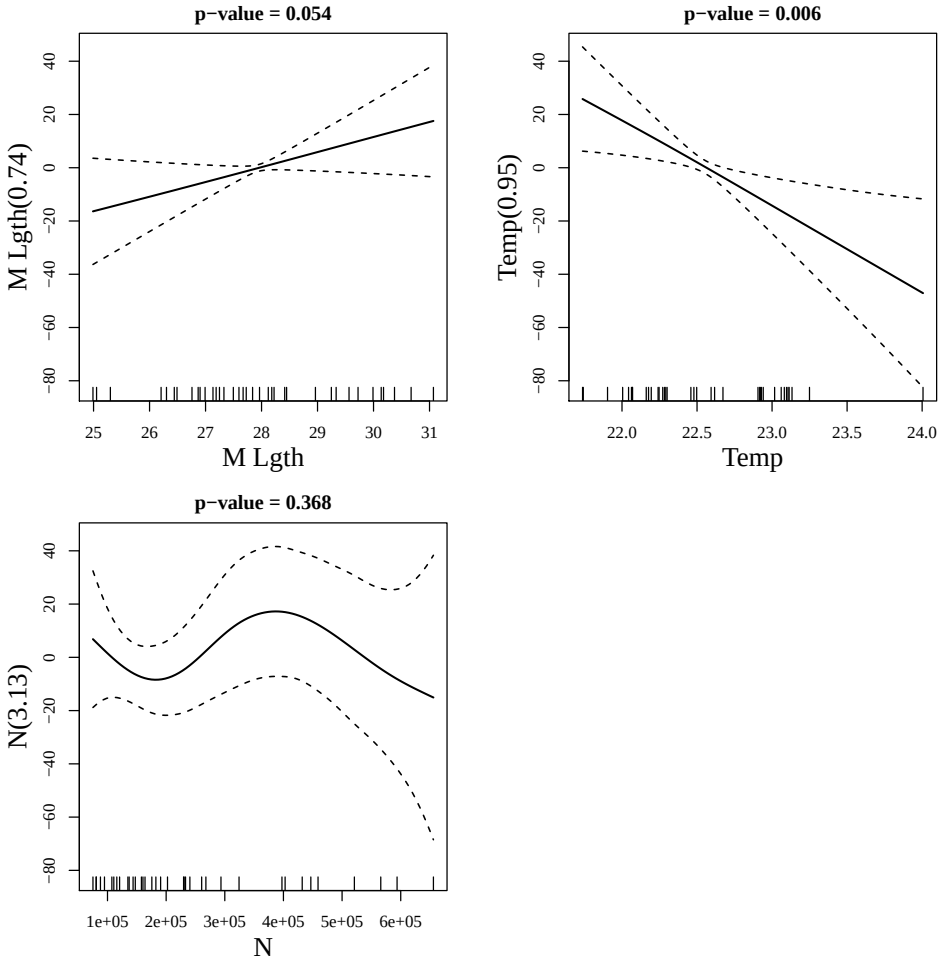

Figure A.18: The smoothed terms for winter flounder in the fall from the generalized additive model $COB_{yr} = s(\overline{L}_{yr}) + s(Temp_{yr}) + s(N_{yr})$.

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Commercially exploitable biomass distribution

Richard Bell	Northeast Fisheries Science Center	rich.bell@noaa.gov
Dave Richardson	Northeast Fisheries Science Center	david.richardson@noaa.gov
Jon Hare	Northeast Fisheries Science Center	jon.hare@noaa.gov

Report to the Atlantic States Marine Fisheries Commission

The state quota allocations for black sea bass, scup and summer flounder were determined based on the catch histories of the three species over specific time periods. The figures show the spatial distribution of the commercially exploitable biomass (legal sized fish) of the species during the time period used to calculate the state quota allocations and their current distributions.

Methods

The allocations were based on the catch histories for black sea bass over the years 1988 – 1997, scup 1983 – 1992, and summer flounder 1980 – 1989. We calculated the distribution of the commercially exploited biomass for the three species over their specified time span and over the last decade (2000 - 2008). The commercially exploited biomass was the biomass of individuals greater than or equal to the commercial size cutoff (black sea bass – 28 cm, scup – 22 cm, summer flounder 35 cm). The data were from the spring and fall bottom trawl surveys conducted by the Northeast Fisheries Science Center. Lengths were converted to weight per tow using species and season specific length-weight relationships.

The biomass of the three species is higher in the 2000s than during the earlier period. While the color bar denoting biomass is the same for all the figures, the scale of the color bar is different between the two periods.

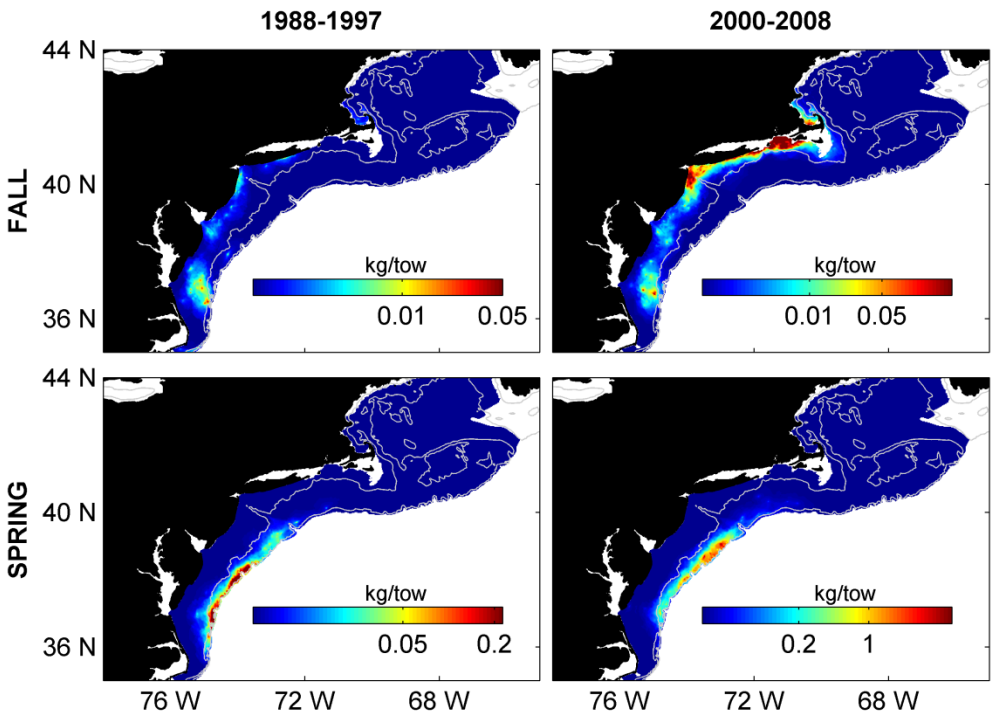

Figure 1. Black sea bass distribution during the period used to calculate the state quota allocations and during the 2000s. The data are from the spring and fall Northeast Fishery Science Center bottom trawl survey. Note the difference in scale of the color bars.

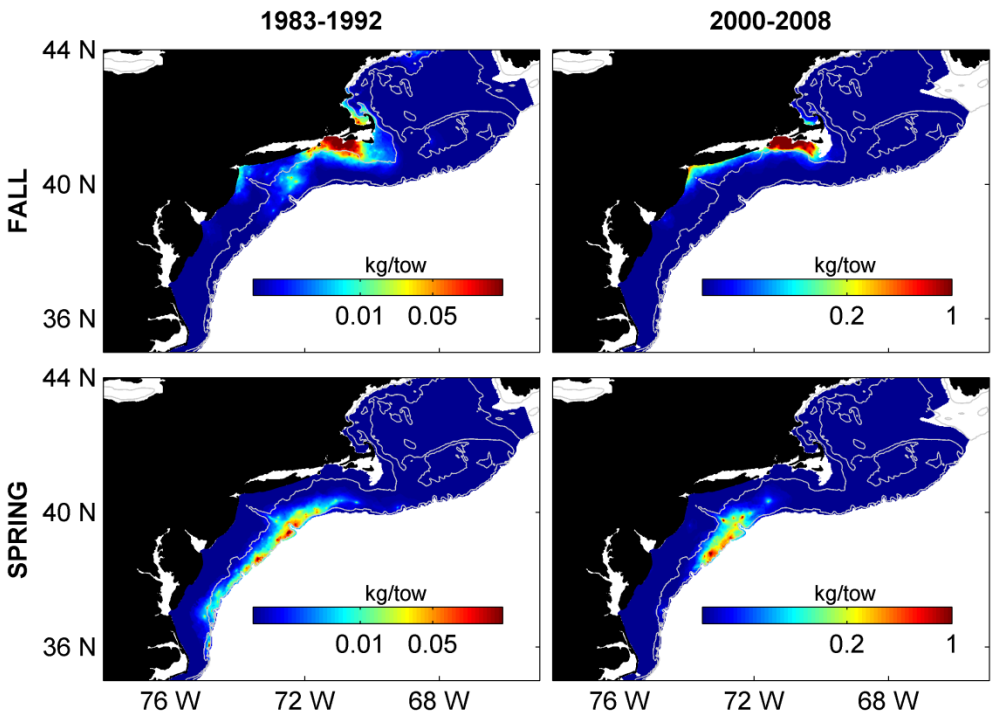

Figure 2. Scup distribution during the period used to calculate the state quota allocations and during the 2000s. The data are from the spring and fall Northeast Fishery Science Center bottom trawl survey. Note the difference in scale of the color bars.

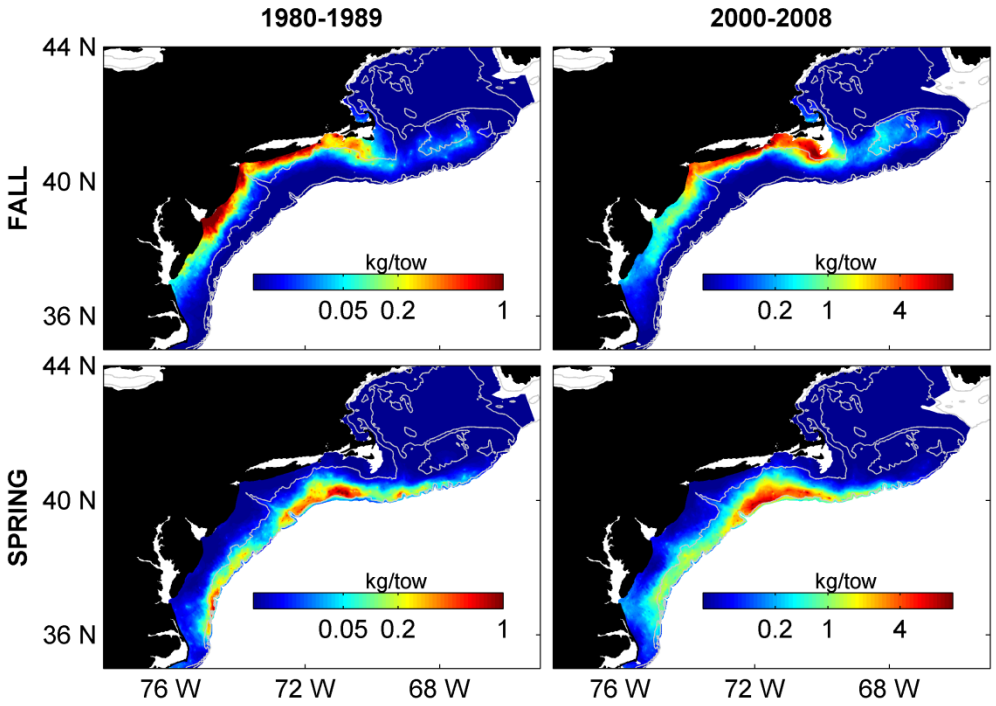

Figure 3. Summer flounder distribution during the period used to calculate the state quota allocations and during the 2000s. The data are from the spring and fall Northeast Fishery Science Center bottom trawl survey. Note the difference in scale of the color bars.

Commonwealth of Massachusetts

Division of Marine Fisheries

251 Causeway Street, Suite 400
Boston, Massachusetts 02114
(617)626-1520
fax (617)626-1509

Paul J. Diodati
Director

Deval Patrick
Governor
Timothy P. Murray
Lt. Governor
Richard K. Sullivan, Jr.
Secretary
Mary B. Griffin
Commissioner

October 4, 2012

Robert E. Beal, Acting Executive Director
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201

Dear Bob,

Our Massachusetts Marine Fisheries Advisory Commission (MFC) asked me to remind the Atlantic States Marine Fisheries Commission (ASMFC) about a discussion between its commissioners and an *ad hoc* group of ASMFC commissioners at last year's annual meeting. During that meeting, MFC commissioners expressed their concern that climate changes likely are having a profound effect on the distribution and availability of migratory species. In some cases, contemporary catches and landings no longer appear to match historical space-time trends upon which numerous species' quota allocations are based. The MFC requested that the ASMFC begin a general review of quota allocations and how they might be periodically re-evaluated.

During the first six months of 2012, the average sea surface temperature for the waters over the Northeast continental shelf from the Gulf of Maine to North Carolina exceeded the average temperature for those months during the past three decades. This finding by NOAA's Northeast Fisheries Science Center (NEFSC) gives evidence supporting the Intergovernmental Panel on Climate Change's conclusion that warming of the climate system is unequivocal.

NEFSC scientists reported that these temperature changes impact virtually all ocean life. They have demonstrated that Atlantic cod and other commercially valuable fish, for instance, have been shifting northeast from their historical distribution centers in recent years because of warming waters. Similarly, the ASMFC Lobster Technical Committee has conducted landmark work showing distributional shifts in spawning behavior resulting from increasing water temperature. This is a major factor contributing to the decline of the Southern New England lobster stock and consequent failure of that fishery.

A 2008 technical memorandum issued by NOAA correctly stated: "With the increasing recognition that climate change is occurring and having large impacts on living marine resources, a sound ecosystem approach to management of those resources requires both understanding how climate affects ecosystems and integration of that understanding into management processes." Fishery management organizations including the ASMFC have thus

far been neglectful by not giving adequate consideration about how to address climate-induced changes in population dynamics in today's fisheries management plans.

On behalf of the Massachusetts Marine Fisheries Advisory Commission, I respectfully request that the ASMFC Policy Board assign a priority charge to our Management and Science Committee (MSC) to consider whether climate-induced distributional shifts of migratory fish populations – such as scup, black sea bass, and fluke – have occurred and if these distributional shift(s) can be used as a basis for re-evaluation of quota allocation decisions. Using this MSC review and its recommendations as to how re-evaluations can be performed, the Policy Board can then decide how best to proceed and revise management plans either on its own or with our management partners, e.g., the Mid-Atlantic Fishery Management Council.

I anticipate that Policy Board members will universally agree that our current general procedure for allocating quota based solely on an average of each jurisdiction's annual landings during some historical base period – which was often a period of relatively high catches – should be reconsidered.

The MFC and I understand this is no easy task, but hopefully it's one that will help ASMFC meet one of the many challenges resulting from climate change. Please contact me with any questions.

Sincerely,

Paul Diodati

cc: Massachusetts Marine Fisheries Advisory Commission

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

February 13, 2013

To: **ISMFP Policy Board**
From: **Mike Armstrong, Management and Science Committee Chair**
RE: **Climate change, stock distributions, and state quota allocations**

The ISFMP Policy Board charged the Management and Science Committee with investigating whether climate change and warming coastal water temperatures are causing shifts in the geographic distributions of several stocks. And, where shifts are occurring, to reconsider the state-by-state allocation schemes and need for adjustment. The Committee has outlined the following plan to address the charge:

1. Define focal species to investigate, based on state allocation scheme and region

2. Evaluate fishery-independent survey data to examine changes in stock ranges and centers of distribution; also evaluate MRIP and commercial catch data
   - Consider both North/South and inshore/offshore distribution shifts
   - Conduct a literature search for existing documentation of stock distribution shifts

3. Summarize the state of knowledge for focal species, define criteria for a significant stock distribution shift, and demonstrate distribution shifts for stocks where it is occurring.

4. Define the methods for possibly adjusting state-by-state allocations

5. Define the frequency for re-evaluating stock distribution changes and allocations

6. Task Technical Committees to re-evaluate stock distributions periodically

7. For stocks where redistribution has been demonstrated, evaluate scientific ramifications:
   - For fishery-independent survey data applications, evaluate the weighting scheme of trawl stations (and other sampling gears), area designations, etc. and the effects on index calculations
   - Evaluate the ecological costs of longer migration pathways that lower production, especially for mid-Atlantic estuarine-dependent stocks

Proposed initial focal species are black sea bass, scup, and summer flounder in the Mid-Atlantic, lobster and Northern shrimp in New England, and red drum and spot in the South Atlantic. However, after the literature search, MSC may pare down the number of species to ensure thorough and quality research that will lead to better evaluations and recommendations from the Committee within the proposed timeline.

Timeline:

	2013										2014				
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Form MSC subcommittee; begin work on steps 1, 2, 3	X	X	X												
Subcommittee report to MSC			X					X							X
Continue work on steps 1, 2, 3; begin work on steps 4 and 5			X	X	X	X	X	X							
MSC initial report to Policy Board								X							
Complete steps 1- 5, based on Board feedback and with TC consultation; draft conclusions and recommendations								X	X	X	X	X	X	X	
Subcommittee investigate step 7												X	X	X	
MSC final report to Policy Board, consider new allocations for implementation in 2015															X

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

April 28, 2014

To: **ISFMP Policy Board**

From: **Joe O'Hop, Chair, Management and Science Committee**

RE: **Climate change, stock distributions, and state quota allocations**

The ISFMP Policy Board charged the Management and Science Committee (MSC) with investigating whether climate change and warming coastal water temperatures are causing shifts in the geographic distributions of several ASMFC managed fish stocks; as well as where shifts are occurring, creating options on how to reconsider the state-by-state allocation structure and need for adjustments. This memorandum contains a summary of the steps the Committee took to address the charge.

1. The Committee conducted an extensive literature search for existing documentation of stock distribution shifts. Using this information, MSC chose focal species to evaluate, based on state allocation regime and region. The focal species the Committee identified for study were black sea bass, scup, and summer flounder in the Mid-Atlantic. This was done to assure thorough research and recommendations from the Committee within their timeline.

2. The MSC collaborated with Northeast Fisheries Science Center (NEFSC) scientists to summarize the state of knowledge for focal species and to demonstrate distribution shifts for stocks where it is occurring. This report determined if the temporal center of biomass changed for four species (black sea bass, scup, summer flounder, and winter flounder) using NEFSC trawl survey data. If species demonstrated a center of biomass shift, these shifts were then attributed to changes in temperature, fishing pressure, or stock rebuilding. For the results of this study, please reference the report included in the Spring 2014 Meeting Materials by Bell et al. "Disentangling the effects of climate, abundance and size on the distribution of marine fish: an example based on four stocks from the Northeast U.S. Shelf".

3. The MSC created a number of straw-man reallocation options, to define the methods for possibly adjusting state-by-state allocations. To determine the applicability of each option, the Committee distributed a survey to ASMFC Commissioners. The MSC compiled a set of recommendations based on Commissioner responses to these reallocation options. Based on the results of the survey, there is interest among the states in looking further at options but in-depth work will be needed to establish specific reallocation structures and determine the most appropriate data sets to use. Robust data sets are critical to making reallocation decisions and

therefore the caveats (e.g., gear selectivity, survey sampling schedules, fishing area, etc.) on the appropriate use of fisheries independent and dependent data should be taken into account.

4. The Commissioners found the Historical/Current Combination reallocation option the most pragmatic, which was outlined as "using the historical allocation for 50% of the quota, and reallocating the remaining 50% of quota based on new biomass". The MSC recommends that percentages should be species-specific and that the historical "fixed" and "adjusted" percentages used in the survey on allocation options was only suggested as 50:50, and that other combinations for historical/current percentages could be used. As an example of the 50:50 option, 50% of the historical annual coast-wide allocation for a species for each state is preserved. If a certain percentage of catch (in biomass) of a species in fisheries independent surveys is found north of a defined latitude, the remaining percentage (e.g., 50%) of the coastal allocation is adjusted state-by-state to reflect the current estimated distribution of biomass. The MSC noted different reallocation percentages should also be considered, such as 90% Historical, 10% Current, or other percentages that could be decided by individual Management Boards in consultation with their Technical Committees. The Historical/Current Combination option will address changes for a stock that is expanding in range, increasing in abundance, or both. This reallocation option may provide management flexibility in terms of adjusting to changes in the distribution of stocks as well as providing for a more gradual change in adjusted allocations for states, because states keep some portion of their historical allocation.

5. Based on the survey results, most state fishery managers recommend that the frequency for re-evaluating stock distribution changes and allocations take place every five years. This should provide enough time and data to discern trends while still keeping allocations relevant and realistic.

6. The MSC also recommends that the ISFMP Policy Board task Technical Committees (TCs) with creating examples or scenarios to explore how any given reallocation option might function for each species. Examples should be created on a stock-by-stock basis for both commercial and recreational fisheries. Scenarios should be flexible, and demonstrate various shifts in the distribution of biomass for a species. The TCs can then provide recommendations to the Management Board as to how a given reallocation option may work for each state-allocated species.

Jonah Crab Fishery

A Briefing for the Atlantic States Marine Fisheries Commission

April 21, 2014

Contents

Executive Summary

Jonah crab has long been considered a bycatch of the lobster industry. In recent years, however, increased targeted fishing pressure on Jonah crab, likely due to fast growing market demand, has seriously compromised the long-term health of the fishery. In the absence of a comprehensive management plan and stock assessment process, harvest of Jonah crab is at risk of compromising the sustainability of the resource, ultimately resulting in inaccessible raw product and lost markets. This is particularly impactful to fishermen who rely on Jonah crab for their livelihoods and to the processors and dealers who have invested in processing technology and building markets for Jonah crab.

Jonah crab has no stock assessment or fishery management plan of its own, due in part to limited data on its population, growth rates, distribution, and sexual maturity. In addition, the limited dealer reports available often don't differentiate by species, confusing Jonah crab (*Cancer borealis*) with rock crab (*Cancer irroratus*).

As Jonah crab increases in value to the region, protecting the resource becomes progressively important. According to the National Ocean Economics Program data, 11,473,264 pounds of Jonah crab was landed in the U.S. in 2012 with a total ex-vessel value of $8,154,806. In fact, the harvest has increased steadily over the past decade. Massachusetts, followed by Rhode Island,

has landed the greatest amount of Jonah crab in the region for the past three years. These numbers are based on reporting data from federal waters, where the vast majority of Jonah crab is presently harvested.

In 2012, Delhaize America, a major grocery retailer with approximately 1,700 stores from Maine to Florida, recognized that Jonah crab does not meet its criteria for sustainable harvest. It faced a decision to either discontinue the item or to engage the industry and others in a formal Fishery Improvement Project (FIP) to address the fishery's sustainability concerns. Over the past year, Jonah crab processors, fishermen, state and federal management representatives, and scientists have worked with Delhaize America to better understand the sustainability concerns of the fishery and to develop a set of recommendations for its management. Facilitated by the Gulf of Maine Research Institute (GMRI), the FIP has conducted a pre-assessment benchmark against Marine Stewardship Council criteria (Appendix A: MSC Pre-Assessment) and developed a work plan (Appendix B: Jonah Crab FIP Work Plan) that outlines a series of deliverables that will address threats to the fishery's sustainability.

The FIP Work Group requests that the ASMFC Policy Board make management of Jonah crab a priority over the coming year in order to address the following problems:

- The crab resource is unregulated in federal waters, with most of the landings coming from Area 3.
- Landings and effort are increasing rapidly and in an unregulated manner.
- There are no minimum size protections for Jonah crab, nor are there regulations to protect spawning biomass, including restrictions on the harvest of females.
- If left unregulated, the expanding crab fishery threatens the effectiveness of the lobster industry's conservation measures to reduce traps in the water and avoid interactions with right whales.
- Supermarkets and other major buyers are positioning to discontinue selling processed and whole Jonah crab unless it is managed sustainably.
- With the loss of market access, the ex-vessel price of Jonah crab is likely to decline.
- With continued unregulated harvest of Jonah crab, the long-term availability of this resource for harvest is compromised.

Specifically, the Work Group's recommendations to the ASMFC include the following:

- Incorporate Jonah crab into the Lobster Management Plan;
- Tie the harvest of Jonah crab to the lobster license and trap tagging requirements as is currently done in Massachusetts, New Hampshire, and Maine. For states that do not have a lobster license, require a license and trap tags for the harvest of Jonah crab.
- Require a 5" minimum carapace width (CW), with an enforcement tolerance.
- Prohibit the harvest of female Jonah crabs.
- Require full reporting of Cancer crabs by species to better understand the fishery and to establish baseline data.

This document provides additional background and justification for the Work Group's recommendations.

Market Demand for Sustainability

Over the past decade, retailers around the world have taken a hard look at how their purchasing impacts the sustainability of the globe's fishery resources. The vast majority of retailers – including Wal-Mart, Giant Eagle, Delhaize America, and Wegmans – have made commitments to sourcing sustainable seafood. While each retailer might have a slightly different definition of sustainability, all recognize that they have a role to play in motivating responsible harvest, ultimately contributing to long-term sustainability of the resource.

Delhaize America has committed to sourcing only seafood that is well-managed and not at risk of over exploitation. As the company reviewed Jonah crab, it discovered that the fishery is not well managed and there is very little scientific data to determine whether the fishery is being overexploited.

Rather than abandon the product, Delhaize America engaged with GMRI and other partners to implement a FIP. Globally, FIPs have been initiated as industry-led voluntary efforts to identify and address sustainability concerns in fisheries (for additional information on FIPs, visit http://www.sustainablefish.org/fisheries-improvement).

The Conservation Alliance for Seafood Solutions (www.solutionsforseafood.org) includes 18 NGOs from North America that engage with the seafood buying marketplace to encourage and inform sustainable sourcing. This Alliance has agreed that encouraging fishery improvements is beneficial to sustainability and has developed formal guidelines (Appendix C: Guidelines for Supporting Fishery Improvement Projects) for FIPS to be recommended to their buyer partners (Appendix D: Summary of NGO and Retailer and Food Service Partnerships).

The Jonah crab FIP follows these guidelines closely, and all information – including the participation agreement, work plan, Work Group, and budget – is made available on a public web site at https://sites.google.com/site/jonahcrabfip. The Work Group members are:

- Chair: Ray Swenton, Bristol Seafood
- David Borden, Atlantic Offshore Lobstermen's Association
- Josanna Busby, Delhaize America
- Lanny Dellinger, Rhode Island Lobstermen's Association
- Bill Gerencer, M.F. Foley Company
- Adam LaGreca, Rome Packing
- Derek Perry, Massachusetts Division of Marine Fisheries
- David Spencer, F/V Nathaniel Lee
- Steve Train, Atlantic States Marine Fisheries Commission
- Rick Wahle, University of Maine
- Jon Williams, The Atlantic Red Crab Company

This Work Group has committed to collaboratively address the sustainability concerns in the Jonah crab fishery. The FIP recognizes that, in the absence of appropriate management measures for the Jonah crab fishery, the market demand for this product – and hence the price per pound

and overall value – is at risk of decreasing precipitously, as major retailers implement their sustainable seafood commitments.

Threats to Biological Sustainability

Although Jonah crab has long been considered a bycatch of the lobster fishery, increasing market for this product – in both live and processed forms – has resulted in increasing targeted effort on Jonah crab. Over the past twenty years, landings of Jonah crab in New England have more than quadrupled (Figure 1.) with the majority landed in Massachusetts, followed by Rhode Island (Figures 2 and 3). The majority of these landings are coming from the Southern New England management area, followed by Georges Bank (Figures 4 and 5).

In the absence of a stock assessment, it isn't possible to determine whether increased landings are market driven or a reflection of an increasing biomass. However, reduced fisheries dependent and independent catch per unit effort (CPUE) data (Figures 6 and 7) may indicate that the biomass may be starting to decrease.

Further, offshore fishing for crab in the absence of a lobster permit or trap tags, which is presently permissible, threatens the lobster industry's effort control plan and conservation measures to reduce whale and other mammal interactions.

Finally, there are no protections in place for undersized or female Jonah crab to preserve a fecund population of crabs that will ensure a sustainable population in perpetuity.

In the absence of effective and robust control measures for the harvest of Jonah crab, the fishery will be harvested unsustainably. The consequences will be dire for fishermen who rely on Jonah crab for their livelihoods, and for the seafood processors that have invested in processing capacity and building markets for Jonah crab products.

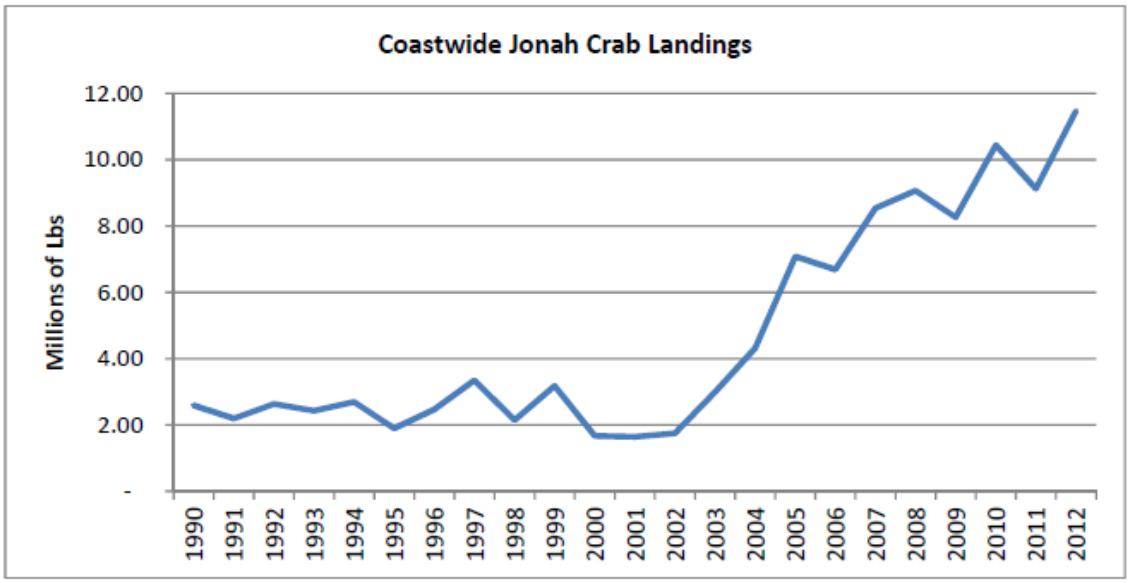

Figure 1: Coast-wide (all states) landings of Jonah crabs 1990-2012, as reported by the Atlantic Coastal Cooperative Statistics Program (ACCSP). Heidi Henninger, Atlantic Offshore Lobsterman's Association (AOLA).

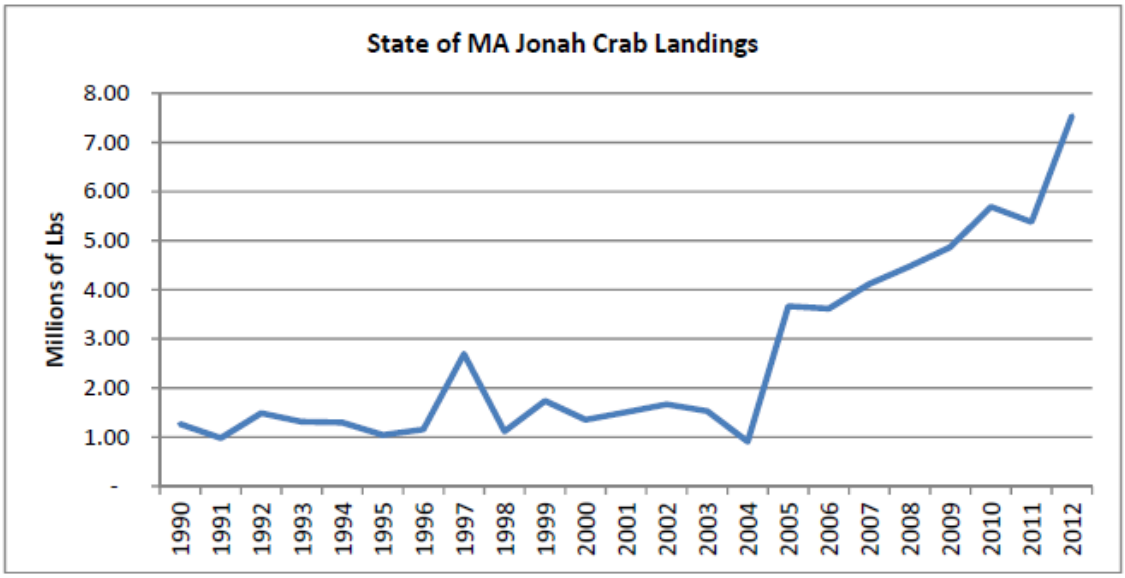

Figure 2: State of Massachusetts landings of Jonah crabs 1990-2012, as reported by ACCSP. Heidi Henninger, AOLA.

