Atlantic States Marine Fisheries Commission

Atlantic Sturgeon Management Board

August 7, 2024
10:15 – 11:15 a.m.

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 (*R. Self*)	10:15 a.m.
2. Board Consent • Approval of Agenda • Approval of Proceedings from August 2018	10:15 a.m.
3. Public Comment	10:20 a.m.
4. Review 2024 Atlantic Sturgeon Stock Assessment Update *(A. Higgs)*	10:30 a.m.
5. Elect Vice-Chair	11:10 a.m.
6. Other Business/Adjourn	11:15 a.m.

The meeting will be held at The Westin Crystal City (1800 Richmond Highway, Arlington, VA; 703.486.1111) and via webinar; click here for details

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

MEETING OVERVIEW

Atlantic Sturgeon Management Board
August 7, 2024
10:15 a.m.– 11:15 a.m.

Chair: Ross Self Assumed Chairmanship: 10/19	Technical Committee Chair: Amanda Higgs (NY)	Law Enforcement Committee Rep: Capt. Thomas Gadomski
Vice Chair: Vacant	Advisory Panel Chair: Vacant	Previous Board Meeting: August 8, 2018
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA, NC, SC, GA, FL, D.C., PRFC, USFWS, NMFS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 2018

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 2024 Atlantic Sturgeon Stock Assessment Update (10:30 – 11:10 a.m.)
Background • The 2024 Stock Assessment Update was completed in July **(Briefing Materials)**. • The TC met via webinar on July 10th to review a draft of the Stock Assessment Update and provide recommendations to the Stock Assessment Subcommittee.
Presentations • Stock Assessment Update overview by A. Higgs

5. Elect Vice-Chair

6. Other Business/Adjourn

Atlantic Sturgeon

Activity level: Low

Committee Overlap Score: Medium (SAS, overlaps with striped bass)

Committee Task List
• Annual compliance reports due October 1st

TC Members: Amanda Higgs (NY, Chair), Ian Park (DE), Danielle Dyson (NJ), Ingrid Braun-Ricks (PRFC), Dewayne Fox (DSU), Greg Garman (VCU), Luke Lyon (DCMF), Steve Minkkinen (USFWS), Eric Schneider (RI), David Secor (UMCES), Ashlee Horne (MD), Bryant Bowen (GA), Catherine Fede (NY), Christopher Davis (VA), Ellen Waldrop (SC), Jacque Benway-Roberts (CT), John Sheppard (MA), Nathaniel Hancock (NC), Syma Ebbin (UCONN), Mike Wicker (USFWS), Mike Mangold (USFWS), Kristen Anstead (ASMFC), James Boyle (ASMFC), Katie Drew (ASMFC)

SAS Members: Michael Celestino (NJ), Jared Flowers (GA), Dewayne Fox (DSU), Amanda Higgs (NY), Bill Post (SC), Eric Schneider (RI), David Secor (UMCES), Jason Boucher (NOAA), Margaret Conroy (DE), Nathaniel Hancock (NC) Katie Drew (ASMFC), Kristen Anstead (ASMFC), James Boyle (ASMFC)

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

ATLANTIC STURGEON MANAGEMENT BOARD

The Westin Crystal City
Arlington, Virginia
August 8, 2018

These minutes are draft and subject to approval by the Atlantic Sturgeon Management Board.
The Board will review the minutes during its next meeting.

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

2. **Approval of Proceedings of October 2017** by Consent (Page 1)

3. **Move to approve the 2018 FMP Review for Atlantic Sturgeon** (Page 10). Motion by Tom Fote; second by Pat Geer. Motion carried (Page 10).

4. **Move to disband the Atlantic Sturgeon Advisory Panel** (Page 11). Motion by Ritchie White; second by Raymond Kane. Motion carried (Page 12).

5. **Adjournment by consent** (Page 12)

ATTENDANCE

Board Members

Douglas Grout, NH (AA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Ritchie White, NH (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Mike Armstrong, MA, proxy for D. Pierce (AA)
Raymond Kane, MA (GA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
David Borden, RI (GA)
Sen. Craig Miner, CT (LA)
Justin Davis, CT, proxy for P. Aarrestad (AA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Jim Gilmore, NY (AA)
Maureen Davidson, NY, Administrative proxy
Heather Corbett, NJ, proxy for L. Herrighty (AA)
Emerson Hasbrouck, NY (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA), Chair
Tom Fote, NJ (GA)
Andrew Shiels, PA, proxy for J. Arway (AA)
Loren Lustig, PA (GA)
Roy Miller, DE (GA)
John Clark, DE, proxy for D. Saveikis (AA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
Russell Dize, MD (GA)
Pat Geer, VA, proxy for S. Bowman (AA)
Sen. Monty Mason, VA (LA)
Bryan Plumlee, VA (GA)
Steve Murphey, NC (AA)
Chris Batsavage, NC, Administrative proxy
Ross Self, SC, proxy for R. Boyles (AA)
Malcolm Rhodes, SC (GA)
Mel Bell, SC, proxy for Sen. Cromer (LA)
Spud Woodward, GA (GA)
Doug Haymans, GA (AA)
Krista Shipley, FL, proxy for J. McCawley (AA)
Marty Gary, PRFC
Dan Ryan, DC Fisheries, proxy for B. King
Mike Millard, USFWS
Derek Orner, NMFS

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

Ex-Officio Members

Staff

Robert Beal
Toni Kerns
Katie Drew
Max Appelman
Jeff Kipp
Jessica Kuesel

Guests

Julie Crocker, NOAA
Mari-Beth DeLucia, The Nature Conservancy
Matt Gates, CT DEEP
Arnold Leo, E. Hampton, NY
Mike Luisi, MD DNR
Chip Lynch, NOAA
Dan McKiernan, MA DMF
Nichola Meserve, MA DMF
Nick Popoff, ME DMR
Jack Travelstead, CCA
Chris Wright, NMFS

The Atlantic Sturgeon Management Board of the Atlantic States Marine Fisheries Commission convened in the Jefferson Ballroom of the Westin Crystal City Hotel, Arlington, Virginia; Wednesday, August 8, 2018, and was called to order at 10:55 o'clock a.m. by Chairman Adam Nowalsky.

CALL TO ORDER

CHAIRMAN ADAM NOWALSKY: I would like to welcome everyone to this meeting of the Sturgeon Board. I'm Adam Nowalsky; our Chair, joined up front here by Max Appelman from staff.

APPROVAL OF AGENDA

CHAIRMAN NOWALSKY: Our first order of business today will be to get through the approval of the agenda as it's been provided. Is there any request for changes to the agenda as it's been provided? Seeing none; the agenda stands approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN NOWALSKY: Second order of business is to approve the proceedings from the October, 2017 Board meeting. Is there any request for changes to those proceedings as they have been presented? Seeing none; those proceedings are approved.

PUBLIC COMMENT

CHAIRMAN NOWALSKY: Our next order of business will be to address public comment. This would be public comment for any issues that are not on the agenda.

We do not have anyone signed up. Are there any hands from any members of the audience that wish to offer public comment? Seeing none; we'll move on to our fourth agenda item, which if anyone's taking notes makes us right on time.

UPDATE ON 5-YEAR STATUS REVIEW OF THE ENDANGERED SPECIES ACT LISTING AND RECOVERY PLAN

CHAIRMAN NOWALSKY: Okay, so we're going to turn to Julie Crocker from the Endangered Fish Branch Chief from GARFO for an update on the 5-year status review of the ESA listing and recovering plan.

MS. JULIE CROCKER: Hi, I'm Julie Crocker; National Marine Fisheries Service, Greater Atlantic Region. I'm going to provide a follow on and update to a presentation that Lynn Lankshear provided to you all at last summer's meeting on where we are with the Atlantic Sturgeon 5-year status review and recovery planning.

The 5-year review is required by Section 4 of the Endangered Species Act. A 5-year review is a periodic analysis of a species status conducted to ensure that the listing classification of a species that is threatened or endangered remains accurate. Because we have five listed DPSs of Atlantic sturgeon, we need to conduct five reviews; but we will consolidate that into one document that will be prepared jointly by the Greater Atlantic Region and the Southeast Region and coordinated with NMFS Headquarters.

On March 16, 2018, we announced in the Federal Register that we are starting the 5-year review process; and requested submissions of information that might be helpful to us as we carry out the review. That 60 day period closed on May 16. We received nine submissions of information; and all of the information that we received is available on the regulations.gov web page. We received information and comments from a small number, but a fairly wide variety of stakeholders that are listed there. A number of questions came into us during and shortly after the period; regarding whether we had access to the data submitted by the states and researchers to ASMFC for the recent stock assessment. We do have access to that and we'll be working to make sure that we consider the stock assessment as the best available source of information.

But we did also want to let people know that even though the formal 60 day period for providing information has ended; we can still accept information if people do have new information sources, new data, new analysis that was completed since the information was provided for the stock assessment. We will certainly continue to take that information.

I'm going to talk a little bit about what the 5-year review entails; and what it will look like. It's important to remember that the 5-year review on its own does not change the listing status for the DPSs; but it will either confirm that the listing status remains accurate, or it will indicate that it's not accurate, which would prompt a new rule-making process including proposed rules, public comment periods, et cetera.

For the five Atlantic sturgeon DPSs, we plan to review the information for and write the draft 5-year review internally. That will be done by the Greater Atlantic Region and Southeast Region in cooperation with our Headquarters office. Use the stock assessment as one of the primary sources of new information.

We do plan to request the Sturgeon Technical Committee to peer review the draft 5-year review; similar to the way that the information was reviewed for the Critical Habitat Designation, and we do intend to complete one review document for all five distinct population segments. To talk a little bit about what the 5-year review will include.

We will have to look at the DPS Policy, consider whether there is any new information that would cause us to reconsider the terminations regarding DPSs. For example, do they continue to meet the criteria for discreetness and significance? We will summarizes new information; sighting detailed information and analyses, and we'll indicate whether there is a change in species status or change in the magnitude or imminence of threats since the last status review.

Then we'll also go through each of the five listing factors; providing summary and relevant new information, including conservation measures regarding the magnitude, scope, and severity and imminence of previously identified threats, and also discuss if there are any new threats to the species. In the synthesis section of the 5-year review, we provide an updated assessment of the status of the species and threats.

We note significant changes and explain why the species continues to meet the definition of threatened or endangered as appropriate. This section concludes with a recommended classification; either for an endangered species to down-list it to threatened, for threatened species we can recommend to up list to endangered.

We could recommend to delist any of the DPSs; or we could recommend that the classification should stay the same. Again, if there was any change recommended in the 5-year review that would prompt a new rule-making process. The 5-year review on its own cannot make a change to the listing status. We expect the final product; the final 5-year review to be ready in 2019. We hope to have a draft available for peer review in early 2019. There is no formal timeline associated with the 5-year review; but we would like to get moving on this and complete it quickly.

There will be a Notice of Availability in the Federal Register when it is completed. If anyone is interested for more information on what the 5-year review will contain;

there is a template available on our website that we will follow for the review. Now I'm going to pivot a little bit and talk about recovery planning.

Section 4 of the ESA requires that recovery plans are developed for all listed species. To the extent that we can work on both at the same time; we're also pursuing recovery planning for the five DPSs, in cooperation with our Headquarters Office in the Southeast Region. But given the focus on the 5-year review we don't expect to get too far into recovery planning until probably this time next year.

A Recovery Plan is basically a road map for species recovery; it lays out the path and tasks required to restore self-sustaining wild populations for the species. I'm going to talk a little bit about what the recovery plan will contain. Before I do that; as a preliminary step towards recovery planning, the Greater Atlantic Region and Southeast Region together developed a Recovery Outline for Atlantic sturgeon, which is really an opportunity for us to present a preliminary conservation strategy to guide the future recovery planning efforts.

I think that was provided in the meeting materials; and it's also available on our website. In terms of recovery planning, as I mentioned we're just at the beginning stages. At this point we're really trying to figure out what the best format to go forward with is. We're working with Southeast Region Headquarters to determine what approach makes the most sense; in light of species needs, limited resources, and differences in common threats across the DPSs.

We could produce one recovery plan for all five distinct populations. We could produce five different recovery plans; which doesn't seem to make a lot of sense, or we could break it up regionally and do a northeast and a southeast plan. We're also considering whether we should fold in short-nosed sturgeon to the Atlantic Sturgeon Recovery Plan to update the 1998 recovery plan for shortnosed sturgeon.

We are looking for feedback, information, ideas people might have on what might be the most effective and efficient approach for recovery planning. I'm going to talk a little bit about what the Recovery Plan will include. A Recovery Plan must have recovery actions, recovery criteria, and estimates of recovery timeline and cost.

I'm going to go through those a little bit on the next slide. The recovery goal is almost always recovery of the species and delisting. The species is listed as endangered. We'd also have an intermediate goal of reclassifying the species as threatened. The recovery objectives are identified in terms of demographic parameters, reduction or elimination of threats to the species, and any other particular vulnerabilities or biological needs inherent to the species. The recovery criteria comprise the standards upon which the decision to reclassify or delist the species is based; and they need to be objective and measurable. They address threats as well as demographic factors; and must be written in terms of each of the five listing factors. There is some question about an example of what recovery criteria might look like.

I pulled this from the draft Green Sturgeon Recovery Plan; just to give an example of what recovery criteria might look like. An example for demographic recovery criteria was the adult southern DPS green sturgeon census population remains at or above 3,000 for three generations. In addition the effective population size must be at least 500 individuals in any given year; and each annual spawning run must be comprised of a combined total from all spawning locations of at least 500 adult fish in any given year.

That gives you a sense of what recovery criteria for Atlantic sturgeon could look like. Then we would also have threat spaced criteria. Then recovery planning is definitely not intended to a closed door process. Section 4 of the ESA allows us to appoint recovery teams made up of public and private entities; who would work with us to develop and implement recovery plans. If a Recovery Team is necessary; NMFS would bring the team together by invitation. There are many forms that a team approach could take.