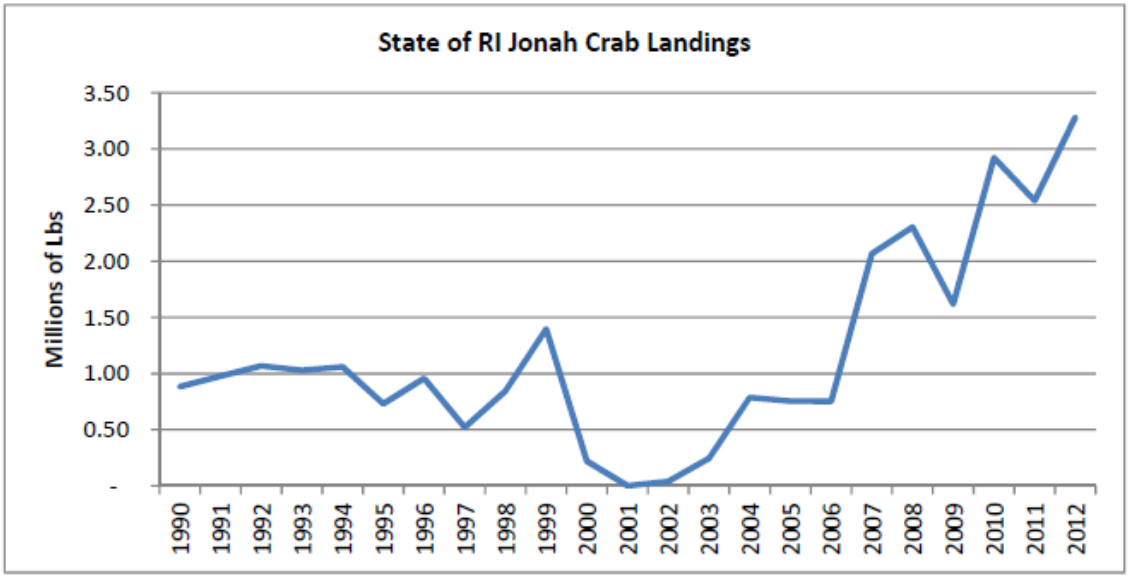

Figure 3: State of Rhode Island landings of Jonah crab 1990-2012, as reported by the ACCSP. Heidi Henninger, AOLA.

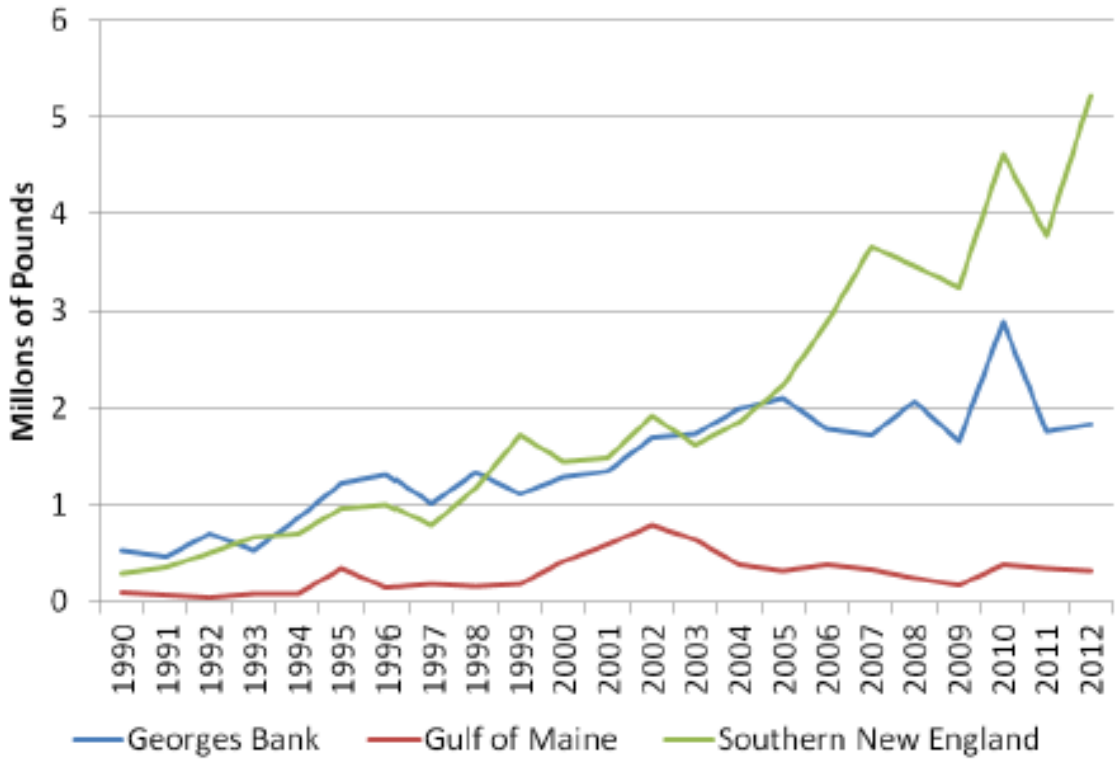

Figure 4: Massachusetts Cancer crab landings (Jonah and rock crabs) by region, 1990-2012.

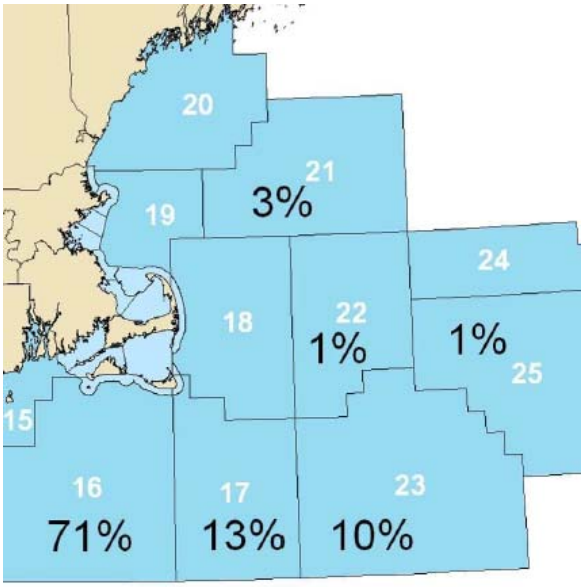

Figure 5: Percentage of Jonah crab landed in Massachusetts by MA Statistical Reporting Areas (SRA) (white numbers), 1990-2012. All areas without a given percentage are <1% of landings. The lighter blue shaded areas are SRA 1 through 14 and collectively are responsible for 1% of all MA Jonah crab landings.

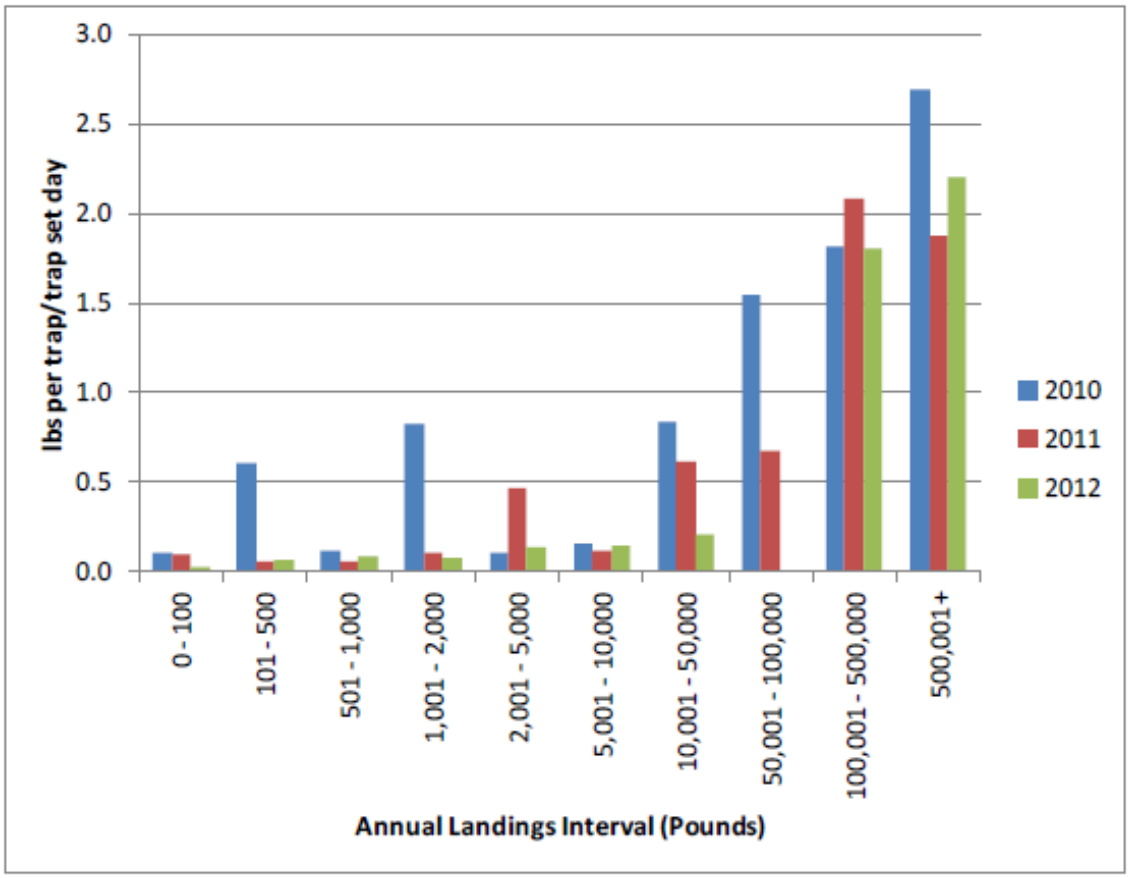

Figure 6: Catch per unit of effort (CPUE) data by landings interval (from DMF trip level reporting and NMFS VTR data).

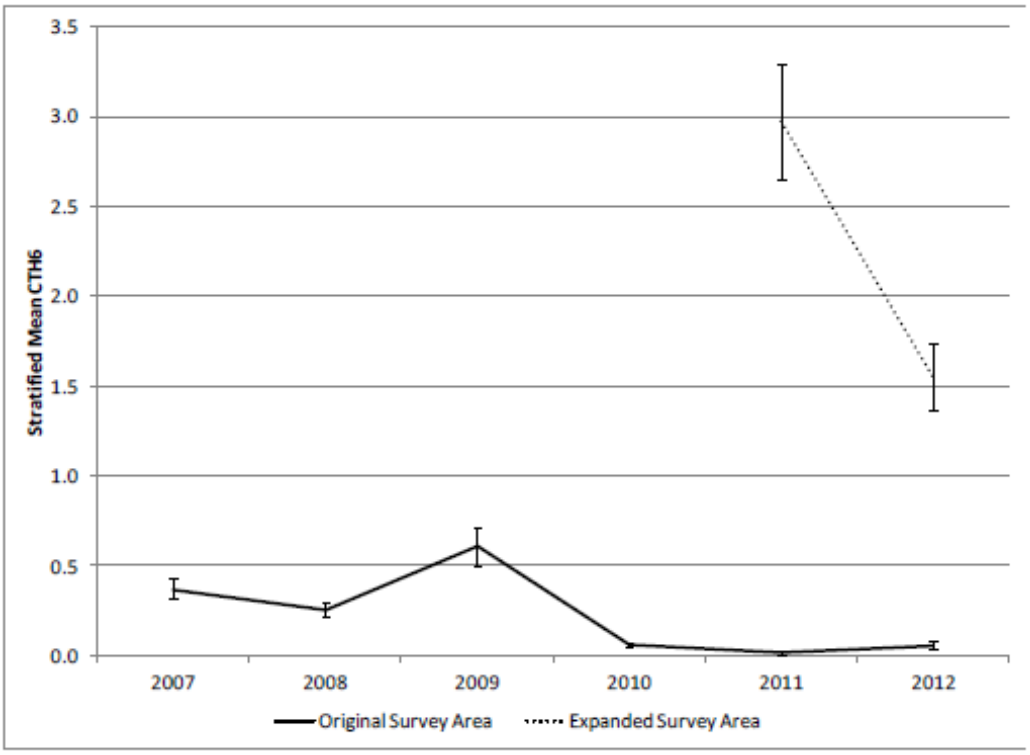

Figure 7: Jonah crab catch per trap haul from MA DMF Ventless Trap Survey. The original survey area was done in state waters; the expanded survey was conducted in both state and federal waters. Error bars around the data points are standard error.

Jonah Crab Management

Jonah crab is managed differently from state to state, and management is completely absent in federal waters. The table below is a summary of state-by-state management measures for Jonah crab.

In Massachusetts and Rhode Island – the states with the highest Jonah crab landings – there is no minimum landing size. There is also no commercial limit to the amount of Jonah crab that can be harvested, and traps are limited only when harvested with lobsters. In federal waters, when fishermen do not harvest lobsters, there are no licensing requirements and no trap limits for Jonah crab. There exist no protections for female Jonah crab.

Summary of Federal and State Crab Regulations	Limit on Trap Qty	Gear Restrictions	Limit on Trap Size	Commercial License required Y/N	Minimum landing Size	Maximum Landing Size	Sex Restrictions	Closed seasons	Closed Areas
New Jersey	N	biodegradable panel	Y	Y	3" - 4.5" varies by hardness (per blue crab regs)	N	No egg bearers	Y	Y
New York	N	escape panel	Y	N	3" - 4.5" varies by hardness (per blue crab regs)	N	No egg-bearers	N	Y
Massachusetts	Y - Lobster limit	Y - Lobster traps	Y-lobster traps	Y	N	N	No egg bearers	Yes; closed Jan 1 - Apr 30 in state waters	N
Maine	Y - Lobster limit	Y - Lobster traps	Y-lobster traps	Y	N	N	None indicated	Dec 30 - Apr 1 in rivers	Y
Rhode Island	N	N	N	Y	N	N	No egg-bearers	N	N
New Hampshire	Y - lobster limit 1200	Y - Lobster traps	Y-lobster traps	Y	N	N	None indicated	N	N
Connecticut	?	Y - lobster trap	Y-lobster traps	Y	3.5" - 5" varies by hardness (per blue crab and lobster regs)	N	No egg bearers	May 1 - Nov 30; commercial closed Dec 1 - Apr 30	N
Maryland	N	Turtle BRD (juvenile), escape vent	Y	N	3.5" - 5" varies by hardness (per blue crab and lobster regs)	N	Comm no females at certain times, Rec no females	Y, opens Apri 1 - Dec 15	Y
Virginia									

Summary of Federal and State Crab Regulations (con't)	Commercial Catch Reporting	Harvest Limits Commercial	Harvest Limits Recreational	Recreational License required Y/N	Recreational Limit on Trap Qty	Notes	Source(s)
New Jersey	Y	N	One bushel per day	Y	Y	Blue Crab Regs	http://www.state.nj.us/dep/fgw/njregs.htm
New York	Y	50/day	50/day	N	N	Blue Crab Regs	http://www.dec.ny.gov/outdoor/7894.html; http://www.dec.ny.gov/outdoor/fishing.html
Massachusetts	Y	N	25/day	N for hand harvest; Y if trap or SCUBA	10 traps	Rec: Blue Crab Regs, applied to other species; Commercial: lobster regs	http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/recreational-regulations/; http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/commercial-regulations/
Maine	Y	200 lbs./day or 500 lbs./trip	N	N/Y	5 traps; no license for hand harvest	Lobster Regs	http://www.maine.gov/ifw/fishing/regulations_seasons/index.htm; http://www.maine.gov/dmr/lawsandregs/re
Rhode Island	Y	N	N	Y	N		Scott Olszewski
New Hampshire	Y	N	N	Y if more than 12 crabs taken	?		http://www.wildlife.state.nh.us/Fishing/fishing.htm; http://www.wildlife.state.nh.us/pubs/digests/SW_2011.pdf
Connecticut	Y	N	N	Y	10 traps hauled per day	Blue Crab regs; Lobster Regs incl other crab	http://www.ct.gov/dep/cwp/view.asp?a=2696&q=322740&depNAV_GID=1647; Matt Gates
Maryland	Y	25 bushels per vessel/day	Y, varies 1 bushel hard crabs, 2 doz soft	N/Y	N, limited harvest qty	Blue Crab Regs	http://www.dnr.state.md.us/fisheries/regulations
Virginia	Y						http://www.dgif.virginia.gov/fishing/

Current Data Collection Programs

Data collection for Jonah crab varies from state to state and survey to survey. Appendix B of the attached MSC pre-assessment (Appendix A) includes a comprehensive overview of data collected on Jonah crab. A great deal of data, albeit inconsistent, exists for Jonah crab. Unfortunately, because this fishery has been considered a low priority, very little of it has been analyzed.

The only survey that exists for Jonah crab applies to only inshore Rhode Island waters. The University of Rhode Island and Rhode Island Department of Environmental Management conduct an annual survey of the abundance of Cancer crab species. The 2012 Rhode Island state assessment indicated that the fishing mortality rate in the state fishery exceeded F_{MSY}, but the biomass had not fallen below B_{MSY} and was not considered overfished (RIDEM 2012[1]). After a

[1] Rhode Island Department of Environmental Management, 2012. 2013 Management Plan for the Crustacean Fishery Sector.

stable fishing mortality rate from 1971 to 2004, the Rhode Island Jonah and rock crab fishery has experienced a sharp increase in fishing effort and decrease in crab abundance.

Massachusetts, Maine, and New Hampshire conduct inshore trawl surveys, but these surveys only provide minimal data on crab species and are primarily used to assess finfish species and none of these surveys are conducted in the federal waters south of New England where approximately 75% of the commercial fishery is executed. The federal trawl survey also offers a time series of Cancer crab abundance and distribution data, distinguished by species, although the data have not yet been analyzed.

Fishery dependent data is comprised of landings data. Unfortunately, it is likely that Jonah crab are confused for other types of crabs in reporting, thus compromising the reliability of that data.

Biology

For the fishery overall, biological reference points are unknown, as are geographical differences in size, fecundity, and recruitment.

Also, the size at sexual maturity and to what extent it might vary from one area to the next is poorly documented. In a study conducted in Canada, the size at 50% morphometric maturity for males was determined to be 127.6mm (5.02") CW (Moriyasu et al, 2002[2]). Existing minimum size restrictions in the Bay of Fundy and the Scotian Shelf for Jonah crab are 121mm and 130mm (4.76" and 5.12") respectively. Little is known about female maturity in Canada, but the size at 50% maturity is believed to be around 92 mm (3.62") CW and females can reach a maximum size of 150 mm (5.91") CW (Pezzack et al. 2011[3]). Male maturity off of Virginia is estimated to be 90-100 mm (3.54-3.94") and approximately 85 mm (3.35") for females (Carpenter 1978[4], Wenner et al. 1992[5]).

What little maturity data exists on Jonah crabs comes from the fringes of their commercially exploitable range. No data exists in the offshore area south of New England where approximately 75% of the commercial fishery currently operates. Male Jonah crabs reach

[2] Moriyasu M, Benhalima K, Duggan, D, Lawton P, Robichaud D (2002) Reproductive biology of male Jonah crab, Cancer borealis Stimpson, 1859 (Decapoda: Cancridae) on the Scotian Shelf, Northwestern Atlantic. Crustaceana 75: 891-913.

[3] Pezzack, D. S., C.M. Frail, A. Reeves, M. J. Trembleay. 2011. Assessment of the LFA 41 Offshore Jonah crab (*Cancer borealis*) (NAFO 4X and 5Zc). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/113:vii-52.

[4]Carpenter, R. K. 1978. Aspects of the growth, reproduction, and abundance of the Jonah crab, (*Cancer borealis*) Stimpson, in Norfolk Canyon and the adjacent slope. MA Thesis, University of Virginia, Charlottesville.

[5] Wenner, E. L., C.A. Barans, G. F. Ulrich. 1992. Population structure and habitat of Jonah crab, *Cancer borealis* Stimpson 1859, on the continental slope off the Southeastern United States. Journal of Shellfish Research 11(1):95-103.

[6] Schields J. D. 1993. The reproductive ecology and fecundity of *Cancer* crabs. In: Wenner A, Kuris A (eds) Crustacean issues vol. 7—crustacean egg production. A. Balkema, Rotterdam.

maturity at a larger size in Canada (5") than they do in Virginia (4"). Northern hemisphere congeneric crab species also reach maturity at larger sizes in more northerly sections of their range (Shields 1993[6]), making it likely that the size of male maturity is between 4 and 5" where most of the commercial fishery is conducted.

Jonah crab is an assessed species in Canada for the small bycatch fishery in the eastern Gulf of Maine and Southeast Nova Scotia. There may be additional biological data that can be procured from their assessment, but likely not much.

Value of the Jonah Crab Fishery

The impact of size and other restrictions on the market for Jonah crab is an important consideration. In Massachusetts, Jonah crab was the 5th most valuable species landed in 2013 (Table 1). According to 2012 data from the National Ocean Economics Program, the ex-vessel value of Jonah crab in New England was $8,086,559 (average $0.71/pound), which was up from $5,530,388 (average $0.61/lb) just the year before. The steady increase in the fishery's value is depicted in Figures 8 and 9 below.

Species	Pounds (Whole)**	Value
Scallop, Sea	244,404,049	$333,047,038
Lobster, American	14,956,166	$60,216,990
Oyster, Eastern	10,539,126	$10,291,065
Goosefish	9,589,132	$8,937,279
Crab, Jonah	**10,070,775**	**$8,930,604**
Flounder, Winter	5,388,992	$8,775,488
Herring, Atlantic, Sea	76,375,477	$8,727,482
Cod, Atlantic	4,142,359	$8,303,059
Pollock, Atlantic	7,934,667	$7,655,851
Haddock	3,975,609	$5,556,242

Table 1: Ten most valuable Massachusetts fisheries from Standard Atlantic Fisheries Information System (SAFIS) for 2013.

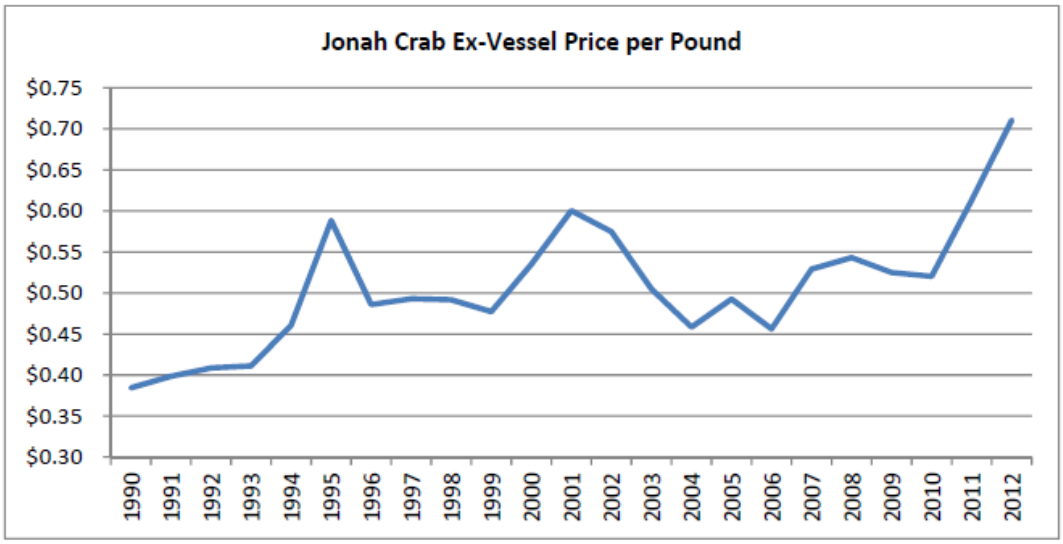

Figure 8: Coastwide (all states) ex-vessel price per pound of Jonah crab 1990-2012, as reported by the ACCSP. Heidi Henninger, AOLA.

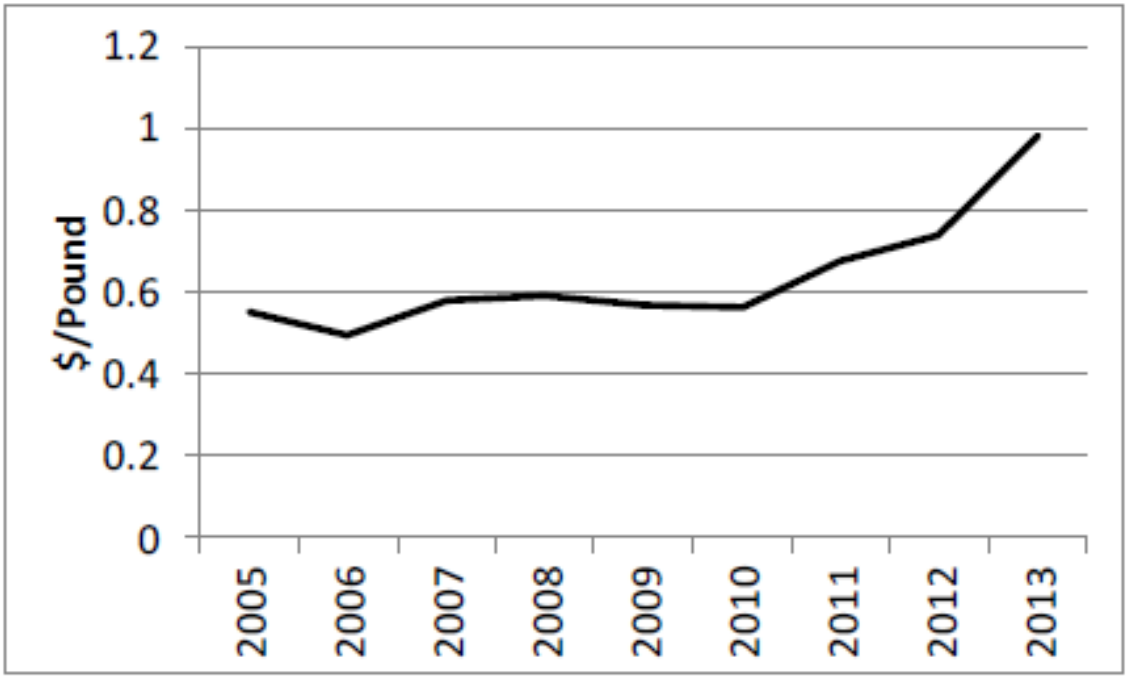

Figure 9: Price per pound for Jonah crab landed in MA from SAFIS.

FIP Work Group Recommendations

The Jonah Crab FIP Work Group met seven times (five in person and two by phone) to discuss the threats to the Jonah crab fishery and to develop recommendations that would protect this valuable resource from overexploitation. These discussions were informed by contracted data

collection done by the University of Maine and GMRI, which culminated in a pre-assessment against MSC criteria (Appendix A).

Following are the Work Group's management and data collection recommendations, which are also outlined briefly in the attached Work Plan (Appendix B).

Data Collection Recommendations

- Develop a standard list of data points that are recommended for all surveys, including:
    - Documentation of egg-bearing individuals.
    - Documentation of size of individuals captured (i.e., carapace width).
    - Abundance (i.e., how many were caught).
    - Weight of catch.
    - Sex of individuals caught.
    - Specifications on gear being used.

  Justification: While data for Jonah crab are presently sporadic, there are numerous opportunities through existing and ongoing state and federal surveys to collect a robust data set that can inform Jonah crab fishery management. Having a shared protocol will enable this data to be integrated and analyzed throughout the fishery's region.

- Develop a sub sampling protocol for fishery-dependent data collection done by observers, including sizes and sexes of the individuals landed versus discarded.

  Justification: To better understand the Jonah crab stock structure, particularly from one area to the next, information about what is discarded at sea is essential, in addition to what is landed.

- Analyze survey data to determine size at maturity for females by comparing egg-bearing females with size data; and
- Conduct research to determine size-specific fecundity (clutch size) and evaluate the geography of size at maturity; and
- Conduct research to determine whether there is a significant difference between the size at physiological maturity and functional maturity in males. The question is whether males must be considerably larger than females to mate with females. The concern is whether harvesting large males will deplete the pool of large males competent to mate.

  Justification: The literature on size at sexual maturity for Jonah crab is lacking. While some research has been done to indicate female Jonah crab are sexually mature at 3.5" CW and males at 5.02", very little is known about whether there are variations in size at sexual maturity from one harvest area to the next, including no information from where the majority of the commercial catch is currently caught.

Management Recommendations

- Incorporate the management of Jonah crab into the lobster management plan through the ASMFC; and
- Tie the harvest of Jonah crab with the lobster license and trap tagging requirements. Require a lobster license in order to harvest Jonah crab. In the absence of a lobster license, require a license for the harvest of Jonah crab.

  Justification: The Jonah crab and lobster fisheries in offshore waters are inextricably tied, as licensed lobstermen presently harvest 98.3% of the Jonah crab landed from federal waters for the region (personal communication, Burton Shank, NOAA Fisheries Science Center, November, 2013). Requiring a lobster license and trap tags for Jonah crab harvest would retain that connection while respecting and building on conservation measures already in place in the lobster fishery, such as trap density reductions.

  Massachusetts, Maine, and New Hampshire already tie Jonah crab harvest to lobster licenses. The lobster fishery is managed under effort controls that address whale entanglement issues. By tying the harvest of Jonah crab to the existing lobster management plan, managers would avoid increasing trap numbers, additional costs to states for plan development and enforcement, and determining resource allocation for the Jonah crab fishery.

  Further, at this point in time, there is not enough information to determine a separate FMP for Jonah crab. For example, there would be very little data that would inform a TAC.

- Require all Cancer crab landed to be reported by species. Educate harvesters and dealers to achieve consistent species identification.

  Justification: Existing data on Jonah crab landings is suspect because of inconsistent reporting by species. Fishermen and dealers use many common names for Cancer crabs interchangeably. Any future stock assessment using fishery-dependent data will require accurate and complete landings data.

- Require a 5” minimum CW for Jonah crab.

  Justification: In the absence of a minimum size restriction for Jonah crab and the preservation of brood stock, the population is at risk of long-term unsustainability. The scientific advisors on the Jonah crab FIP Work Group (Burton Shank, NOAA; Rick Wahle, University of Maine; and Derek Perry, Massachusetts DMF) agree that, based on the best available science regarding size at sexual maturity, a 5-inch minimum CW would maintain reproductive capacity in the fishery. From a market perspective, processors have indicated that they do not want to purchase crabs that are smaller than 5.25” CW, while dealers of live crab have indicated that a minimum harvest size of 5” would reflect a marketable size (per personal communication with three Jonah crab processors and one live dealer). While interviews with Jonah crab buyers indicate little interest in crabs smaller than 5” CW, markets are emerging that warmly welcome smaller crab, including for use as bait. While the FIP Work Group does not recommend rules restricting Jonah crab from being used as bait, it

does maintain that all restrictions (e.g., minimum size) be applied for harvest of all Jonah crab, regardless of its ultimate use.

- Prohibit the harvest of female Jonah crabs.

  Justification: The protection of females in the Jonah crab fishery is a critical factor in ensuring long-term sustainability of the fishery. This recommendation is consistent with existing rules in the lobster fishery. A 5" CW size restriction would protect most female crabs from harvest, as very few females exceed this size. However, the Work Group wants to be explicit that protection of female crabs is of utmost importance. In particular, the Work Group recommends a zero tolerance for egg-bearing Jonah crab.

- Consider a tolerance level for the enforcement of rules.

  The majority of the Work Group members recommend designating a tolerance level for the enforcement of the minimum size restriction, because it will likely not be possible to measure each individual given the numbers landed per trip. Previous attempts to measure Jonah crab with calibers and measuring boards have demonstrated that Jonah crabs are very difficult to measure even if there were small volumes (i.e., three people using a measuring board have recorded three different measurements for the same crab).

  There is precedent in other fisheries for tolerance levels (See Appendix E, Crab Species With Tolerances, for a summary). The tolerance level should be set to allow for mistakes, while also avoiding a leniency that allows for significant harvest of undersized product, as has also been observed in other fisheries (i.e., fishermen have been observed to fish right up to the tolerance level, basically resulting in a decreased size restriction). For the enforcement of a 5" size restriction on male crab, the Work Group recommends a tolerance between 1% and 10%. For female crab, the Work Group recommends a tolerance not to exceed 1%. The Work Group recommends a zero tolerance on the harvest of egg-bearing females.