We're likely to hold at least one workshop; likely in probably late 2019, focused on recovery criteria, trying to figure out how we would know that the species is recovered, and likely an additional workshop on how to identify and prioritize recovery actions. We also expect that the beginning of the recovery planning process; or probably sometime in 2019, we would put out a public notice soliciting information and public comment for us to consider as we developed the recovery plan.

All recovery plans are made available in draft for public comments; so we would be doing that and likely also reaching out to the Technical Committee for peer review of the draft plan, particularly focused on the objectives and the criteria and the recovery actions. That is what I have, and happy to answer any questions as time allows.

CHAIRMAN NOWALSKY: Very good Julie, thank you very much. There is no specific action item that we need to act on as a Board today. But we would certainly entertain questions and discussion. Let me see a show of hands of who has questions or discussion. Okay, so I've got Lynn, Justin, Chris, and John. All right we'll start with Lynn; go ahead.

MS. LYNN FEGLEY: Thank you for your presentation. I just wonder with the recovery criteria; and I am pretty sure I know the answer to this. Do those criteria come with funding; and how do you deal with the fact that you have recovery criteria that nobody has the money to monitor toward? Is the money taken into account when you develop those criteria?

MS. CROCKER: We do need to identify a cost of recovery; and the recovery actions are typically broken down as to who we expect would carry those out. The recovery plan wouldn't come with any new funding. That is always a concern; is to how to actually get all of this done in the current climate.

CHAIRMAN NOWALSKY: Justin Davis.

MR. JUSTIN DAVIS: Thanks Julie for that presentation. There was a bullet in one of the slides relative to recovery plans that talked about site-specific criteria, or site-specific objectives. I guess my question was just what constitutes a site; and we were talking about an individual river system or the whole Atlantic coast. I'm just kind of curious about what sort of spatial scale you're talking about there when referencing site-specific things.

MS. CROCKER: I think that is in reference to the recovery actions; that the recovery actions need to be specific. For example, I have an example of threat-based criteria for the Green Sturgeon Recovery Plan. It says volitional passage is provided for adult green sturgeon through the Yolo and Sutter bypasses. That activity and location specific portion is important to identifying the recovery actions; so that they're specific and can actually be acted upon.

CHAIRMAN NOWALSKY: Next I have Chris Batsavage.

MR. CHRIS BATSAVAGE: Julie, with the green sturgeon you gave an example for their recovery plan of trying to recover three generations of green sturgeon. I guess to get a sense of how that would look for Atlantic sturgeon if there were something similar in place for Atlantic sturgeon. How many years would that represent; as far as trying to recover three generations of sturgeon? I'm trying to get a sense of when this is put together; how many years would we expect it to take, in order to hit some of the recovery criteria for in the plan?

MS. CROCKER: Sure, I don't know enough about the differences between green sturgeon, Atlantic sturgeon to say would we use these comparable criteria or not. But looking at recovery plans in general; they typically look at somewhere between 25 and 100 year horizon. Looking at a long horizon with very significant price tag attached to them is not unusual.

CHAIRMAN NOWALSKY: John Clark.

MR. JOHN CLARK: Thank you for the presentation, Julie. I'm just wondering how this ties in. I know the recent actions that are proposed by the Fish and Wildlife Service and with NOAA Fisheries; about the ESA, and just reiterated the delisting criteria be the same as listing criteria. When you gave the example again about the green sturgeon, you were talking about actual numbers of fish.

Yet with the Atlantic sturgeon there was no population actually estimated, was there when they were listed. Would you be looking at coming up with a population targets for Atlantic sturgeon; given that wasn't used to list them, or is it more different type of measures you'll be using when you consider delisting?

MS. CROCKER: That is going to be one of the things that we're going to be looking for input and advice and comment from; is really to consider what makes the most sense for those recovery criteria, and matching them up to what the available information is. We don't want to set a set of recovery criteria that is so quantitative that they can never be reached; because we don't ever expect to have that information. We will need to match the recovery criteria to the types of information that we have available.

CHAIRMAN NOWALSKY: Okay with no further hands up; I want to thank Julie for her time here with this presentation. For the benefit of the Board that Federal Register Notice, as well as the Recovery Outline that the presentation was based on, is in the meeting materials. I'm sure this will continue to be on this Board's radar for some time to come. Thank you again.

REVIEW TECHNICAL COMMITTEE REPORT REGARDING HIGHEST PRIORITY DATA SOURCES FOR STOCK ASSESSMENTS

CHAIRMAN NOWALSKY: We'll now move on to the next agenda item; which is a TC report regarding the highest priority data sources for stock assessments, and that presentation is coming from Katie Drew. Katie.

DR. KATIE DREW: I'm going to review the report that the TC has put together on addressing these Board tasks. At the last meeting after we presented the stock assessment; the Board asked the TC to identify the datasets that are most important to Atlantic sturgeon stock assessment, and to develop recommendations about where to focus state resources, in order to improve the data quality and improve the assessment quality for this species.

The 2017 Benchmark Assessment obviously contained a detailed, prioritized list of research recommendations. But these were really sort of an ideal world list; that is there was really no consideration of funding constraints or other time constraints. It was just like this is what we would like in an ideal world.

In order to address the Board tasked them to sort of provide some new information or new context to these recommendations. The TC reprioritized this list; to identify sort of the most cost effective actions, or to recognize how can we get the most bang for our limited buck with these recommendations.

That is sort of the context of the recommendations that we're presenting in this memo; compared to the more detailed, extensive list in the assessment report itself. I'm just going to go through the actual recommendations and touch briefly on each one of them. I think our first recommendation was to encourage data sharing among partner agencies and academic institutions.

One of the strengths of this assessment was the ability to pull in data from a number of different sources; including a lot of sources that we don't always go to in a traditional stock assessment. But I think limited data, and I think difficulties in getting some data also held us back in certain areas, and in certain aspects of this assessment.

The TC reiterates its support of encouraging data sharing across a number of different agencies; and making that more easy for everyone to do. Our second recommendation was to continue to conduct the fishery independent surveys; that were used to develop indices of abundance for Atlantic sturgeon, either the ones that are existing now or the ones that were identified as being good potential indices with more years of data.

In addition, states should consider modifying existing surveys to be more effective at monitoring sturgeon; so identify strata or areas or methods that your current surveys could change slightly to be more effective at actually catching sturgeon. These are the high priority indices that we identified. The ones in green are the ones that were actually used in the assessment to track abundance. The ones in blue are ones that we identified as good potential indices; but that just needed more years of data in order to be reliable for this long-lived species. It's a combination of juvenile and adult indices here.

Our third recommendation was to continue to acoustically tag Atlantic sturgeon; and maintain the receiver arrays. The tagging model was our primary source of information on mortality rates; and so in order to be able to monitor the current mortality levels of, are we killing too many sturgeons for whatever reasons. We need to be able to continue to collect data from these tagged sturgeon; and these receiver arrays.

Our fourth recommendation was to collect and improve data collection on the incidental catch of Atlantic sturgeon; and the fifth one was to collect data to quantify the numbers of Atlantic sturgeon killed by ship strikes each year. Bycatch and ship strikes were two of the main sources of anthropogenic mortality that the Stock Assessment Subcommittee identified as a concern for Atlantic sturgeon; and both of those are not well monitored under our current data collection.

Getting more data on these sources of mortality is very important. Our sixth recommendation was to continue processing genetic samples; to update and improve the DPS definitions, especially in the less well represented areas like the Carolina DPS and the South Atlantic DPS, to get a better handle on the genetics of this species, and the correct DPS definition.

Our seventh recommendation and I guess our final recommendation; was to consider sort of a snapshot approach to this fishery independent and fishery dependent monitoring that we've recommended, to sort of think outside the annual monitoring box, if you will. A lot of the expense of monitoring programs comes from the fact that you need to do this stuff every year.

But for sturgeon, which is long-lived, slow to mature, we're not expecting to see big changes in the population from year to year. A short-lived species like herring you want to be monitoring that every year; because you're going to see changes. For sturgeon, if we take a snapshot of the population every five years or every ten years; when it comes to things like recruitment or spawning stock surveys, we can still get a handle on how that population is progressing, but it can be more cost effective and a better use of resources.

This can also let us take advantage of short-term funding opportunities; so SK grants, things like that where an SK grant isn't going to fund a long-term monitoring program, but it can fund a two to three year study of spawning stock biomass in a river. Then come back in another five or ten years and say how are we doing compared to that original study? This is also a good chance to partner with academic institutions.

These can be good grad student projects; to get somebody to work on this, and get a good product for a short term, and then come back to it repeatedly over time. But just keep in mind that maintaining those consistent methods across the snapshots is critical; so that we can compare down the road what happened in this year with two years from now, five years from now, ten years from now. But in a sort of a limited funding situation, this can be a good alternative for something like sturgeon; where again we're not expecting to see big swings in population abundance, or even the fishery dependent pressure like bycatch. Characterizing bycatch or ship strikes could be a snapshot approach as well. The TC just wanted to highlight a couple of things out of this; basically Number 1, the permitting process does make some of these recommendations more difficult. Both permitting for things like maintaining receiver arrays in the ocean, but also things like just getting the ability to handle a sturgeon; because of the ESA listing can be difficult.

States need to make sure they're staying on top of that and are proactive with that kind of issue. Of course, I think there was some concern from the TC about unfunded mandates; that state budgets are already strained. Producing mandates to come up with a new sturgeon spawning stock survey in a state without the associated funding is going to mean difficult choices for states agencies, in terms of taking funding away from other surveys from other projects.

This was definitely a concern; and why the TC, I think, focused on how you get the most bang for your buck with what we already have? But you know there are some positive things happening that we do have improved bycatch monitoring through the Section 10 process in some states; and it provides, so states are working on getting better data for some of these fisheries.

There is a Sturgeon Carcass Report out of Delaware State University to improve the ship strike mortality estimates; so basically just throwing a bunch of dead sturgeon in the river and see how many of them are actually reported, so that we can know if people are telling you we saw five ship strike sturgeon. Is that 5 percent of the ones that were there? Is that 100 percent of the ones that happened?

There is also work being done; to process the back log of genetic samples from some of our underrepresented DPSs. Just to end on a positive note. Some of this work is going on; and should when we get to the next benchmark, help improve that as well. But there is definitely more work to be done. With that I'll take questions.

CHAIRMAN NOWALSKY: The take away from this is as a result of the last benchmark assessment and the presentation that we had; there were questions from the Board about what more can we do. Obviously, given the information we have in the last presentation, we would all like more information about this.

But funding seems to continue to be the inhibiting issue here; to get to where we would all like to see a lot of this. Action here today, there is no action here required by the Board. We have recommendations that have come from the TC. There is the opportunity for the Board to codify any one of those as an actual requirement.

If it is the will of the Board to do so today, or again just take the information presented so far, as well as information you get from questions or discussion that comes out. Take that home; and then see what could possibly be done. With that I'll turn to the Board for questions, comments, discussion on this agenda item. A show of hands, I've got two. We'll start with John Clark.

MR. CLARK: Thank you, Katie. Just curious on the surveys that were rejected for the time series, too short, did the TC want those surveys to continue?

DR. DREW: Yes that was the TCs recommendation is that when identifying the priority surveys; the ones that were identified as having potential but being too short, should definitely be continued so that they could be folded into the assessment at a later date.

CHAIRMAN NOWALSKY: Pat Geer.

MR. PAT GEER: Mine is more of a comment. I think using the fisheries independent surveys to gather some of this information is a great idea. There are a lot of surveys out there. You listed dozens of them. A lot of those already have to have incidental take permits. If we ask them to go ahead and modify or add a new strata to target sturgeon; ironically they're going to catch more sturgeon, which ironically will go over their ITP.

That has to be addressed somehow; and it's happened in some states already, where they're seeing an increase year after year in what they're catching in their surveys. They have to go back and ask for an increase in their allowable take.

CHAIRMAN NOWALSKY: Further discussion or comments; hopefully this information from this last tasking has been helpful to the Board. Again, we can take some of this information home; and hopefully translate it into some results. Thank you for the presentation, Katie.

CONSIDER APPROVAL OF THE 2018 FISHERY MANAGEMENT PLAN REVIEW AND STATE COMPLIANCE

CHAIRMAN NOWALSKY: Next turn to our next agenda item; which at the end will require Board action and that will be Consider Approval of the 2018 Fishery Management Plan Review and State Compliance. Max will be giving us that presentation.

MR. MAX APPELMAN: This year's FMP Review actually covers the 2016 fishing year; because compliance reports are due at the end of the year covering the previous year's fishery. There is sort of this lag in the reporting period and when the actual review report is developed. This is the 2018 review of the 2016 fishing year.

First was status of the FMP and fishery. The fishery is still under moratorium; implemented through Amendment 1 in '98, and then carried into the EEZ in '99. The moratoria are expected to remain in effect until 20 year classes of spawning females are established. Moving to status of the stock, we know that all five DPS of Atlantic sturgeon were listed under the ESA in 2012, four of which were listed as endangered, and one the Gulf of Maine DPS listed as threatened.

Then in 2017, NOAA published two final rules designating critical habitat for Atlantic sturgeon. There are two documents there; one covering the Gulf of Maine/New York Bight, and Chesapeake Bay DPS, and the other for the Carolinas and South Atlantic DPS. Also in 2017, the Commission's benchmark stock assessment went through peer review. Results indicate that the population remains depleted; relative to historic abundance.