  The Work Group also requests that the ASMFC includes options for sampling protocols developed by enforcement in the informational documents that go out for public comment. These protocols should include a sufficient sample size that is statistically representative of the catch being audited.

! Emergency Measure Recommendation

The Jonah Crab FIP Work Group is increasingly concerned that a robust market for smaller female Jonah crab already exists and is growing. The group requests that the ASMFC consider implementing an interim measure prohibiting the possession of female Jonah crab (with a 0.5-1% enforcement tolerance). The process of establishing a management plan for Jonah crab is likely to take a couple of years, at which point the long-term reproductive capacity might already be seriously compromised.

List of Appendices

Appendix A: MSC Pre-Assessment

SEE SEPARATE ATTACHMENT: ***Jonah Crab Pre-Assessment November 1 2013***

Appendix B: Jonah Crab FIP Work Plan

Jonah Crab Fishery Improvement Project
2014 Workplan
Updated: March 28, 2014

Participants

Chair: Ray Swenton, Bristol Seafood
David Borden, Atlantic Offshore Lobstermen's Association
Josanna Busby, Delhaize America
Lanny Dellinger, Rhode Island Lobstermen's Association
Bill Gerencer, M.F. Foley Company
Adam LaGreca, Rome Packing
Derek Perry, Massachusetts Division of Marine Fisheries
David Spencer, F/V Nathaniel Lee
Steve Train, Atlantic States Marine Fisheries Commission
Rick Wahle, University of Maine
Jon Williams, The Atlantic Red Crab Company

Status of the Fishery

- The status of the Jonah crab fishery is unknown as there is no stock assessment for Jonah crab.
- The management and governance for the Jonah crab fishery varies from state to state. Licensing is often, but not always, linked to the lobster fishery with input controls in place. In the federal management zones, harvest of Jonah crab is unregulated.
- Jonah crab is harvested using traps. Some landings are a result of bycatch in the lobster fishery. The majority of the volume landed is a result of directed harvest by lobster licensed fishermen with slightly modified traps to target crab.
- Available data on Jonah crab vary throughout the region and are not analyzed to develop an overall stock assessment.
- There are live markets and value-add markets for Jonah crab.

Sustainability Needs

Fishery-Independent Data Needs

- More information about patterns of abundance by life stage (life history, including eggs and fecundity, spatial patterns over time, size at maturity data, maturity schedules, growth, and molt frequency).

- Understanding of whether the Jonah crab resource comprises multiple or single stocks, including a characterization of the inshore/offshore fisheries (need definitions).

- Seasonality, inter-annual variations, and environmental influences on Jonah crab distribution, size, and abundance.

- Analysis of trophic interactions, including Jonah crab food and predators to inform eventual ecosystem-based management.

Fishery-Dependent Data Needs

- Clearly distinguishing Jonah crab from other crab species in reporting data.

- Information on performance of various gear types (e.g., vent sizes and shapes).

- Understanding the distribution of fishing effort, catch, landings, and types of gear used over time and space (including targeted versus bycatch) and what influences fishing effort (including price, availability, etc.).

Stock Assessment Need

A stock assessment is a critical need to inform a management plan, including appropriate effort and size restrictions. The Jonah crab FIP Work Group recommends a regular analysis of the best available data in the form of a stock assessment, inclusive of the data needs identified above.

Fishery Management Plan Need

A fishery management plan is necessary to ensure the long-term sustainability, and hence supply, of Jonah crab. Following are strategies and recommendations developed by the Work Group.

Strategies and Recommendations to Address Needs

Fishery Dependent and Independent Data

- Develop a standard list of data points that are recommended for all surveys, including:
    - Documentation of egg-bearing individuals.
    - Documentation of size of individuals captured (i.e., carapace width).
    - Abundance (i.e., how many were caught).
    - Weight of catch.
    - Sex of individuals caught.
    - Specifications on gear being used.

- Develop a sub sampling protocol for fishery-dependent data collection done by observers, including sizes and sexes of the individuals landed versus discarded.

- Analyze survey data to determine maturity for females by comparing egg-bearing females with size data.

- Conduct a distinct research effort to compare number of eggs to size of individual in females to establish baseline. Attempt to capture geographically distributed samples to understand differences in geography and continue to monitor episodically (every two years at outset).

- Determine maturity schedules for males through distinct research experiments that analyze male physiological and functional maturity (e.g., through laboratory dissection).

- Require all Cancer crab landed to be reported by species. Educate harvesters and dealers to achieve consistent species identification.

- Solicit industry participants as data collectors.

- Optimize gear selectivity for sustainability and marketability.

Management

- Incorporate the management of Jonah crabs into the lobster management plan through the ASMFC.

- Establish some baseline information to understand the fishery, including the proportion that is inshore versus offshore, how many harvesters have a lobster license, what gear is used (dominant gear type, different vent sizes), and the effort in the fishery (number of harvesters who are active, seasonal patterns, number of traps).
    - Pull data from each state/NOAA to describe landings, permits, active permits, effort, soak time, harvest locations, etc. Also identify information gaps.

- Tie the harvest of Jonah crab with the lobster license and trap tagging requirements. Require a lobster license in order to harvest Jonah crab. In the absence of a lobster license, require a license for the harvest of Jonah crab.

- Require a minimum size for Jonah crab based on the biological and market realities of the fishery.

- Prohibit the harvest of female Jonah crabs.

Table of Activity

Topic/Activity	Deliverables	Deadline	Status
Project Start Up	Work Group and Participation Agreement made public.	January, 2014	Completed
	Web site with FIP information established.	January, 2014	Completed
	MSC Pre-assessment drafted and made public.	January, 2014	Completed
	Work Plan made public.	April, 2014	Not Completed
	Distribute work plan to management entities for review and feedback.	April, 2014	Not Completed
Implement a Management Plan	Letter to the ASMFC from the FIP Work Group with recommendations, including integration of Jonah crab into lobster management.	April, 2014	Not Completed
	Presentation at the May ASMFC meeting, including integration of Jonah crab into lobster management.	May, 2014	Not Completed
	Require a lobster license and trap tags to harvest Jonah crab. Manage according to the conservation measures in place for the lobster fishery, including trap reduction programs.	May, 2015	Pending ASMFC Review/Action
	Implement a 5" minimum size limit for Jonah crab harvest along with a maximum tolerance level for errors.	May, 2015	Pending ASMFC Review/Action

	Require a male-only Jonah crab harvest.	May, 2015	Pending ASMFC Review/Action
Fill Data and Information Gaps	Develop protocols for data collection.	March, 2014	Not Completed
	Pilot implementation of data collection protocols.	August, 2014	Not Completed
	Require full reporting of Jonah crab landings.	May, 2015	Pending ASMFC Review/Action
	Assimilate and analyze available Jonah crab data.	September, 2014	Not Completed
	Solicit industry participants to capture needed data.	April, 2014	Not Completed
	Conduct research to compare number of eggs to size of individual in females to establish baseline. Attempt to capture geographically distributed samples.	June, 2015	Not Completed
	Determine maturity schedules for males through distinct research experiments that analyze male physiological and functional maturity (e.g., through laboratory dissection).	June, 2015	Not Completed
	Develop a Stock Assessment	May, 2017	Not Completed
Outreach and Communications	Host an industry stakeholder meeting to gather input.	November, 2013	Completed
	Update the Jonah crab FIP web site.	Ongoing	Completed
	Distribute an announcement to popular press and endemic media announcing the FIP.	February, 2014	Not Completed

Appendix C: Guidelines for Supporting Fishery Improvement Projects

CONSERVATION ALLIANCE FOR SEAFOOD SOLUTIONS

www.solutionsforseafood.org BLUE OCEAN INSTITUTE • DAVID SUZUKI FOUNDATION • ECOLOGY ACTION CENTRE ENVIRONMENTAL DEFENSE FUND • FISHCHOICE • FISHWISE • LIVING OCEANS SOCIETY • MONTEREY BAY AQUARIUM NATURAL RESOURCES DEFENSE COUNCIL • NEW ENGLAND AQUARIUM • OCEAN CONSERVANCY • SHEDD AQUARIUM SIERRA CLUB BC • SUSTAINABLE FISHERIES PARTNERSHIP • VANCOUVER AQUARIUM • WORLD WILDLIFE FUND—US

Guidelines for Supporting Fishery Improvement Projects

Ratified by: Blue Ocean Institute, David Suzuki Foundation, Ecology Action Centre, Environmental Defense Fund, FishChoice, FishWise, Living Oceans Society, Monterey Bay Aquarium, Natural Resources Defense Council, New England Aquarium, Ocean Conservancy, Shedd Aquarium, Sierra Club British Columbia, Sustainable Fisheries Partnership, Vancouver Aquarium Ocean Wise, World Wildlife Fund – U.S.

Working together, conservation groups and the seafood industry can be a powerful force for improving the sustainability of seafood and the health of ocean ecosystems.

Members of the Conservation Alliance for Seafood Solutions support the efforts fisheries are making to improve the sustainability of their seafood products. There are many different ways to address management and environmental problems in fisheries, including policy change, targeted strategies such as bycatch reduction, and comprehensive fishery improvement projects. We believe all of these methods are valuable and play an important role in helping fisheries become more sustainable over time.

Recently, the seafood industry has expressed increasing interest in fishery improvement projects and members of the Conservation Alliance are often asked their position on this specific strategy. While members of the Conservation Alliance support efforts to help fisheries improve, it is important to ensure that fishery improvement projects that receive recognition in the marketplace are making measurable progress toward environmental sustainability. To be considered for recognition by members of the Conservation Alliance for moving toward sustainability, a fishery improvement project must take measureable steps within a defined timeframe to achieve a level of sustainability consistent with an unconditional pass of the Marine Stewardship Council standard.

The goal of this document is to define the kind of fishery improvement projects members of the Conservation Alliance will support and establish guidelines for communicating about these projects to buyer and consumer audiences.

This document includes:

- A brief explanation of the role seafood buyers can play in creating incentives for fisheries to address environmental problems;
- The Conservation Alliance's accepted definition of a fishery improvement project;
- The Conservation Alliance's accepted process for running a fishery improvement project that is eligible for recognition; and
- Guidelines for how the Alliance aims to recognize fishery improvement projects at different stages in the process.

This document is a first step toward defining how members of the Conservation Alliance will support fishery improvement projects. As work on this strategy evolves over time, we expect that our guidelines will evolve as well.

The Role of Seafood Buyers in Improving Fisheries

In 2008, the Conservation Alliance released the Common Vision for Environmentally Sustainable Seafood, a guide that outlines six steps businesses can take to develop and implement a sustainable seafood policy. One of these steps is for retailers, suppliers and processors to buy environmentally responsible seafood. To fulfill this step, buyers that purchase seafood from sources with serious environmental problems can pursue a variety of strategies to help those sources move toward sustainability. One such strategy is engaging suppliers, producers and other industry partners in a fishery improvement project.

If a company is unable to work with its seafood sources to improve their environmental performance, it can temporarily stop purchasing from these sources until improvements are made that meet the criteria required by the company's sustainable seafood purchasing policy. We recommend that companies that take this approach also convey the problem areas in the fishery that need to be addressed for sourcing to resume.

Fishery improvement projects need to be accountable for meeting specific milestones and deadlines for improvement. If a fishery does not make measurable improvements in its environmental performance over time, we recommend buyers and suppliers engaged in the improvement project stop buying seafood from that source.

The decision about whether to engage one's supply chain in an improvement project or stop buying until improvements are made rests with the buyer and will depend on the specific requirements of the company's sustainable seafood policy. Both approaches are legitimate when structured to create incentives for measurable, positive change in our oceans and seafood supply – which is the ultimate goal.

Definition of a Fishery Improvement Project

A fishery improvement project is a multistakeholder effort to improve a fishery. These projects are unique because they utilize the power of the private sector to incentivize positive changes toward sustainability in the fishery. Participants may vary depending on the nature of the fishery and the improvement project, and may include stakeholders such as producers, nongovernmental organizations, fishery managers, government and members of the fishery's supply chain.

The ultimate goal of a fishery improvement project is to perform at a level consistent with an unconditional pass of the MSC standard. However, we recognize that for some fisheries performance at this level is a long-term goal and we do not control a fishery's decision to pursue certification.

A fishery improvement project must have the following characteristics:

- Draw upon market forces, which might include suppliers, retailers, food service, fishing industry, etc., to motivate fishery improvements.
- A workplan with measureable indicators and an associated budget.
- Explicit willingness from participants to make improvements (e.g., a signed memorandum of understanding, email correspondence stating a commitment, etc.).
- Willingness from participants to make the investments required to make improvements as outlined in the workplan and budget.
- A system for tracking progress.

To be considered for public recognition for moving toward sustainability, an improvement project must have the characteristics listed above and also:

- Have a scoping document completed by a third party experienced with applying the Marine Stewardship Council Fishery Assessment Methodology (see step one, below).
- Have a workplan specifically designed to address deficiencies in the fishery to achieve a level of sustainability consistent with an unconditional pass of the MSC standard (see step two, below).
- Employ a system for tracking and reporting progress against the indicators in the workplan (see step three, below).
- Include active participation by supply chain companies, at a minimum local processors and exporters.

Process for Fishery Improvement Projects

To be considered for recognition for moving toward sustainability, fishery improvement projects must follow the process described below.

STEP ONE – Scoping
During the scoping phase, the fishery's performance is reviewed against the MSC standard and any other potential areas of concern in the fishery that have been identified. The scoping phase includes:

- **A stakeholder mapping and engagement process.** Identify which parties make most sense to bring into the process. Consider who will play an essential role in making improvements in the fishery including government representatives, industry (fishers, processors, exporters, etc.), environmental NGOs and the scientific community.
- **An MSC pre-assessment.** Conduct an MSC pre-assessment to determine where the fishery falls short of the MSC standard. This assessment must be completed or audited by an entity accredited to apply the MSC's Fishery Assessment Methodology.
- **A scoping document/white paper.** Develop a synthesis of the assessment and potential strategies the fishery could implement to increase its sustainability.

STEP TWO – Workplan Development
Based on the scoping document, a workplan is developed that lists the activities that will help the fishery meet the deficiencies identified in the MSC pre-assessment. Workplans include:

- **A list of activities.**
- **Responsible parties.** Organizations/people responsible for completing each activity.
- **Timeframes.** An estimate of the timeframe needed to complete each activity (e.g., < six months, six to 12 months, 12 months+).
- **Metrics and key performance indicators.** Milestones to enable the project participants to track progress, or lack thereof, over time and to communicate about the changes in the fishery.
- **An associated budget.** Costs and funding opportunities for each activity as appropriate. There are generally two sets of costs: (1) process costs (e.g., costs associated with developing the scoping document, holding stakeholder meetings, developing the workplan), and (2) implementation costs (e.g., costs for the fishery to actually make changes).

See Appendix A for a template workplan (*in progress*).

STEP THREE – Implementation and Tracking Progress
The implementation phase includes:

- **Implementing the workplan.**
- **Tracking and reporting on progress.** Progress should be reported publicly every three to six months according to the objectives and timeline outlined in the workplan. Additional reporting may occur if significant milestones are met in the interim.

We recognize that the tracking of implementation is a work in progress. The key goals of tracking are to ensure fishery improvement projects adhere to the definition above and make progress against the milestones laid out in the workplan, and the work is as transparent as possible. This will include a move to make pre-assessment public moving forward. Organizations managing improvement projects must aim to track progress so that they can credibly and publicly report:

1. The actions taken by the project to encourage improvements;
2. The impact of these actions, in terms of changes in fisheries policy, management or fishing practices;
3. The results on the water.

Recognizing Fishery Improvement Projects

Recognition of fishery improvement projects can help to engage additional seafood businesses in existing projects as well as spur demand from buyers and suppliers for new projects to improve other fisheries with environmental problems.

We will strive to communicate about improvement projects that meet the definition and process for potential recognition outlined in this document according to the conditions in the chart below. NGOs and their business partners may choose to engage with FIPs meeting the minimum requirements for FIPs (first set of bullets in "Definition" section of document) to encourage these fisheries to further develop FIPs that meet the full definition.

The ultimate decisions about engaging their supply chain, sourcing from or communicating about fishery improvement projects rests with companies and will depend on the requirements of their sustainable seafood policies. Consequently, we will present options and make recommendations to our buyer partners according to the guidelines below but cannot require or guarantee their specific actions.

To enable communication with buyers and consumers about fishery improvement projects, it is the responsibility of organizations coordinating the projects to provide timely information on their development, progress and conclusion. The workplan and, if possible, the scoping document or MSC pre-assessment must be available for Alliance members to review prior to communicating with buyer partners about options for sourcing from an improvement project.

When sourcing from a fishery in an improvement project, it is important to be able to trace the product back to the specific fishery in order to distinguish it from other products in the marketplace. We recommend that all fishery improvement projects include a path toward traceability in their workplans, particularly when the improvement project covers only a segment of a larger fishery.

		Fishery Improvement Project Stage		
		Step One: Scoping FIP is in development and areas of concern are identified	**Step Two: Workplan** FIP has completed its workplan and made it publicly available	**Step Three: Implementation** FIP is making progress according to the indicators and timelines in its workplan, achieving milestones such as policy changes, improvements in fishing practices, or impact on the water
NGO Activity	Communicate as appropriate with relevant buyers that a FIP is in development and present options for them to engage their supply chain	√	√	√
	Present options for relevant buyers to make strategic procurement decisions*	√	√	√
	Provide options for buyers to communicate about the FIP to consumers if they are procuring the product		√	√
	Profile the FIP in NGO consumer-facing communications that provide an opportunity to tell the story of the FIP			√
	Integrate key milestones into relevant seafood ranking reports			√

* As mentioned above, a company's decision about which products to buy will be based on the requirements of its sustainable seafood sourcing policy. These policies may allow companies to source from a fishery engaged in an improvement project or may require that a company discontinue sourcing until the fishery achieves a verified level of environmental performance. Because these policies differ by company, members of the Conservation Alliance will present "strategic procurement options" according to the specific stage of the improvement project:

- In **Step One**, companies may continue to source from a fishery where an improvement project is in development to incentivize progress or discontinue purchasing until improvements are made. We will not recommend that companies shift their purchasing to the fishery developing the improvement project at this stage.
- In **Steps Two and Three**, companies may continue to source from the fishery in the improvement project, shift their sourcing to the fishery in the improvement project, or discontinue purchasing until improvements are made.
- **At any stage**, we recommend that companies that discontinue sourcing convey the problem areas in the fishery that need to be addressed for sourcing to resume.

When a fishery improvement project ends, Alliance members will make individual decisions about whether to recommend that companies continue, start or refrain from sourcing from the fishery. These decisions will be based on the level of sustainability the fishery can be verified to achieve, each organization's criteria and the procurement policies of buyer partners. If the recommendation is to refrain from sourcing, we recommend that Alliance members or their buyer partners communicate the additional improvements that are needed in the fishery's environmental performance to change the recommendation.

Appendix D: Summary of NGO and Retailer and Food Service Partnerships

Retailer	NGO Partner
Walmart	WWF, SFP
Costco	WWF
Kroger	WWF
Supervalu	WWF
Safeway	Fishwise
Loblaw	WWF
Publix	SFP
Ahold	New England Aquarium
Delhaize	Gulf of Maine Research Inst.
Meijer	SFP
Sobey's	SFP

Retailer	NGO Partner
Metro	Greenpeace Canada
BJ's Wholesale	SFP
Giant Eagle	SFP
Whole Foods	MBAq, MSC
Aldi	SFP
Wegman's	SFP
Raley's	SFP

Company	NGO Partner
McDonald's	SFP
Compass Group	Monterey Bay Aquarium
Aramark	Monterey Bay Aquarium
Sodexo	MSC
Darden Restaurants	New England Aquarium
Disney	SFP, Monterey Bay Aquarium
Sysco	WWF
Santa Monica Seafood	Monterey Bay Aquarium

CRAB SPECIES WITH TOLERANCES

Location	Species	Min. Size (male unless noted)	Max. Size	Tolerance (harvester requirement unless noted)	Rationale/Enforcement
CA	Dungeness	6¼ "	none	1% by count allowance for undersized.	1% per load or lot can be between 5 ¾" and 6 ¼". No allowance for smaller crabs.
CA	Tanner Crab			5% by weight allowance for other invertebrate species.	
DE	Blue	5" hard 3" peeler 3 ½" soft	none	5% "by any commercial measure" allowance for undersized.	No minimum size for hard, non-egg bearing females.
NC	Blue	5" M & immatureF hard	*Enacted as needed* 6 ¾" hard females 5 ¼" peeler females	10% by count allowance for undersized hard; 5% for oversized hard female and white-line peelers; and 3% for all other peelers.	Tolerances by count in "any container"
VA	Blue	3¼"/ 3½"* peelers 5" M & immature F hard	none	10/bushel or 5% by count/container allowance for undersized. 10/bushel or 35/barrel allowance for dark sponge crab.	Any marine patrol officer may grade or cull any number of barrels, baskets or containers of crabs in any person's possession. Could not find tolerance regulations for hard crabs.
Gulf States	Blue	5" M & F hard	none	TX/FL - 5% by count allowance for undersized. LA- 1 stone crab/crate of blue crab.	Tolerance confirmed in TX and FL (2001 not present day) regulations. Didn't find reference to tolerance in AL, MS or LA regulations
Atl. States	Deep Sea Red	None	none	One tote allowance for females/trip.	Small allowance for incidental retention in directed fishery. From Original FMP "The allowance for the incidental retention of female crabs by the controlled access vessels allows these fishermen to continue current fishing practices and represents a very small fraction of the total crabs retained and landed on each fishing trip (i.e., one standard U.S. fish tote is estimated to equate to roughly 100 pounds, which would be approx.. 0.13% of the 75,000 pound trip limit)."

*Varies by season, area, or gear type.

Other crab species:

Alaskan crab fisheries (red king, blue king, golden king, tanner *bairdi,* snow/tanner *opilio,* and Dungeness) had a 1% tolerance when the fisheries were derby style. When fisheries converted to ITQ the tolerance was removed understanding that fishermen would have more time to sort crab and to avoid a 1% set aside. Canadian pacific crab fisheries (red king, golden king, red rock, and Dungeness) also removed tolerances when management measures changed.

Could find no evidence for historic or modern tolerances in the following crab fisheries: MD and RI blue crab, Washington state Dungeness, Oregon Dungeness; California tanner; Florida stone; Canada Atlantic tanner/snow; and Canadian exploratory fisheries for porcupine, Jonah, and rock. The Canadian snow crab fishery does monitor the proportion of soft shelled animals in the haul and closes management areas at a threshold (~20%).

EVIDENCE FOR TOLERANCE REGULATIONS IN OTHER FISHERIES IN STATES PARTICIPATING IN ASMFC

Location	Species	Min. Size	Tolerance (harvester requirement unless noted)	Rationale/Enforcement
ME	Sea Urchin	Min: 2 1/6" Max: 3"	5% by count of "bulk pile" allowance for under or oversized" for "all persons". 20% of any bulk pile for harvesters (divers) prior to culling in some areas. Unlimited tolerance before culling in other areas.	Determined by numerical count of not less than a randomly selected ½ bushel or the entire pile if less than ½ bushel. Catch is seized if more than 5% are outside of the allowable size range unless proof of purchase from another state is shown.
ME	Mussel	106/2 qrt	10% by count allowance.	Determined by numerical count of randomly selected two quarts.
NH	Sea Urchin	2"	5% by count of "bulk pile" allowance for undersized.	Determined by numerical count of not less than one peck nor more than 3 peck randomly selected.
RI	Quahogs, Soft-Shell Clams, Oysters	1", 2", 3"	10% by count (*confusing language see Rationale/Enforcement)*	Additionally, any person who takes and/or possesses shellfish of less than the minimum size commingled and/or otherwise stored or contained with shellfish of not less than the minimum size, where the percentage of the less than minimum size shellfish is not less than ten percent (10%) of the total piece count of the commingled and/or otherwise stored or contained package, shipment, or container, shall be subject to seizure and/or forfeiture of the entire commingled and/or otherwise stored or contained package, shipment, or container in accordance with the provisions of §§ 20-1-8(e) and (f) and 20-1-8.1.
NJ	Mackerel/Herring		5% by weight allowance for river herring and shad.	
DE	Hard Clams	1 ½"	5% "by any commercial measure" allowance for undersized.	
DE	Oysters		5% per 2 bushel allowance for shells and other materials.	
MD	None			
VA	Oysters	3"	More than 4 qrts./bushel allowance for undersized or dead shell and after cull	
VA	Surf Clams	4 ¾"	240 clams/"full cage" allowance for undersized.	Provision can be suspended annual to maintain consistency with federal jurisdiction.
NC	Bait Finfish	4"	5% - measurement procedure not defined.	For finfish without other minimum sizes. Appears to be a dealer regulation.
NC	Oyster	Set annually	10% by volume allowance for undersized or dead shells after cull.	Violation determination by grading all or any portion of the catch.
NC	Scallop	3 ½"	10% by count allowance for undersized	Violation determination by grading all or any portion of the catch.
FL	Oysters	3"	5% by count allowance for undersized unattached/bag 15% by count allowance for undersized attached/bag	
FL	Hard Clam	1"	3% by count/bag allowance for undersized.	
FL	Mullet	11"	10% by total weight allowance for undersized.	

EVIDENCE FOR TOLERANCE REGULATIONS IN OTHER STATE MARINE FISHERIES

Location	Species	Min. Size	Tolerance (harvester requirement unless noted)	Rationale/Enforcement
AL	Red Drum	Min: 16" Max: 26"	1 oversized fish/day in rod and reel recreational fishery.	
AL	Oyster	3"	5% allowance for undersized "per load" or 10% per "sack"	Measurement unit (count vs. volume) for tolerance not described. Violation determination procedure not described.
MS	Red Drum	Min: 18" Max: 30"	1 oversized fish allowance in commercial and recreational fisheries.	
LA	Shrimp	100 count/lb white shrimp	10% by weight allowance for undersized white shrimp when 50% by weight of shrimp taken are seabobs or brown shrimp. Commercial and recreational tolerance.	
LA	Red & Black Drum	Min: 16" Max: 27"	1 oversized fish allowance/day in recreational fishery.	
TX	Oysters	3"	15% by number possession allowance for ¾" to 3" length oysters in commercial and recreational fisheries.	
TX	Black Drum	Min: 14" Max: 30"	1 oversized fish (over 52") allowance/day in recreational fishery	
TX	Red Drum	Min: 20" Max: 28"	1 oversized fish/year in recreational fishery.	Oversized fish must be affixed with proper tag.
TX	Shrimp		10% by weight or number allowance for other species of shrimp when fishing for seabobs. Commercial tolerance.	In some areas only.
Gulf States	Purse seine fisheries		Many of the Gulf States have 5-10% tolerance by weight allowances for non-target species in the purse seine fisheries.	
CA	Bonito	Min: 24" or 5 lbs	18% allowance for undersized when fishing with round haul net. 1,000 lb of undersized allowed when fishing with gill or trammel nets.	
CA	Angel Shark	Min: 42" F: 40" M	10% allowance/load for sharks measuring not more than ½" less than minimum size.	
CA	Sea Urchin	Possession prohibition 1 ½ " to 3"	Allowance for 30 by number/person/load in this size range in some areas.	
WA	Walleye		Allowance for one over 22"/day.	
WA	bass	Max: 12" lg mouth Max: 14" sm mouth	Allowance for one large mouth bass over 17"/day and one small mouth bass over 14"/day.	

Jonah Crab
(*Cancer borealis*)

Current Status & Information Sources

In support of Fishery Pre-Assessment
Along Marine Stewardship Council (MSC) Standard
31 Principle Indicators

November 1, 2013

Prepared in Collaboration between
Gulf of Maine Research Institute and University of Maine

Table of Contents

Introduction

Statement of Purpose

The following compendium of information related to the current stock status has been presented as a fishery pre-assessment, along with the thirty-one Performance Indicators (PI) defined by the Marine Stewardship Council (MSC) standard. This report has been commissioned by the client group, which seeks to identify fishery improvement opportunities and maps existing information and materials gathered by the academic community along these PIs.

Jonah Crab Distribution and Life History

Geographic Distribution

The Jonah crab, *Cancer borealis*, is found in coastal and shelf waters along the Atlantic coast of North America, from Newfoundland as far south as Florida (Haefner 1977; Stehlik et al. 1991; Wenner et al. 1992; Williams 1984). However, the type-locality for *C. borealis* is from Nova Scotia to Cape Cod, Massachusetts.

Jonah crabs may have complex population structures, with migratory and non-migratory groups (Leland 2002). Several studies have suggested that the species undertakes inshore to offshore movements (Jeffries 1966; Haefner 1977; Carpenter 1978; Krouse 1980). Although the extent of their movement patterns is largely unknown, it is believed that females may move inshore to molt and spawn (Krouse 1980; Maher 1999). In the shelf waters off Chesapeake Bay, Virginia, for example, smaller females occupy depths less than 150 m whereas males occupy greater depths (FOC 2009). In the Mid Atlantic Bight, crab body size trends upward with depth and distance from shore, suggesting an offshore movement as crabs mature (Haefner 1977). Carpenter (1978) suggests that distinct size groups can be found at different depths depending on time of year. Spatial segregation by both size and sex, coupled with the possibility of fidelity to specific areas (e.g. feeding or spawning sites), may make male Jonah crabs particularly vulnerable to targeted fishing.

Environmental variables, such as depth, temperature, and habitat characteristics affect the abundance of Jonah crabs (Haefner 1977; Carpenter 1978; Krouse 1980; Stehlik et al. 1991). Jeffries (1966) found Jonah crabs on rocky areas in association with American lobster. Auster et al (1991) suggest Jonah crab prefer shell and biogenic depression microhabitats to sandier substrates, and also suggest seasonal variation of abundance within these microhabitats. Circadian patterns of abundance have also been observed. In near-shore rocky habitats down to 11m, active *Cancer*

borealis were ten times more abundant during the day than at night. Significant depth by time-period interactions have been reported, with daytime densities higher in deeper waters and night time densities higher in shallow waters (Novak 2004).

Water temperatures also affect distributions. During 2003 and 2004, for example, there was a higher proportion of soft-shell Jonah crabs landed off Nova Scotia, which was interpreted to be the a result of colder than normal water temperatures (Petrie et al. 2005; DFO 2006; Robichaud and Frail 2006).

Growth and Reproduction

Growth of the two sexes is similar up to 30-40mm carapace width (CW), but does not exceed15mm during the first year. Thereafter females grow more slowly than males, attaining up to 100mm CW in 8 years with 14 molts whereas males grow up to 130mm CW after 13-14 molts in 6-7 years (Williams 1984). There is much variability surrounding the onset of sexual maturity in both sexes. Williams 1984 cites the onset of sexual maturity for both sexes around 30-40mm CW, although males often mature at a smaller size than females. However, some females have been found to mature at CW as low as 14-30mm (Williams 1984). Despite maturating at a smaller size than females, male crabs are considered functionally mature when they can engage in the copulatory embrace, and this may occur at a considerably larger size than physiological maturity. Moriyasu et al. (2002) estimated that the functional maturity of male Jonah crabs occurred at 128 mm CW. More information is needed surrounding age at maturity as it may be important in determining a minimum harvest size.

Information on the timing of the molt has been gleaned from commercial trawl samples in southern New England, stomach content analyses of predacious fishes and SCUBA observations also suggest seasonality of spawning and molting processes (Reilly and Saila 1978). The largest females molted in December and the largest males from January to March, with a smaller group of males, 40-60mm CW molting in May. A study of Dungeness crabs (*Cancer magister*), a close relative to Jonah crabs found in the Pacific Northwest, revealed increased mortality immediately following their molt (Zhang et al. 2004). If the same holds true for Jonah crabs, the species might benefit from protection during peak molting times.

Mating takes place after the female has molted and sperm can be stored for an indefinite period of time. Spawning consists of the extrusion of fertilized eggs beneath the abdomen where they are brooded for 5-6 months until larvae hatch (Reilly and Saila 1978, Elner 1985). Clutch size increases exponentially with carapace width: Reilly and Saila (1979) estimated ovigerous females of 21mm CW to carry 4430 eggs and 88mm CW females to carry 330,440 eggs. Once mature, female Jonah crabs probably spawn one clutch per year and about five times per lifetime (Cobb et al. 1997). The spawning season progresses from south to north along the coastal and shelf waters. In the Mid-Atlantic Bight, spawning takes place from late

winter to early spring; in Rhode Island spawning begins in mid-July; and in Maine, it commences in August through September (FOC 2009). In southern New England Reilly and Saila (1978) found ovigerous females from March to June. Previous studies from the Mid-Atlantic Bight suggest that the timing of gonad development may be size-dependent, with crabs >100mm CW having mature gonads in June, whereas crabs <80mm CW were undeveloped or slightly developed and spawned in the fall and spring (Haefner 1977).

The Jonah Crab Fishery in the US

Jonah crabs are taken in crab pots and lobster traps (Wilson 2004, Robichaud and Frail 2006; Reardon 2006). The pots or traps are either deployed individually or attached to each other via a groundline along the seafloor, depending on the fishery. Jonah crab was originally known only as bycatch in nearshore lobster fisheries. In the late 1980s, as stocks of the more popular crabs became depleted, New England fishermen began to experiment with alternative fisheries, including Jonah crab and other edible crabs.

For historical perspective on harvest volumes, in 1990 Rhode Island landed 400.5 metric tons (mt) of Jonah crab, by far the largest share (NMFS 2004a) (Figure 1). Maine was in second place, with 183.2 metric tons. Maryland, New Jersey, and New York each landed less than 10 mt of Jonah crab in that year (NMFS 2004a). By 1994, Delaware, New Hampshire, and Massachusetts had joined the fishery. Maine's landings dropped below 25 mt and held steady around that figure for several years. Massachusetts has now taken the lead in Jonah crab landings (NMFS 2004a). In 2000, Massachusetts landed 612.2 mt, and New Hampshire landed 235 mt. Maine and Rhode Island each landed approximately 100 mt, New York approximately 25 mt, and Virginia, Connecticut, and New Jersey less than 10 mt each (NMFS 2004a). These figures indicate an emerging fishery for Jonah crab, based in the New England region but flexible as to landings sites. Total landings, while small, doubled in the decade from 1994 to 2004 (NMFS 2004a).

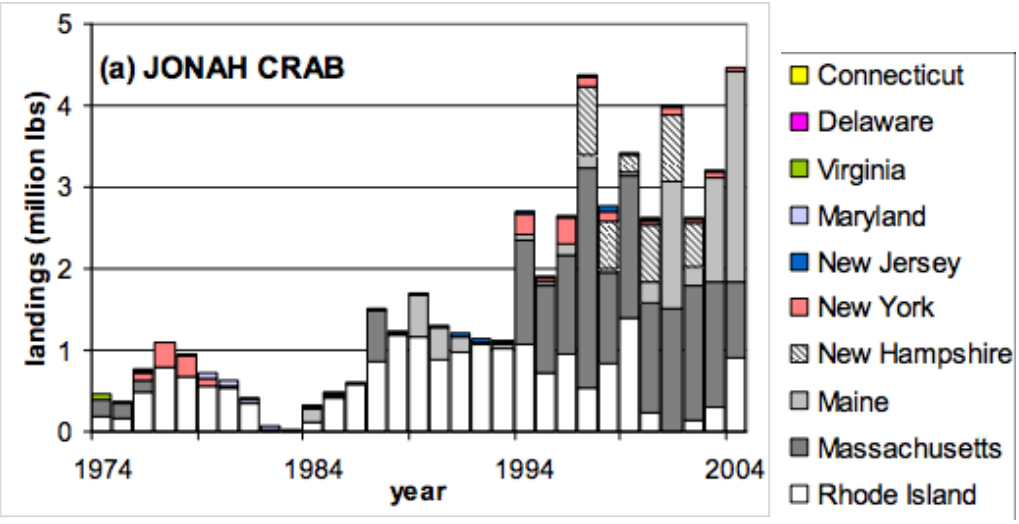

Figure 1. Source: Reardon Masters Thesis

More recently, Jonah crabs are landed in greater volume than rock crabs, and Jonah crab landings result in a significantly higher value. Massachusetts, followed by Rhode Island, has landed the greatest amount of Jonah crab in the region for the past eight years (Figures 2, 3). For example, in 2011, Massachusetts landed 2,440.30 mt of Jonah crab, Rhode Island landed 1,152.30 mt, Maine landed 497.10 mt, and Connecticut landed 0.1 mt (NMFS 2012). In 2011, 4,089.8 mt of Jonah crab was landed in New England with a total ex-vessel value of $5,530,388 (average $0.61/lb), while a total of 907.6 mt of rock crab was landed with an ex-vessel value of $895,587 (average $0.44/lb) (NMFS 2012, Figure 4).

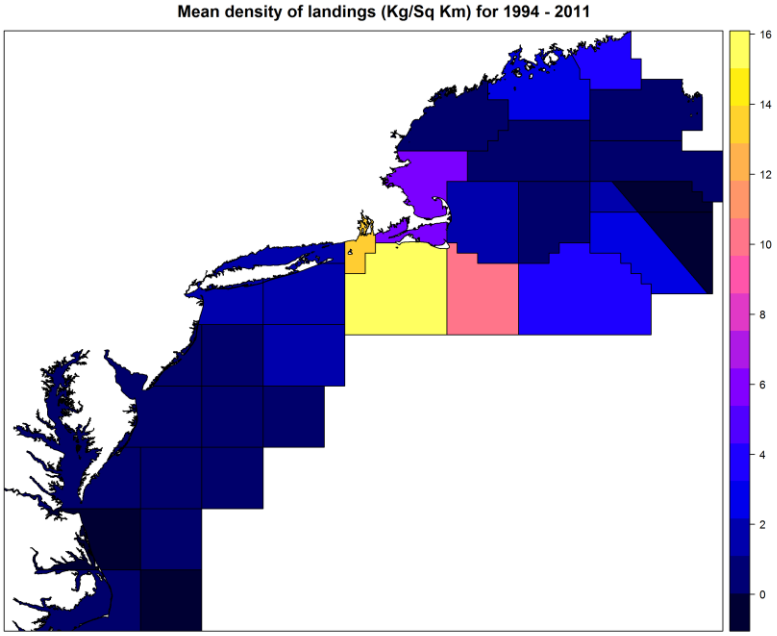

Figure 2. Source: Burton Shank, NOAA

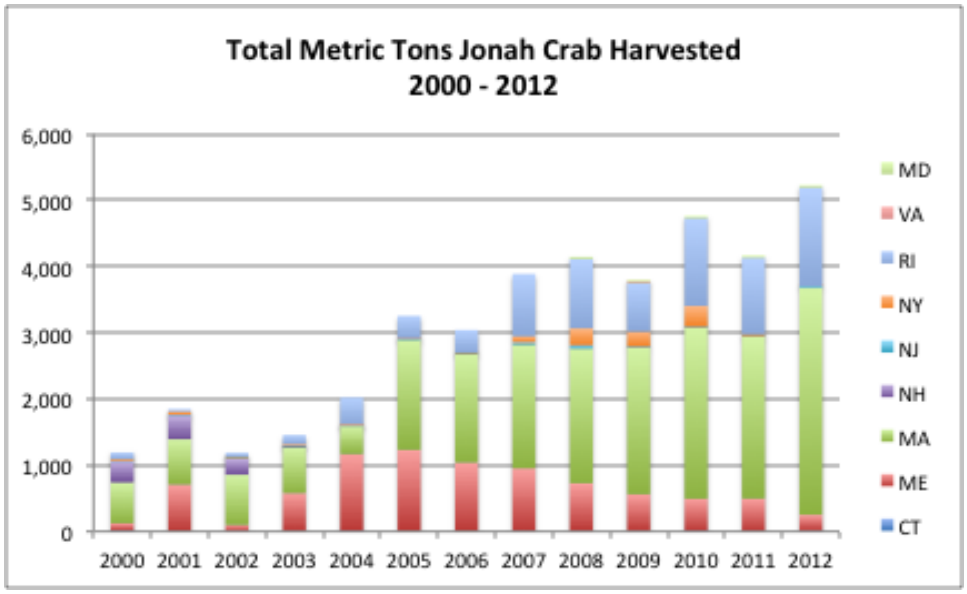

Figure 3. Source: NMFS

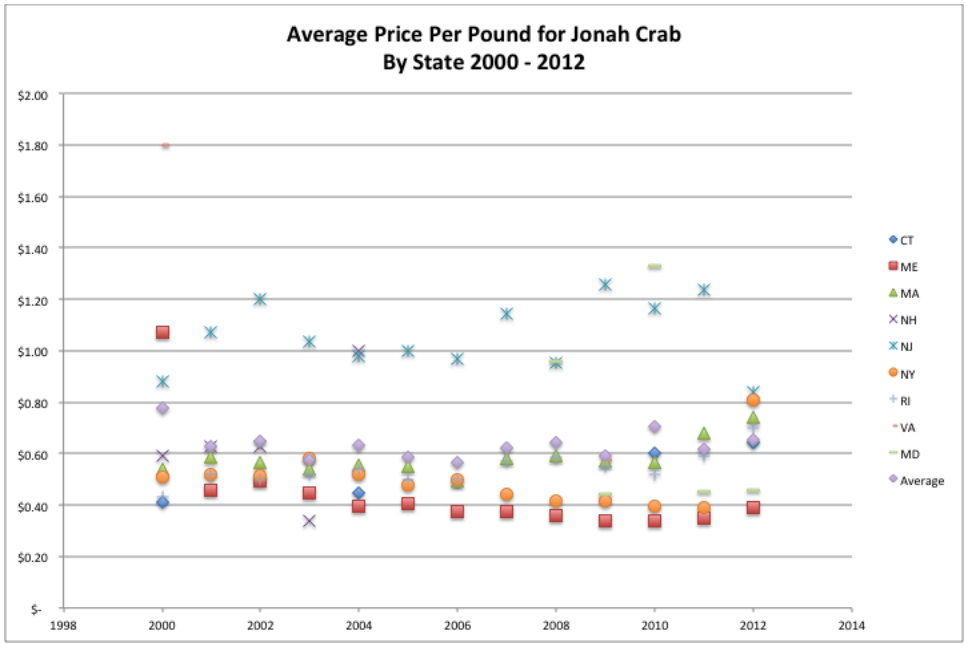

Figure 4. Source: NMFS

Jonah crabs have also been landed as bycatch in U.S. lobster fisheries for over 80 years (Krouse, 1980). Although the number of Jonah crabs taken in lobster fisheries is not fully known, data suggest that the number of Jonah crabs taken from at least some lobster fisheries may be far higher than the amount specifically targeted. In addition, lobster fishermen sometimes use Jonah crab bycatch as bait in their traps, and this could contain smaller individuals and females.

Pre-Assessment Report

Principle 1

Component: Outcome

1.1.1 Stock Status

Objective: The stock is at a level that maintains productivity and has a low probability of recruitment overfishing.

Summary of Findings:

- There is no stock assessment for Jonah crab, although some surveys and landings information might be useful to determine trends over time.
- State and federal data may be confounded as a result of misidentification of species or lumping crab species.
- Therefore this PI has not been met, but may be attainable with information currently available, at least for parts of the species range.

In the United States, crab stocks in federal waters have not been assessed, but assessments have been conducted in some state waters. See Appendix A for full detailed information regarding scientific data collection and sampling programs.

The University of Rhode Island and Rhode Island Department of Environmental Management conduct an annual survey of the abundance of *C. borealis* and *C. irroratus* (Jonah and rock crab, respectively), but the assessment is limited to Rhode Island state waters. Figure 5 below shows the URIGSO trawl survey time-series for the two *Cancer* crab species (Jonah and rock crabs combined). Recent (2006-2011) *Cancer* crab abundance is below the time-series mean.

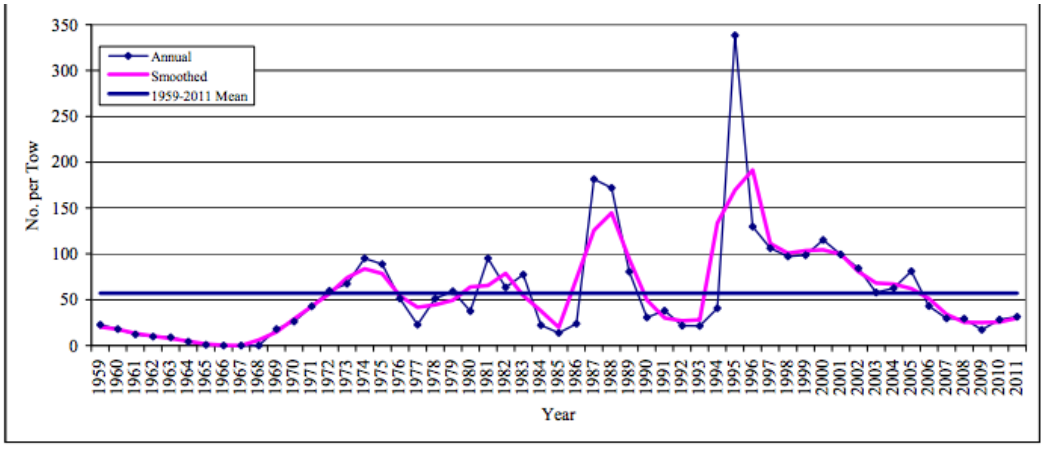

Figure 5. Source: URIGSO trawl survey.

When utilizing different sources of data to understand stocks, it is important to understand the limitations of different sampling programs. For example, Reardon 2006 points out an important consideration when using fishery dependent vs. fishery independent data in the abundance plots below (Figure 6a,b). Not surprisingly, the size/sex composition of the catch differs between sea sampling with commercial traps (which target larger males), and trawl survey (which want to catch a broader spectrum of sizes.)

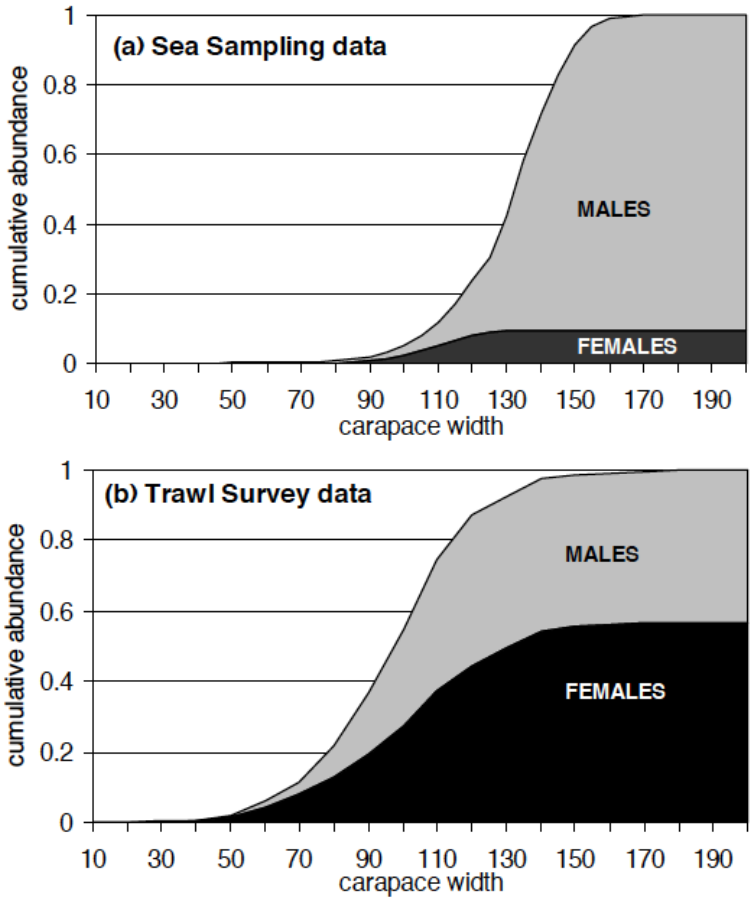

Figure 6a, b. Source: Reardon Masters Thesis 2006

1.1.2 Reference points

Objective: Limit and target reference points are appropriate for the stock.

Summary of Findings:

- Other than those found in Rhode Island, there are no limit and target reference points for the stock. Even in Rhode Island, the crab species are combined so the implications for Jonah crab alone are equivocal.
- Long-term information from other states and federal references is lacking.

Other than the reference points for the inshore fisheries found in Rhode Island, there are no limit and target reference points for the stock.

As additional background, Canada's Department of Fisheries and Oceans has conducted assessments on Jonah crab populations in Lobster Fishing Area 41 (LFA 41) or the northeast edge of Georges Bank, as well as on Scotian Shelf, but neither assessment was able to determine biological reference points or maximum sustainable yield for the commercial fisheries (DFO 2000, DFO 2009). The 2009 DFO assessment of LFA 41 indicated a decline in Jonah crab biomass, but the assessment was unable to determine production or recruitment rates for Jonah crab (DFO 2009). Although uncertain, the 2009 assessment suggests that a decrease in population is the result of fishing pressure in the area, and that the total allowable catch set in 1995 has not been sustainable (DFO 2009).

1.1.3 Stock Rebuilding

Objective: Where the stock is depleted, there is evidence of stock rebuilding within a specified timeframe.

Summary of Findings:

- In the absence of stock assessments or biological reference points, it is not possible to determine whether the stock is depleted.

Although U.S. and Canadian Jonah crab populations have not yet been fully assessed, some areas have demonstrated trends where they were abundant when initially fished, declined considerably, and then showed signs of recovery and renewed abundance. However, because these are in effect uncontrolled experiments, it is unclear whether the upward trend in landings is the result of changes in fishing effort or natural variability in recruitment. Given that comparatively low fishing effort (relative to most other fisheries) has led to quick declines in some areas (e.g. see Robichaud and Frail 2006), Jonah crab populations may be sensitive to even small fishing pressures (FOC 2009).

In 1990, Maine landed 183.2 metric tons of Jonah crab, but by 1994, catches had dropped to less than 25 metric tons (NMFS 2004). In 2002, however, catches in Maine had rebounded to about 101 metric tons (NMFS 2004).Declines in Jonah crab landings may be reflective of declines in fishing effort or declines in the populations. For example, in one of Canada's mid-shore Jonah crab fisheries, landings peaked in 2000 at 280 metric tons and decreased to 58 metric tons in 2004, while fishing effort peaked in 2001 at 59,955 trap hours, but declined by 73%, to 15,954 trap hours in 2004 (Robichaud and Frail 2006).

Very little biological data is collected in current surveys (see Appendix A). Some biological information is available from the experimental Jonah crab fishery project

supported by the Maine Department of Marine Resources from 2002 to 2004 (Table 1).

	# of crabs	average carapace width (mm)
total crabs measured	6686	130.6
total male crabs	6049	132.9
soft	954 (16%)	139.8
hard	5095 (84%)	131.6
>127	4461 (74%)	139.9
>127mm and hard	3610 (60%)	139.1
total female crabs	637	108.7
berried female crabs	42	116.2

Table 1. Composition of Jonah crabs measured during at-sea observer trips from all sampled traps. Source: Reardon Masters Thesis 2006

Component: Management

See Appendix B for detailed information regarding state level management efforts.

1.2.1 Harvest Strategy

Objective: There is a robust and precautionary harvest strategy in place.

Summary of Findings:

- There is no harvest strategy specific to Jonah crab, as most crabs are harvested as bycatch in the lobster fishery.
- However, research assessing the use and efficiency of a modified crab trap has been explored.

There does not appear to be a harvest strategy associated with Jonah crab specifically. These crabs are primarily caught as a by-catch of lobster traps and in state exempted top entry traps.

From 2002 to 2005, Maine Department of Marine Resources undertook a project to develop a modified Jonah crab-specific trap designed to reduce or eliminate lobster bycatch (Wilson 2005). The design of the modified side entry trap worked using specific entrance and escape dimensions to maximize catch of large male crabs (>127 mm CW) and minimize the catch of legal size lobsters (>82.5 mm carapace length) (Reardon 2006). Lobster behavior with escape vents has shown a significant relationship of lobster CW size and the ability to escape or enter through rectangular openings (Nulk, 1978). Crab carapace width and depth limit entrance to or escape from a rectangular opening, while lobster carapace width and length limit entrance to and escape from circular openings. Using body dimensions of both

lobsters and Jonah crabs, DMR determined that a 63.5 mm (2.5”) entrance head and 82.55 mm (3.25”) circular escape vent would attain the goal of maximizing large crabs and minimizing legal size lobsters as compared to a standard lobster trap (Reardon 2006, Figure 7). That trap is not currently in use and no further development has been initiated.

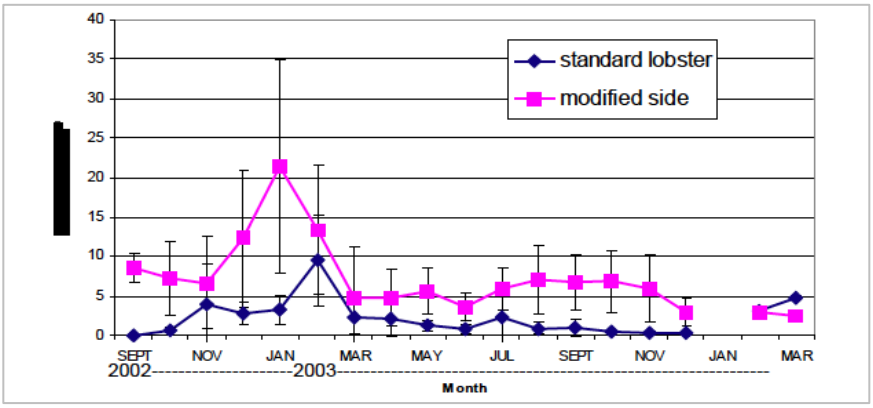

Figure 7. Source: Reardon Master’s Thesis 2006

1.2.2 Harvest Control Rules and Tools

Objective: There are well-defined and effective harvest control rules in place.

Summary of Findings:

- There are no federal harvest control rules in place and regulations are inconsistent from state to state.
- State management efforts utilize combination lobster/crab permits or lump Jonah crabs with “other edible crabs” under blue crab regulations.

In the U.S., Jonah crab populations are managed by individual states as opposed to federally, although catch reporting is processed by the National Marine Fisheries Service. There are no regulations regarding Jonah crabs in Federal waters (Wilson 2005). Management measures for Jonah crabs appear to be non-specific, although many states have specific harvest regulations for other commercially viable crab species such as blue crab and horseshoe crab, which include minimum size limits, sex restrictions, seasonal and area closures, as well as limits on trap size, configuration, and trap numbers (see Appendix B) (Reardon 2006; FOC 2010). Some states (e.g. Maine, Connecticut, and Massachusetts) require joint lobster and crab permits for the harvest of crabs in state waters and do not have separate crab permits. Other states (e.g. Maryland) cover Jonah crabs under a crustacean permit (Reardon 2006). Most states require a license for commercial harvest and transport of crabs, which are stated generally enough to include Jonah crabs.

Overall, we did not find Jonah crab-specific directed fisheries regulations in any of the New England states, although crab fishery regulations were found specific to other species in Southern New England and Mid-Atlantic states, such as blue crab in

particular. There are currently no size limits for recreational harvest of Jonah crab in ME, NH, MA, RI, CT, NY or NJ (reference the state regulation table in Appendix B), although regulations related to other crabs such as blue crab often do have restrictions on harvest size. The two states with highest reported landings – Massachusetts and Rhode Island – do not adequately describe management frameworks specific to Jonah crab, but rather include the harvest of Jonah crab within lobster regulations (see Appendix B).

Commercial harvest limits for Jonah crabs specifically do not appear to be established in most states. Maine does have a daily commercial maximum of 200 lbs. for general harvest of crabs (See Maine Laws & Regs p.15) . Recreational landings and alternate harvest methods, such as scuba and hand harvest, are described in the regulatory frameworks for blue crabs (e.g. Massachusetts and Connecticut), and often are broadly written to include Jonah crabs as an edible crab.

Maryland, with a large blue crab fishery, has provided for the most detailed regulatory framework, which could be a model for Jonah crab, but currently does not include Jonah crab specifically.

As background information, we see that in Canada Jonah crabs have been taken in near-shore lobster fisheries since the 1960s (Elner 1986; Robichaud and Frail 2006). When populations of more popular crabs became depleted, fishermen began targeting Jonah crabs. During the late 1980s and early 1990s, exploratory directed Jonah crab fisheries commenced along the northeast Atlantic coast (Robichaud et al. 2000a,b). Regulations were put in place to manage Jonah crab fisheries, with management efforts intended to protect the reproductive capacity of Jonah crab populations (Robichaud and Frail 2006). Additional management measures include limited entry access, bycatch provisions, logbooks and at-sea observers, third-party catch verification, and a total allowable catch (TAC) (FOC 2010). Directed offshore fisheries commenced in 1995 and from 1999 to 2002 an experimental offshore Jonah crab fishery was developed. However, landings declined sharply in less than a decade and the offshore fishery is no longer active (FOC 2009). It appears that the TAC of 720 metric tons set in 1995 was not sustainable.

1.2.3 Information and Monitoring

Objective: Relevant information is collected to support the harvest strategy.

Summary of Findings:

- Landings data, mostly from the near shore lobster fisheries, are available.
- State sea sampling programs do not collect information on the Jonah crab catch.
- Some biological information does exist, however, from federal and state fishery dependent and independent surveys.
- State and federal trawl surveys may provide relevant information to support a harvest strategy.

The reporting of commercial harvest of crabs in general does appear to be required by most States, and would include Jonah crab among other edible crabs although Jonah crab is not specifically cited in these reporting requirements. The National Marine Fisheries Service data reporting portal does have a category for Jonah crab specifically, which suggests that reporting is occurring and landings data in the U.S. are available. However, Jonah crabs can be easily confused with rock crab, so confusion around species identification might create false landings data.

As well, to date a fair amount of biological data about Jonah crabs have been gathered from bottom trawl surveys, and also through inshore surveys performed by various state agencies and can provide an indicator of relative changes in spatial and temporal abundances (See Appendix A). However, trawls cannot sample certain habitats and Jonah crab may learn to avoid them (Reardon 2006). State and federal trawl surveys may provide relevant important historical and current fishery-independent information to support the harvest strategy, but they have not been examined for this purpose.

Catch levels may be an index for Jonah crab population abundance. However, these may also be skewed by changes in effort as determined by market forces, regulations, availability of other fisheries, etc. As well, species identification remains an issue, where Joan crab is often confused with rock crab and this is likely to confound the existing data.

As noted earlier, the number of Jonah crabs taken in lobster fisheries is not fully known, and anecdotal reports suggest that the number of Jonah crabs taken from at least some lobster fisheries may be far higher than the amount specifically targeted. In addition, lobster fishermen sometimes use Jonah crab bycatch as bait in their traps, and this could contain smaller individuals and females.

1.2.4 Assessment of Stock Status

Objective: There is an adequate assessment of stock status.

Summary of Findings:

- There is no assessment of stock status or evaluation of all the relevant data with the goal of determining whether the resource is overfished.
- In the case of RI, the two Cancer species seem to have been combined, and results therefore are very equivocal.

To date no comprehensive stock assessment has been undertaken at the U.S. federal level, and information to undertake such an assessment has data gaps (refer to Appendix A.)

The 2012 Rhode Island state assessment indicated that the fishing mortality rate in the state *Cancer* crab fishery (both Jonah and rock crabs) exceeded F_{msy}, but the biomass had not fallen below B_{msy} and therefore was not considered overfished

(RIDEM 2012). According to the report, fishing mortality for *Cancer* crab species has recently exceeded the F_{msy} level (Figure 8) and should be monitored in the future. Biomass, however, was above the B_{msy} level, so the Jonah and rock crab resource was not considered over-fished at this time (see Figure 9 below).

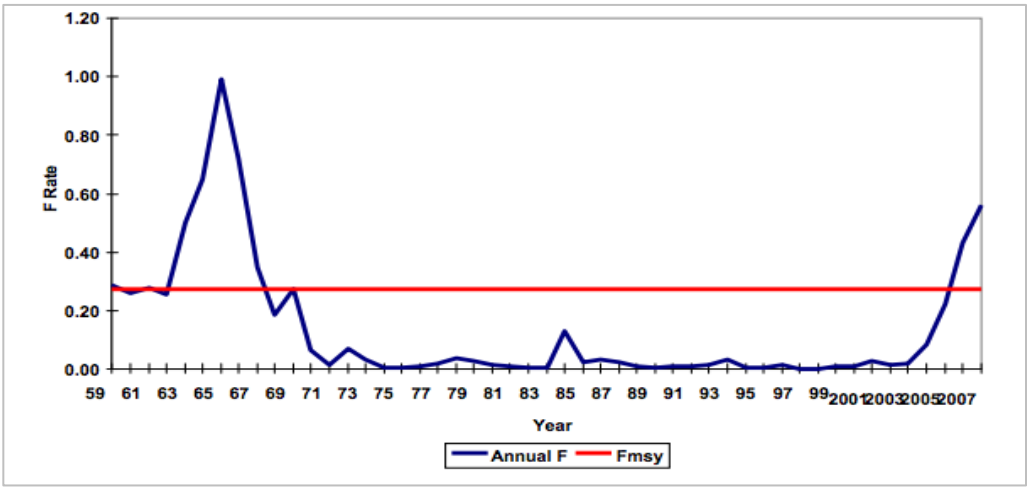

Figure 8. Source: RIDEM

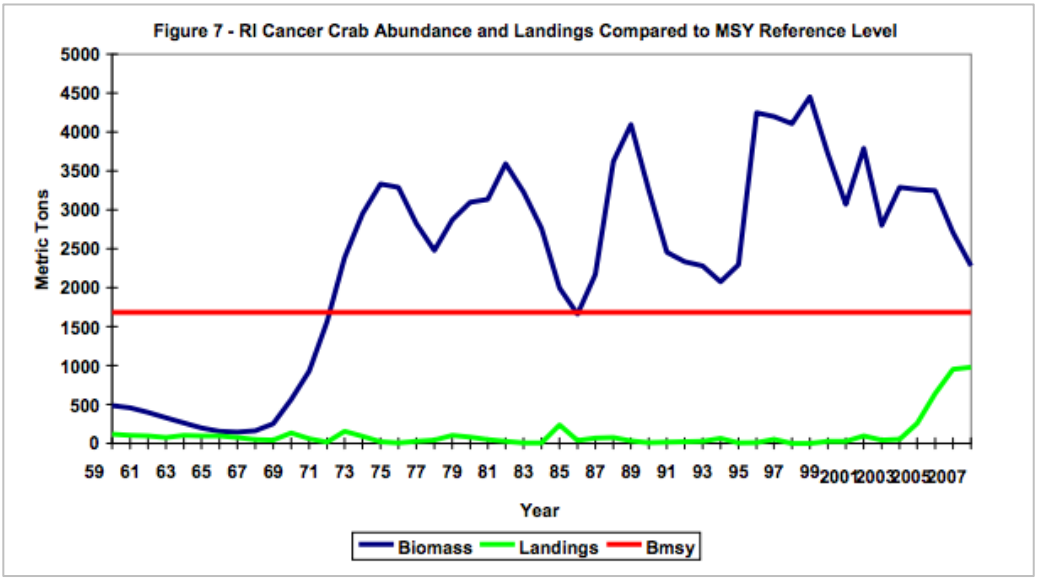

Figure 9. Source: RIDEM

As previously noted, Jonah crab appears to be landed primarily in American lobster fisheries and as a component of other edible crab fisheries. The take in lobster fisheries is hard to assess because fishermen sometimes use Jonah crab as lobster bait or do not report their catch (Reardon 2006). Until the levels of Jonah crab catch in lobster fisheries are fully understood, and lobster fishermen report all of their Jonah crab catch (whether it is used directly as bait or sold commercially), accurate assessments of the fisheries that land Jonah crab will be difficult (Robichaud and Frail 2006; Reardon 2006).

Principle 2

Component: Retained Species

2.1.1 Outcome

Objective: The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.

Summary of Findings:

- Not enough information is available to determine the risks to the retained species.
- Expansion of biological sampling in fishery dependent and independent surveys could increase our understanding of this issue.

Information to understand the impact of removals on the retained species abundance and recovery in the case of decline does not appear to be available. The biological sampling data gathered (see Appendix A) could however yield some insights.

In fisheries that target large males, such as the Jonah crab fishery, the fishery will likely modify the size distribution of males in the population (Jamieson et al. 1998). The concern here is whether removal of large reproductive males affects the stock performance and yield of the population. There may also be concerns about removing claws as a harvesting strategy, and discarding the carapace. This has prompted regulations in Maryland that specify that no more claws may be found on board than twice the number of carapaces.

2.1.2 Management

Objective: There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.