However, on a coastwide scale the population appears to be recovering slowly; since the '98 moratorium. Still the population experiences mortality from several sources; but the assessment indicates that total mortality is sustainable. Bycatch was identified as the primary source of fishing mortality; and it may be hindering population recovery. Sturgeon are most susceptible to mortality from gillnet and trawl interactions. Unfortunately total losses from bycatch are largely unknown; due to low to nonexistent rates of observer coverage in most fisheries that may encounter sturgeon. The Plan Review Team reiterates the importance of mandatory reporting or observer coverage; to effectively monitor Atlantic sturgeon bycatch in state fisheries. Ship strikes were also contributing to mortality; and were identified as an emerging issue in the assessment. Sturgeons are particularly vulnerable to ship strikes when there is a lot of cargo vessel traffic occurring in these relatively shallow shipping channels; where sturgeon routinely pass through between their ocean habitats and spawning grounds.

Moving on to ESA Section 10, Incidental Take Permits. Based on the compliance reports, a few states have received their ITPs for its fisheries; but most of the states are in the application development stage, or have just recently submitted applications. The recommendation from the PRT is familiar. It's just to continue to coordinate with the Commission regarding the status of those permits.

We've summarized the status of those permits in the report; and if you just take a look and let us know that we're up to date that would be helpful. Moving to aquaculture, so the U.S. Fish and Wildlife Service still maintains Atlantic sturgeon at three of its research facilities. Again, this is the reporting period through 2016; so these numbers up on the screen are accurate up through 2016.

Also, Maryland DNR had sturgeon captive at a number of its facilities for various research initiatives; but those activities have been terminated, due primarily to the lack of funding. Currently there are no plans to culture sturgeon in the future. LaPaz LLC, this is a commercial aquaculture company based out of North Carolina, was granted permission through Addendums II and III to import Canadian sturgeon for the purpose of commercial production.

However, recently LaPaz has shifted their focus away from the species; and is no longer in possession of Atlantic sturgeon. The majority of the fish were culled or euthanized. A handful was sold to Horse Creek Aqua Farm; which is located in Florida and covered under Addendum I to the FMP. Right now they are holding onto 117 fish as of 2016.

The remaining fish were donated to West Virginia University; to be used in various research activities. The PRT expressed some concerns about this regarding the transfer of fish to facilities outside of the Commission's jurisdiction; since West Virginia is not a Commission member state. The disposition of these fish is not well documented.

Regarding compliance in 2016, following review of the compliance reports the Review Team determined that all states and jurisdictions had implemented management and monitoring programs consistent with the management plan. Up on the screen are the various reporting requirements for your reference. I'm happy to take any questions, Mr. Chair.

MR. NOWALSKY: Very good, thank you, Max. We can entertain questions and/or any discussion. We will need a motion from the Board to approve this review. John Clark.

MR. CLARK: Thank you, Max. I guess this question actually would kind of go to Julie; because it's about the Section 10 permits. I'm just curious for the ones that have been issued so far. Do all of them require onboard observers for the fisheries that have received Section 10 permits?

CHAIRMAN NOWALSKY: Julie?

MS. CROCKER: None of the permits that have been issued to date have come out of my office; I think they've all come out of the Headquarters Office, so I'm not familiar with the specific requirements. I believe that there is some observer, or it was a commitment from the states for an observer requirement for those fisheries. But I'm not familiar with the details.

CHAIRMAN NOWALSKY: Next up I had Mike Millard.

MR. MIKE MILLARD: Max, just an update as the Director of the Services Fisheries Center in Lamar, PA, I can tell you we have zero Atlantic sturgeon on station anymore.

CHAIRMAN NOWALSKY: Any further questions or discussion? Seeing none; I'll entertain a motion to approve the FMP review**. Tom Fote, making that motion, yes, so we have a motion from Tom to approve the FMP Review. Move to approve the 2018 FMP Review for Atlantic sturgeon. Max, given your earlier comments about this is for the 2016 fishing year. Do you believe it would be helpful to include that in the motion, to call it the 2018 FMP Review of the 2016 Atlantic sturgeon fishing year?**

MR. APPELMAN: I think review covers the fact that it's the 2016.

CHAIRMAN NOWALSKY: Okay, everybody is clear on that then? Was that a second from Pat Geer? Is there any discussion on the motion? I can't imagine there would be any; but any public comment on the motion? **Seeing none; is there any objection to the motion as presented? Okay seeing none; that Review stands approved**, and that will move us along to the next agenda item. Tina Berger. Good morning, Tina.

REVIEW RECOMMENDATION TO DISBAND THE ADVISORY PANEL

MS. TINA BERGER: Good morning, thank you, Mr. Chairman.

CHAIRMAN NOWALSKY: We'll now turn to Tina for some discussion about the Advisory Panel.

MS. BERGER: The Advisory Panel was established over 20 years ago; and that was sort of the last time they met, when they provided input on Amendment 1. Given the fishery has been under a moratorium, we've kept them abreast of emerging issues, but they have not met since 1998. The membership is whittled down; and given that the assessment showed very little change in the stock status, we don't see the need for the Advisory Panel to be maintained, at least at this point.

Staff's recommendation would be for the Board to disband the Advisory Panel. We can always reestablish a panel when and if that is necessary. If the Board chooses to maintain it we'll do so. But we just thought it doesn't make sense to maintain a primarily defunct AP. Thank you.

CHAIRMAN NOWALSKY: I'll turn to the Board for discussion, comments. Again, this would be the consideration of a motion if it was the will of the Board to act on this. Pat Geer.

MR. GEER: Just a question for Tina. There were no members of the AP who wanted to comment on the ESA listing?

MS. BERGER: I'm going to punt that back to Max. I don't know if he reached out to the AP on that.

MR. APPELMAN: The ESA listing was before my time. But it's my understanding that they did not meet as a panel of the Commission to provide their comment on the listing; that they were made aware of the opportunity to provide comment, and might have done so as individuals.

CHAIRMAN NOWALSKY: I think it would really be at the discretion of this Board; whether there were issues that we wanted to specifically charge our AP with trying to get comment on, given the timeframe since they've lest met. I think that would need to have some review by the states of their current AP memberships as well. I'm guessing most are likely not up to date. Lynn Fegley.

MS. FEGLEY: I was just wondering if it would be useful for the Board to have an AP panel to provide input on the 5-year review, since Julie said she was going to be looking for comment. I don't know if that would help, Julie your efforts. I'm just curious if that would be something they could do.

CHAIRMAN NOWALSKY: Again, I think that would be, I think Tina and staff have brought the issue before us is that we've not had a formal AP meeting for this species in a very long time. The question is; what do we do? Staff made a recommendation. Again, it's the will of this Board if we feel that there is the need for the AP to continue. Then in that case, I think it would be worthwhile in making sure we get the AP up to date; as well as finding tasks and specifically engage them moving forward, would be my thoughts. Ritchie White.

MR. G. RITCHIE WHITE: I'll make a motion to disband the Atlantic sturgeon Advisory Panel at this point.

CHAIRMAN NOWALSKY: Motion made by Ritchie White; seconded by Ray Kane. I had a couple other hands go up; so let me turn to them for discussion. First I'll ask Ritchie if he feels any further comments needed on his part; shaking his head no. I had hands up from Roy Miller and Tom Fote. Roy.

MR. ROY W. MILLER: I kind of like Lynn's suggestion of considering an Advisory Panel to provide comments for the 5-year review. Otherwise, the obvious question is who would do that review? Would it be just the Technical Committee without input from any advisory panel? Perhaps you have an answer to that Mr. Chairman.

CHAIRMAN NOWALSKY: I do not personally. I'll look to my right to see if there is any input on who would do that. Max is going to give that a go.

MR. APPELMAN: I'll just make the Board aware of how we went about this in the past with the ESA listing; and most recently with the Critical Habitat Designation. What happened is that the Technical Committee did not formally as a group provide comment or review on those draft reports.

Instead, staff reached out on behalf of NOAA reached out to the Technical Committee to ask for a handful of members to take their own time to provide a review on those documents. That is sort of the approach that we see happening with any other ESA related documents down the road.

CHAIRMAN NOWALSKY: Next up I had Tom Fote.

MR. THOMAS P. FOTE: With the implementation of Atlantic Coast Conservation Act, it was important that one of the charges that a bunch of us made was that we would have advisors to every board from the community; the recreational, commercial and the environmental community on the Boards.

Except the Board hasn't met in 20 years, I'm a little hard pressed to push to continue running a Board. Even though I feel strongly that we should have an AP Board for every species; it just basically says we're not going to have the Board for the sturgeons, since nobody has met in 20 years. I don't know.

CHAIRMAN NOWALSKY: Are there any further comments on the motion before us? Seeing none; I'll give the Board 30 seconds to caucus. We've had a moment to caucus. Before we vote on this I'll just simply ask if there is any comment from public on this. Prior to the voting I did see a hand go up from the Board. Maureen.

MS. MAUREEN DAVIDSON: As you know I'm kind of new at this. I would like to ask, if this Panel hasn't met in 20 years, is it because the Panel as a group itself chose not to meet or were they not called to meet by the Commission?

CHAIRMAN NOWALSKY: I'll go to Toni.

MS. TONI KERNS: They haven't been called upon to meet; because we haven't had any actions to bring forward to the Panel, because there has been a moratorium for the last 20 years.

MS. DAVIDSON: Any actions that have been taken for Atlantic sturgeon since 1998, the Panel was not just called to participate.

CHAIRMAN NOWALSKY: This Board has not had any management actions. Obviously there have been actions that have taken place at the Federal level. This Board has not asked formally for the AP to provide comment through the Board to the entities that are enacting those actions. Those AP members that remain have had the ability to, and I'm sure some have, directly commented on it. But we as a Board have not asked them to provide us and then provided that comment on.

MS. DAVIDSON: Thank you.

CHAIRMAN NOWALSKY: **Okay, so let's go ahead and take a vote on this. Move to disband the Atlantic sturgeon Advisory Panel; motion by Mr. White, seconded by Mr. Kane. All those in favor please raise your right hand. Thank you, you can put your hands down. All those opposed, abstentions, null votes; motion carries 17 to 0 to 0 to 0.**

ADJOURNMENT

CHAIRMAN NOWALSKY: Is there any further business to come before the Board today? Seeing no further business; and having completed the agenda as it was presented, this Board stands adjourned, thank you very much.

(Whereupon the meeting adjourned at 11:40 o'clock a.m. on August 8, 2018)

Atlantic States Marine Fisheries Commission

2024 Atlantic Sturgeon Stock Assessment Update

For Board Review

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Atlantic Sturgeon Stock Assessment Update
Prepared by the ASMFC Atlantic Sturgeon Stock Assessment Subcommittee:
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The Commission also expresses deep gratitude to the many individuals outside the TC and SAS who contributed telemetry data for the survival model, including Matt Balazik (Virginia Commonwealth University), Adam Fox (University of Georgia), Eric Hilton (Virginia Institute of Marine Science), Micah Kieffer (USGS Eastern Ecological Science Center), Pat McGrath (Virginia Institute of Marine Science), and Gayle Zydlewski (University of Maine). The Commission also thanks Barb Lubinski, Robin Johnson, Cassia Busch, and Shannon White of the USGS Eastern Ecological Science Center for their efforts to genotype and assign telemetered sturgeon, and Matt Breece (University of Delaware) for assistance with obtaining the tagging data.

EXECUTIVE SUMMARY

The purpose of this assessment was to update the 2017 Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report (ASMFC 2017) with recent data from 2016-2022. Data from a variety of fisheries-dependent and independent sources were used to develop bycatch, effective population size, and mortality estimates.

Several states closed their Atlantic sturgeon fisheries in the mid to late 1990s, and a coastwide moratorium was implemented in 1998, ending the directed Atlantic sturgeon landings time series. For this assessment, bycatch in other fisheries was quantified from federal observer programs from Maine to North Carolina and in North and South Carolina from other fishery programs. Bycatch data begins in the 2000s and estimates of Atlantic sturgeon bycatch have generally been decreasing in recent years, with the exception of estimates from gill nets from the federal program.

Nine fishery-independent surveys were developed into indices of relative abundance for Atlantic sturgeon. Most indices either had no trend over the time series or were increasing. The individual indices were combined to develop a coastwide index of relative Atlantic sturgeon abundance. The coastwide index is variable from 1990-2022 but has been steadily increasing since 2013.

Estimates of total mortality (Z) produced from an acoustic tagging model were compared to total mortality thresholds defined as the value of total mortality, Z, that results in an egg-per-recruit (EPR) that is 50% of the EPR of an unfished stock, $Z_{50\%EPR}$, at both the coastwide and DPS-level. Total mortality was low for the coastwide population. For individual DPSs, the Gulf of Maine had the highest Z estimates whereas the Chesapeake Bay had the lowest Z estimates.

Stock status determination was made qualitatively relative to historical abundance and quantitatively relative to 1998 (or, for surveys that started after 1998, the first year of the survey), the start of the coastwide moratorium when more quantitative datasets were available. The terminal year index values of the selected fisheries-independent surveys were compared to the index value that occurred during 1998 to evaluate whether abundance was higher or lower than at the start of the moratorium. At the coastwide level, while Atlantic sturgeon remain depleted relative to historic levels, the composite index had a 100% probability of being above the 1998 value and a significant positive trend over the time series, and the probability of total mortality being above the total mortality threshold was less than 2%.

At the individual DPS level, results were more mixed. Individual indices varied, with slightly more than half having a greater than 50% chance of being above the reference year value; most indices showed a positive or no significant trend. The average probability of being above the reference year was greater than 50% for the New York Bight and the Carolina indices, and less than 50% for the other indices, similar to the results of the 2017 assessment. The Gulf of Maine

DPS had a 55.5% probability of annual Z being above the Z threshold, but all other DPSs had a less than 50% probability of exceeding the Z threshold.