Summary of Findings:

- Not enough information is available at this time.
- States have different regulations for Jonah crab harvest.

There is no federal management plan for Jonah crab stocks, but crab species are harvested in the federal lobster fishery, and the federal regulatory framework for lobsters includes restrictions on trap limits, size, and configurations that applies to

crab harvested in that fishery (ASFMC 1997). As previously noted, individual states manage Jonah and rock crab through joint licenses that allow fishermen to harvest lobster as well as crab, or under the blue crab regulations, and therefore the lobster regulatory frameworks provide much of the current protections. Massachusetts has implemented a closed crab season for edible crabs in general from January 1 to April 30 (MA DMF 2012), while Maine utilizes seasonal closures in specific harvest areas for lobster and crab combined (ME DMR 2012). Other states have provided for seasonal closures in their blue crab and other edible crab fisheries, but these do not necessarily target the reproductive cycles of Jonah crab specifically.

2.1.3 Information

Objective: Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species.

Summary of Findings:

- The majority of information results from findings from the lobster fishery.
- Reardon's (2006) and Wilson's (2005) experimental fishery and modified trap project could provide some insight.

Commercial harvest volumes of Jonah crab are reported to the National Marine Fisheries Service, and deemed to be accurate, barring the previously mentioned misidentification issue between rock crab and Jonah crab. However, biological sampling data have not been tied back to these removals to provide a comprehensive understanding of the impact of fishing mortality on the population. Although there are several fishery independent surveys that could provide information useful in assessing the impact of fishing (See Appendix B), comprehensive stock-wide analyses have yet to be done. We therefore don't know if the information available is adequate to determine the risks posed by the fishery and the effectiveness of any management plan.

Component: Bycatch Species

2.2.1 Outcome

Objective: The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.

Summary of Findings:

- Because there are no directed Jonah crab fisheries in the U.S., much of the information available is from American lobster bycatch information.
- Atlantic cod, white hake, and cusk were identified as main species caught as bycatch in the lobster fishery.
- Additional bycatch data specific to modified Jonah crab traps are available.

The Jonah crab harvest in the U.S. has itself been largely seen as a bycatch in the lobster fishery and therefore many of the bycatch discussions are confounded by this nuance, and assessment of the impact of any directed Jonah crab fishery is difficult. In the Gulf of Maine, Reardon (2006) reported very low bycatch rates of non-target species when asked about Jonah crab harvest specifically,all at less than 1% of the total catch. For discussion, we see that in Canada, bycatch of lobsters in directed Jonah Crab fisheries appears to be negligible (0.4 lobster per trap haul) (Robichaud and Frail 2006). For this section, we will therefore focus attention on the findings of the lobster fishery, which may offer applicable parallels.

If bycatch in the Maine lobster fishery is any indication of what might be expected in a directed Jonah crab fishery, according to the American Lobster Marine Stewardship Council Certification report, at least 10 finfish species are recorded as discarded bycatch (data provided by C. Wilson, Maine DMR).

The species found to be most abundant in the bycatch analysis of the lobster fishery (longhorn sculpin) made up 0.5% of the lobster catch over the three years sampled, and all other species were well below this level. Total numbers of individuals taken and discarded can be estimated based on an estimate of 260,000 trips made in 2008 (the first year for which such an estimate is available). Discard survival rate is unknown but probably greater than zero, since the fishery operates in relatively shallow waters.

Species that comprise less than 5% of the total catch by weight may normally be considered minor species (not “main”), unless they are of high volume or particular vulnerability. Using this guidance it was concluded that three species are considered to be main bycatch species owing to their vulnerability:

- The Gulf of Maine Atlantic cod, which are overfished (that is, they are below a chosen abundance reference point) and overfishing is occurring (that is, fishing mortality is higher than the chosen reference point) (NEFSC 2011).
- White hake, which are overfished and overfishing is occurring. (NEFSC 2012)
- Cusk, which has been identified as a "species of concern" following a steep decline in trawl survey indices and a Canadian assessment of the shared population indicating an "at-risk" status.

According to Reardon (2006), reported non-targeted species catch was very low during the reporting period. Sublegal lobsters had the highest catch rate, Atlantic redfish, hake, and legal size lobsters followed sublegal lobsters in catch rate. Lobsters, redfish, and hake were the only regulated species bycatch observed during DMR observer trips.

2.2.2 Management

Objective: There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations

Summary of Findings:

- Some requirements on harvest strategy decrease risks of harm to bycatch populations.
- The main bycatch species of concern also have management strategies to ensure their sustainability.

In U.S. trap and pot fisheries, all pots are mandated to contain devices that allow sub-legal lobsters and crabs to escape, and fishermen have developed modified Jonah crab traps that are highly successful at reducing lobster and other non-targeted species bycatch (Reardon 2006). In addition, pots are required to use biodegradable webbing in the event that pots are lost (FOC 2009, 2010). In the Maryland crab fisheries, turtle bycatch reduction devices similar to escape vents in lobster traps, are required.

For discussion, based on data from the last decade, the number of sub-legal male (< 130 mm CW; < 2.5 crabs per trap haul) and female Jonah crabs per trap haul (< 7 females per trap haul) in Canadian fisheries has remained low, indicating that trap escape vents were effective in limiting the amount of females that were taken (Robichaud and Frail 2006).

Additional concerns arise from traps which are no longer retrievable, often called 'Ghost gear." No records of amount of gear lost are available. Fishermen advise that they make every effort not to lose gear, and to retrieve gear which is lost, because of the high cost of gear (approximately $100 per trap); GPS systems are now widely

available and facilitate retrieval of lost gear. By regulation, traps must include a biodegradable escape panel. No studies of length of time for these to degrade are available, but they are usually replaced annually (C. Wilson, pers. comm.).

Diving experience shows wide prevalence of ghost gear on the bottom in shallow water within SCUBA depths (C. Wilson, pers. comm.). In November of 2009, The Gulf of Maine Lobster Foundation initiated the two-year National Fish and Wildlife Foundation-funded *Derelict Lobster Gear Retrieval, Salvage and Disposal* project. The project employs lobstermen from each of Maine's seven lobster management zones to remove derelict lobster gear. Although the project will continue into early 2012, an interim report from October 2011 indicated that of the 3037 traps retrieved during the first two years of the project, the majority held a State tag to indicate the last year fished. Of these, the majority of recently lost traps had closed escape panels while the majority of older traps had open panels. For example, the 2011 report indicated that of those traps recovered with 2010 tags, 223 had closed panels while 66 had open panels. Of those traps recovered with 2009 tags, 38 had closed panels while 72 had open panels (Ludwig 2011).

2.2.3 Information

Objective: Information on the nature and amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch.

Summary of Findings:

- The majority of bycatch information comes from the lobster fishery.
- Bycatch of cod and white hake species is not considered in their assessments, apparently because the levels are so low.

We refer again to the lobster fishery findings. Information on discarded bycatch in the lobster fishery has been collected on sea sampling trips in 2006, 2007, and 2008 (Table 2). The sea sampling program targets 3 trips per month in each of the 7 fishery management zones; although the target is not always met, sampling covers areas and seasons well. A total of 542 trips were sampled for bycatch in the three years for which data are available (varying from 171-186 per year), for a total of 123,269 traps sampled (varying from 40,482-41,782 per year). Of the 542 trips sampled, 465 (with 103,439 traps) had observed bycatch. Finfish bycatch relative to lobster catch, per trip and per trap is very low in this fishery (Table 2 below).

Species	Individuals taken on 465 sampling trips (3yrs)	Individuals per trip	Total individuals taken in 2008 fishery
Lobster	322,356		
Sculpin longhorn	1,765	3.80	986,882
Sea raven	996	2.14	556,903
Sculpin shorthorn	745	1.60	416,559
Cunner	414	0.89	231,484
Cod	**317**	0.68	177,247
Redfish Acadian	**302**	0.65	168,860
Cusk	**201**	0.43	112,387
Sculpins	140	0.30	78,280
Spiny dogfish	**129**	0.28	72,800
Hake unclassified	**96**	0.21	54,600
Flatfishes unclassified	**77**	0.17	44,200
Mackerel Atlantic	**67**	0.14	37,462
Pollock	**27**	0.06	15,097
Lumpfish	18	0.04	10,065
Horseshoe crab	**16**	0.03	8,946

Note: species in bold are managed species. Total individuals taken is an estimate based on individuals taken per trip from observer program and an estimate of 260,000 trips made for 2008.

Table 2. Source: Lobster MSC certification document.

Estimated catches of cod and white hake are very low compared to other sources of mortality. In other words, assuming an average weight of 1 kg per individual (based on the size of cod likely to be able to enter a trap), 177 tons of Atlantic cod were discarded in 2008 in the lobster fishery, compared to total landings of Atlantic cod of 3,989 tons in 2007 and similar levels in preceding years; there are also recreational catches and discards (NEFSC 2008). Based on the same assumptions, discards of white hake in the lobster fishery (55 t/yr) were low compared to reported landings (1,600 t in 2007, higher in preceding years) (NEFSC 2008). Bycatch of these species is not considered in their assessments, apparently because the levels are so low.

Cusk taken as bycatch in the Maine lobster fishery are part of a stock shared with Canada, with the center of abundance on the Scotian Shelf (Harris and Hanke 2010). Cusk is not considered a commercial species in either Canada or the U.S. (although bycatches from groundfisheries may be landed) but has been identified as a “species of concern” for possible listing under the US Endangered Species Act (ESA) (NMFS 2009). “Species of Concern” are those species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA. "Species of concern" status does not carry any procedural or substantive protections under the ESA.

Total removals of Cusk include fishery landings of the order of 100 tons/yr in the U.S. (O’Brien 2006), 800 tons/yr from fisheries in Canada and 200 tons/yr lobster bycatch in Canada (DFO 2008). Annual Maine lobster fishery bycatch would be around 112 tons/yr from the table above. A recent population assessment (Harris and Hanke 2010) indicates that survey abundance catch rates have been stable since the late 1990s; commercial catch rates have declined but this may be due to management restrictions on the fisheries in which cusk are taken as bycatch. DMR

received a federal grant to evaluate the extent and degree of Cusk bycatch in the trap and longline fisheries. This project began in Spring 2011 and measure the condition and survival of cusk caught in non-directed fisheries. These data will be used in stock assessments and future management of this resource (DMR 2011).

Component: ETP Species

2.3.1 Outcome

Objective: The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.

Summary of Findings:

- Measures are taken in the lobster fishery to maximize protection of ETP species.
- This is cited as a challenge to the use of a modified trap design since it would allow an additional 200 traps into waters (Wilson 2005).

Fixed gear trap and pot fisheries have been criticized for critically endangering North Atlantic right whales (*Eubalaena glacialis*), which sometimes become entangled in the lines that connect the traps or pots together (Johnson et al. 2005). Entanglements appear to be relatively common, as opposed to isolated events. For example, scar studies of right whales revealed that 72% of the population has been entangled in fishing lines at least once and entanglement appears to be increasing (Knowlton and Kraus 2001; Knowlton et al. 2003). In addition, a scar study of humpback whales in the Gulf of Maine indicated that more than half of the population had been entangled in fishing lines, with 8 – 25% of individuals receiving new injuries each year (Robbins and Mattila 2004). Johnson et al. (2005) found that 80% of North Atlantic Right Whale entanglements and 56% of humpback whale entanglements occurred in Lobster pot gear despite management efforts that included a minimum number of pots allowed per vessel and limited entry into the fishery. The researchers reported that right whale entanglements occurred in pot gear 71% of the time, with the next most frequent gear type (gillnets) substantially lower at 14% (Johnson et al. 2005).

2.3.2 Management

Objective: The fishery has in place precautionary management strategies designed to:

- Meet national and international requirements;
- Ensure the fishery does not pose a risk of serious or irreversible harm to ETP species;
- Ensure the fishery does not hinder recovery of ETP species; and
- Minimize mortality of ETP species.

There is a strategy in place for managing ETP species that is designed to ensure the fishery does not hinder the recovery of ETP species.

Summary of Findings:

- The Jonah crab fishery does not specifically have any management strategies in place, precautionary or otherwise.
- There is information to the extent that there is information from the lobster fishery, which appears to be applicable.

In U.S. waters, North Atlantic Right Whales are currently managed under the Atlantic Large Whale Take Reduction Plan (ALWTRP), with several measures in place to reduce entanglement in fishing gear such as pots and traps (NMFS 2010). Specific management strategies include the following:

- Fishing gear modifications (e.g. the use of sinking or neutrally buoyant line and weak links between lines and traps/buoys; Johnson et al. 2005; Kraus et al. 2005),
- Seasonal area management zones (e.g. no fishing in high-use areas during spring and summer), and
- Dynamic area management zones (e.g. no fishing when aggregations are located) to regulate fishing efforts, a disentanglement network, and a sighting advisory system (NMFS 2010).

Although the population remains critically low, recent data indicate it appears to be slowly increasing (NARWC 2010), which suggests that these measures may be working.

2.3.3 Information

Objective: Relevant information is collected to support the management of fishery impacts on ETP species, including:

- Information for the development of the management strategy;
- Information to assess the effectiveness of the management strategy; and
- Information to determine the outcome status of ETP species.

Summary of Findings:

- There is no information specific to Jonah crab.
- There is information from the lobster fishery, which appears to be applicable.

NMFS (2010) published a biological opinion on whether impacts of the American lobster fishery would be likely to appreciably reduce the likelihood of survival or recovery of endangered, threatened and protected species. The species considered, for which there are documented interactions with the American lobster fishery, were:

- North Atlantic right whale
- Humpback whale
- Fin and Sei whales
- Loggerhead turtle
- Leatherback turtle

All of the whale species are listed under the ESA as endangered. The ESA describes a "distinct population segment" of loggerhead turtle as "threatened" and the leatherback turtle as endangered.

Three minke whales were reported entangled in lobster gear in the Maine fishery in 2010, so this species must also be considered. Minke whales are not listed under the ESA but are protected under the U.S. Marine Mammal Protection Act, and are listed on Appendix I of CITES, as are all of the above listed species.

The following sections review information available to the assessment on these species and concludes with a summary of the results of NMFS (2010) on the potential impacts of the fishery on them. Further detail on the NMFS (2010) analysis as it affects scoring is found in the scoring table.

The population of right whales is one of the most critically endangered marine species and is known to interact with the Maine lobster fishery.
Current population size of right whales is estimated at somewhere between 300 and 400 individuals. Annual calf production, and estimated population trend (decreasing, stable, or increasing) have been highly variable over the past two decades, with calf production low in the early 2000s and a production of nearly 40 calves in 2008. The most recent population assessment concluded that the population had been increasing in the period 1990-2005 (NMFS 2010a).

Component: Habitats

2.4.1 Outcome

Objective: The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.

Summary of Findings:

- Information is available on the impact of lobster pots on habitats.
- Lobster pots impact an area approximately two to three times larger than their actual footprint due to dragging when the pots are set and retrieved.
- Overall, the effect of fishing practices in the American lobster fishery, and therefore in the Jonah crab fishery, rates as a moderate conservation concern.

Jonah crabs are harvested from both sensitive (e.g. rocky) and resilient (e.g. sandy or silty) benthic habitats. Jonah crab can be found at depths ranging from 1 to 800m. Their habitat preferences vary from shallow to deep water and from rocky to sandy bottoms. In Narragansett Bay (Jeffries 1966) and Maine (Krouse 1980), they are found along rocky bottoms, whereas in the deep water of the continental slope they are found on silt and clay (Musick and McEachran 1972; Wenner et al. 1992; Robichaud and Frail 2006). Habitat preferences also vary seasonally. For example, in Rhode Island, Jonah crab occupy inshore areas during the spring and move to deeper, warmer waters during the winter (FOC 2009). These benthic habitats are likely sufficiently robust to support Jonah crab.

As previously noted, Jonah crabs are taken in crab pots and lobster traps (Wilson 2004, Robichaud and Frail 2006; Reardon 2006). The pots or traps are either deployed individually or attached to each other via a groundline along the seafloor, depending on the fishery. Traps used in the American lobster fishery are reported to affect an area two to three times the footprint of the trap (Table 3; Northeast Region Essential Fish Habitat Steering Committee 2002). The overall impact from pots and traps will vary between benthic habitats. Although the impact of an individual pot may be seem minimal, the cumulative impact of more than four million lobster pots may be cause for concern (NREFHSC 2002). The Essential Fish Habitat Steering Committee concluded, however, that the resilience of the bottom habitat is considered moderate to high, depending on the bottom habitat.

Gear type	Effect of fishing gear on habitats	Habitat resilience to disturbance	Geographic extent of fishery effects	Evidence of food web disruption	Evidence of ecosystem changes	Sources
Lobster traps/ pots	Moderate	Moderate	Moderate	None	None	Northeast Region Essential Fish Habitat Steering Committee 2002

Table 3: Habitat effects of gear used to catch American lobster. Source: American Lobster MSC certification document.

2.4.2 Management

Objective: There is a strategy in place that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to habitat types.

Summary of Findings:

- There is information from the lobster fishery, which appears to be applicable.

Although pots and traps are required to use biodegradable webbing in the event that they become lost at sea (FOC 2009, 2010), no known efforts are currently in place to mitigate damage to sensitive seafloor habitats (e.g. rocky bottoms, deep corals).

2.4.3 Information

Objective: Information is adequate to determine the risk posed to habitat types by the fishery and the effectiveness of the strategy to manage impacts on habitat types.

Summary of Findings:

- The recent high abundance of lobster in Maine area suggests that impacts of the fishery on lobster habitat, at least, are not substantial.
- However impacts of dragging ground ropes over the bottom were greater than those of traps alone.

(The below reference material provided as excerpts from the 2013 Maine Lobster MSC report.)

According to the Maine lobster MSC findings, the inner continental shelf off the Maine coast has been mapped using sidescan sonar and related data (Barnhardt et al 1998; Maine Geological Survey n.d.). Surficial geology in this area is extremely complex, a mosaic of rock, gravel, and mud habitats often changing over short distances (Barnhardt et al 1998). Fishermen report that fishing areas for Jonah crab are primarily on rocky and muddy bottoms which are the predominant bottom types in the area within 3 miles where the fishery is concentrated (Maine Geological Survey data provided by the MLA). Natural disturbance from storms and currents (including strong tidal currents) is high down to 30 m depths (Witman 1998), so one would not expect to see development of the complex, long-lived erect fauna which are particularly sensitive to fishery impacts, including trap fishery impacts. A variety of invertebrate and algal assemblages are associated invertebrate species

(Ojeda and Dearborn 1989; Witman 1987). More complex, emergent fauna might be expected to occur at greater depths and lower-energy environments; fishing does occur at depths beyond 30 m where natural disturbances would be less pronounced.

The impact of trap gear on bottom habitats has generally been considered to be much lower than that of towed gear, although information on trap impacts is very limited. Several studies have provided observations of trap impacts on benthic habitats. Eno et al (2001) studied impacts of trap fishing on emergent fauna (sponges, bryozoans, ascidians, soft corals, and tube worms) at three sites off the British Isles, and concluded that impacts were generally low. Soft, erect fauna (sea pens) tended to bend as traps descended, and although some were uprooted, recovery was relatively rapid. Impacts on other emergent fauna were limited. However impacts of dragging ground ropes over the bottom were greater than those of traps alone. Further, the authors noted that the study did not assess the impacts of long periods of repeated fishing which could have been more significant. Recent studies, including Adey (2007) (*Nephrops* creel impact on soft-bodied emergent fauna, Scotland), Stone (2006) (crab pot impact on corals, Alaska) and Troffe et al (2005) (prawn trap impacts on sea pens), all concluded that traps can damage emergent fauna, but did not provide assessments of the degree of damage. Troffe et al (2005) observed that prawn traps caused more damage to emergent fauna (sea whips) than beam trawls, while Stone (2006) observed less damage from crab pots to corals than longlines and trawls.

A workshop on effects of fishing gear on marine habitats in the Northeastern U.S. (NEFMC 2002) concluded that the degree of impact caused by pots and traps to biological and physical structure and to benthic species in mud, sand, and gravel habitats was low. Impacts were expected to be greater in rocky habitats where emergent epifauna or biogenic structures are present. Impacts from dragging a trap along the bottom, or from ground ropes linking several traps, could increase the impact over that of a single trap. The general conclusion that trap gear is likely to have lower impacts on bottom habitats than towed gear was confirmed by the detailed review of NEFMC (2011a). Stevenson et al (2004) reviewed impacts of fishing gear on bottom habitats off the Northeastern U.S., citing Eno et al (2001) as the only available study of trap impacts on bottom habitats at that time. The recent requirement to use sinking ground ropes in parts of the Maine lobster fishery area to reduce potential for whale entanglements could potentially contribute to increasing damage to bottom habitats, since dragging ground ropes increase the risk of trap fishery damage to habitats.

The collective footprint of the Maine lobster trap fishery, in terms of distribution of trap hauls, is not well known, although studies have provided improved information on this. Trap fishing effort appears to be extremely intensive, with high trap densities throughout state waters (at least in the summer) and relatively frequent hauling of gear. In total ,Maine DMR issues over 3 million trap tags annually, but not all of these are used. A study of vertical line distribution and abundance, based on information from a survey of all federal permit holders in Maine (Smith 2006), provided estimates of numbers of vertical lines in the water by season and by

fishing area along the coast of Maine, along with information on trap fishing configurations (singles, pairs, trawls, etc.), which could be used to estimate the number of trap contacts with the bottom. Generally, trap densities are much greater within state waters, lower in the nearshore area (3-12 mile zone) and lower still offshore (outside 12 miles); densities are greatest in summer months, peaking in July and August, in state waters but greatest in the fall beyond 12 miles. Pairs and singles are the dominant fishing configuration inside 12 miles, while trawls of 10 to 20 traps (which have the potential to cause more damage to benthic fauna than pairs and singles) are much more important outside 12 miles. Information on distribution of fishing compiled by the Maine Lobsterman's Association (MLA), based on logbook information, shows fishing to be strongly concentrated in the state waters peaking at over 100 traps per km2 in July-September. Traps are hauled several times per week during summer when weather is favorable, less frequently in spring and fall when storms may impede fishing operations.

Component: Ecosystem

2.5.1 Outcome

Objective: The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.

Summary of Findings:

- There is potential to cause harm to the ecosystem, to the extent that the fishery targets a key mid-level consumer in the benthic ecosystem and may also impact the habitat and other species as bycatch.
- As a consumer, Jonah crab has the potential to initiate a trophic cascade by direct and indirect controls of urchin abundance, which in turn could have important positive effects on the structure of macroalgal communities.

Jonah crab co-exists with rock crab and the American lobster (*Homarus americanus* (Williams 1984). In Narragansett Bay, Jeffries (1966) reported the rock crab and Jonah crab partition the estuary into sandy and rocky habitat respectively. He found the difference in metabolic rates could explain the differential speed of movement and habitat choice. The difference in pace allows rock crab to escape predation by moving away rapidly while the slower Jonah crab must find shelter in complex habitat. In Narragansett Bay, Jonah crab likely exclude rock crab from the preferred shelter rich habitat (Fogarty 1976), but in more northern latitudes, like in the Gulf of Maine, juvenile rock crab are found in rocky substrate (Krouse 1980). Lobster, especially at smaller sizes, is also known to live in rocky habitat for shelter (Wahle and Steneck 1991). Richards and Cobb (1986) found in lab experiments that Jonah crab and lobster utilize similar habitat, but if competing for limited shelter, Jonah crab will often be displaced by lobster.

Atlantic cod (*Gadus morhua*) and other groundfish are important predators of Jonah crab. NMFS trawl data showed a 4-fold increase in Jonah crab abundance in 2000 and 2001 in the Gulf of Maine, which may be related to a continuing decline in Gulf-wide fish predator populations. It is therefore speculated that highly mobile Jonah crabs at high densities may have replaced groundfish as apex predators since their release from predatory control by groundfish (e.g. cod) in some shallow subtidal zones of the Gulf of Maine. Additionally, predation by gulls may directly influence distribution and abundance of invertebrates into intertidal zones, possibly limiting their upper distributions (Good 1992). Cascading effects of predation are well-known in ecological communities, and such interactions may be important in rocky intertidal zones. The impact of avian predators on lower trophic levels remains unknown, and future work requires experiments which can separate the effects of invertebrate, fish, and bird predators.

Adult Jonah crabs prey on small invertebrates on the seafloor. In turn, Jonah crabs are preyed upon by a variety of fishes and American lobsters (Ojeda and Dearborn 1991). With population decreases of large predatory fishes (e.g. Atlantic Cod) during the past half-century, Jonah crabs have become apex predators on sea urchins in some areas (Leland 2002; Steneck et al. 2004). Current levels of Jonah crab likely remain high enough to maintain their increasingly important roles in the marine ecosystem. Therefore there is potential to cause harm to the ecosystem, to the extent that the fishery targets a key mid-level consumer in the benthic ecosystem and may also impact the habitat and other species as bycatch.

Jonah crab are a voracious generalist predator in the subtidal zone of the Gulf of Maine, consuming mussels, polychaetes, sea urchins, and crab and fish remains (Ojeda and Dearborn 1991). In turn, small Jonah and rock crabs were found to be the most common prey of cunner, sculpin, and lobsters. In deeper waters, Jonah and rock crab are reported to be the preferred prey of large predatory groundfish, including cod , that once dominated the Gulf of Maine ecosystem (Link and Garrison 2002). Leland (2002) and Steneck et al. (2004) provide evidence that the Jonah crab has become an “apex” predator, especially on urchins, since the populations of large predatory finfish decreased in the past half-century.

In August and September, predation by migratory populations of large Jonah crabs decimated relocated urchin populations and restored fleshy-algal dominance at these locations (Leland 2002). Laboratory experiments confirmed that sea urchin grazing decreases algal biomass and that Jonah crabs are stronger sea urchin predators than rock crabs.

In laboratory experiments, the presence of Jonah crabs significantly decreased sea urchin grazing rates on kelp (McKay and Heck 2008). The results suggest Jonah crabs could have important positive effects on kelp abundance through their direct or indirect effects on urchins.

Urchin mortality was significantly lower in the mussel habitat than in habitats dominated by the macro algae *Codium fragile* or urchin barrens (Siddon and Witman

2004). Crab diet was determined by prey availability. It was dominated by mussel prey in mussel beds and sea urchins in urchin barrens. In the barrens, crab predation on urchins indirectly increased the abundance of the introduced ascidian, *Diplosoma* sp., whereas *Codium* density did not change among treatments. A significant risk reduction for urchins occurred in *Codium* and barren habitats, but not in mussel habitats when crabs and lobsters were combined. Lobsters also produced a positive indirect effect on mussels by reducing crab predation. Thus, lobsters modify crab behavior and dampen changes in community structure.

To date there has been no assessment of whether the removal of American lobster, or Jonah crab, has substantially disrupted the foodweb. There is evidence, however, that the addition of bait from lobster traps may have measureable trophic impact by enhancing lobster growth rates (Grabowski et al. 2010), and there is reason to believe this would also be true for Jonah crabs. Overall, the effect of fishing practices in the American lobster fishery, and therefore in the Jonah crab fishery, rates as a moderate conservation concern.

2.5.2 Management

Goal: There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function

Summary of Findings:

- There do not appear to be measures in place to ensure the fishery does not pose a risk to the ecosystem, associated with Jonah crab specifically.
- Measures mentioned in above sections could help reduce ecosystem impacts, but no measures are in place to specifically address this question.

2.5.3 Information

Objective: There is adequate knowledge of the impacts of the fishery on the ecosystem

Summary of Findings:

- There does not appear to be adequate information to inform the knowledge of impacts of the fishery on the ecosystem, associated with Jonah crab specifically.

Principle 3

Component: Governance and Policy

3.1.1 Legal and Customary Framework

Objective: The management system exists within an appropriate and effective legal and/or customary framework, which ensures that it:

- Is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2, and
- Observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; and
- Incorporates an appropriate dispute resolution framework.

Summary of Findings:

- There does not appear to be a legal and customary framework associated with Jonah crab specifically.

3.1.2 Consultation, roles and responsibilities

Objective: The management system has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organizations and individuals who are involved in the management process are clear and understood by all relevant parties.

Summary of Findings:

- There do not appear to be Management Consultation, roles and responsibilities associated with Jonah crab specifically.

3.1.3 Long term objectives

Objective: The management policy has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria, and incorporates the precautionary approach.

Summary of Findings:

- There do not appear to be long-term management objectives associated with Jonah crab specifically.

3.1.4 Incentives for Sustainable fishing

Objective: The management system provides economic and social incentives for sustainable fishing and does not operate with subsidies that contribute to unsustainable fishing.

Summary of Findings:

- There do not appear to be incentives for sustainable fishing associated with Jonah crab specifically.

Component: Fishery Management System

3.2.1 Fishery Specific Objectives

Objective: The fishery has clear, specific objectives designed to achieve the outcomes expressed in MSC's principles 1 and 2.

Summary of Findings:

- There do not appear to be Fishery specific objectives associated with Jonah crab specifically.

3.2.2 Decision making processes

Objective: The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives and has an appropriate approach to actual disputes in the fishery under assessment.

Summary of Findings:

- There does not appear to be a decision making process associated with Jonah crab specifically.

3.2.3 Compliance and Enforcement

Objective: Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with.

Summary of Findings:

- There does not appear to be a Jonah crab specific enforcement plan, nor do there appear to be regulations specific to Jonah crab which require enforcement.
- There is information from the lobster fishery, which appears to be applicable to Jonah crab.

Enforcement of any federal regulations is coordinated through the National Oceanic and Atmospheric Administration's Office of Law Enforcement (OLE). OLE Special Agents and Enforcement conduct criminal and civil investigations, board vessels fishing at sea, inspect processing plants, and conduct patrols on land, in the air and at sea. In addition to this enforcement work, the OLE administers the Cooperative Enforcement Program (CEP), which authorizes certain coastal state and territorial marine conservation law enforcement agencies to enforce federal laws and regulations in the Exclusive Economic Zone (EEZ). OLE also partners with the U.S. Coast Guard (USCG) and various other federal agencies, fishery management councils, and non-governmental organizations. Federal and state law enforcement agents

3.2.4 Research Plan

Objective: The fishery has a research plan that addresses the information needs of management.

Summary of Findings:

- To date there is no formal research plan.
- However, the first steps in gathering information to inform the design of such a plan have been undertaken by the Jonah crab FIP.

The FIP team has compiled a literature review, a list of fishery-dependent and –independent surveys, and focused studies to identify key monitoring programs that could contribute to a stock assessment. This effort has already identified information gaps in current surveys that could be filled by gathering additional data on Jonah crab. Literature and monitoring of other *Cancer* species in the in the North Atlantic, Northeast and Southeast Pacific may also prove useful in the absence of specific information on Jonah crab.

3.2.5 Management performance evaluation

Objective: There is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives. There is effective and timely review of the fishery-specific management system

Summary of Findings:

- There does not appear to be a Management performance evaluation associated with Jonah crab specifically.

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Appendix A: Summary of Biological Sampling Efforts

See attached.