Population	Mortality Status	Biomass/Abundance Status		
	P(*Z*)>$Z_{50\%EPR}$ Reference Point	Relative to Historical Levels	NOAA Designation	Average probability of terminal year of indices > reference year*
Coastwide	1.80%	Depleted		100%
Gulf of Maine	55.50%	Depleted	Threatened	45%
New York Bight	20.20%	Depleted	Endangered	59%
Chesapeake Bay	14.10%	Depleted	Endangered	27%
Carolina	18.20%	Depleted	Endangered	77%
South Atlantic	26.50%	Depleted	Endangered	31%

***Reference year is 1998, or the first year of the survey for indices that started after 1998**

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INTRODUCTION

This Terms of Reference (TOR) report describes the update to the most recent benchmark stock assessment for Atlantic sturgeon (ASMFC 2017). This assessment extends the fishery-independent and –dependent data for Atlantic sturgeon through 2022, reruns the tagging, autoregressive integrated moving average (ARIMA), and egg-per-recruit models and estimates annual bycatch and total mortality. Stock status is determined using the total mortality reference point defined and accepted for management use in 2017.

Atlantic sturgeon are categorized into five distinct population segments (DPS): Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic (Figure 1). The DPSs have different physical, genetic, and physiological characteristics (NOAA 2012a). The SAS note that while surveys used in this assessment are categorized by DPS, they are likely catching a mixed population. The SAS is making the assumption, based on genetic work (Kazyak et al. 2021), that the surveys encounter predominantly Atlantic sturgeon from populations which spawn nearby, but some Atlantic sturgeon from other DPSs may be mixed in as well.

TOR 1. Fishery-Dependent Data

Update fishery-dependent data (landings, discards, catch-at-age, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

Several states closed their Atlantic sturgeon fisheries in the mid to late 1990s, and a coastwide moratorium was implemented in 1998, ending the directed Atlantic sturgeon landings time series. Historical commercial landings are available in ASMFC 2017.

However, Atlantic sturgeon are still caught as bycatch in fisheries for other species. Estimates of Atlantic sturgeon bycatch are available from federal and state data collection programs and were updated for this assessment.

a. Northeast Fishery Observer Program Bycatch Estimates

Following the approach used by Miller and Shepherd (2011), Miller (2015), Curti (2016), and Boucher and Curti (2023), the same generalized linear model (GLM) framework with quasi-poisson assumption was used for modeling Atlantic sturgeon takes as a function of the trip-specific species mix, year, and quarter factors. In Miller and Shepherd (2011), the "species mix" was comprised of those species currently managed with federal fishery management plans. In this analysis, the modifications applied in ASMFC 2017 were followed, where the "species mix" covariates were those species caught most on observed hauls encountering Atlantic sturgeon.

The selected model for each gear type was applied to vessel trip reports to predict Atlantic sturgeon take for all trips. The new NEFSC/GARFO Catch Accounting and Monitoring System (CAMS) was not used to develop the estimates, to be more consistent with the methods used in the 2017 benchmark assessment. The total bycatch of Atlantic sturgeon from bottom otter trawls ranged between 478 – 1,187 fish over the time series (Table 1). The proportion of the encountered Atlantic sturgeon recorded as dead ranged between 0 – 18% and averaged 4%. This resulted in annual dead discards ranging from 0 – 212 fish. Likewise, the total bycatch of Atlantic sturgeon from sink and drift gillnets ranged from 281 – 1,583 fish (Table 2). The proportion of Atlantic sturgeon recorded as dead ranged between 12 – 51% and averaged 30%, resulting in annual dead discards ranging from123 – 594 fish. The estimates from the updated model for this assessment were very similar to the estimates from the benchmark model for both gears (Figure 3). The percent of dead sturgeon in both otter trawls and gillnets was higher in 2021-2022 than it was in earlier years, but observer coverage was lower in 2021-2022, resulting in higher uncertainty around the estimates.

b. North Carolina Atlantic Sturgeon Bycatch Estimates from the Estuarine Gill Net Fishery

A GLM framework was used to predict Atlantic sturgeon interactions in North Carolina's estuarine gill net fishery based on data collected during 2013-2022 using the same methods as ASMFC 2017 although the time period of data has changed. Since 2017, the bycatch database in North Carolina has improved and their Protected Resources Section no longer recommends using the data from 2004-2012 as was done in the benchmark. For this update, only the data from 2013-2022 was used. The best-fitting GLM was a zero-inflated Poisson model with an offset for trips that used year, season, management unit, and mesh size in the count part and year, management unit, and mesh size in the zero-inflated part. Atlantic sturgeon bycatch in North Carolina's estuarine gill net fishery reached a high of 1,413 Atlantic sturgeon in 2015 and a low of 119 in 2019 (Table 3). In general, the Atlantic sturgeon bycatch in this fishery has decreased over time, due in part to additional regulations on the gillnet fishery to minimize bycatch of Atlantic sturgeon as a result of the ESA listing.

c. South Carolina Atlantic Sturgeon Bycatch Estimates from the American Shad Fishery

Following the methods of ASMFC 2017, Atlantic sturgeon bycatch estimates in South Carolina were estimated. Between years 2000-2022, a total of 1,728 Atlantic sturgeon were reported in the Winyah Bay and Waccamaw, Great Pee Dee, and Santee Rivers American shad fisheries (Table 4). Previous observer coverage indicated that the vast majority of sturgeon caught in this fishery are alive when released, as the fishery occurs in the spring when the water temperatures are cooler. Therefore, all sturgeon reported as bycatch are assumed to be released alive unless specifically reported dead. Based on genetic makeup and ecological groupings included in the recent 2012 listing of the Atlantic sturgeon to the Endangered Species List, these rivers are part of the Carolina DPS (NOAA 2012a). Average effort during the same time series equaled 3,342,073 net yard hours with an average catch per unit effort (CPUE) of 0.0000035 Atlantic sturgeon per net yard hours. It is also important to note, since shad regulation changes in 2013 as part of requirements of South Carolina's Shad Sustainably Plan, reported numbers of Atlantic sturgeon for Carolina DPS rivers decreased by 30% and CPUE decreased by 38%. These are notable decreases to already low levels of overall impact.

Between years 2000-2022 a total of 69 Atlantic sturgeon were reported in the Edisto, Combahee, and Savannah Rivers shad fisheries (Table 4). Based on genetic makeup and ecological groupings included in the recent 2012 listing of the Atlantic sturgeon to the Endangered Species List, these rivers are part of the South Atlantic DPS (NOAA 2012a). Average effort during the same time series equaled 261,195 net yard hours with an average CPUE of 0.0000016 Atlantic sturgeon per net yard hours. It is important to note, since shad regulation changes in 2013 as part of requirements of South Carolina's Shad Sustainably Plan, reported numbers of Atlantic sturgeon for South Atlantic DPS rivers was one fish. These are also notable decreases to already low levels of overall impact. This combined with overall declining effort suggests by-catch in this fishery may not be a concern to sturgeon populations in these rivers.

TOR 2. Fishery-Independent Data

Update fishery-independent data (abundance indices, age-length data, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

As noted in ASMFC 2017, Atlantic sturgeon are not often encountered by fishery-independent surveys. Nine surveys were developed into indices of relative abundance and were standardized using generalized linear models. Because of low positive tows, several surveys used a binomial error structure as recommended by the Peer Review Panel (Table 5). Indices were combined for a coastwide index of relative Atlantic sturgeon abundance using the Conn method (Conn 2010). The coastwide index is variable from 1990-2022 but has been steadily increasing since 2013 (Figure 4). Individual survey plots can be found in the Appendix (Figure A6 - Figure A22).

A power analysis was completed on the abundance indices (ASMFC 2017; Gerrodette 1987). Median coefficients of variation (CVs), or proportional standard error, ranged from 0.14–1.15 for the surveys analyzed and power values ranged from 0.13 to 1.00 (Table 6). The Maine-New Hampshire Trawl had the lowest power and the South Carolina Edisto Sturgeon Monitoring Project Survey had the highest power to detect a 50% increase or decrease in abundance. The results were similar to the benchmark (ASMFC 2017).

TOR 3. Life History Information

Tabulate or list the life history information used in the assessment and/or model parameterization (M, age plus group, start year, maturity, sex ratio, etc.) and note any differences (e.g., new selectivity block, revised M value) from benchmark.

The life history information used to parameterize the eggs-per-recruit (EPR) reference point model was the same as used in the benchmark. The median life history information is presented in Table 7.

TOR 4. Models

Update accepted model(s) or trend analyses and estimate uncertainty. Include sensitivity runs and retrospective analysis if possible and compare with the benchmark assessment results. Include bridge runs to sequentially document each change from the previously accepted model to the updated model.

a. Tagging Model

The tagging analysis from ASMFC (2017) was repeated to estimate annual survival of telemetry tagged Atlantic sturgeon. The dataset consisted of tag detection data for Atlantic sturgeon tagged and observed on receiver arrays across the Atlantic coast. Detection data from the 2017 assessment was updated to included additional detections and tags through the time period ending in 2022. Tagged Atlantic sturgeon were individually assigned a DPS based on genetics if a genetic assignment was available, then location of tagging if genetics were unavailable (Table 8). Tagged individuals were separated into two groups for size-at-tagging, subadults (<1,300 mm) and adults (>1,300 mm), with the break approximating size at maturation. The benchmark assessment only looked at parameter estimates over a single block of time, but for this update both single and dual time stanzas were evaluated. Based on the pattern in tag detections, representing shifts in effort across DPSs, a cutoff date of December 2015 was used to split detections into early (2006-2015) and late periods (2016-2022).

The Cormack-Jolly-Seber model and estimated parameters, detection probability (P) and annual survival (S), were the same as in the benchmark model. Similarly, scenario runs used 2,500 burn-in and 10,000 model iterations and best performing models were selected using Deviance Information Criterion (DIC). The scenarios evaluated by the model included those from the benchmark assessment and the additional early and late time blocks.

The best model for each DPS and size group varied, with a single estimate of P performing better for certain DPSs, while monthly DPS estimates were better for others. Size groups showed less of a pattern for P. Models using the early and late S blocks were less supported than those using single blocks, and the S estimates did not vary greatly between times. The peer review from the benchmark assessment recommended presenting the median, instead of mean, value of the posterior distribution for estimates, due to skewing in the distributions related to sample size.

Total mortality (Z) was calculated from survival using the equation:

$$Z = -\ln(S)$$

Overall, estimates of Z were similar to those in the benchmark assessment, in most cases equal or lower. Across DPSs, Z was also similar, although the Gulf of Maine DPS was somewhat higher (Table 9; Figure 5-Figure 10). Atlantic sturgeon migrate over large areas throughout their subadult and adult stages (Kazyak et al. 2021) and mortalities may occur beyond the geographic area associated with a specific DPS. Therefore, the DPS-specific estimates represent estimates for individuals originating from the DPS, rather than the conditions within the geographic area associated with the DPS itself. Subadult Z was also generally higher than adult Z; see Appendix A for more detailed results.

The number of tags available were greatly increased over the benchmark, improving estimates, but the tagging model was still sensitive to sample size, notably in the results for the Gulf of Maine DPS. Importantly, many tagged Atlantic sturgeon originate through shorter-term studies that are focused on answering specific research questions and may not have steady funding. Continued application of this model will require continued operation of acoustic telemetry arrays and ongoing deployment of acoustic tags. Improved tagging and detection data could also lead to future model improvements as additional modeling aspects, such as covariates, or finer resolution temporal or spatial parameter estimates can be developed.

b. Stochastic Eggs-per-Recruit (EPR) Model

During the update, a revision was made to how uncertainty was parameterized for the stochastic EPR model used to estimate the Z reference point. This revision made the standard deviation of the drawn parameters align more closely with the published values where available when parameters were drawn from a lognormal distribution. Otherwise, the parameterization of the model was the same as in the benchmark assessment. Median selectivity values for the bycatch and ship strike fleets are presented in Table 7.

The adjustment to the uncertainty parameterization had a negligible effect on the overall distribution for the $Z_{50\%EPR}$ reference point compared to the benchmark values. The 80th percentile of the $Z_{50\%EPR}$ distribution is used as the reference point and was equal to 0.14.

c. Mann-Kendall Test

Analyses from ASMFC (2017) were repeated with raw updated indices. For ASMFC (2017), only one index, North Carolina Program 135's (NC p135) spring index for juveniles, had a significant (increasing) trend (α = 0.05). For the present report, the following raw indices had increasing trends: New Jersey Ocean Trawl, NC p135's spring index for young-of-the-year (YOY) and juveniles, NC p135's spring index for juveniles, NC p135's fall index for YOY and juveniles, NC p135's fall index for juveniles, and the Conn index (Table 12). No survey had a significant declining trend.

d. ARIMA

The fishery-independent indices were analyzed using the autoregressive integrated moving average (ARIMA) methods described in ASMFC (2017) with the following changes:

- In 2017, only contiguous years of a survey index with no missing index values were used in ARIMAs (Figure 11); due to COVID and other reasons (e.g., vessel mechanical issues), sampling for several surveys was suspended during at least 2020 and so for the present assessment, the ARIMA code (the *surveyfit* and *surveyref* functions from the *fishmethods* package) was modified to allow missing values; the bootstrapping routine within *surveryref* was also modified so that missing years of data always had missing data and no additional missing years were added via re-sampling.

- Given the variability in available terminal years relative to ASMFC 2017 (Figure 11), the data was not subset to a common set of years as a sensitivity analysis. The goal of this sensitivity analysis in 2017 was to determine whether the comparison of the terminal year to the 25th percentile of the time series was sensitive to the specific years over which the 25th percentile was calculated. For the present analyses, due to COVID and other issues, surveys have variable terminal years and years missing adjacent to terminal years, and so the SAS found this sensitivity analysis to be less relevant (i.e., trimming surveys to a common terminal year would only add four additional years to ASMFC (2017), resulting in a terminal year of 2019, approximately 5 years ago – this was judged to be of little use).

Consistent with ASMFC (2017), probabilities greater than or equal to 0.50 were considered credible evidence that an index value was greater than a reference point.

Descriptive statistics for all model runs are provided in Table 11. When adjusted for multiple tests (Holm 1979; RCT 2017), residuals from all model fits were normally distributed, except for the South Carolina Edisto Sturgeon Monitoring Project Survey (SC Edisto).

Fitted indices, grouped by DPS, are plotted in Figure 13 - Figure 15. Plots of ARIMA fits with reference values are provided in the Appendix (Figure A1). Significant trends (Holm-adjusted p-values ≤ 0.05) are summarized in Table 12 and reported below.

Comparison of ARIMA fits from 2024 with those generated in 2017 are provided in Figure 16. Direct comparison of index fits is complicated by index model structures changing in some instances (e.g., GLM vs generalized additive model, or GAM, for New York State Department of Environmental Conservation Juvenile Atlantic Sturgeon Abundance Monitoring Program, or NY JASAMP) and additional years of data becoming available (e.g., Connecticut Long Island Sound Trawl Survey, or CT LIST, in the spring) due to changes in ARIMA methodology from ASMFC (2017; e.g., allowance for missing years of data).

All ARIMAs were credibly above their respective 25th percentiles of abundance except for the CT LIST for the index using all months and the Virginia Institute of Marine Science (VIMS) Shad and River Herring Monitoring Survey in the James River in the spring (Table 12). The situation was more mixed when considering terminal year fits compared to the fitted index from 1998 (or the first year of the survey). When including all indices, the terminal year for 7 of 18 indices were not above the 1998 (or surrogate) value. As was done in ASMFC (2017), because some survey indices, when subset to different ages or months, are strongly correlated with each other, 'duplicative' surveys were removed for final status determination. In this case, for the group of NC p135 spring indices, the juvenile index was strongly correlated with both the YOY and the YOY and juvenile indices (while those two indices were not strongly correlated with each other). Since the indices are not lagged, only the YOY and juvenile index was removed, since similar information is contained in the individual indices. For the group of NC p135 fall indices, all three indices were strongly correlated with each other. Following the reasoning for NC p135 spring indices, YOY and juvenile indices was removed. With these adjustments, 7 of 16 indices were not above their respective fitted 1998 (or surrogate) index value. See Table 13 for results summarized by DPS, or Table 12 for individual survey results.

Results from the reverse retrospective analysis are provided in Figure 17 - Figure 18. Figure 17 suggests that the terminal year comparisons with the 25th percentile of the CT LIST index for all months, CT LIST spring index, NY JASAMP, and VIMS (James River only) indices are all somewhat sensitive to the start year of the survey. In each of those surveys, except for NY JASAMP, the probability of being above the 25th percentile of abundance tends to increase with later starts in the survey – this is an intuitive result as early years of these surveys tended to have relatively high index values, and so as those years are sequentially removed, the 25th percentile of the time series drops, making it more likely that the terminal year will exceed that value.

Figure 18 suggests that the conclusions with respect to comparisons with the index value in 1998 (or start year of the survey for surveys that began after 1998) for CT LIST index using all months, CT LIST index in the spring, Maine-New Hampshire Inshore Groundfish Trawl Survey (ME-NH Trawl), SC Edisto, US Fish and Wildlife Cooperative Tagging Cruise (USFWS), and both VIMS indices are all somewhat sensitive to the start year of the survey. The reasons for this may be similar to those stated above – early years of these indices tend to have comparatively large values with wide swings in abundance, the removal of which can have a strong influence on the ARIMA trend.

A correlation matrix of all ARIMA fits is provided in Figure 19. Index fits in the New York Bight DPS are uncorrelated or negatively correlated with each other. Index fits in the Chesapeake Bay DPS are uncorrelated with each other. Index fits in the Carolina DPS are uncorrelated or positively correlated with each other. The Northeast Area Monitoring and Assessment Program Trawl Survey (NEAMAP), which corresponds to the New York Bight, Chesapeake Bay, and Carolina DPSs, is uncorrelated with all index fits, save CT LIST index for the fall; the Conn index fit is positively correlated with all Carolina DPS index fits, and the New Jersey Ocean Trawl fit, but uncorrelated or negatively corelated to the remainder of the index fits. See Figure 19 for relationships among all survey fits.

For detailed DPS- and index-specific results, see Appendix C.

TOR 5. Stock Status

Update the biological reference points or trend-based indicators/metrics for the stock. Determine stock status.

Atlantic sturgeon was designated as a federally endangered species in 2012 (Federal Register 2012). However, there remains no estimates of unexploited biomass or abundance at the coastwide or DPS-level against which to evaluate Atlantic sturgeon status, and estimates of current abundance are limited to a few rivers. Also, for a species that has been under a moratorium for nearly twenty years, the traditional “overfished” and “overfishing” status designations are not as meaningful.

For this assessment, quantitative stock status was determined from the probability of the estimate of total mortality from the tagging model being greater than the $Z_{50\%EPR}$ reference point and the probability that the terminal year of the indices for a given DPS was greater than the reference year for each index, as evaluated by the ARIMA analysis. Because the available indices only cover the most recent time period, long after the height of exploitation, metrics like trends in landings and consideration of anecdotal reports of historical distribution and abundance were used to determine a qualitative biomass or abundance status relative to historical levels.

For total mortality, the distributions of the annual estimate of *Z* from the tagging model were compared to the total mortality EPR reference point to determine the probability of total mortality for the coast and for each DPS being above the reference point. The 80th percentile of the stochastic $Z_{50\%EPR}$ estimate for the coast was used as the reference point. Total mortality was low for the coastwide population; median annual *Z* was estimated to be 0.01 for 2006-2022, with only a 1.8% chance that *Z* was higher than the *Z* reference point (Table 9, Figure 5).

At the individual DPS level, estimates of survival were lower and estimates of *Z* were higher, due to the lower sample size and the broader parameter distributions (Table 9, Figure 6 -Figure 10). The Gulf of Maine had the highest median annual *Z* at 0.15, with a 55.5% probability of being above the *Z* threshold. The New York Bight DPS median annual *Z* was 0.06, with a 20.2% probability of being above the *Z* threshold. The Chesapeake Bay DPS had a median annual *Z* of 0.05, with a 14.1% probability of being above the *Z* threshold. The Carolina DPS had a median annual *Z* of 0.05, with an 18.2% probability of being above the *Z* threshold. The South Atlantic DPS had a median annual *Z* of 0.07 with a 26.5% probability of being above the *Z* threshold. Overall, the probability of exceeding the *Z* threshold was lower for the coast and for all DPSs than was estimated for the 2017 benchmark assessment. The two time-block model had less statistical support than the single time-block model, so this lower probability may result from an improved ability to estimate *Z* in the update, with the larger sample size and longer time series, rather than a reduction in *Z* in recent years. In all DPSs and at the coastwide level, Atlantic sturgeon were determined to be depleted relative to historical levels, a term that acknowledges the impact of not just directed fishing mortality, which has ceased since 1998, but other factors such as bycatch mortality, ship strikes, and reductions in productivity due to habitat loss.

At the coastwide level, while Atlantic sturgeon remain depleted relative to historic levels, the composite index had a 100% probability of being above the 1998 value and a significant positive trend over the time series, and the probability of total mortality being above the total mortality threshold was less than 2% (Table 14).

At the individual DPS level, results were more mixed (Table 14). Individual indices varied, with slightly more than half having a greater than 50% chance of being above the reference year value; most indices showed a positive or no significant trend (Table 13). The average probability of being above the reference year was greater than 50% for the New York Bight and the Carolina DPSs, and less than 50% for the other DPSs, similar to the results of the 2017 assessment. The Gulf of Maine DPS had a 55.5% probability of annual Z being above the Z threshold, but all other DPSs had a less than 50% probability of exceeding the Z threshold (Table 14).

Atlantic sturgeon is a data-limited species, and there are several limitations and sources of uncertainty in the datasets used in this assessment that should be taken into account when evaluating stock status. Even though Z has a low probability of exceeding the Z reference point at the coastwide level, sources of mortality like bycatch and ship strike mortality may not be affecting each DPS or even each river within a DPS equally. Only half of the tagged fish were able to be assigned to a DPS based on genetics; the rest were assigned based on where they were tagged. This makes the estimates of Z at the DPS level less reliable, as fish from other DPSs are likely mixed with the true DPS fish in the analysis. In addition, the tagging model is predominately measuring Z on adult fish, based on the size of the fish in the model and the time at large, and mortality on juveniles may be higher. For abundance trends, the probability of a DPS being above or below the reference level is based on a limited number of surveys for each DPS. Indices are assigned to a DPS based on where the survey occurs, not on the genetics of the fish caught by that survey. While genetic work (Kazyak et al. 2021) suggests that the surveys encounter predominantly Atlantic sturgeon from populations which spawn nearby, some Atlantic sturgeon from other DPSs may be mixed in as well, potentially confounding some of the trends reported for each DPS.

In addition, tag data and indices were not available for all rivers within each DPS, so the results reported here represent only the component of each DPS, and the coastwide population, that are represented in the available data.

TOR 6. Projections

Conduct short term projections when appropriate. Discuss assumptions if different from the benchmark and describe alternate runs.

Projections cannot be conducted with the models used in this assessment.

TOR 7. Research Recommendations

Comment on research recommendations from the benchmark stock assessment and note which have been addressed or initiated. Indicate which improvements should be made before the stock undergoes a benchmark assessment.

a. Progress on Benchmark Research Recommendations

Since the 2017 Atlantic sturgeon Benchmark Assessment, research and management information has been published on a variety of topics that help address research priorities. Appendix D lists the complete list of research recommendations from ASMFC 2017.

High Priority Recommendations

Identify spawning units along the Atlantic coast at the river or tributary and coast-wide level.

Significant progress has been made towards identifying and characterizing extant spawning units along the Atlantic Coast since the last benchmark stock assessment. Two studies found evidence of small breeding populations in rivers that had not been documented prior. Savoy et al. (2017) found evidence of breeding in the Connecticut River by a limited number of breeders, which appear to have originated from much more southern locations. These results indicate that re-colonizers of extirpated populations may not necessarily come from nearby populations. Secor et al. (2022) studied spawning in the Nanticoke River-Marshyhope Creek (Chesapeake Bay), finding a small adult population with a small effective population size genetically (N_e = 12.2, 95% CI = 6.7-21.9) and small spawning runs (<100 adults; Coleman et al. 2024). In addition to these field studies, molecular analysis found evidence of distinct spring- and fall- spawning populations in the Pee Dee and Ogeechee Rivers (White et al. 2021). Despite this progress, there are likely still additional spawning populations which have not yet been formally documented, particularly within the Carolina DPS.

Expand and improve the genetic stock definitions of Atlantic sturgeon, including developing an updated genetic baseline sample collection at the coast-wide, DPS, and river-specific level for Atlantic sturgeon, with the consideration of spawning season-specific data collection.

Several studies have advanced our knowledge of genetic stocks of Atlantic sturgeon. Farrae et al. (2017) found that fall- and spring-spawned Atlantic sturgeon in the Edisto River are genetically distinct but both with high genetic diversity indicating lack of inbreeding and lack of recent bottlenecks. White et al. (2021) published a genetic baseline for Atlantic sturgeon, consisting of representative individuals from 18 genetically distinct groups collected in 13 rivers and one estuary. This baseline includes discrete spring- and fall-spawning populations from four rivers. In most cases, genetic differentiation was lower within DPSs versus among populations from separate DPSs. A notable finding from White et al. (2021) was that populations that spawn in the same season (i.e., spring or fall) are often more similar than populations which spawn within the same river. The White et al. (2021) baseline is currently being used by the U.S. Geological Survey, NOAA Fisheries, and US Army Corps of Engineers to allocate take to specific DPSs to support federal management of Atlantic sturgeon under the Endangered Species Act. The U.S. Geological Survey is continuing to expand and augment this genetic baseline, with ongoing efforts to improve stock characterization in the South Atlantic and Carolina DPSs, as well as populations which spawn in Canadian rivers. Wirgin et al. (2023) used microsatellite analysis to estimate the genetic population structure of Atlantic sturgeon from 13 spawning rivers from St. Lawrence River, Quebec, to Satilla River, Georgia, and found two distinct genetic clusters of juveniles in Ogeechee River, Georgia (spring- and fall-spawned) differing significantly in mean total length and evidence that one cluster is resident while the other is highly migratory. The Savannah and Altamaha River populations showed no such partitioning.

Our enhanced understanding of genetic population structure in Atlantic sturgeon has been leveraged to improve our characterization of stock composition in habitats where mixing may occur. For example, Wirgin et al. (2018) studied the genetics of 148 subadult Atlantic sturgeon collected in the tidal Hudson River estuary and 8 dead specimens found floating (likely victims of vessel strikes) and found 142 live and all 8 dead were Hudson River (New York Bight DPS), 2 Kennebec River (Gulf of Maine DPS), 2 Delaware River (New York Bight DPS), 1 Ogeechee River (South Atlantic DPS) and one James River (Chesapeake Bay DPS). This result does not differ markedly from the retrospective mixed-stock analysis on the New York Bight fishery fin spines collected 30 years ago which suggest the fishery primarily harvested individuals from the Hudson River population, with a few from at least eight other populations (White et al. 2021).

Kazyak et al.'s (2021) mixed-stock microsatellite analysis of 1,704 Atlantic sturgeon found extensive stock mixing in the mid-Atlantic with individuals from all five regions were commonly observed (north of Cape Cod, Massachusetts, and south of Cape Hatteras, North Carolina, stocks were dominated by individuals from regional stocks). Subadults and adults encountered in offshore environments had moved 277 km on average from their natal source with 23% being found over 500km from their natal source.