Federal Waters

Sampling Program	Data collected						Source	Geographic Coverage	Depth Range (fathoms)	No. Sites	Sampling Method	Sampling Frequency	Length of Time Series	Proprietary Issues	Limitation	Contact Person	Contact Info	Link to Reports/Data
	species ID	count	weight	carapace width	sex	eggs												
NEFSC Bottom Trawl- Spring	x	x		x			NEFSC	Cape Lookout to Scotian Shelf	10-100+	370	Otter trawl/ Stratified	Annual- spring	1963- present			Burton Shank	burton.shank@noaa.gov	
NEFSC Bottom Trawl- Fall	x	x		x			NEFSC	Cape Lookout to Scotian Shelf	10-100+	370	Otter trawl/ Stratified Random	Annual - fall	1968- present			Burton Shank	burton.shank@noaa.gov	
NEFSC Bottom Trawl- Winter	x	x		x			NEFSC	Cape Hatteras to Georges Bank	10-100+	105-160	Otter trawl/ Stratified Random stratified	Annual - winter	1992-2007			Burton Shank	burton.shank@noaa.gov	
NEFSC Winter Flatfish	x	x		x			NEFSC				Otter trawl/ Stratified	Annual - winter			Does not include	Burton Shank	burton.shank@noaa.gov	
NEFSC/ ME DMR GOM Shrimp	x		x	x			NEFSC	Gulf of Maine	0-100	84	Trawl/ Random Stratified	Annual - Summer	2000- present		daylight hours only	Russell Brown	Russell.Brown@noaa.gov	http://www.nefsc.noaa.gov/femad/ecosurvey/mainpage/s
NEFSC Clam Dredge	x	x		x			NEFSC	S. VA to Georges Bank		453	"Pre-selected stations"	Every 3 years	Since 2008			Burton Shank	burton.shank@noaa.gov	
NEFSC Scallop Dredge Survey	x	x	x				NEFSC	MAB-BG	13-83	307	Scallop dredge, random	Annual - Early	2000- present			Burton Shank	burton.shank@noaa.gov	
Sea Sampling	x	x		x			NEFSC	Fed waters					1995- present		limited coverage/ total of 65	Burton Shank	burton.shank@noaa.gov	
Port Sampling	x		x				NEFSC						2007- present		75 observed trips/ 2157 crabs	Burton Shank	burton.shank@noaa.gov	
Dealer Reports/ Landings		x					NEFSC								from Federally permited vessels	Burton Shank	burton.shank@noaa.gov	
NEAMAP Trawl survey	x			x	x		NEAMAP	state/fed waters NC to s. MA	3-20	150	Otter trawl/ stratified	Annual - spring/fall	2007- present					http://www.vims.edu/research/departments/fisheries/programs/multispecies_fisherie
HABCAM							NEFSC	Georges Bank, mid-Atlantic Bight			Towed sled, Hi-Res still image transects		2007-2009 scallop survey, other surveys		limited spatial coverage	Scott Gallager	sgallager@whoi.edu	http://habcam.whoi.edu/category_table.pl
SMAST Scallop Drop Camera Survey	x	x					SMAST/ UMass	Fed waters Mid-Atlatnic shelf to Georges Bank			Drop camera random grid	Annual summer				Kevin Stokesbury	kstokesbury@umassd.edu	

	Data collected																
Sampling Program	**species ID**	**count**	**weight**	**carapace width**	**sex**	**eggs**	**Source**	**Geographic Coverage**	**Depth Range (fathoms)**	**No. Sites**	**Sampling Method**	**Sampling Frequency**	**Length of Time Series**	**Proprietary Issues**	**Limitation**	**Contact Person**	**Contact Info**	**Link to Reports/Data**
NH																		
ME-NH Inshore trawl survey	x	x		x			ME DMR	NH-ME state waters	5-50+	120	Fixed & random stratified combo	Spring/Fall annually	2000-present		Large catches were subsampled to 100, weight and length	Sally Sherman (ME DMR)	Sally.Sherman@maine.gov	http://www.maine.gov/dmr/rm/trawl/index.htm
Seabrook Monitoring Program	x	x		x			Normandeau Assoc./NextEra	Coastal NH		7	Ventless lobster Traps	3x weekly, June-Nov	1975-current			Paul Geoghegan	pgeoghegan@normandeau.com	
American Lobster Settlement Index	x	x		x			NH DF&G	NH state waters	2-10	3	Suction sampling of fixed sites	annually	1995-1997, 2008-current			Joshua Carloni	Joshua.Carloni@wildlife.nh.gov	
ME																		
ME/NH Inshore Trawl Survey	x	x		x			ME DMR	NH-ME state waters	5-50+	120	Fixed & random stratified combo	Spring/Fall annually	2000-present		Large catches were subsampled to 100, weight and length	Sally Sherman	Sally.Sherman@maine.gov	http://www.maine.gov/dmr/rm/trawl/index.htm
ME DMR Urchin Survey	x	x		x	x		ME DMR	ME state waters	0-8	162	Diver quadrat/ drop camera Fixed, Not stratified, combined per site		2002-present			Robert Russell	Robert.Russell@maine.gov	http://www.maine.gov/dmr/rm/seaurchin/research.htm
American Lobster Settlement Index	x	x		x			ME DMR	ME state waters	2-10	36	Suction sampling/ Fix sites	Annual Sep-Oct	1989-present			Carl Wilson	carl.wilson@maine.gov	
ME DMR Lobster Sea Sampling							ME DMR	ME state waters			commercial lobster traps				no bycatch data collected	Carl Wilson	carl.wilson@maine.gov	
ME DMR Ventless trap survey							ME DMR	ME state waters		138	unvented commercial lobster traps		2006-present		no bycatch data collected	Carl Wilson	carl.wilson@maine.gov	
ME DMR Crab Trap Report	x	x		x	x		ME DMR	ME state waters	100	39	Random stratified (camera)	1 year	2004		Difficult to ID to species from images	Carl Wilson	carl.wilson@maine.gov	
ME DMR Port Sampling							ME DMR	ME state waters							no bycatch data collected	Carl Wilson	carl.wilson@maine.gov	
Dealer Reports	x		x				ME DMR	ME state waters					2008-present		Reporting not mandatory until 2008; Jonah & Rock crab often reported	Heidi Bray	Heidi.Bray@maine.gov	

	Data collected																
Sampling Program	**species ID**	**count**	**weight**	**carapace width**	**sex**	**eggs**	**Source**	**Geographic Coverage**	**Depth Range (fathoms)**	**No. Sites**	**Sampling Method**	**Sampling Frequency**	**Length of Time Series**	**Proprietary Issues**	**Limitation**	**Contact Person**	**Contact Info**	**Link to Reports/Data**
RI																		
RIDEM Inshore Trawl Survey	?						RIDEM	RI state waters	~10-30	40+	Random stratified	spring & fall annually	1978-present		No Jonah in database, but possibly in the field logs.	Jason McNamee	jason.mcnamee@dem.ri.gov	
URIGSO Trawl	x	x		x			URI	Narragansett Bay	5-15	2	Fixed sites	weekly	1959-present		Not identified to species.	Jeremy Collie	jcollie@gso.uri.edu	
American Lobster Settlement Index	x	x		x			RIDEM	RI state waters	2-5	6	Suction sampling/ Fix sites	annual - late-Aug/Sep	1990-present			Scott Olszewski	Scott.Olszewski@DEM.RI.GOV	http://www.umaine.edu/marine/people/sites/rwahle/ALSIPage.htm
Ventless Trap	x	x		?			RIDEM	RI state waters			Ventless lobster Traps		2006-current		Need to fill in the blanks here. Unable to find via internet search.	Jason McNamee	jason.mcnamee@dem.ri.gov	
Sea Sampling	x	x		?			RIDEM	RI state waters			commercial lobster traps		1990-current		Need to fill in the blanks here. Unable to find via internet search.	Jason McNamee	jason.mcnamee@dem.ri.gov	
Port Sampling	x	x		?			RIDEM	RI state waters					2006-current			Jason McNamee	jason.mcnamee@dem.ri.gov	
Logbook catch and effort, VTR, Dealer reports	x		x				RIDEM	state waters					2005-current		Possible confounding of species issues	Jason McNamee	jason.mcnamee@dem.ri.gov	
MA																		
MA DMF Inshore Trawl Survey	x	x		x	x		MADMF	MAstate waters	0-30	100	Random stratified	Spring (May)/Fall (Sept.) Annually	1978-present			Derek Perry	derek.perry@state.ma.us	http://www.mass.gov/dfwele/dmf/publications/tr_38.pdf
Industry-based Survey for GOM cod	x	x	x				MADMF	ME, NH, MA	10-79 (9 strata)	1125	Random stratified	5 cruises /year	2003-2007				marine.fish@state.ma.us	http://www.mass.gov/dfwele/dmf/programsandprojects/ibs_final_report.htm
American Lobster Settlement Index	x	x		x			MADMF	MA state waters	to 10	22	Suction sampling/ Fix sites	August-October	1995-present			Bob Glenn	Robert.Glenn@state.ma.us	
MA Sea Sampling							MADMF	MA state waters							no bycatch data collected			
MA Ventless Trap Survey	x	x					MADMF	MA state waters	<30	Variable	Ventless lobster Traps	Spring/Fall annually	2005-2012			Derek Perry	derek.perry@state.ma.us	
MA Dealer Reports	x		x				MADMF	All state landings				Year round	2005-present			Derek Perry	derek.perry@state.ma.us	
MA Vessel Landings Reports	x		x				MADMF	All state landings				Year round	1995-present		suggested that only 2006-present be used due to various issues	Derek Perry	derek.perry@state.ma.us	
MA Port sampling							MADMF	All state landings				Year round			no bycatch data collected	Derek Perry	derek.perry@state.ma.us	

	Data collected																
Sampling Program	**species ID**	**count**	**weight**	**carapace width**	**sex**	**eggs**	**Source**	**Geographic Coverage**	**Depth Range (fathoms)**	**No. Sites**	**Sampling Method**	**Sampling Frequency**	**Length of Time Series**	**Proprietary Issues**	**Limitation**	**Contact Person**	**Contact Info**	**Link to Reports/Data**
CT																		
Long Island Sound Trawl Survey	x	x	x				CT DEP	Long Island Sound	<20		Otter trawl/ Random Stratified	spring (May)/Fall (Sept.)	1978-present		No Jonah crab found, but included as a source for other species?	Penny Howell	Penny.Howell@ct.gov	http://www.ct.gov/deep/lib/deep/fishing/fisheries_management/2011_long_island_sound_trawl_survey.pdf
Millstone Power Station Monitoring Survey	x	x		x			Millstone Power Station	Niantic River, CT	<10	3	Triplicate bottom tows	Every other week	?	Millstone Power Plant project, not accessible from website.	No weights or lengths			
NY																		
NY Ocean trawl survey	x	x					NY DEP	NY state waters		?	Otter trawl/ Random Stratified	?			no Jonah crabs in the data set	Kim McKown	kamckown@gw.dec.state.ny.us	
Peconic Bay trawl survey	x	x	?				NY DEP	Peconic Bay NY		?	Otter trawl	?				Kim McKown	kamckown@gw.dec.state.ny.us	
Sea Sampling	x	x					NY DEP									Kim McKown	kamckown@gw.dec.state.ny.us	
Ventless Trap Survey	x	x					NY DEP						2006-2009			Kim McKown	kamckown@gw.dec.state.ny.us	
Dealer Reports	x	x					NY DEP									Kim McKown	kamckown@gw.dec.state.ny.us	

Summary of Existing and Potential U.S. Federal and State Regulatory Frameworks for Jonah Crab

Compiled in the context of a FIP directed at the Jonah Crab Fishery

	Limit on Trap Qty	Gear Restrictions	Limit on Trap Size	Commercial License required Y/N	Minimum landing Size	Maximum Landing Size	Sex Restrictions	Closed seasons	Source(s)
New Jersey	N	biodegradable panel	Y	Y	3" - 4.5" varies by hardness	N	No egg bearers	Y ?	http://www.state.nj.us/dep/fgw/njregs.htm
New York	N	escape panel	Y	N	3" - 4.5" varies by hardness	N	No egg-bearers	N	http://www.dec.ny.gov/outdoor/7894.html; http://www.dec.ny.gov/outdoor/fishing.html
Massachusetts	Y -Lobster limit	Y - Lobster traps	Y-lobster traps	Y	N	N	No egg bearers	Yes; closed Jan 1 - Apr 30	http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/recreational-regulations/; http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/commercial-regulations/
Maine	Y -Lobster limit 500/800	Y - Lobster traps	Y-lobster traps	Y	N	N	None indicated	Dec 30 - Apr 1 in rivers	http://www.maine.gov/ifw/fishing/regulations_seasons/index.htm; http://www.maine.gov/dmr/lawsandregs/regs/25.pdf
Rhode Island	N	N	N	Y	N	N	No egg-bearers	N	Scott Olszewski; <Scott.Olszewski@DEM.RI.GOV>
New Hampshire	Y - lobster limit 1200	Y - Lobster traps	Y-lobster traps	Y	N	N	None indicated	N	http://www.wildlife.state.nh.us/Fishing/fishing.htm; http://www.wildlife.state.nh.us/pubs/digests/SW_2011.pdf
Connecticut	?	Y - lobster trap	Y-lobster traps	Y	3.5" - 5" varies by hardness	N	No egg bearers	Y; Rec Open May 1 - Nov 30; commercial closed Dec 1 - Apr 30	http://www.ct.gov/dep/cwp/view.asp?a=2696&q=322740&depNAV_GID=1647; Matt Gates
Maryland	N	Turtle BRD (juvenile), escape vent	Y	N	3.25" - 5/25" varies by season, hardness	N	Commercial no females at certain times, Rec no females at all	Y, opens Apri 1 - Dec 15	http://www.dnr.state.md.us/fisheries/regulations
Virginia									http://www.dgif.virginia.gov/fishing/

Continued:

	Closed Areas	Commercial Catch Reporting	Harvest Limits Commercial	Harvest Limits Recreational	Recreational License required Y/N	Recreational Limit on Trap Qty	Notes	Jonah Specific Regs	Source(s)
New Jersey	Y	Y	N	One bushel per day	Y	Y	Blue Crab Regs	N	http://www.state.nj.us/dep/fgw/njregs.htm
New York	Y	Y	50/day	50/day	N	N	Blue Crab Regs	N	http://www.dec.ny.gov/outdoor/7894.html; http://www.dec.ny.gov/outdoor/fishing.html
Massachusetts	Y	Y	50/Day personal use no traps; unlimited commercial	25/day	N for hand harvest; Y if trap or SCUBA	10 traps	Rec: Blue Crab Regs, applied to other species; Commercial: lobster regs	N	http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/recreational-regulations/; http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/commercial-regulations/
Maine	Y	Y	200 lbs./day or 500 lbs./trip	N	N/Y	license for hand harvest	Lobster Regs	Y	http://www.maine.gov/ifw/fishing/regulations_seasons/index.htm; http://www.maine.gov/dmr/lawsandregs/regs/25.pdf
Rhode Island	N	Y	N	N	Y	N	Limited findings	N	Scott Olszewski; <Scott.Olszewski@DEM.RI.GOV>
New Hampshire	N	Y	N	N	Y if more than 12 crabs taken	?		N	http://www.wildlife.state.nh.us/Fishing/fishing.htm; http://www.wildlife.state.nh.us/pubs/digests/SW_2011.pdf
Connecticut	N	Y	N	N	Y	10 traps hauled per day	Blue Crab regs; Lobster Regs incl other crab	Y	http://www.ct.gov/dep/cwp/view.asp?a=2696&q=322740&depNAV_GID=1647; Matt Gates
Maryland	Y	Y	25 bushels per vessel/day	Y, varies 1 bushel hard crabs, 2 doz soft	N/Y	N, limited harvest qty	Blue Crab Regs	N	http://www.dnr.state.md.us/fisheries/regulations
Virginia		Y							http://www.dgif.virginia.gov/fishing/

Stock Assessment Schedule Adjustments- May 2014

American lobster
The American lobster benchmark stock assessment was delayed by approximately four months to allow time for errors in Massachusetts landings to be corrected and incorporated into analyses. Lead analysts and TC members were committed to other assessment workshops this summer, causing the next workshop to be delayed until September. The benchmark peer review will likely occur in late winter/early spring of 2015 in preparation for the Spring Meeting.

Black sea bass
The NRCC is currently considering a new plan for the next benchmark black sea bass assessment in which data preparation work would begin in fall 2014 and modeling work would commence in early 2015. The proposed timeline would include a peer review in 2016, the results of which should be available for 2017 specs-setting.

Horseshoe crab
The ASC and horseshoe crab TC recommend that a benchmark stock assessment be placed on hold until procedures regarding the use of confidential biomedical data in assessment and management are formalized. Until that time, analysts will be unable to provide results of their analyses to peer reviewers, the Board, or the public. In the meantime, updates of available fishery-independent survey indices will be conducted as scheduled.

Multispecies VPA
The ASC recommended that the benchmark review of the MSVPA tentatively scheduled for 2016 be placed on hold until after the results of the 2014 Atlantic menhaden assessment are finalized. Use of the MSVPA for ecosystem-based management will be reviewed at December 2014 SEDAR review.

Northern Shrimp
Northern shrimp did not pass the most recent peer review, so the stock assessment subcommittee recommends a new benchmark sooner than the 5 year trigger, ideally in 3 years (2017). This will allow the SASC and our collaborators at the University of Maine time to address the issues identified by the peer review panel and continue testing of the length-structured model under development.

Spot
The ASC recommends that a new spot benchmark be conducted in tandem with the Atlantic croaker benchmark assessment scheduled for peer review in 2016. Such an approach would maximize the efficiency of data requests and preliminary analyses given the expected overlap among likely TC members, data sets, and modeling issues (e.g., treatment of shrimp trawl bycatch).

Long-Term Benchmark Assessment and Peer Review Schedule

Updated May 2014

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013		2014	2015	2016	2017	2018	SA Staff
American Eel	ASMFC							ASMFC						x		GN
American Shad			ASMFC					x								KD
American Lobster	ASMFC				ASMFC							ASMFC				GN
Atlantic Croaker						SEDAR 20							x			KD
Atlantic Menhaden		Update				SEDAR		Update			SEDAR			Update		GN
Atlantic Sea Herring		TRAC			Update			SARC 54								KD
Atlantic Striped Bass	Update		SARC-Fall		Update		Update		SARC 57			Update		Update		KD
Atlantic Sturgeon											ASMFC					KD, JK
Black Drum												ASMFC				JK
Black Sea Bass		SARC-Spring		DataPoor Wkshp	Update	Update	SARC-Fall	Update	Update		Update	Update	ASMFC	Update	Update	GN
Bluefish	SARC-Spring	Update	Update	Update	Update	Update	Update	Update	Update		Update	*SARC-Spring*	Update	Update	Update	KD
Horseshoe Crab					ASMFC				Update				Update			KD
Multispecies VPA	SARC-Fall				Update			Update			Update					GN, KD
Northern Shrimp	Update	Update	SARC-Spring	Update	Update	Update	Update	Update	Update		*SARC-Spring*	Update	Update	x	Update	KD
Red Drum					SEDAR							SEDAR				JK
River Herring								ASMFC						x		KD
Scup				DataPoor Wkshp	Update	Update	Update	Update	Update (x)		Update	*SARC-Spring*	Update	Update	Update	GN
Spanish Mackerel				SEDAR				SEDAR 28								KD
Spiny Dogfish	Update	SARC-Spring	Update	Update	Update	TRAC	Update	Update	Update		Update	Update	Update	Update	Update	GN
Large Coastal Sharks		SEDAR					SEDAR									GN
Small Coastal Sharks			SEDAR				SEDAR		SEDAR							GN
Spot													x			GN
Spotted Seatrout																KD
Summer Flounder	SARC-Spring	Update	Update	SARC-Spring	Update	Update	Update	Update	SARC 57		Update	Update	Update	Update	Update	GN
Tautog	ASMFC	Update					Update				ASMFC					KD
Weakfish		ASMFC		DataPoor Wkshp	SARC-Spring							ASMFC				KD
Winter Flounder	Update			SARC-Spring			SARC 52						x			KD

SEDAR External Review

ASMFC External Review

Fall SARC Review

Spring SARC Review

x = 5 year trigger date or potential review

Completed

Italics = under consideration, but not officially scheduled

2013 marks transitioning to the new NE Stock Assessment Process

Please note that all species scheduled for review must be prioritized by management boards and Policy Board for the type of review.

Additional Notes:

Black Sea Bass	Delayed to 2016 for new model development; was scheduled for Fall 2014 SARC
Horseshoe Crab	Update underway in 2013; TC recommends update in 2016.
Large Coastal Sharks	SEDAR 21-Sandbar (was LCS, now research); LCS-Dusky (prohibited); SCS-Blacknose (quota); DW Jun; AW Sep-Mar; RW Apr 2011
Small Coastal Sharks	SEDAR 34-HMS bonnethead and Atlantic sharpnose 2013
Spot	PRT annually reviews; recommended for assessment 2016
Spotted Seatrout	States conducting individual assessments

Prioritizing Fish Stock Assessments

NOAA Fisheries

February 2014

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Prioritizing Fish Stock Assessments

NOAA Fisheries

February 2014

EXECUTIVE SUMMARY

Assessments for managed fish and shellfish stocks are an important core activity of NOAA Fisheries. The Magnuson-Stevens Act (MSA) requires that fisheries management be based on the best scientific information available, thus the need for stock assessments. Well-established protocols for these assessments have been developed and highly focused deliverables satisfy the MSA requirements. Stock assessments analyze fishery catch monitoring, fishery-independent surveys of fish abundance, biological and other data to produce the required outputs. These data collection and analysis activities constitute a considerable portion of the NOAA Fisheries budget and it is important that they be prioritized to focus on the most important needs.

The prioritization system described here encompasses the updating of assessments for previously assessed stocks and first time assessments for stocks that have never been assessed. Given that the status of many stocks remains listed as "unknown", a comprehensive scan across all stocks can guide priority for first time assessment among the unassessed stocks. These priorities should be based on fishery importance, ecosystem importance, biological vulnerability to overfishing, and preliminary information on fishery impact level (stock status). This simple overview of information may identify stocks of low importance and risk such that further assessment is a low priority. Some high priority assessments may not be feasible to immediately implement due to lack of data or staff.

For stocks that have been previously assessed, the prioritization approach has three components: (1) setting the target assessment level (how comprehensive an assessment is needed), (2) setting the target assessment frequency, and (3) setting the priority among stocks for conducting assessments to achieve their target levels and frequencies, given available data and assessment capacity. The factors that contribute to setting target levels, frequencies and priorities include: fishery importance, ecosystem importance, stock status, and stock biology. In addition, the recent history of new data acquisition and assessment updates contribute to deciding whether the next assessment should be conducted as an update, which uses the same approach as previous assessments and simply incorporates more recent data of the same types, or as a benchmark assessment that involves a more thorough analysis of alternative approaches and requires a more extensive peer review before accepting results.

A stock's target assessment level, e.g. degree of comprehensiveness, has a large impact on the data requirements to conduct the assessment. Stocks with high fishery importance, high ecosystem importance, and biological factors that lead to high natural fluctuations will warrant high level assessments. High level assessments typically need precise and accurate fishery

independent surveys and data on fish ages from the fishery and the surveys. These high level assessments provide more direct information on fishing mortality and on fluctuations in stock productivity (recruitment), and thus can be more accurate and provide better forecasts of needed changes in annual catch limits. Stocks at moderate levels of importance or expected fluctuations can suffice with less data-rich assessments. Some stocks will be identified as sufficiently minor components of the fishery such that their assessments need not extend beyond baseline monitoring of catch and simple indicators. At all assessment levels, there should be consideration of environmental and ecosystem factors to help distinguish natural from fishery effects on the stocks.

A stock's target assessment frequency should depend on its intrinsic variability over time as well as its importance to the fishery and ecosystem. The greatest fluctuations are expected for stocks with short life spans and high variability in productivity. Stocks with longer lifespans tend to fluctuate less because of the many age classes in the population. High fluctuations create a greater need for frequent updates in annual catch limits. Stocks with high fishery and/or ecosystem importance need more frequent assessment updates to quickly provide access to increases in abundance while keeping the chance of overfishing at an acceptable level. Target update periods are expected to typically be 1-3 years, but some may range up to about 10 years.

The priority for updating an assessment depends principally upon the degree to which it is overdue relative to its target frequency. Stocks that are more overdue will have highest priority for updates. For stocks that are equally due or overdue according to their target frequency, priority will be given to stocks that are on rebuilding plans or are at risk of overfishing or depletion. Among stocks that are still tied, priority would go to stocks that have new information indicating a drift from the previous forecast and to stocks with higher fishery importance.

It is not realistic to create a single national prioritization list because of the importance of regional fishing communities. Further complications include regional differences in total fishery value, assessment data availability, and long-standing processes for arriving at regional assessment prioritization decisions. Additional prioritization challenges are incurred for those Centers that engage in assessments with various international fishery management organizations. While the ideas presented here may be useful in those international settings, the principle focus of this prioritization process will be for domestic stocks in federal fishery management plans.

The proposed prioritization approach centers on the delivery of consistent information to each science/management group to help support and standardize their decision-making with regard to assessment priorities. This report and a database containing all the factor scores will be updated and made available to all parties involved in deliberations regarding assessment prioritization. The first time each Center works on prioritization with its respective management group (Fishery Management Council, regional or international commission, NMFS region or headquarters) may take some time, but subsequent updates should be straightforward and not require a large effort. A portfolio of assessments is expected to evolve, with some activity directed towards first-time assessments, some towards baseline monitoring of low priority stocks, some towards high quality assessments of high priority stocks, and some towards more intensive investigation of ecosystem linkages where needed.

As each region [1]deliberates on its assessment prioritization process, there also should be consideration of the process and time needed to conduct reviews of assessments and to move assessment results into implementation of management actions. It is recommended that each region conduct management strategy evaluations on a few representative stocks in order to understand the implications of stock variability, assessment imprecision, assessment frequency, and time lags between assessment and management implementation. In the future, this prioritization process can provide the necessary framework to guide wise national investments in improving survey and staffing capabilities for more accurate, precise, and timely scientific information in support of stock assessment requirements.

[1] The generic term "region" is used to refer to the group composed of a NMFS Science Center and its management partners.

BACKGROUND

SITUATION

The Magnuson-Stevens Act provides the foundation by which Fishery Management Plans (FMP) are created for fisheries that are in need of conservation and management. Each FMP lists fish stocks that are managed under that plan, and the FMP then specifies optimum yield for that fishery, criteria to determine whether overfishing is occurring or if any of the stocks have become overfished (depleted), and specifying annual catch limits such that overfishing does not occur. Determination of overfishing and overfished levels and annual catch limits is required to be guided by the best scientific information available. Fish stock assessments are designed to provide exactly the quantitative scientific information needed to determine the status of fish stocks and to guide annual catch limits.

Stock assessments are analyses of the population dynamics of the stock. Full assessments utilize catch data from fishery monitoring programs, stock abundance data from fishery-independent surveys or fishery catch rates, and data on the biology of the stock from various sources. These data feed into stock assessment models which integrate the information from the various sources and provide estimates of stock abundance, stock productivity, and fishing mortality over time. If the assessment is based on weak, imprecise data or has not been updated recently, there is a chance that it is providing guidance that is either allowing overfishing or is forgoing available fishing opportunities. It is impossible to confidently prevent overfishing while attaining a yield that is a large fraction of the theoretical Maximum Sustainable Yield (MSY) without having an accurate, precise and timely stock assessment to guide frequent adjustments to catch levels. With accurate and precise stock assessments, the recommended catch can approach the theoretical MSY while having only a small chance of overfishing. Thus, it is important that stocks for which the fishery strives to achieve as large an optimum yield as possible are supported by data-rich, frequently updated stock assessments.

Stock assessments are conducted principally by the six NMFS Science Centers in collaboration with State, Council, international and academic partners. Assessment results are delivered to the NMFS fishery managers, the Fishery Management Councils and international fishery management organizations for their use in developing recommendations for management of the fishery. Because assessments directly support the regulatory process, the assessment results can be contentious. For stocks managed under federal Fishery Management Plans, the MSA's National Standard 2 Guidelines defines the requirement for certifying that the assessment represents the best scientific information available. The reauthorization of the MSA in 2006 specifically addresses this review issue by establishing an opportunity for the Secretary of Commerce with each Council to establish a peer review process, and by designating the Council's Scientific and Statistical Committee with specific roles in providing the Council with scientific advice on fishing levels including the acceptable biological catch that would prevent overfishing. The relationship between NMFS science programs and the regional Fishery management Councils, NMFS regulatory offices and various international partners for highly migratory and other treaty-managed stocks, such as those off Antarctica, is important for successfully turning assessment data into useful management advice on a timely basis. These relationships should include an objective

process to determine which stocks are priorities for assessment, and then to effectively conduct, review, and communicate the assessment to the affected public.

Since publication of the Marine Fish Stock Assessment Improvement Plan (SAIP) (Mace et al, 2001), numerous national programs and working groups have been developed to improve assessments. These include:

- National Stock Assessment Workshops and National SSC Workshops provide a forum for development and advancement of the scientific approaches and protocols;
- Advanced Sampling Technology Working Group develops improved data collection and processing technologies;
- Fisheries Information System program management team coordinates catch monitoring nationally;
- National Observer Program and Marine Recreational Information Program do the same for at-sea observers and recreational fishery catch monitoring, respectively;
- Assessment Methods working group focuses on improvement of the analytical stock assessment methods.
- Species Information System provides a national, web-based portal to all assessments and fishery status determinations and provides outputs that can be efficiently provided to inquiries at both the regional and national level
- Fisheries and the Environment (FATE) and the Habitat Assessment Improvement Plan work to improve the inclusion of environmental, ecosystem and habitat information in assessments.

Collectively, these national groups achieve a federated stock assessment enterprise under the leadership of the NMFS Science Board. This assessment enterprise meets national mandates established by the MSA and other legislation and executive orders, and is responsive to regional assessment needs and opportunities.

The cost associated with conducting a particular assessment is complicated. Each assessment is not an individually contracted task. There is a complex, many-to-many relationship between the several assessments conducted in each region and the several multi-species data sources that support those assessments. Most funds go into large scale, long-term data collection programs that simultaneously collect data on many co-occurring stocks. Assessment programs encompass a broad portfolio of activities from basic fishery data collection, to surveys, conducting standard assessments, and studies to improve consideration of ecosystem, environmental and habitat effects on fish stocks. The fishery-dependent aspect of the overall program is conducted in strong partnership between the Science Centers, Regional Offices, coastal states and marine fisheries commissions and Councils. The fishery-independent aspect of the program is partially conducted through use of the NOAA OMAO Fishery Survey Vessels, as well as fishing vessels contracted by the Science Centers and various partners, state surveys, and cooperative research programs. Further the costs of conducting assessments vary tremendously depending on the type of assessment, size of the stock, its range and habitat. The many-to-many relationship between funding of data collection programs and resultant assessment outcomes confounds detailed budget accounting. Thus, identification of which assessments would be conducted on the basis of new funds is fundamentally fuzzy. New funds build regional assessment capacity, including expanded

data collection. The returns on these investments result in improved assessment output some years hence depending on the specifics of the situation.

The SAIP in 2001 provided a baseline description of the NOAA Fisheries' stock assessment enterprise. It set the goal of at least baseline monitoring (basically just catch and perhaps some simple indicators) for all stocks, standard assessments for core stocks, ecosystem-linked assessments for select stocks. The SAIP defined five levels at which an assessment could be conducted:

1. Assessment based on empirical trends in relative stock abundance;
2. Assessment based on a snapshot equilibrium calculation;
3. Assessment based on time series of catch and an abundance index to support application of a dynamic model;
4. Assessment is age-structured, so needs time series of age and/or size data and can now estimate changes in fishery characteristics over time and can estimate fluctuations in annual recruitment, and has direct information on the fishing mortality of each year class entering the stock;
5. These assessments link to ecosystem, habitat or climate factors to help explain and forecast the fluctuations that are empirically measured in a level 3 or 4 assessment.

Today, assessments at level 3 are generally considered to be able to determine overfishing and overfished status, but are marginal for the purpose of forecasting changes in annual catch limits. Most assessments are conducted at level 4 today and a few have achieved a level 5 status. Several different modeling approaches are used, but there has been evolution towards models that are internally age-structured but very flexible in data requirements. A revision of these levels is underway as an update of the SAIP.

NEED FOR PRIORITIZATION

The demand for rapid updating of assessments became acute with the requirement for annual catch limits in all fisheries. If stocks fluctuate in abundance and an annual catch limit is to be set at a level that will attain a target level of fishing mortality, then the ACL must be updated sufficiently close to the onset of a fishing season in order to take advantage of timely information on the forecast abundance of the fish stock. This is because the ACL is effectively the product of a target fishing mortality level (F) and the forecast of the available stock biomass (B) in the upcoming fishing year. So if the actual B in the upcoming year differs from the forecast B, then catching the ACL will over- or under-achieve the target F level. Hence, consideration of the target assessment frequency should also take into account the time it takes to make management updates (including ACL adjustments) on the basis of assessment updates. Where there are high fluctuations in B, there is greater need for shortening the timeframe between data collection and management implementation. For example, to the assessment to management transition is just a few months for short-lived species like Pacific salmon managed by the Pacific Fishery Management Council and by the US-Canada process managing the highly fluctuating Pacific whiting stock which begins entering the U.S. fishery at age 2. Other regions have developed short-turnaround processes for some key stocks, but there are insufficient resources to assess all stocks on an annual basis, and many stocks

do not need annual assessments. Hence an objective and quantitative approach for establishing assessment priorities is necessary.

NMFS Science Centers have recognized the need for prioritization and streamlining of the assessment process. For example, the Northeast Fisheries Science Center, at the request of the Northeast Regional Coordinating Committee, created and used a revised process in conducting assessment updates in 2012 (NEFSC, 2012). A particular focus of this revision was an effort to move more assessments from a time-intensive benchmark assessment process, to a streamlined update process. Many of the concepts embodied in the NE process are represented in the national prioritization process presented here.