Wirgin et al. (2023) conducted individual-based assignment testing on 1,512 Atlantic sturgeon from coastal environments, focusing their analysis on individuals which demonstrated affinity to the South Atlantic DPS. Their analysis found a disproportionate contribution from one of the genetic groups from the Ogeechee River, which the authors interpreted to suggest significantly different migratory strategies (i.e., resident and highly migratory).

White et al. (2023) reported individual-based assignment testing results for 329 Atlantic sturgeon which were encountered as mortalities or taken during federally-permitted activities. The majority of these animals assigned to the Hudson River population, with substantial additional contributions from the James River (fall-spawning) and Delaware River populations. Nonetheless, a considerable number of individuals originated from distant populations from the southeastern United States.

White et al. (2024) examined the composition of >500 juvenile and subadult Atlantic sturgeon captured during monitoring surveys at Haverstraw Bay from 2017-2022. The majority of these fish assigned to the Hudson River population, and there were no patterns of natal origin with respect to sex, size, or age. This work indicates that the long-term survey data collected at this location primarily reflects demographic trends in the Hudson River population.

> *Determine habitat use by life history stage including adult staging, spawning, and early juvenile residency; expand the understanding of migratory ingress of spawning adults and egress of adults and juveniles along the coast.*

The frequency of spawning and spawning population abundance has been examined to further our understanding since 2017. Breece et al. (2021) found that females spawn at much shorter mean intervals than historical literature suggests in the Hudson River with mean intervals between spawning periods 1.66 years for females and 1.28 years for males. Additionally, they found significantly longer occupancy in the spawning grounds for males (45 days) than females (21 days). The authors documented that fish returned in September when water temperatures are 20 - 27°C and departed as fall temperatures declined below 20°C. They preferred hard bottom and spawned mostly on sand-cobble and cobble. Movement was higher at night and fish covered multiple spawning regions. Kazyak et al. (2020) integrated side-scan sonar with acoustic telemetry to estimate size of the 2014 spawning run for the Hudson River (N=466, 95% confidence interval = 310-745). If reported spawning intervals were taken into account, the estimate appears similar to the historical total adult population estimate by Kahnle et al. (2007). Vine et al. (2019a and 2019b) examined spawning abundance and migration cues in the Savannah River in South Carolina and Georgia using side-scan monitoring as an alternative to traditional mark-recapture techniques and found maximum daily spawner abundance between 35 and 55 individuals in the fall spawning season. Their conclusion is that directed flow regulation (e.g., intermittent flood pulsing) during key temperature thresholds may facilitate upriver movement and aid in the conservation of sturgeon. Acoustic monitoring and mixed-effects models in the Great Pee Dee River, North Carolina (Denison et al. 2023), indicated that discharge affected water temperature influencing migration initiation and upriver movement. Spring runs cued on rising temperature and high discharge, while fall runs cued on falling temperatures and low discharge. Analogously, in spring Atlantic sturgeon travelled further upriver when discharge was decreasing, while in the fall they travelled upriver when discharge was increasing. They migrated significantly further upstream in fall than spring.

Recent work by White et al. (2024) highlights the extent to which adult sturgeon utilize non-natal rivers. In the Delaware River, a significant proportion of sturgeon which are in freshwater reaches during the spawning season appear to be from other populations. However, despite the physical presence of non-natal adults in spawning reaches, the observed levels of genetic differentiation among population indicate that little effective gene flow is occurring.

Rulifson et al. (2020) tracked Atlantic sturgeon in a strategically placed acoustic array just south of Cape Hatteras where the continental shelf area is naturally constricted finding presence in fall, winter, and spring at approximately the same time as spiny dogfish which could be a problem for bycatch in the spiny dogfish fishery.

Collect DPS-specific age, growth, fecundity, and maturity information.

Several studies address Atlantic sturgeon growth. Kehler et al. (2018) observed hatchery fish marked with an oxytetracycline (OTC) marker and seven recaptures of wild fish and found that growth was different between spring and fall collections with two-part zone for each year of growth. They found mean growth rates of 0.3 mm/day and 2.4 g/day and were unable to effectively estimate fork lengths of age classes. Markin and Secor (2019), through a lab experiment, determined the strain (river of origin) does not support the existence of latitudinal counter gradient growth variation and growth differences are due to the thermal environment alone. They found that spring and fall spawning impacts to growth vary by latitude, predicting that fall spawning should not occur north of the Chesapeake DPS owing to a curtailed fall-winter growth season. They conclude that conservation success is “most sensitive to factors that influence first-year survival.”

The Southern Division American Fisheries Society (SDAFS) held a workshop on Atlantic and Gulf sturgeon ageing as part of their 2024 Annual Meeting, which provided a forum for researchers to discuss their experience and challenges with ageing sturgeon. ASMFC is planning an ageing workshop and exchange for Atlantic sturgeon to develop a standardized protocol for processing and reading Atlantic sturgeon hard parts. The project has recently been revived to build on the discussions at the SDAFS meeting. The workshop is being planned for later in 2024 followed by a hard part exchange. This will provide better, more consistent life history information for the next benchmark, helping to address this research recommendation.

> *Collect more information on regional vessel strike occurrences, including mortality estimates. Identify hot spots for vessel strikes and develop strategies to minimize impacts on Atlantic sturgeon.*

Since 2017 several authors investigated ship strikes as a threat to Atlantic sturgeon. Fox et al. (2020) placed 164 carcasses along the shoreline of the Delaware River Estuary to estimate reporting rates and found overall reporting rate was 4.8% and only included areas easily accessible to the general public, such as beaches. Additionally, they found there was little movement of carcasses and no trends in number of carcasses along the shoreline from 2005-2019. They concluded that because reporting rates of Atlantic sturgeon carcasses are low, the magnitude of vessel strikes may be unsustainably high and directly impeding recovery. In related work, Fox and Madsen (2020) determined that sturgeon use the mouth of Delaware Bay heavily and could be directly (vessel strikes) or indirectly (disruption to foraging habitats) impacted by an increase in vessel traffic. DiJohnson (2019) investigated the influence of vessels on Atlantic sturgeon movement and found no evidence that Atlantic sturgeon behavior is affected by commercial shipping, but is more influenced by sediment type. Recent work by White et al. (2024) highlights the prevalence of non-natal sturgeon throughout the Delaware River and its estuary, suggesting that ship strikes in these areas may be impacting populations from a broad area of the coast.

Despite suggesting areas of focus for ship strike mortality, Kahn et al. (2023) estimated adult annual survival of 99.2% (95% confidence interval: 97.9-99.7%) in the York River, Chesapeake Bay, with 80% of the suspected mortalities' last detections occurring in a shipping channel.

Atlantic sturgeon are highly migratory with complex and not fully understood movement patterns. Two recent papers studied regional movement. Melnychuk et al. (2017) analyzed movement using acoustic telemetry and survival patterns with multi-state mark-recapture models finding that late spring is particularly sensitive period for Atlantic sturgeon along the coast of Long Island, New York. The authors suggest that managers could use real-time observations from acoustic telemetry to implement short fishery closures to reduce incidental mortality. Rothermel et al. (2020) used a gradient-based array of acoustic telemetry receivers on or near wind-farm lease areas off the coast of Maryland and Delaware to study both Atlantic sturgeon and striped bass movement. The highest incidence of Atlantic sturgeon was in spring and fall biased toward shallow regions. The incidence was often transient (mean =~2 days) with increased residency (>2 days) during autumn and winter, often concentrated in the lease areas during the winter. No diel pattern among seasons was noted. Atlantic sturgeon appeared to select areas based on temperature and depth rather than specific benthic characteristics.

> *Establish regional (river or DPS-specific) fishery-independent surveys to monitor Atlantic sturgeon abundance or expand existing regional surveys to include annual Atlantic sturgeon monitoring. Estimates of abundance should be for both spawning adults and early juveniles at age. See Table 8 for a list of surveys considered by the SAS.*

Abundance estimates have been developed for several populations. White et al. (2022) investigated genetic-based estimates of breeding population size and how genotyping and sampling effort influence bias and precision. As an example, they evaluated the number of successful spawners (N_S) for the Delaware River breeding population of Atlantic sturgeon resulting in a breeding population three orders of magnitude below historic sizes (N_S likely between 125 and 250 adults). The pedigree-based approach to estimating breeding populations has several strengths including using juvenile genotypes which may be easier to obtain than adult and simulation analysis to objectively evaluate magnitude and direction of bias which can be used to optimize sampling and genotyping strategies.

Kazyak et al. (2020) integrated side-scan sonar with acoustic telemetry to estimate size of the 2014 spawning run for the Hudson River (N=466, 95% CRI = 310-745). If reported spawning intervals were taken into account, the estimate appears to similar to the historical total adult population estimate by Kahnle et al. (2007).

Coleman et al. (2024) developed a similar integrated side-scan sonar and acoustic approach to estimate spawning runs in the Marshyhope-Nanticoke River system (Chesapeake DPS), relying on an extensive telemetry array. Estimates were 32 (95% CRI=23-47) and 70 (95% CRI=49-105), respectively in 2020 and 2021. Both the Marshyhope Creek and upper Nanticoke River were extensively occupied by these spawning runs.

Kahn et al. (2019) used a suite of mark-recapture models to estimate the abundance of adult Atlantic sturgeon in the York River population. This study presents a series of annual abundance estimates from 2013-2018. The most recent population estimate (2018) using the Schumacher-Eschmeyer model indicated an abundance of 145 adults (95% CI: 89-381).

Vine et al. (2019) used *N*-mixture models to estimate the abundance of Atlantic sturgeon in the Savannah River using side-scan sonar and estimated the maximum daily spawner abundance (95% CI:35-55) within a portion of the river. However, this estimate is not a full census of spawning run size or overall adult abundance for this population.

> *Encourage data sharing of acoustic tagged fish, particularly in underrepresented DPSs, and support programs that provide a data sharing platform such as The Atlantic Cooperative Telemetry Network. Data sharing would be accelerated if it was required or encouraged by funding agencies.*

The Bureau of Ocean Energy Management funded a large collaborative synthesis of existing acoustic telemetry data (led by Matthew Breece, David Kazyak, and Dewayne Fox, in partnership with many researchers) for Atlantic sturgeon which will wrap up in 2024. This effort helped to foster collaborative relationships among researchers, and also provided each participating researcher with a list of their tag detections from across a vast area.

> *Maintain and support current networks of acoustic receivers and acoustic tagging programs to improve the estimates of total mortality. Expand these programs in underrepresented DPSs.*

Although the number of tools which can leverage acoustic telemetry to provide management relevant insights into Atlantic sturgeon continue to grow (e.g., ASMFC 2017, Kazyak et al. 2020), the distribution of telemetry receivers continues to be ad hoc, and some important arrays have not been maintained. Many arrays are funded by specific grants and research questions, and consequently there are often not resources to main longer-term continuity. Maintenance and continued support of these arrays (and ongoing deployment of acoustic transmitters) is critical to enable continued application of mortality and abundance models used in the ASMFC Atlantic sturgeon assessment.

Moderate Priority Recommendations

> *Evaluate the effects of predation on Atlantic sturgeon by invasive species (e.g., blue and flathead catfish).*

Using a DNA-based approach, Bunch et al. (2021) examined the factors that influence first-year survival. Using gut contents to assess consumption of Atlantic sturgeon early life stages, they found eggs or days-old larvae in 4% of the samples from 23 fish species collected during September and October in the Pamunkey River, Virginia. The highest percent were found in common carp (*Cyprinus carpio*) and striped bass (*Morone saxatilis*). Six percent of blue catfish (*Ictalurus furcatus*) samples had target DNA.

> *Evaluate methods of imputation to extend time series with missing values. ARIMA models were applied only to the contiguous years of surveys due to the sensitivity of model results to missing years observed during exploratory analyses.*

The SAS considered the research recommendation from ASMFC 2017 to evaluate methods of imputation to extend time series with missing values. Imputation methods were explored but those methods were deprioritized once the ARIMA code was modified to allow for missing values (see TOR 3). The SAS might consider further exploration of imputation methods for comparison to results of ARIMAs with missing values.

b. New Research Recommendations

- Improve understanding of offshore habitat use, particularly in areas where offshore energy development and mineral removal are planned or occurring.

- Leverage species distribution models and acoustic telemetry data to identify key areas of occupancy along the coast throughout the year (for the species overall, and specific to each spawning population and DPS).

- Monitor for the potential presence of non-native sturgeon taxa throughout the native range of Atlantic sturgeon and evaluate potential risk of captive sturgeons to wild populations.

- Characterize the degree to which vessel strikes in specific rivers and estuaries may be impacting populations which spawn in other locations.

- Develop cost-effective strategies for long-term monitoring of Atlantic sturgeon.

- Evaluate strategies to reduce or mitigate mortalities from ship strikes. Improve understanding of how dredging may concentrate Atlantic sturgeon within high-traffic shipping channels and elevate risk of adverse interactions.

- If the NC p135 surveys are no longer being conducted, there would be no surveys in the Carolina DPS to characterize trends or status after 2019. Finding alternative surveys for this region will be important.

- Further explore uncertainty in ARIMA results (e.g., consider incorporating reverse retrospective results into survey-specific probabilities of exceeding reference points, what role lags in recruitment can play in interpretation of results or selection of reference points, whether autocorrelated models are appropriate for sturgeon YOY surveys).

- Explore the application of alternative ageing approaches such as DNA methylation-based methods (e.g., Mayne et al. 2021, Weber et al. 2024) to Atlantic sturgeon.

- Prioritize the genetic assignment of tagged fish, including the processing of archived samples, to improve the estimates of *Z* at the DPS-level.

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TABLES

Table 1. Annual sturgeon bycatch estimates for otter trawl gear based on application of the best performing model to otter trawl vessel trip records.

Year	Total Bycatch Estimate	Standard Error	Percent Dead	Dead Bycatch Estimate
2006	1,187	103	18%	212
2007	1,099	105	9%	95
2008	1,033	156	16%	167
2009	1,025	116	2%	21
2010	986	96	1%	9
2011	922	97	0%	0
2012	848	85	0%	0
2013	892	96	0%	0
2014	789	79	0%	0
2015	735	72	0%	0
2016	759	71	0%	0
2017	723	72	0%	0
2018	684	69	8%	54
2019	835	94	0%	0
2020				
2021	633	64	6%	40
2022	478	52	9%	43

Table 2. Annual sturgeon bycatch estimates for gillnet gear based on application of the best performing model to gillnet vessel trip records.

Year	Total Bycatch Estimate	Standard Error	Percent Dead	Dead Bycatch Estimate
2006	1,512	332	12%	187
2007	1,506	386	20%	301
2008	813	495	28%	227
2009	1,151	561	13%	148
2010	281	84	51%	143
2011	442	228	44%	195
2012	281	81	44%	123
2013	1,583	620	38%	594
2014	668	199	33%	223
2015	711	112	28%	197
2016	1,209	151	32%	382
2017	1,276	215	22%	276
2018	1,049	149	27%	278
2019	1,029	132	20%	206
2020				
2021	1,077	375	46%	497
2022	561	108	33%	183

Table 3. Estimated numbers of Atlantic sturgeon bycatch from the North Carolina's Atlantic sturgeon bycatch data.

Year	Total Bycatch	Percent Dead	Number Dead
2013	508	7%	34
2014	1,104	3%	37
2015	1,413	4%	57
2016	998	6%	58
2017	765	6%	44
2018	365	8%	30
2019	119	25%	30
2020	388	0%	0
2021	406	23%	94
2022	498	17%	85

Table 4. Number of Atlantic sturgeon reported as incidental bycatch by commercial American shad fisherman in South Carolina, 2000-2022. The Carolina DPS includes the Waccamaw, Pee Dee, Winyah, and Santee Rivers. The South Atlantic DPS includes the Edisto, Combahee, and Savannah Rivers.

Year	Carolina DPS			South Atlantic DPS		
	# Atlantic Sturgeon	Effort (Net Yard Hours)	CPUE (#Atlantic Sturgeon/Net Yard Hours)	# Atlantic Sturgeon	Effort (Net Yard Hours)	CPUE (#Atlantic Sturgeon/Net Yard Hours)
2000	40	2,284,770	0.0000175	5	559,575	0.0000089
2001	128	3,339,789	0.0000383	20	493,149	0.0000406
2002	74	4,222,339	0.0000175	5	301,618	0.0000166
2003	16	3,881,793	0.0000041	3	425,421	0.0000071
2004	11	4,094,782	0.0000027	0	527,201	0.0000000
2005	0	3,963,111	0.0000000	1	367,849	0.0000027
2006	226	6,607,328	0.0000342	2	389,517	0.0000051
2007	162	2,562,688	0.0000632	6	384,197	0.0000156
2008	76	4,070,683	0.0000187	0	270,265	0.0000000
2009	186	5,110,128	0.0000364	3	276,875	0.0000108
2010	12	3,357,022	0.0000036	3	221,982	0.0000135
2011	173	5,818,003	0.0000297	8	240,967	0.0000332
2012	194	5,617,356	0.0000345	11	260,664	0.0000422
2013	157	3,457,182	0.0000454	1	214,095	0.0000047
2014	15	2,876,558	0.0000052	0	163,182	0.0000000
2015	10	3,207,376	0.0000031	0	148,910	0.0000000
2016	15	1,782,507	0.0000084	0	126,589	0.0000000
2017	66	2,486,297	0.0000265	0	122,626	0.0000000
2018	138	2,436,613	0.0000566	0	108,405	0.0000000
2019	19	1,529,485	0.0000124	0	189,697	0.0000000
2020	2	1,777,785	0.0000011	0	80,115	0.0000000
2021	4	1,235,016	0.0000032	0	71,515	0.0000000
2022	4	1,149,057	0.0000035	1	63,061	0.0000016

Table 5. Fishery-independent surveys used to develop indices of relative abundance. The months and model used for the index are listed in addition to the start and end year of the survey. A length cutoff was used for determining if surveys catch predominantly young-of-the-year (YOY; <500 mm), juveniles (500-1300 mm), or adults (>1300 mm).

Survey	Months/Season	Model	Stage	Start Year	End Year
Maine-New Hampshire Trawl (ME-NH Trawl)	May, Sept, Nov	Binomial	Juveniles and Adults	2000	2022
Connecticut Long Island Sound Trawl Survey (CT LISTS)	Fall	Binomial	Juveniles	1992	2021
CT LISTS	Spring	Binomial	Juveniles	1992	2021
CT LISTS	All	Binomial	Juveniles	1992	2021
Northeast Area Monitoring and Assessment Program Trawl Survey (NEAMAP)	Fall	Binomial	Juveniles	2007	2021
New York State Department of Environmental Conservation Juvenile Atlantic Sturgeon Abundance Monitoring Program (NY JASAMP)	Spring	GAM	Juveniles	2004	2022
New Jersey Ocean Trawl Survey (NJ OT)	Jan, Apr, Jun, Oct	GLM	Juveniles	1990	2022
Virginia Institute of Marine Science Shad and River Herring Monitoring Survey (VIMS)	Spring	Binomial	Juveniles	1998	2019
VIMS James River Only	Spring	Binomial	Juveniles	1998	2019
North Carolina Program 135 (NC p135)	Spring	GLM	YOY and Juveniles	1991	2019
NC p135	Spring	GLM	YOY	1991	2019
NC p135	Spring	GLM	Juveniles	1991	2019
NC p135	Fall	GLM	YOY and Juveniles	1990	2019
NC p135	Fall	GLM	YOY	1990	2019
NC p135	Fall	GLM	Juveniles	1990	2019
South Carolina Edisto River Sturgeon Monitoring Project Survey (SC Edisto)	All Months	GLM	Juveniles	2004	2022
US Fish and Wildlife Cooperative Tagging Cruise (USFWS Coop)	Winter	GLM	Juveniles and Adults	1988	2010

Table 6. Results of the power analysis by survey for linear and exponential trends in Atlantic sturgeon abundance indices over a 20-year period. Power was calculated as the probability of detecting a 50% change. Time series length, life stage, and median coefficient of variation (CV) is reported for each index. Survey name abbreviations can be found in Table 5.

Survey	DPS	Index Timeseries	Life Stage	Median CV	Linear Trend		Exponential Trend	
					+50%	-50%	+50%	-50%
ME-NH Trawl	Gulf of Maine	2000-2022	Juvenile & Adult	1.154	0.13	0.16	0.15	0.22
CT LISTS	New York Bight	1992-1998, 2000-2009, 2011-2019, 2021	Juvenile	0.694	0.21	0.29	0.23	0.35
CT LISTS	New York Bight	1992-1998, 2000-2009, 2011-2019, 2021	Juvenile	0.722	0.20	0.27	0.22	0.33
CT LISTS	New York Bight	1992-1998, 2000-2009, 2011-2019, 2021	Juvenile	0.455	0.36	0.50	0.38	0.55
NY JASAMP	New York Bight	2004-2022	Juvenile	0.190	0.92	0.99	0.93	0.99
NJ OT	New York Bight	1990-2019, 2022	Juvenile & Adult	0.401	0.43	0.59	0.44	0.63
VIMS	Chesapeake Bay	1998-2019	Juvenile	0.518	0.30	0.48	0.32	0.48
VIMS James only	Chesapeake Bay	1998-2019	Juvenile	0.403	0.42	0.59	0.44	0.63
NEAMAP	New York Bight-Carolina	2007-2019, 2021	Juvenile	0.444	0.37	0.52	0.39	0.57
USFWS Coop	Carolina	1988-2010	Juvenile & Adult	0.506	0.31	0.44	0.33	0.49
NC p135	Carolina	1990-2019	YOY & Juveniles	0.182	0.94	0.99	0.94	0.99
NC p135	Carolina	1990-2019	YOY	0.258	0.73	0.90	0.74	0.91
NC p135	Carolina	1990-2019	Juveniles	0.289	0.65	0.83	0.66	0.85
NC p135	Carolina	1991-2019	YOY & Juveniles	0.317	0.58	0.77	0.59	0.79
NC p135	Carolina	1991-2019	YOY	0.423	0.40	0.55	0.41	0.60
NC p135	Carolina	1991-2019	Juveniles	0.407	0.42	0.58	0.44	0.62
SC Edisto	South Atlantic	2004-2022	Juvenile	0.138	1.00	1.00	1.00	1.00

Table 7. Median life history information used in the $Z_{50\%EPR}$ reference point. Table continues on the next page.

Age	Length (cm)	Proportion Mature	Bycatch Selectivity	Ship-Strike Selectivity	Weight (kg)	*M*	Fecundity
1	32.1	0.00	0.08	0.00	0.2	0.31	90995.9
2	50.8	0.00	0.23	0.00	0.8	0.21	90995.9
3	67.1	0.00	0.50	0.00	1.9	0.17	90995.9
4	81.9	0.00	0.79	1.00	3.5	0.14	90995.9
5	95.1	0.01	0.93	1.00	5.6	0.12	90995.9
6	106.8	0.01	0.98	1.00	8.0	0.11	90995.9
7	117.5	0.02	0.99	1.00	10.6	0.10	91335.2
8	127.3	0.03	1.00	1.00	13.4	0.09	92520.9
9	136.2	0.05	1.00	1.00	16.6	0.09	96470.8
10	144.4	0.08	1.00	1.00	19.7	0.08	104291.7
11	152.0	0.12	1.00	1.00	23.1	0.08	115423.8
12	158.9	0.19	1.00	1.00	26.4	0.08	135527.6
13	165.2	0.27	1.00	1.00	29.8	0.07	183316.7
14	171.1	0.38	1.00	1.00	33.3	0.07	339359.8
15	176.7	0.50	1.00	1.00	36.5	0.07	490655.7
16	181.9	0.63	1.00	1.00	39.9	0.07	629404.6
17	186.7	0.74	1.00	1.00	43.2	0.07	770975.8
18	191.3	0.82	1.00	1.00	46.4	0.06	903715.8
19	195.4	0.89	1.00	1.00	49.6	0.06	1024231.2
20	199.4	0.93	1.00	1.00	52.7	0.06	1139715.1
21	202.9	0.96	0.99	1.00	55.7	0.06	1241324.0
22	206.4	0.97	0.97	1.00	58.8	0.06	1344861.1
23	209.6	0.98	0.91	1.00	61.6	0.06	1439418.1
24	212.8	0.99	0.77	1.00	64.4	0.06	1530709.6
25	215.6	0.99	0.50	1.00	67.2	0.06	1612340.4
26	218.3	1.00	0.21	1.00	70.0	0.06	1693249.2
27	220.9	1.00	0.06	1.00	72.4	0.06	1769304.0
28	223.3	1.00	0.02	1.00	74.9	0.06	1837289.8
29	225.5	1.00	0.01	1.00	77.1	0.05	1903293.5
30	227.7	1.00	0.00	1.00	79.2	0.05	1964925.8
31	229.4	1.00	0.00	1.00	81.4	0.05	2015602.3
32	231.4	1.00	0.00	1.00	83.5	0.05	2075587.8
33	233.2	1.00	0.00	1.00	85.2	0.05	2126190.9
34	234.8	1.00	0.00	1.00	87.2	0.05	2174873.7
35	236.5	1.00	0.00	1.00	88.7	0.05	2223011.3
36	238.0	1.00	0.00	1.00	90.4	0.05	2266675.2
37	239.4	1.00	0.00	1.00	91.9	0.05	2309000.0
38	240.7	1.00	0.00	1.00	93.4	0.05	2346197.8

Age	Length (cm)	Proportion Mature	Bycatch Selectivity	Ship-Strike Selectivity	Weight (kg)	*M*	Fecundity
39	241.9	1.00	0.00	1.00	94.9	0.05	2380814.5
40	243.0	1.00	0.00	1.00	96.3	0.05	2411883.3
41	244.3	1.00	0.00	1.00	97.6	0.05	2449495.1
42	245.5	1.00	0.00	1.00	99.0	0.05	2484347.2
43	246.4	1.00	0.00	1.00	100.1	0.05	2512884.9
44	247.3	1.00	0.00	1.00	101.1	0.05	2539675.2
45	248.3	1.00	0.00	1.00	102.5	0.05	2567953.4
46	249.0	1.00	0.00	1.00	103.3	0.05	2588918.2
47	249.7	1.00	0.00	1.00	104.5	0.05	2609761.0
48	250.6	1.00	0.00	1.00	105.6	0.05	2635485.3
49	251.4	1.00	0.00	1.00	106.5	0.05	2658257.6
50	252.2	1.00	0.00	1.00	107.5	0.05	2682246.7
51	252.8	1.00	0.00	1.00	108.3	0.05	2699340.3
52	253.4	1.00	0.00	1.00	109.1	0.05	2716885.6
53	254.0	1.00	0.00	1.00	110.1	0.05	2733578.0
54	254.7	1.00	0.00	1.00	111.0	0.05	2755329.4
55	254.3	1.00	0.00	1.00	110.9	0.05	2742443.5
56	254.9	1.00	0.00	1.00	111.5	0.05	2761337.8
57	255.4	1.00	0.00	1.00	112.3	0.05	2775846.9
58	255.9	1.00	0.00	1.00	112.8	0.05	2788317.5
59	256.5	1.00	0.00	1.00	113.7	0.05	2805446.1
60	256.9	1.00	0.00	1.00	114.3	0.05	2818772.7

Table 8. Number of acoustically tagged Atlantic sturgeon by DPS and size group.