Other nations have also recognized the need for coordinating the pace of assessments and the expectations for timeliness of management updates. In Australia, Dowling et al. (2013) investigated the historical patterns of investment to attempt to better understand the trade-off between research and management costs, risk to the stock and ecosystem, and level of allowable catch. In Europe, the ICES organization formed a working group (WKFREQ) to investigate factors that could allow for reduced frequency from their typical annual assessment updates (ICES, 2012). In 2011, ICES conducted annual assessment updates for 144 stocks and biannual assessments for 48 stocks, thus nearly twice the number of assessments than are conducted in the U.S. each year The ICES report reached the following conclusion with regard to reducing assessment frequency and deriving multi-year management advice from some assessments:

> *"WKFREQ suggests that multiannual management approaches can only be considered for a limited subset of ICES stocks, namely those with robust assessments and modest exploitation, those with a limited amount of new information each year, those with very noisy data, those in which management is only weakly directed by assessments, and those in which individuals are very long lived and exploitation is (again) modest. Stocks in any other circumstances are unlikely to be suitable for a multiannual approach.*
>
> *Even in suitable cases, the risk of changing to a multiannual system needs to be evaluated using a quantitative approach such as an Management Strategy Evaluation. Such an evaluation needs to consider the assessment model used and its uncertainty, survey and recruitment variability, the initial state and trajectory of the stock, the management approach used, how well the fishery performs economically, and more qualitative aspects such as political sensitivity. An evaluation that ignores one or more of these aspects in determining suitability may well reach the wrong conclusion, with potentially damaging consequences."*

The U.S. situation differs from the European situation in that we have been successful in reducing overfishing, thus achieving a more modest exploitation rate for more stocks, a situation that is more amenable to reduced assessment frequency. Nevertheless, the WKFREQ recommendation for Management Strategy Evaluation holds true for the U.S. as well. A prioritization system informed by MSE will be more objective and transparent as to its expected benefits.

Scope: Stocks and Regional Scale

The species (stocks) to be considered in an assessment prioritization scheme are numerous and diverse. In some cases, a managed stock is a geographic subset of a species. In other cases, the

stock is a complex containing a few to many species. The total number would be greater than 1000 if all species within complexes were counted individually. The fact that some species have been lumped into a complex for management purposes does not completely discharge stewardship responsibility to assure that members of the complex are not being unduly affected by the fishery. Across the nation, FMPs have varied tremendously in the degree to which they have included species within the plans. Some are single-species plans and some include a wide range of species that are targets of the fishery or associated with these target species in some way. In some cases, the FMPs have included a large number of co-occurring species which, by their inclusion, would inherit the requirements for status determinations and annual catch limits. The 2009 update of the National Standard 1 Guidelines recognized this conundrum and established a category termed "ecosystem component species". A species can be placed in the ecosystem component category if it is not targeted or retained by the fishery and its level of bycatch is determined to have a negligible impact to the stock. Thus, a low-level stock assessment is to determine if a species is a member of a management unit or is an ecosystem component species . In 2013, there are 478 managed stocks and stock complexes in the fishery management plans.

The species scope for this plan is also complicated by our engagement in the international arena. In some cases the managed stocks are included in fishery management plans, but the assessments occur in an international working group setting that is not under Council or NMFS control and involves factors that would not be easily incorporated into a US domestic prioritization process. In other cases, there are internationally managed stocks such as CCAMLR managed Antarctic stocks, that are outside of FMPs but still require use of US assessment resources.

In 2005, the Fish Stock Sustainability Index (FSSI) was created and the 230 stocks included in this index effectively became the previously undefined "core" stocks from the SAIP. FSSI stocks contribute 90% of the catch, although some stocks are on this list because of a history of overfishing or other reasons to establish importance. A Departmental-level performance measure was created to track progress in improving the FSSI and in providing adequate assessments for these 230 FSSI stocks. An adequate assessment is considered to be one that can provide information relative to status determination criteria[2] on both overfishing and overfished status (SAIP level 3), has been updated within the past 5 years, and has been validated as best scientific information by a review process. The breakout of stocks and stock complexes is shown in Table 1. They are unequally distributed among the jurisdictions of NMFS regions, regional Fishery Management Councils, and Fishery Management Plans. These 46 FMPs each contain from 1 to many tens of managed stocks.

The proposed schedule for application of the prioritization process would have each Center take a tiered approach with their respective Regional Council or other partners to cover all stocks in their jurisdiction. The first tier would cover the domestically assessed and managed FSSI stocks. The second tier would extend to other managed stocks, species within managed stock complexes, ecosystem component stocks, non-FMP internationally managed stocks, and state/commissioned managed stocks as appropriate for the particular Center.

[2] Note that level 1 and 2 assessments support some status determinations and status determinations are retained even when assessments are more than 5 years old.

We propose to take a regional scope to prioritization because of the large challenge in calculating each stock's contribution to national benefits. Optimum yield from fisheries should be defined in terms of benefits to the nation, so it is logical that the prioritization of assessments also be in national terms. In practice, however, the degree to which social, economic, ecological and biological analyses can quantify optimum yield in terms of benefits to the nation is quite limited. The importance of regional communities is a challenge to quantify. Typically, optimum yield is defined only in terms of an amount of catch for a particular stock and is not even extended to a multi-species analysis within an FMP. Consequently, it will not be feasible to quantitatively define absolute priorities for stock assessment at a national level. The assessment prioritization process described here will focus on facilitating the standardization of regional prioritization processes and providing a national reporting system for the results of this regional prioritization. Higher level decisions regarding allocation of national resources between regions can be guided indirectly by the results of the regional prioritization.

PRIORITIZATION OVERVIEW

In brief, the proposed prioritization process involves the following steps:

1. Target Assessment Level and Frequency: Among unassessed and previously assessed stocks, set medium-term assessment goals
   - Among stocks that never have been assessed, set priority for first-time assessment, if any, or conclude that current level of baseline monitoring is sufficient.
   - For stocks that need assessment, set target assessment level; this drives the data requirements
   - Set target assessment update frequency for each stock
2. Prioritize to Achieve Targets: Annually update priorities for conducting assessments, with a portfolio approach to allocate assessment capacity to achieve a mix of first-time, benchmark, and update assessments:
   - Benchmark assessments for assessments needing improvement or for which new data will allow advancing to higher level;
   - Update assessments for stocks that are at or exceed their target update period.

The Target-Setting stage is important because it is not possible to prioritize without having clear targets to be achieved. These targets relate to how comprehensive the assessment should be (e.g. its assessment level) and how frequently it should be updated. While it is inevitable that current data availability will influence consideration of a stock's target level, this should not be an overriding influence. It will be better to establish goals that are independent of current data and then to consider the gap between current data and the stock's goal. The Prioritization stage then directs assessment efforts to accomplish these targets. The "First Time Assessments" distinction is needed because it is not realistic to establish a single set of factors that encompasses both the updating of assessments for previously assessed stocks and first time assessments for stocks that have never been assessed. For stocks that have never been assessed, we lack the information needed to establish longer-term expectations for its assessment level and frequency. In the sections

below, we will first describe the factors to be considered in the process, and then describe how these factors are used to assign targets and priorities to stocks.

FACTORS TO CONSIDER IN TARGET SETTING AND PRIORITIZATION

The major factors that influence the setting of assessment targets and priorities are described in this section and summarized in Table 2. These factors are:

1. fishery importance (commercial and recreational value to the regional fishing communities, with additional considerations);
2. ecosystem importance (role of the stock in the ecosystem and strength of its interactions with other species);
3. stock status (relative to target and limit levels of abundance and fishing mortality);
4. stock biology (how much change is expected per year, on average);
5. history of assessment, including availability of new information to resolve extant issues or indicate a change in stock abundance.

FISHERY IMPORTANCE

Fishery importance on a per stock basis would best be described in terms of benefits to the nation from fishing activities affecting that stock. As described earlier, it is not feasible to quantify importance in these terms, nor would it be politically feasible to create a system that ignored the regional importance to coastal fishing communities. It would be ideal to be able to calculate the incremental value to the nation of conducting an assessment on one stock versus another stock, but such a detailed economic analysis is not feasible. Consequently, the proposed system described here will use both commercial landed value and recreational catch, while providing an opportunity to adjust a stock's importance level according to less quantifiable factors, including stocks that are limiting factors in mixed stock fisheries, stocks that have recognizable non-catch value to society, and stocks that contribute to subsistence fisheries. Importantly, the commercial and recreational scores will be provided separately and not explicitly added together.

For a stock's commercial importance, the landed value of the catch will be the data from which a non-linear ranking would be calculated. If raw catch value is used, then the most valuable stocks would overwhelm the low valued stocks and there would be little ability for other factors to establish a priority for assessment of the low valued stocks, for which there still is a mandated need to prevent overfishing. On the other hand, if the stock-specific catch values were binned into categories with equal numbers of stocks and bins were assigned scores of 1 to 5, then then high value stocks would receive only a small amount of higher priority than the low value stocks. The proposed progressive score transforms the raw catch values as $\log_{10}(1.0 + \text{landed value})$ to reduce the range, and then scales this range to have a maximum value of 5.0.

Although good databases with commercial catch by species are available, commercial and recreational catch values on a stock-specific basis for all stocks are not readily available. A preliminary exercise collected catch information from each region for all stocks in 2009. It is used here to demonstrate some general characteristics of the range of catch across stocks. Annual updating of this stock-specific catch information is underway to provide commercial and

recreational catch relative to annual catch limits. These data will be used for the prioritization process when they become available.

An example exercise for fishery importance used the commercial domestic landed catch amount in 1000s of pounds of whole weight for 2009. On this basis, stocks with a catch of approximately 100 million lbs would have a score of 4.0 (after rescaling so that the maximum score would be 5.0), 5.5 million for a score of 3, 310 thousand for a score of 2, and 16 thousand for a score of 1.0. With this approach, many FSSI stocks would have values in the range of 2-3 (Figure 1a), and most non-FSSI stocks would have values less than 1.0, and many would score near 0. Note however that some of these zero scores were because catch data on some of the minor, unassessed stocks were not available.

Recreational catch in 2009 was processed in the same way as the commercial catch, e.g. the recreational score is $\log_{10}$(1.0 + retained catch in 1000 lbs), then scaled to have a maximum score of 5.0. As with commercial, this is done on a national basis. There are 134 FSSI stocks and 215 non-FSSI stocks for which we found no reported recreational catch in 2009 (Figure 1b). The top three recreational stocks (Table 3), with catches of 9-17 million pounds, were: Summer flounder - Mid-Atlantic Coast, Bluefish - Atlantic Coast, and Yellowfin tuna - Central Western Pacific.

Scaling each of commercial and recreational to have a maximum scale of 5.0 on a national basis has desirable characteristics for this exercise, but should not be interpreted as a judgment that commercial and recreational value are of equal importance. It would take a very involved economic analysis to actually place recreational value on the same basis as commercial value. Consequently, the commercial and recreational scores will be kept separate. With catch ranked nationally in this way it is still feasible to use the national values within each region or within FMP. By using a maximum of 5.0 for each, this essentially places commercial and recreational importance on the same scale nationally, however this will play out differently within each region as these scores are used to actually assign assessment priorities. Off Alaska, recreational catch of federally managed stocks is very small compared to commercial catch so the low recreational score for all stocks will have negligible effect on the relative ranking of stocks. Whereas in the Southeast, recreational catch is greater than commercial catch for many stocks, so both the commercial and recreational rankings will have an impact on prioritization. The scaling of commercial versus recreational value and the inclusion of non-catch and subsistence would need further attention if comparisons between regions are to be considered.

Figure 2 shows that the stocks with highest recreational score nationally tend to have at least a moderate score on the commercial scale. This is true for both the FSSI stocks and for the non-FSSI stocks. On the other hand, stocks with the highest commercial score nationally tend to have very low recreational catch.

The values displayed here have been based on landed catch amount, not value, and have only been displayed nationally, not regionally, so these figures and lists are preliminary and will certainly change as landed value, not catch, is used as the common metric.

FISHERY IMPORTANCE MODIFIERS

In addition to the commercial and recreational score, additional factors can contribute to the fishery importance score for a stock. These include:

- +1.0 for stocks on rebuilding plans because their recent catch value is depressed below long-term potential;
- +1.0 for stocks that have a particularly high constituent demand for excellence in stock assessment. For example, stocks that are in catch shares programs or stocks that are in a multi-stock fishery and their status is limiting the fishery's ability to harvest more productive stocks in that multi-stock fishery. In this case, good assessment of the smaller, less valuable stock is important to prevent undue restriction on harvesting of the more valuable stock. A cap on the percentage of stocks that can receive this bonus will need to be established to prevent excessive usage rendering it meaningless.
- +1.0 for stocks that have a high non-catch value (for example underwater viewing of reef fish).
- +1.0 for stocks important to subsistence fishing.

ECOSYSTEM IMPORTANCE

All species have ecosystem importance but their importance increases if they constitute a major forage species for one or more managed species, or if their role as a predator is important for structuring ecosystems, including changing the natural mortality rate of other species. Importance would increase further if the forage species was critical for an endangered or protected species. The ability to define ecosystem importance for predator species is more difficult since the consequences of apex predator depletion are often difficult to trace, much less quantify. However a mixture of food habits data, basic ecological information and model exploration (when available) can usually identify ecosystem components that have potential or likely substantive impacts on predation mortality rates or community structure. As the data and models to make such determinations are evolving, default scores of 1 are likely to be most reasonable for most species in the absence of evidence of some sort to the contrary.

Ecosystem Score considers both bottom up and top down possibilities where:

"Bottom-up" (Forage or habitat) score

1. if only a minor dietary or habitat provider for managed stocks (e.g., Pacific grenadier)
2. if major dietary or habitat component for one or more managed stocks (e.g., Pacific cod, corals)
3. if major dietary or habitat component for a broad range of managed stocks, or an endangered or otherwise protected and vulnerable stock (e.g., walleye pollock, skipjack tuna, menhaden, krill, shrimp)

"Top-down" (predator/ecosystem interaction) score

1. if change in abundance would likely have minor or unmeasurable impacts on other managed stocks (e.g., splitnose rockfish)

2. if change in abundance would likely have notable changes in predation mortality, recruitment or other vital rates for one or more managed stocks (e.g., lingcod, marlin)
3. if change in abundance would likely result in substantive changes in predation mortality, recruitment or other vital rates for one or several managed stocks (e.g., arrowtooth flounder in Gulf of Alaska).

Ecosystem score = maximum of above scores, so could be up to 3. Assignment of scores will need to be an iterative process to achieve a balanced approach across regions.

Ecosystem Effects

The discussion above with regard to ecosystems is based upon the degree to which harvested fish stocks are important to ecosystems, thus harvest levels for these fish stocks must be managed to protect the ecosystem of which they are members. The converse is also true; changes in the ecosystem, climate, and habitat will affect the productivity of fish stocks and better assessments will take these effects directly into account. More complete single species stock assessments are designed to be flexible enough to track the fish stock's response to these factors, but the assessments do not include the factors directly, so their response at best will lag behind true changes and forecasts can be biased. Here in this prioritization document, we have not attempted to include the need for studies to better understand these effects on fish stocks and to incorporate them directly into the assessments. NOAA recognizes the need for such work, otherwise we risk losing sight of the forest while focusing too closely on the trees. At this time, NOAA Fisheries is working on an update to the Stock Assessment Improvement Plan (2001). There the issue of expanding assessments to more directly account for these effects will be addressed. Future evolution of a prioritization process should seek a more broadly balanced portfolio that includes such ecosystem work.

Stock Status

The stock's status is based on the most recent estimates of the stock's abundance (spawning biomass, SB) and fishing mortality rate (F) relative to limits and targets for these quantities. For stocks that have previously been assessed, the intent would be to use the results of the most recent assessment to guide the importance of conducting an update of that assessment. The minimum score is 2 for a stock that has a low F, is abundant, and is not on a rebuilding plan. The maximum score is 9 for a stock that is overfished, is experiencing overfishing, and is on a rebuilding plan. Stocks that are near their target level of F and SB will have a score of 4. Stocks that are currently unknown with regard F and SB will have a score of 6.

F Category	Score		Abundance Category	Score
LOW IMPACT $F_C <= 0.25*F_{MSY}$	1		ABOVE TARGET $SB_C > 1.25*SB_{MSY}$	1
MODERATE IMPACT $0.25*F_{MSY} < F_C <= 0.9*F_{MSY}$	2		NEAR TARGET $MSST < SB_C < =1.25*SB_{MSY}$	2
CAUTION or UNKNOWN $F_C <> F_{MSY}$ is unknown	3		CAUTION or UNKNOWN $SB_C <>$ MSST is unknown	3
HIGH IMPACT $F_C > 0.9*F_{MSY}$	4		OVERFISHED $SB_C <=$ MSST	4
			On Rebuilding Plan	" +1"

Where:

F_C is the most recent (e.g. current) fishing mortality rate

SB_C is the most recent spawning biomass

SB_{MSY} is the target spawning biomass level, or suitable proxy such as 40% of $SB_{unfished}$

F_{MSY} is the limit fishing mortality rate, or suitable proxy, above which overfishing is occurring

MSST is the limit spawning biomass level, or suitable proxy, below which overfished status occurs.

Among 220 assessed stocks with information on F/Fmsy in 2013, the range of values is displayed in Figure 3. 88% have F/Fmsy < 1.0. Below that level, there is no obvious clustering or breakpoints; stocks are nearly uniformly distributed according to this ratio as shown by the nearly linear pattern for the lower 80% of the stocks. There are 187 stocks in 2013 with information on B/Bmsy. Of these, there are 49% with B/Bmsy > 1.25 and 65% with B/Bmsy > 1.00.

Over time, the boundaries between the levels may needed to be adjusted, or replaced by a system that uses the estimated ratios directly rather than use scores associated with binned values. For example, the F score could be equal to 4.0*F/Fmsy, and the B score could be 2.0*Bmsy/B (note the inverted ratio). For now, the binned approach has the advantage of providing a scoring system even when only approximate values are available.

STOCK BIOLOGY

The consideration of stock biology is important because it sets the scale for how much the stock abundance, and hence its ACL, is expected to change between assessments. This will be a factor in determining the types of data needed and a primary factor in setting the target frequency of assessment updates. There are two counter-acting forces to consider.

- One factor is the annual fluctuations in recruitment of young fish into the stock. This "recruitment variability" has a coefficient of variation often near 60% and can be greater than 100% for some stocks. Stocks may also fluctuate over time if there are changes in adult natural mortality and/or growth.
- The counter-acting force is the inertia to change that result from the fact that there typically are many age groups in the stock, so the total stock abundance tends to average out the fluctuations. When adult mortality is high, the occurrence of older age

groups is diminished. Since the goal is inertia that opposes too frequent changes in annual catch limits, a suitable proxy is the mean age of fish in the catch multiplied by some factor to be determined later. The mean age should be measured as an average over several years to smooth out the effect of recruitment fluctuations, and in cases where it cannot be directly calculated, it should be estimated from life history correlates.

For the purposes of setting target levels for various data types (see Target Assessment Level below), it is suitable to simply categorize stocks as having a low, moderate, or high expected degree of fluctuation. For the purposes of setting the target period between assessments, the protocol will use the mean age of fish in the catch multiplied by a factor, and then to add or subtract one year based on the degree of recruitment variability.

Another aspect of stock biology that was considered, but not quantitatively included here, is the susceptibility of the stock to the adverse effects of overfishing. Here the arguments with regard to overfishing and overfished are different, but both related to the inertia concept. For short-lived stocks, which have high natural mortality rates, the target levels of fishing mortality are correspondingly high, and the fraction of the stock that is caught each year is high. Thus, if the ACL is set too high due to scientific uncertainty, or it is exceeded, then the fraction of the stock that escapes the fishery could be quite low. If the stock is able to continue to produce good recruitment from this low spawning biomass (i.e. high recruitment resiliency), then it should recover quickly from this overfishing event. On the other end of the spectrum are stocks with low natural mortality rates and low target fishing mortality rates (sometimes <5% of the available stock). In this case, a one year excess catch will have little impact on the fraction of the stock that escapes the fishery that year. However, if the assessment is not updated for several years, or the same assessment bias persists for several assessment updates, then the catch overage will compound annually. Although such long-lived stocks are only slowly affected by short-term moderate overfishing, if they do decline into an overfished condition then it could take many years for them to rebuild because annual recruitment is a small fraction of the standing stock. The Productivity-Susceptibility Analysis (PSA) (Patrick et al. 2010) includes vulnerability due to slow-recovery and low M, and will be used in the examination of stocks for first-time assessments in the next section. For the prioritization of previously assessed stocks, we have not included the PSA score directly because several of the PSA factors (natural mortality rate, F/Fmsy, etc.) are already included elsewhere in the prioritization.

History of Assessment and New Information

Some new information is simply the addition of a new data point to the end of a time series in order to track changes in the stock. These new data will not perfectly match the forecast from the previous assessment because of two primary factors. One is that all data have some measurement error so they individually will not perfectly represent the state of the fish stock. The other is that all models are simplifications of the processes in nature so cannot take into account all factors that cause changes in fish stocks over time; if the forecasts could be perfect, new data would not be needed. So the new data are used to update the calibration of the model, but the updated model should not overreact to the new data because all data have measurement error. Assessment models are designed to get a good balance between tracking the process over time while not getting off

track due to noisy data. When data are noisy, it is best to wait a few years to accumulate data points to better average out the noise. But when data are of high quality, then they can be used to quickly update stock status.

Another kind of new information is of a more fundamental nature. For example, the introduction of a new survey that directly measures fish abundance, or the completion of a new research project that provides a more accurate measure of natural mortality. When situations like this occur, then it is important to conduct an assessment to take into account this new information. However, all assessments have some number of factors, such as natural mortality, for which the information has uncertainty. It is not useful to simply redo the assessment to re-examine these issues unless it is known ahead of time that new information to help resolve the issue will be available. Otherwise, the assessment effort is better directed to other stocks.

PRIORITIZATION PROCESS

The prioritization process uses the above factors in two steps. First is the setting of goals for the comprehensiveness and timeliness of assessments for each stock (Figure 4). This needs to be done as an initial step and updated occasionally, but not annually. This step includes consideration of which stocks need assessments and which of these assessments can be simple baseline monitoring. It is expected that these goals will outreach current capacity to conduct assessments. The second prioritization step is near annual evaluation of changing stock status, new information, fishery importance, etc. in order to establish priorities for conducting assessments (Figure 5) to achieve, to the extent possible, goals of comprehensiveness and timeliness.

SETTING ASSESSMENT GOALS

FIRST-TIME ASSESSMENTS

Many stocks, most with low amounts of catch, have never been assessed and have little data suitable for use in an assessment. Consequently, much of the information needed to establish targets and priorities for future assessments are not available. These unassessed stocks need a quick examination to determine which of these can stay at an unassessed level, which can be adequately tracked with simple baseline monitoring, and which need a first time assessment. Two recently developed tools can assist in this task.

One tool is the Productivity-Susceptibility Analysis (PSA) (Patrick et al., 2010). This procedure looks at simple information regarding the productivity of each stock and its exposure (susceptibility) to the fishery. Together these produce a score that ranks stocks according to their vulnerability to being overfished. Application of this procedure can identify those stocks that are potentially at risk and thus in need of assessment to provide a more complete evaluation of the status of the stock.

Another useful tool is designed to provide a data-poor approach to setting an Annual Catch Limit (Only Reliable Catch – ORCS) (Berkson et al., 2011). This tool looks at available information

regarding catch, other species in the fishery, and simple indicators of trends in stock abundance (see Table 4 which reproduces Table 4 from the ORCS report). It evaluates whether recent exploitation rate is light, moderate, or heavy; then provides advice on an Annual Catch Limit that should prevent overfishing until a more complete assessment can be completed.

The priority for first-time assessment of stocks can then be based on the PSA's biological vulnerability to overfishing, the ORCS' information on fishery impact level (stock status), and fishery and ecosystem importance. PSA scores range from 1.0 for the lowest vulnerability to 3.0 for the highest vulnerability. The ORCS score for exploitation status also ranges up to a maximum value of 3.0. These two scores will be added to a fishery importance score and ecosystem importance score to obtain an overall score. In some cases, data to even implement PSA and ORCS will be lacking and expert judgment will be needed. The result will be a set of scores within a region to rank stocks according to their need for a first time assessment. Some of these will show a high need, but sufficient data to conduct the assessment may be lacking. Others may have sufficient data for an assessment, usually because data has been collected by a multi-species sampling program that provides data on all encountered species. Some species will score low on this scale, so have low priority for immediate assessment. They should not be ignored. Baseline monitoring to the extent feasible should continue and PSA and ORCS should be updated on a 5-10 year basis.

Previously Assessed Stocks

After a stock has been assessed once, there should be enough information available to evaluate medium term goals for future assessments. Ideally the goal would be stated in terms of a desired degree of statistical confidence in assessment results. While many assessments present results with confidence intervals, the methods are too diverse to support direct comparison and all are not yet able to incorporate the effect of changing ecosystem factors on uncertainty in assessment results. Consequently, a simpler approach is to establish a target for the comprehensiveness (level) of each assessment, and a target frequency for updating the assessment.

Level and frequency are considered separately because the types of resources needed to accomplish them are quite different. Increasing the level of an assessment generally requires acquiring a new kind of information. For example, going to an age-based assessment requires routine collection of data on fish ages. Addition of fishery-independent survey is another type of investment that can improve assessments. Increasing the frequency of assessments does not require new kinds of data, but does require addressing bottlenecks that impede conducting more assessments each year. For example, these bottlenecks could be more age readers to process existing age samples more quickly, more scientists to simultaneously work on more assessment updates, and/or better assessment standardization to streamline the assessment review process.

TARGET ASSESSMENT LEVEL

High level assessments that need more types of data should be reserved for situations with high ecosystem importance, high fishery importance, and/or biological factors that create a high level of natural fluctuations. Stocks that are only moderately important to the fishery and ecosystem and which are not expected to fluctuate much in abundance (and hence ACL) can suffice with a lower level assessment and may not warrant the extra expense to develop a targeted fishery-independent survey and collect extensive age data in order to conduct a higher level assessment.

Fishery importance affects the target level because higher assessment levels (e.g. with routine age-structured data) are more responsive to changing conditions, so can more closely track stock abundance for these high value stocks. Models that use age data can have improved forecasts of upcoming changes in stock abundance and potential yield. Low value stocks are unlikely to warrant the extra expense for collection of age data or instituting a dedicated fishery-independent survey. High value species tend to be more abundant and thus easier to survey because they are detected in most samples. Paradoxically, species that are less common are difficult to survey because their low encounter rate means that even more sampling stations may be needed to attain adequate precision. Fortunately, many fishery-independent surveys are able to simultaneously collect data on a wide range of species regardless of their value to the fishery.

Stocks with high ecosystem importance warrant higher level assessments to guard against ecosystem harm. Assessments backed by fishery-independent surveys and age composition are better able to investigate ecosystem interactions and work towards taking these interactions into account in the assessment.

The biology of the stock influences the assessment level. Stocks with high fluctuations in productivity benefit from age-structured assessments that can better track and forecast the fluctuations. These stocks are exhibiting sensitivity to ecosystem/habitat/climate shifts that warrant age-structured assessments to track these fluctuations and perhaps ecosystem investigations to incorporate the factors causing the fluctuations into the assessment. Note that a stock's sensitivity to ecosystem and environmental change is different from a stock's importance to the ecosystem.

Additional types of data allow for improved assessment calibration. Some assessments simply use a sufficiently long time series of a fishery-dependent stock abundance indicator and catch to calculate the degree to which changing levels of catch cause changes in the stock indicator. A more important stock may warrant requesting a more expensive fishery-independent stock abundance indicator, rather than a fishery-dependent indicator, to have more confidence in the standardization of the indicator over long time periods. Moving to an age-based assessment can provide a more direct indicator of the level of fishing mortality and an ability to account for natural fluctuations in stock productivity (recruitment). These assessments require addition of size and/or age data. These data require biological sampling of the fisheries and surveys, followed by laboratory processing to determine the ages of the sampled fish. Where time series are short and not informative about the impact of the fishery on the stock, then addition of advanced technology data collection can provide a directly calibrated measure of fish abundance. Where changes in fish stocks over time are not explainable simply by fishery effects, then addition of information about changing ecosystem/environmental/ habitat factors can help resolve the impact of fisheries.

The assessment levels in the SAIP (Mace et al, 2001) were described in terms of the type of model used. Separate factors were used to score the quality of the fishery-dependent biological data and the fishery-independent survey data. Since that time, evolution of assessment software has blurred these assessment model levels such that it now seems more important to focus on the types of data available than the model itself. For the purposes of prioritization, a system that relates directly to possible investment decisions is more pertinent. Higher levels of assessment modeling require more types of data and it is the acquisition of these data on an ongoing basis that constitutes much of the cost of more comprehensive and more completely calibrated assessments. The SAIP is currently being updated and a revision of the categorization used to describe the level of data available for each stock will be included and then used for this prioritization process also. While the SAIP will be descriptive of the current state of data availability, the prioritization process will add consideration of whether this state is satisfactory or if improvements are needed.

These target assessment levels will serve two purposes. First, as new data become available to move a stock up to its target level for a data type, then priority for updating that stock's assessment to use these new data will increase. Second, investment decisions can be guided by the gap between current data availability and the data needed for that target level.

TARGET ASSESSMENT FREQUENCY

The period between assessments defines how closely the assessment will be able to track fluctuations in stock abundance and to forecast corresponding changes in the annual catch limit. Stocks with short life spans and/or high fluctuations in productivity are most in need of frequent updating to keep catch limits up-to-date. Fishery importance also is recognized as a factor in the frequency of updates.

One paradox occurs when the survey or fishery data used to track stock abundance are noisy relative to the magnitude of the real fluctuations in the stock. Often the new survey result will lead to constituent requests to quickly update the assessment because the data seem to indicate a change in stock abundance. Unfortunately, the models will tend to track the noise in the latest datum and cause excessive fluctuations in management advice. A better response when the signal/noise ratio is low could be to slow down the frequency of assessment updates so that a modified assessment setup is better able to smooth out these data fluctuations and provide more stable management advice. Ideally, one would conduct a management strategy evaluation to determine the degree to which uncertainty in the assessment increases as the interval between assessments increases. It is recommended that such evaluations occur on some example stocks in each region.

Stocks that are expected to have high natural fluctuations not only need frequent updating, they also need suitable data to use in this updating. For short-lived species, this means an indicator of changes in stock abundance must be very quickly (months) turned into management advice on catch limits for the upcoming fishery season. This is a major rationale for the exemption from ACLs for stocks with one-year life spans; otherwise the ACL would always be out of date relative to the current fluctuation in actual stock abundance. For medium lifespan species, this generally means

that size and/or age data needed for estimation of incoming recruitment will need to be collected and processed quickly to enable a quick turnaround from data collection to management action.

Factors Affecting Target Assessment Frequency

A pragmatic starting point is to use the mean age of fish in the catch as the target interval between assessments. Alternatively, one could use a formula based on total mortality (Z) or natural mortality (M) as roughly equivalent (Fig. 6). If all fish are recruited at age 1, then mean age in the catch is closely approximated by 0.5+(1/Z), or by 0.5+(1/(2*M)). It may be necessary to multiply this mean age by a scaling factor to achieve a good overall level of assessment frequency, and to average mean age data over several years to remove the effect of variable recruitment. The value of this scaling factor will be set after enough of the data elements are collected to do a preliminary application of the target setting process. Then decrease this interval by a specific amount for stocks with high levels of recruitment variability, or increase by a specified amount for stocks with low variability. A nonlinear scale or a cap may be needed so that very long-lived stocks are not assigned an unreasonably long assessment interval. Evaluation and refinement of this approach and consideration of additional biological factors must wait for collation of life history information for more stocks.

Fishery importance and ecosystem importance should affect the target frequency of assessments because of the improved fishing opportunity obtained by quickly tracking upturns in stock abundance, and conversely the fishery and ecosystem risk avoided by preventing acceleration of downturns.

Arguably, stock status could influence the target frequency because stocks that are known to be approaching an overfished or overfishing condition need to be watched more closely to enable ACL adjustments to avoid crossing into overfishing or overfished conditions. Because stocks that are approaching overfishing or overfished status will also tend to be stocks that have high fishery importance, and because a stock's status is constantly changing, it seems preferable to use fishery importance in setting the target assessment frequency and then use stock status in the prioritization step as a tie-breaker among stocks that are equally due for assessment. While stocks that are on rebuilding plans, or approaching an overfishing or overfished condition need somewhat more frequent updates because these conditions are indications of changing stock abundance or fishing mortality rates, the prioritization system should ward against excessive diversion of assessment efforts from healthy stocks that are supporting major fisheries. Doing so will weaken tracking of these stocks and hinder close tracking of their available yield. The proposed system will prevent this diversion because the years overdue will be a primary factor in setting assessment priorities.

Target Assessment Frequency

1. **Mean Age of Fish in Catch * Scaling Factor**
2. **Adjust for recruitment variability:**
    a. **-1 year(e.g. more frequent) for stocks with high recruitment variability;**
    b. **+ 1 year for stocks with low recruitment variabilityvariability**
3. **Adjust for fishery value:**
    a. **– 1 year for stocks with commercial or recreational score above a level to be specified**
    b. **+ 1 year for stocks with commercial and recreational score below a level to be specified**
4. **Adjust for ecosystem importance similarly to fishery value**

EXAMPLE:

1. **Mean age in catch is 4.5 years and scaling factor is 1.0;**
2. **Recruitment variability is high (so subtract 1 year);**
3. **Fishery value is high for commercial but low for recreational (so subtract 1 year);**
4. **Ecosystem importance is moderate (so no change to target);**
5. **Target Assessment Frequency = 4.5*1.0 -1 -1 +0 = 2.5 years**
6. **Round down to 2 years.**

SETTING PRIORITIES FOR ASSESSMENTS

The priority for updating an assessment starts with the number of years that it is overdue relative to its target update frequency, but allows for new data availability, fishery importance and stock status to adjust this priority.

Once a target frequency for assessment updates has been established, the goal is to keep as close to this schedule as possible given available resources. Conducting assessments more frequently is an inefficient use of assessment expertise and burdens the regulatory system with too frequent and unnecessary changes. Waiting too long to conduct an update means that management is based upon increasingly stale information. With each passing year, there is a greater chance that

the stock has drifted off the previous forecast and the fishery is being overly or insufficiently restricted.

After accounting for the years overdue, then additional factors of stock status, new information, and fishery importance are added as fractional values in order to keep them from overly influencing the prioritization. First, stock status (which has values of 1 to 9) is divided by 10 and added to the number of years overdue. This means that stocks on rebuilding plans, or stocks approaching an overfished or overfishing condition, will have priority over stocks that are equally due/overdue but have a less at-risk status. However, at-risk stocks that are not yet due relative to their target frequency will not leapfrog ahead of stocks that are overdue for assessment. This approach will provide a balanced portfolio that will address the most overdue assessments, then the stocks with more at-risk status, and then the less at-risk stocks that are at their target frequency of updating.

When the target interval between assessment updates is several years, then it may be possible to make a quick evaluation of new information as it becomes available and adjust the stock's priority for assessment up or down based upon how closely the new data match expectations from forecasts from the previous assessment. Note that adjustments of this sort are disruptive to an organized planning process and should be applied cautiously. Even making these quick evaluations involves data preparation, staff analysis, and report writing that will detract from the program's capability to conduct planned assessments. A score of up to 1.0 is allowed for this factor.

Fishery importance has already been taken into account when setting the target assessment frequency. However, it is reasonable to use fishery importance as a small factor when other factors are equitable. This is accomplished by adding the fishery value score divided by 10.

Assessment uncertainty is not included as a quantitative factor. For example, some assessments have high uncertainty because the time series of data is short. For these assessments, more frequent updates in the short-term could improve the assessment because data are accumulating rapidly. On the other hand, some assessments have high uncertainty because the data are inherently noisy or there are unknown factors causing fluctuations or retrospective patterns in the assessment. In such cases, it seems better to not shorten the time between assessments and instead to put the effort into better understanding of the factors causing the uncertainty. Consequently, past assessment uncertainty is only used as a factor if there are new information or research results available that are expected to resolve some of that uncertainty. Simply re-doing an assessment because the past assessment had uncertainty is undesirable because that assessment effort could more productively be directed to other stocks.

Prioritizing Assessments Updates

1. **Years overdue relative to target frequency;**
2. **Add stock status score divided by 10;**
3. **Add up to 1.0 if there is new information that indicates a chance from the past assessment;**
4. **Add fishery importance divided by 10;**

EXAMPLE:

1. **Assessment is 2 years past its target date for updating;**
2. **Stock status score is 6;**
3. **There is no new information that indicates an obvious change**
4. **Commercial value score is 3.5 and recreational score is 1.4 and no additional fishery importance factors;**
5. **Priority score = 2.0 + 6.0/10 + 0.0 + (3.5+1.4)/10 = 3.09**

Benchmark vs. Update Assessment

The history of recent assessments is primarily a factor in deciding between doing another update, or doing a full benchmark assessment[3]. The staff time and review effort needed to conduct a benchmark assessment is substantially greater than that needed to provide an update, so decisions to do full benchmarks should carefully consider the forgone opportunity to do updates for several stocks instead of the benchmark. There are three issues that contribute to a decision to do the benchmark assessment:

1. A new data type or research finding is available. A benchmark assessment is needed to fully investigate the assessment performance with this new information, especially if it would lead to elevating the level of the assessment.
2. The previous assessment identified a shortcoming that is not feasible to investigate with available methods and data. Simply re-doing a benchmark should be avoided unless there is good reason to expect more certainty to come from the new benchmark.
3. Several updates have been conducted and a refresh of selected aspects of the assessment is reasonable, although not specifically identified by either issue 1 or 2 above.

[3] An update assessment uses a previously reviewed modeling approach and data types and simply updates the assessment using the most recent data. Only minimal review is needed. A benchmark assessment introduces new methods or data types and may involve a thorough investigation of all aspects of the assessment. A fuller review commensurate with the degree of innovation and controversy is warranted.

Benchmarks should not be done if none of the three criteria are met, irrespective of the age of the assessment. Most of a region's assessments need to be conducted as simple updates if a high pace of assessments is to be accomplished, as in the North Pacific. The fact that a stock has high importance or a low status should not be a primary driver for doing full benchmark assessments. These factors have already contributed to setting target assessment frequency and prioritizing stocks relative to this update frequency. When benchmark assessments are done without having fundamentally new information to consider, the assessment generally treads over the same issues that were unresolved in the earlier assessment.

CHALLENGES

This proposed prioritization system is a first attempt at a comprehensive approach. It will need adjustments as it begins to be applied. Nevertheless, the compilation and presentation of information described in this document can immediately improve the basis on which priorities are set.

One challenge will be to ward against a lopsided application of the system. The goal is somewhere in between a situation in which all stocks are perceived to need equally good assessments, and a situation in which only the most important stocks get assessed. All stocks need some level of baseline assessment and the most important and vulnerable stocks need better assessments. The proposed system is designed to help achieve such a balance, but adjustments may be needed after a few years of implementation.

The degree to which this prioritization system addresses the need for inclusion of ecosystem factors is preliminary, at best. The focus has been upon getting basic assessments done. Ongoing work on an update of the Stock Assessment Improvement Plan should provide additional guidance on how to determine which stocks are most in need of a broader ecosystem consideration. All assessments should recognize that every fish stock exists within a regional ecosystem and the effect of ecosystem changes on the stock should always be considered to the extent feasible.

Many aspects of this prioritization approach are somewhat ad hoc. The ICES investigation of factors affecting assessment frequency clearly indicated that only through a management strategy evaluation can one ascertain the expected improved performance from better data and shorter time lags. This same situation is true for assessments and fishery management in the U.S.

Application of this prioritization system will not get more assessments done each year. The goal is to be more objective about which assessments get done. It is likely that many stocks will be identified as needing better assessments than present data allow, and many stocks for which more frequent assessments are needed. These gaps can identify needs, but filling these needs will require an expanded assessment program. Alternatively, the system could be used to determine what target level of assessment frequency is achievable given current assessment capacity.

The complete science-management system has more elements than the assessments themselves. There are potential bottlenecks associated with timing of peer reviews, time needed to develop management responses to updated assessments, alignment of assessments with start dates

of fishing years, etc. These additional steps in the overall process also warrant consideration as overall improvements in throughput are sought.

IMPLEMENTATION PLAN

- Distribute draft to Fishery Management Councils, NMFS Regional Offices, Fishery Commissions for comment – February 2014;
- Create database of needed information as an added table in the Species Information System – spring 2014;
- Each region begins work on comprehensive Productivity-Susceptibility Analysis and Only Reliable Catch Analysis to serve as baseline for determining which stocks need assessments – begin spring 2014;
- Test prioritization system to determine if adjustments to scaling factors are needed to achieve reasonable results – summer 2014;
- Make database available to regional coordinating committees charged with setting priorities for regional assessments – fall 2014; Create access through SIS public portal;
- Commission Management Strategy Evaluations to test the expected performance of this prioritization system over time – 2015;
- Explore Decision Support System facilitators to guide regional coordinating committees through application of the prioritization process – 2016.

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TABLES

Table 1. This table presents the distribution of FSSI and non-FSSI stocks among Councils and Science Centers in 2014. Each row in this table represents a category within which prioritization could occur, with exceptions in the note below.

Council	Centers	Non-FSSI	FSSI	All
CFMC	SE	37	8	45
Atl_HMS	SE	6	21	27
GMFMC	SE	15	23	38
SAFMC	SE	21	22	43
NEFMC	NE	2	37	39
MAFMC	NE	0	11	11
NPFMC	AK	30	35	65
PFMC	NW-SW	17	45	62
PFMC_salmon	NW-SW	67	0	67
Pac_HMS	SW-PI	14	18	32
WPFMC	PI	42	7	49
		251	227	478

Note: HMS refers to Highly Migratory Species. Stocks that are shared between the GMFMC and SAFMC would be covered by the GMFMC unless otherwise arranged by the SEDAR (Southeast Data and Assessment Review) committee. The MAFMC and NEFMC could be covered by the same prioritization process, as occurs now with the Northeast Regional Coordinating Committee.

Table 2. Summary of factors considered.

FACTOR	First-time assessments	Target assessment level	Target Assessment frequency	Priority for assessment	Priority for benchmark
Fishery importance	Yes	Yes	Yes	Yes	
Ecosystem importance	Yes	Yes	Yes		
Stock status	Yes, from ORCS & PSA			Yes	
Stock biology		Yes	Primary		
Assessment history; Due or overdue?				Primary	
New data indicates drift from forecast				Yes	
New data can raise level or resolve uncertainty					Yes

Table 3. This table shows the ranking of stocks with the largest commercial and recreational catch levels in 2009. Note that values are whole weight, not meat weight, so quahog and clam are higher than one would expect.

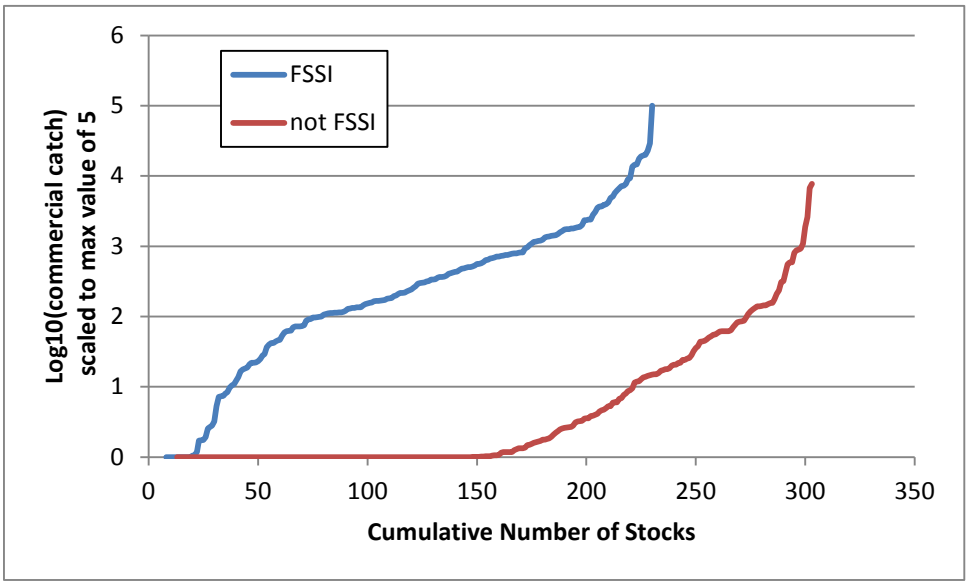
Top 20 Commercial Catch	Top 20 Recreational Catch	High Recr and Comm
Walleye pollock - Eastern Bering Sea	Bluefish - Atlantic Coast	Atlantic mackerel - Gulf of Maine / Cape Hatteras
Pacific cod - Bering Sea / Aleutian Islands	Yellowfin tuna - Central Western Pacific	Pollock - Gulf of Maine / Georges Bank
Ocean quahog - Atlantic Coast	Summer flounder - Mid-Atlantic Coast	Scup - Atlantic Coast
Yellowfin sole - Bering Sea / Aleutian Islands	Red snapper - Gulf of Mexico	Pacific chub mackerel - Pacific Coast
Atlantic surfclam - Mid-Atlantic Coast	King mackerel - Southern Atlantic Coast	Summer flounder - Mid-Atlantic Coast
Atlantic herring - Northwestern Atlantic Coast	Scup - Atlantic Coast	Dolphinfish - Southern Atlantic Coast / Gulf of Mexico
Opalescent inshore squid - Pacific Coast	Gag - Gulf of Mexico	Red grouper - Gulf of Mexico
Atka mackerel - Bering Sea / Aleutian Islands	Black sea bass - Mid-Atlantic Coast	Bluefish - Atlantic Coast
Pacific hake - Pacific Coast	King mackerel - Gulf of Mexico	Caribbean spiny lobster - Southern Atlantic Coast / Gulf of Mexico
Pacific sardine - Pacific Coast	Skipjack tuna - Central Western Pacific	Spanish mackerel - Southern Atlantic Coast
Walleye pollock - Gulf of Alaska	Spanish mackerel - Southern Atlantic Coast	Vermilion snapper - Gulf of Mexico
Pacific cod - Gulf of Alaska	Dolphinfish – Pacific	Yellowfin tuna - Central Western Pacific
Brown rock shrimp - Gulf of Mexico	Spanish mackerel - Gulf of Mexico	King mackerel - Southern Atlantic Coast
Brown shrimp - Gulf of Mexico	Little tunny - Gulf of Mexico	King mackerel - Gulf of Mexico
Bering Sea / Aleutian Is. Arrowtooth Flounder	Gray snapper - Gulf of Mexico	Red hake - Southern Georges Bank / Mid-Atlantic
White shrimp - Gulf of Mexico	Red grouper - Gulf of Mexico	Atlantic Large Coastal Shark Complex
Bering Sea / Aleutian Islands Other Species	Atlantic mackerel – Gulf Maine / Cape Hatteras	Red snapper - Gulf of Mexico
Sea scallop - Northwestern Atlantic Coast	Greater amberjack - Gulf of Mexico	Atlantic Small Coastal Shark Complex
Arrowtooth flounder - Gulf of Alaska	Cobia - Gulf of Mexico	Yellowtail snapper - Southern Atlantic Coast / Gulf of Mexico
Atlantic mackerel - Gulf of Maine / Cape Hatteras	Greater amberjack - Southern Atlantic Coast	

Table 4. Table of attributes for assigning stock status for historical catch-only assessments (from Berson et al 2011).

Overall scores are obtained by an unweighted average of the attributes for which scoring is possible, although alternative weighting schemes could also be considered. An initial assignment to a stock status category is: mean scores>2.5—heavily exploited; stocks with mean scores 1.5-2.5--moderately exploited; and stocks with mean scores<1.5--lightly exploited. When the attribute does not apply or is unknown it can be left unscored.

Attribute	Stock status		
	Lightly exploited (1)	**Moderately exploited (2)**	**Heavily exploited (3)**
Overall fishery exploitation based on assessed stocks	All known stocks are either moderately or lightly exploited. No overfished stocks	Most stocks are moderately exploited. No more than a few overfished stocks	Many stocks are overfished
Presence of natural or managed refugia	Less than 50% of habitat is accessible to fishing	50%-75% of habitat is accessible to fishing	>75% of habitat is accessible to fishing
Schooling, aggregation, or other behavior responses affecting capture	Low susceptibility to capture (specific behaviors depend on gear type)	Average susceptibility to capture (specific behaviors depend on gear type)	High susceptibility to capture (specific behaviors depend on gear type)
Morphological characteristics affecting capture	Low susceptibility to capture (specific characteristics depend on gear type)	Average susceptibility to capture (specific characteristics depend on gear type)	High susceptibility to capture (specific characteristics depend on gear type)
Bycatch or actively targeted by the fishery	No targeted fishery	Occasionally targeted, but occurs in a mix with other species in catches	Actively targeted
Natural mortality compared to dominant species in the fishery	Natural mortality higher or approximately equal to dominant species ($M \geq M$)	Natural mortality equal to dominant species ($M \approx M$)	Natural mortality less than dominant species ($M < M$)
Rarity	Sporadic occurrence in catch	Not uncommon, mostly pure catches are possible with targeting	Frequent occurrence in catch
Value or desirability	Low value (< $1.00/lb, often not retained (< 33% of the time)	Moderate value ($1.00 - $2.25), usually retained (34-66% of the time)	Very valuable or desirable (e.g., > $2.25/lb), almost always retained (>66% of the time).
Trend in catches (use only when effort is stable)	Catch trend increasing or stable (assign score of 1.5)	Catch trend increasing or stable (assign score of 1.5)	Decreasing catches

FIGURES



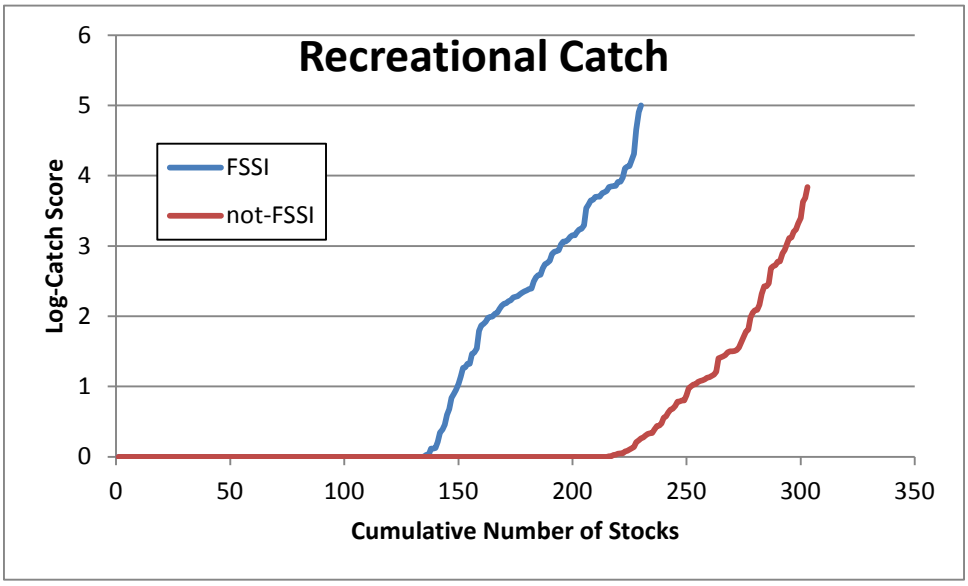
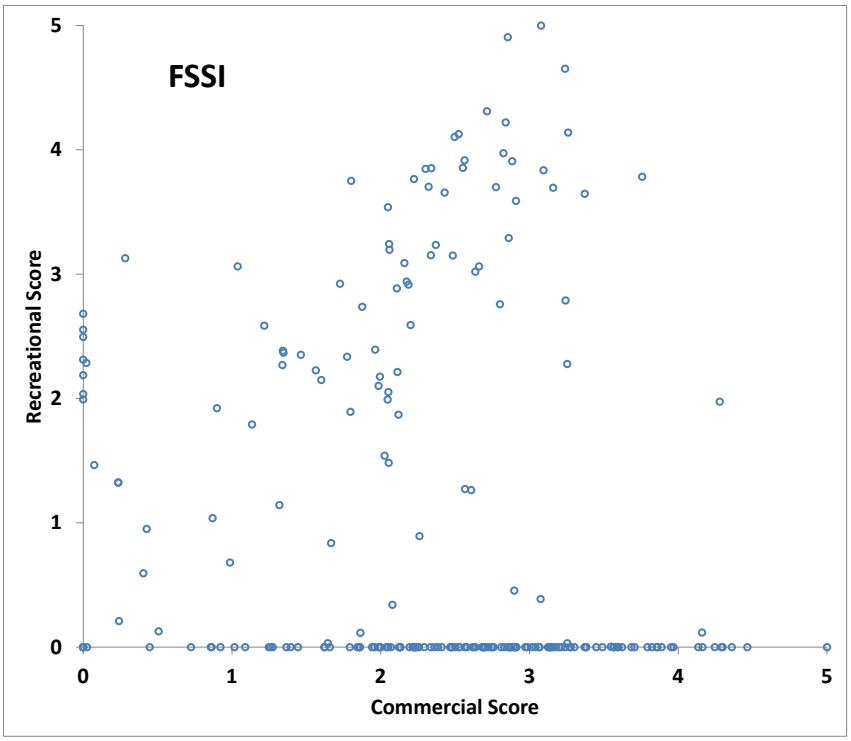


Figure 1. Ranking of stocks according to the amount of catch. Each stock's score is calculated as the log10(1.0+catch (in thousands of pounds)). (a) commercial catch results are shown at the top and (b) recreational catch is shown at the bottom. Results are shown separately for the 230 stocks included in the Fish Stock Sustainability Index (FSSI) and for the other stocks in Fishery Management Plans. For each plot, the stocks are re-ordered according to their catch.



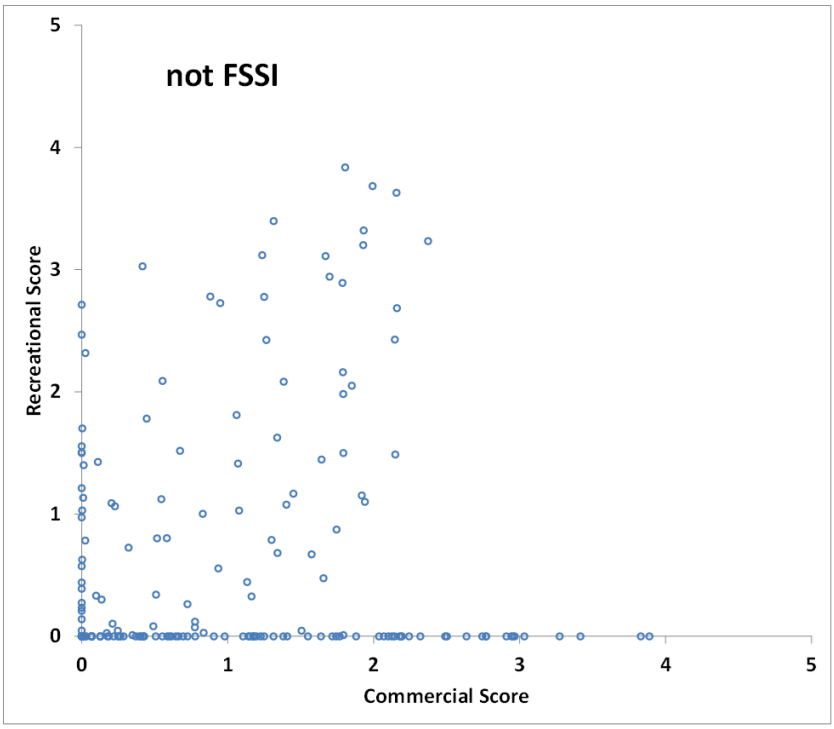


Figure 2. Preliminary relationship between commercial score and recreational score for FSSI stocks and non-FSSI stocks..

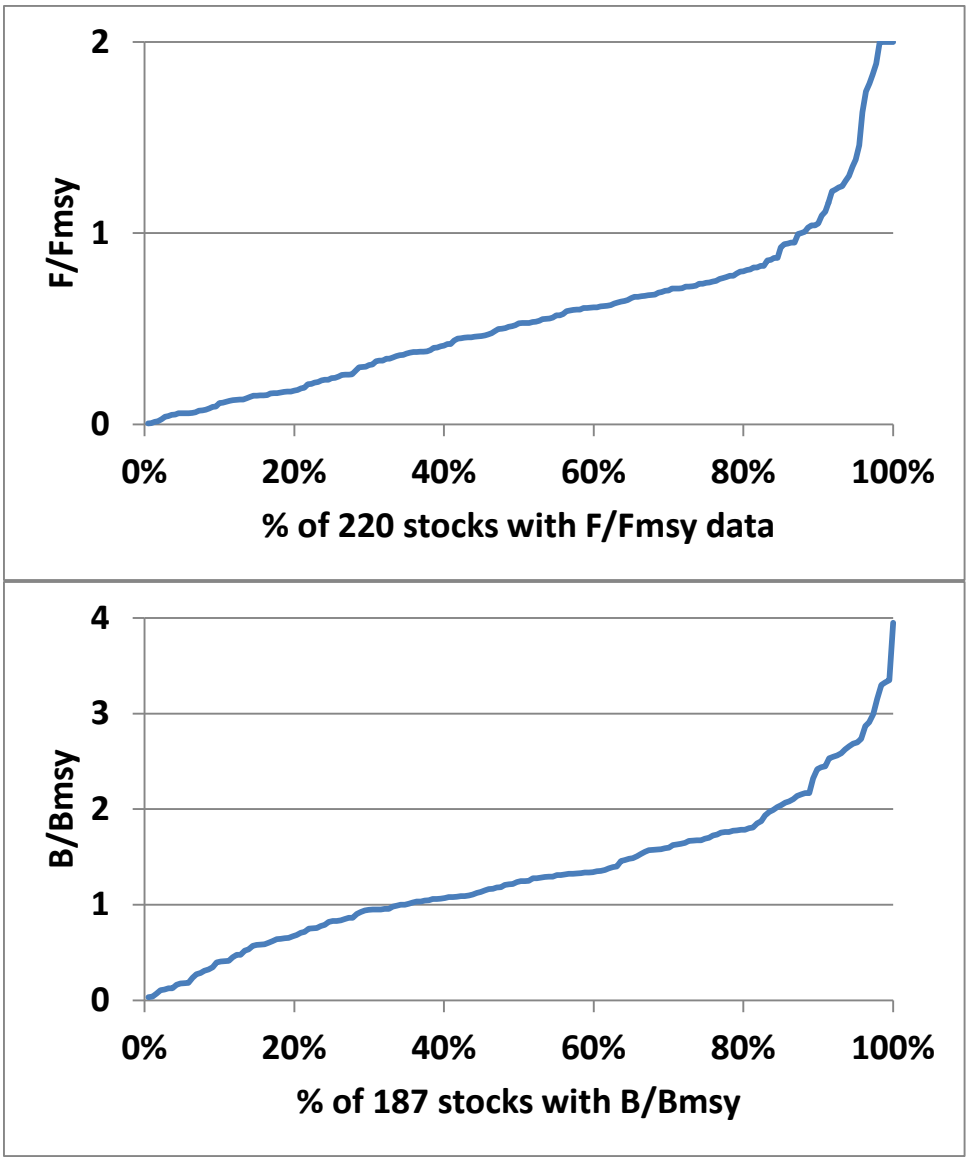


Figure 3. Cumulative distribution of the ratio of F to Fmsy in the most recent assessment of 220 stocks (upper panel), and cumulative distribution of B to Bmsy for 187 stocks in the lower panel

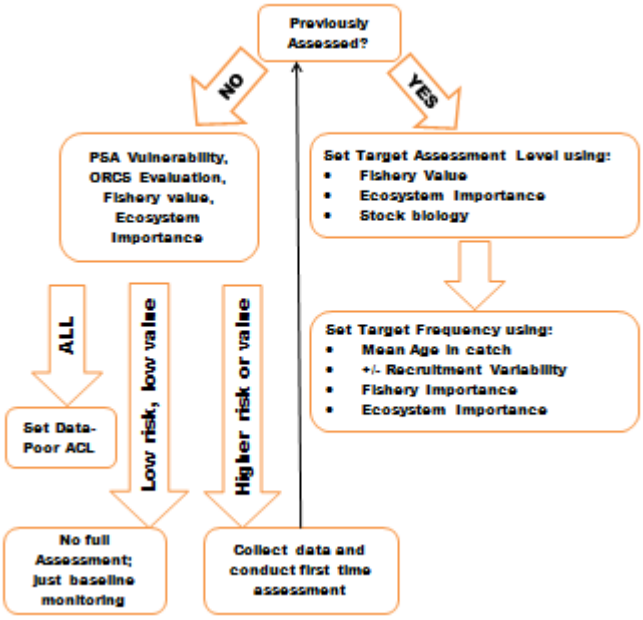


Figure 4. Flowchart showing steps in the setting of assessment target levels and assessment frequencies.

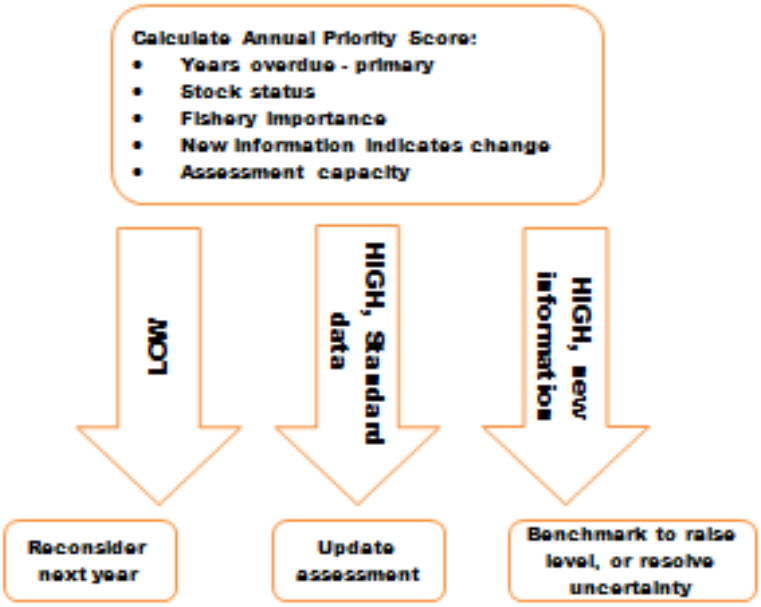


Figure 5. Flowchart showing steps in the setting of annual assessment priorities.

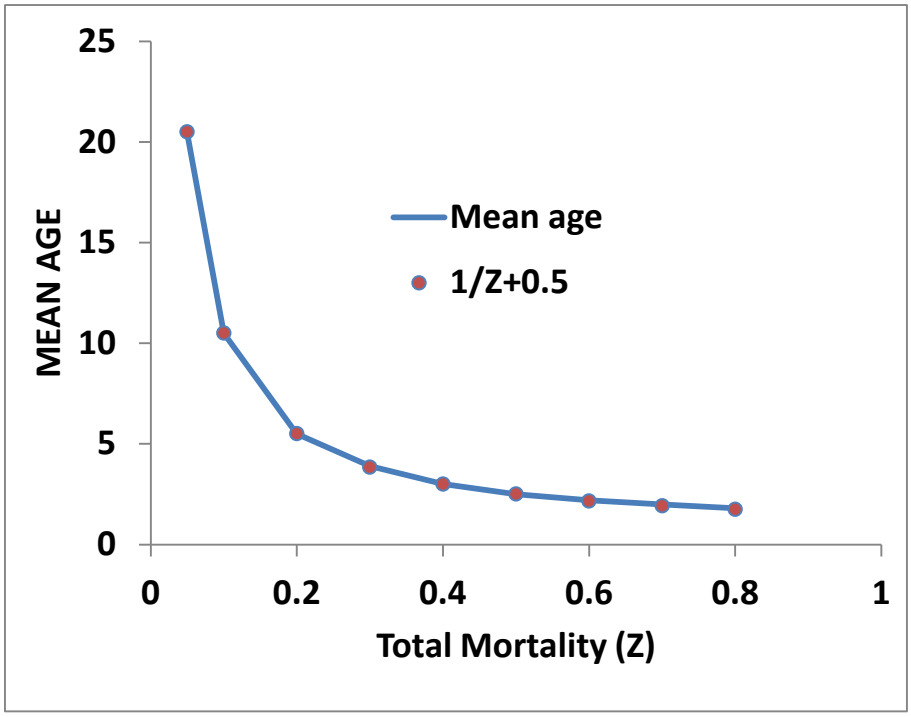


Figure 6. Relationship between total mortality rate (Z) and the expected mean age of fish in the stock.