	Total	< 1300 mm	> 1300 mm
Gulf of Maine	224	55	169
NY Bight	534	144	390
Chesapeake Bay	464	74	390
Carolina	489	208	281
South Atlantic	364	133	231

Table 9. Estimates of annual survival, total mortality, and the probability of *Z* being above the *Z* threshold for the coastwide population and for each individual DPS.

Population	Median Annual Survival Rate, *S* (2.5^{th}-97.5^{th} percentiles)	Median Annual Total Mortality, *Z* (2.5^{th}-97.5^{th} percentiles)	$Z_{50\%\ EPR}$ reference point	Probability that *Z* is greater than the $Z_{50\%EPR}$ reference point
Coast	0.99 (0.89-1.00)	0.01 (0.001-0.11)	0.14	1.8%
Gulf of Maine	0.86 (0.34-0.98)	0.15 (0.018-1.08)		55.5%
NY Bight	0.94 (0.63-1.00)	0.06 (0.005-0.46))		20.2%
Chesapeake Bay	0.95 (0.67-1.00)	0.05 (0.003-0.41)		14.1%
Carolina	0.95 (0.63-1.00)	0.05 (0.003-0.46)		18.2%
South Atlantic	0.93 (0.60-1.00)	0.07 (0.004-0.51)		26.5%

Table 10. Probability that *Z* is greater than the $Z_{50\%EPR}$ reference point from the 2024 update and the 2017 benchmark.

Population	2024 Update	2017 Benchmark
Coast	1.8%	6.5%
Gulf of Maine	55.5%	73.5%
NY Bight	20.2%	31.2%
Chesapeake Bay	14.1%	30.0%
Carolina	18.2%	75.4%
South Atlantic	26.5%	40.2%

Table 11. Summary statistics for ARIMA model results. n = number of years in time series, W = Shapiro-Wilk statistic for normality, adj p = Holm-adjusted probability of rejecting the null hypothesis regarding normality of model residuals, r1, r2, and r3 = the first three sample autocorrelations for the first differenced logged series, (θ) = moving average parameter, SE = standard error of theta, σ^2_c = variance of index. JYR = James, York, Rappahannock.

DPS	Survey	Years avail	n	W	adj p	r_1	r_2	r_3	θ	SE	σ^2_c
GOM	ME-NH Trawl	2000-2022	23	0.96	0.37	-0.54	-0.1	0.41	1.00	0.13	0.22
NYB	CT LISTS Fall	1992-2021	30	0.98	1.00	-0.65	0.46	-0.29	0.55	0.22	0.31
NYB	CT LISTS Spring	1992-2021	30	0.96	1.00	-0.23	-0.44	0.1	0.92	0.12	0.39
NYB	CT LISTS All Months	1992-2021	30	0.98	1.00	-0.43	-0.1	-0.09	1.00	0.12	0.19
NYB	NY JASAMP	2004-2022	19	0.97	1.00	-0.3	-0.08	-0.06	0.47	0.29	0.49
NYB	NJ Ocean Trawl	1990-2022	33	0.98	1.00	-0.35	0.08	-0.12	0.40	0.17	0.36
CB	VIMS-JYR	1998-2019	22	0.91	0.12	0.19	-0.32	-0.33	0.39	0.29	0.71
CB	VIMS-J Spring	1998-2019	22	0.93	0.12	-0.17	-0.23	-0.03	1.00	0.14	1.3
C	NC p135 Spring YOY + Juv	1991-2019	29	0.98	1.00	-0.18	-0.28	-0.12	0.63	0.25	0.37
C	NC p135 Spring YOY	1991-2019	29	0.97	1.00	-0.36	-0.17	0.12	1.00	0.31	0.25
C	NC p135 Spring Juv	1991-2019	29	0.93	0.31	-0.18	-0.33	-0.29	0.66	0.13	0.13
C	NC p135 Fall YOY+Juv	1990-2019	30	0.97	1.00	-0.26	-0.28	0.12	0.74	0.15	0.56
C	NC p135 Fall YOY	1990-2019	30	0.96	1.00	-0.37	-0.28	0.22	0.92	0.13	0.93
C	NC p135 Fall Juv	1990-2019	30	0.96	1.00	-0.26	-0.31	0.2	0.55	0.17	0.1
C	USFWS	1988-2010	23	0.94	1.00	-0.54	0.31	-0.37	1.00	1.6	0.5
SA	SC Edisto	2004-2022	19	0.88	0.02	-0.52	0.1	0.27	0.77	0.33	0.33
NYB-CB-C	NEAMAP Fall	2007-2021	15	0.96	0.71	-0.43	-0.16	0.26	0.59	0.29	0.21
Coast	Conn	1990-2022	33	0.95	0.11	-0.44	0.04	0.12	0.53	0.15	0.06

Table 12. ARIMA and trend analysis results for Atlantic sturgeon indices of abundance. Shown are the probabilities that the terminal year (ty) of an index is greater than the 25th percentile of a time series and the probabilities that the terminal year of an index is greater than the index value in 1998 (or surrogate reference year if survey started after 1998); green shading indicates ≥ 50% probability. The Mann Kendall tau (τ) statistic, Holm-adjusted probability of the Mann-Kendall time series trend being significant, and whether the trend is increasing (+), decreasing (-), or not significant (n.s.). Light grey font indicates a strong (0.60) within survey correlation. JYR = James, York, Rappahannock. Underlined probabilities are those values represented in the DPS tallies and averages presented Table 13.

										Trend analysis results ARIMA fits			Trend analysis results Raw index		
DPS	Survey	Months	Ages	P(ty > 25th pctl)	P(ty > yrAsRefPt)	n	First yr	Terminal yr	yrAsRefPt	M-K $_\tau$	M-K p_{adj}	Trend	M-K $_\tau$	M-K p_{adj}	Trend
GOM	ME-NH Trawl	5, 10, 11	Juveniles and Adults	0.59	0.45	23	2000	2022	2000	-0.45	0.00	-	-0.08	0.63	n.s.
NYB	CT LISTS Fall	Fall	Juveniles	0.96	0.97	30	1992	2021	1998	0.09	0.53	n.s.	0.07	0.65	n.s.
NYB	CT LISTS Spring	Spring	Juveniles	0.51	0.29	30	1992	2021	1998	-0.74	0.00	-	-0.22	0.44	n.s.
NYB	CT LISTS All Months	All	Juveniles	0.43	0.12	30	1992	2021	1998	-0.62	0.00	-	-0.14	0.57	n.s.
NYB	NY JASAMP	Spring	Juveniles	0.65	0.57	19	2004	2022	2004	0.36	0.08	n.s.	0.24	0.49	n.s.
NYB	NJ Ocean Trawl	1, 4, 6, 10	Juveniles	1.00	1.00	33	1990	2022	1998	0.52	0.00	+	0.38	0.02	+
CB	VIMS-JYR	Spring	Juveniles	0.97	0.38	22	1998	2019	1998	-0.13	0.40	n.s.	-0.02	1.00	n.s.
CB	VIMS-J Spring	Spring	Juveniles	0.45	0.15	22	1998	2019	1998	-0.45	0.00	-	0.07	1.00	n.s.
C	NC p135 Spring YOY + Juv	Spring	YOY+Juveniles	1.00	0.99	29	1991	2019	1998	0.79	0.00	+	0.44	0.00	+
C	NC p135 Spring YOY	Spring	YOY	0.82	0.82	29	1991	2019	1998	0.52	0.00	+	0.18	0.51	n.s.
C	NC p135 Spring Juv	Spring	Juveniles	1.00	1.00	29	1991	2019	1998	0.93	0.00	+	0.60	0.00	+
C	NC p135 Fall YOY+Juv	Fall	YOY+Juveniles	0.99	0.99	30	1990	2019	1998	0.76	0.00	+	0.37	0.02	+
C	NC p135 Fall YOY	Fall	YOY	0.66	0.63	30	1990	2019	1998	0.67	0.00	+	0.17	0.51	n.s.
C	NC p135 Fall Juv	Fall	Juveniles	1.00	1.00	30	1990	2019	1998	0.90	0.00	+	0.55	0.00	+
C	USFWS	Winter	Juveniles and Adults	0.53	0.42	23	1988	2010	1998	0.09	0.56	n.s.	0.17	0.51	n.s.
SA	SC Edisto	5-9	Juveniles	0.76	0.31	19	2004	2022	2004	0.38	0.03	+	0.19	0.26	n.s.
NYB-CB-C	NEAMAP Fall	Fall	Juveniles	0.93	0.84	15	2007	2021	2007	0.32	0.13	n.s.	0.27	0.19	n.s.
Coast	Conn	All Months	YOY, Juv, Adult	1.00	1.00	33	1990	2022	1998	0.67	0.00	+	0.55	0.00	+

Table 13. Summary of tally and percentage of surveys, by DPS, where terminal year index (ty) is greater than the reference value, either the 25th percentile of a given time series or the index value in 1998 (or start year of survey, whichever is later) for a given index (a). See columns 1 and 2 of Table 12 for list of surveys included in each DPS. Results from ASMFC (2017) are provided for comparative purposes. Plot of (a) mean, by DPS and assessment year. * = 1998 or first year of survey, whichever is more recent (b).

(a)

ASMFC (2024)

Tally

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	1 of 1	0 of 1
NYB	4 of 5	3 of 5
CB	1 of 2	0 of 2
C	5 of 5	4 of 5
SA	1 of 1	0 of 1
NYB-CB-C	1 of 1	1 of 1
Coast	1 of 1	1 of 1

Pct

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	100%	0%
NYB	80%	60%
CB	50%	0%
C	100%	80%
SA	100%	0%
NYB-CB-C	100%	100%
Coast	100%	100%

Mean

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	0.59	0.45
NYB	0.71	0.59
CB	0.71	0.27
C	0.80	0.77
SA	0.76	0.31
NYB-CB-C	0.93	0.84
Coast	1.00	1.00

ASMFC (2017)

Tally

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	1 of 1	1 of 1
NYB	4 of 4	3 of 4
CB	1 of 1	0 of 1
C	5 of 5	3 of 5
SA	1 of 1	0 of 1
NYB-CB-C	0 of 1	0 of 1
Coast	1 of 1	1 of 1

Pct

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	100%	100%
NYB	100%	75%
CB	100%	0%
C	100%	60%
SA	100%	0%
NYB-CB-C	0%	0%
Coast	100%	100%

Mean

DPS	P (ty > 25th pctl)	P (ty > 1998*)
GOM	0.61	0.51
NYB	0.80	0.75
CB	0.96	0.36
C	0.72	0.67
SA	0.51	0.28
NYB-CB-C	0.49	0.33
Coast	0.95	0.95

(b)

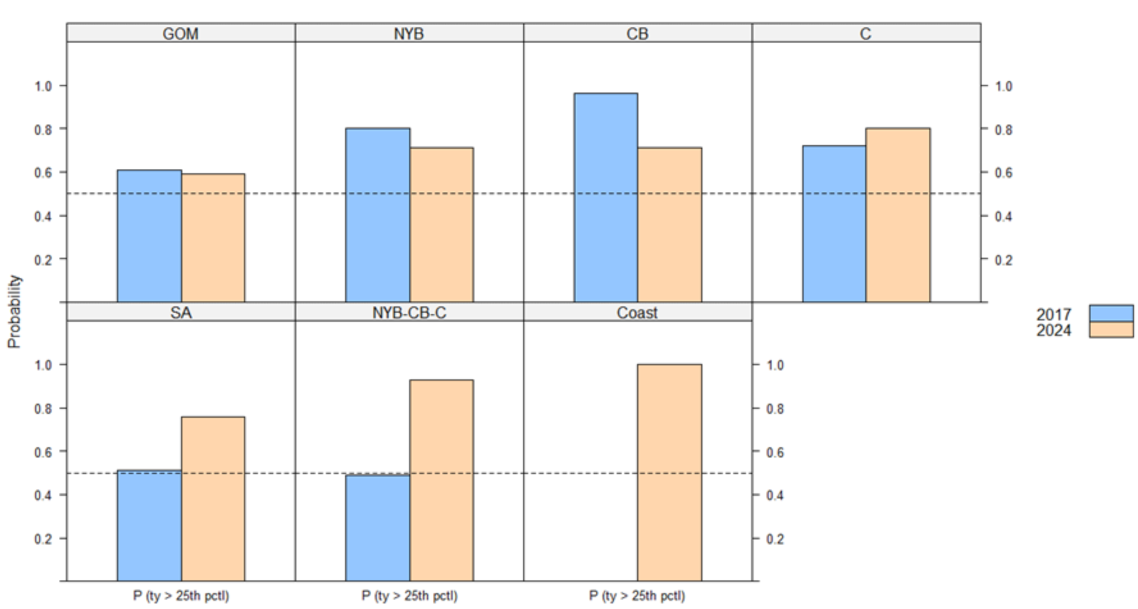


Table 14. Stock status determination for the coastwide stock and individual DPSs based on morality estimates and biomass/abundance status relative to historic levels and the terminal year of indices relative to the start of the moratorium as determined by the ARIMA analysis.

Population	Mortality Status	Biomass/Abundance Status		
	P(Z)>$Z_{50\%EPR}$ Reference Point	Relative to Historical Levels	NOAA Designation	Average probability of terminal year of indices > reference year*
Coastwide	1.80%	Depleted		100%
Gulf of Maine	55.50%	Depleted	Threatened	45%
New York Bight	20.20%	Depleted	Endangered	59%
Chesapeake Bay	14.10%	Depleted	Endangered	27%
Carolina	18.20%	Depleted	Endangered	77%
South Atlantic	26.50%	Depleted	Endangered	31%

***Reference year is 1998, or the first year of the survey for indices that started after 1998**

FIGURES

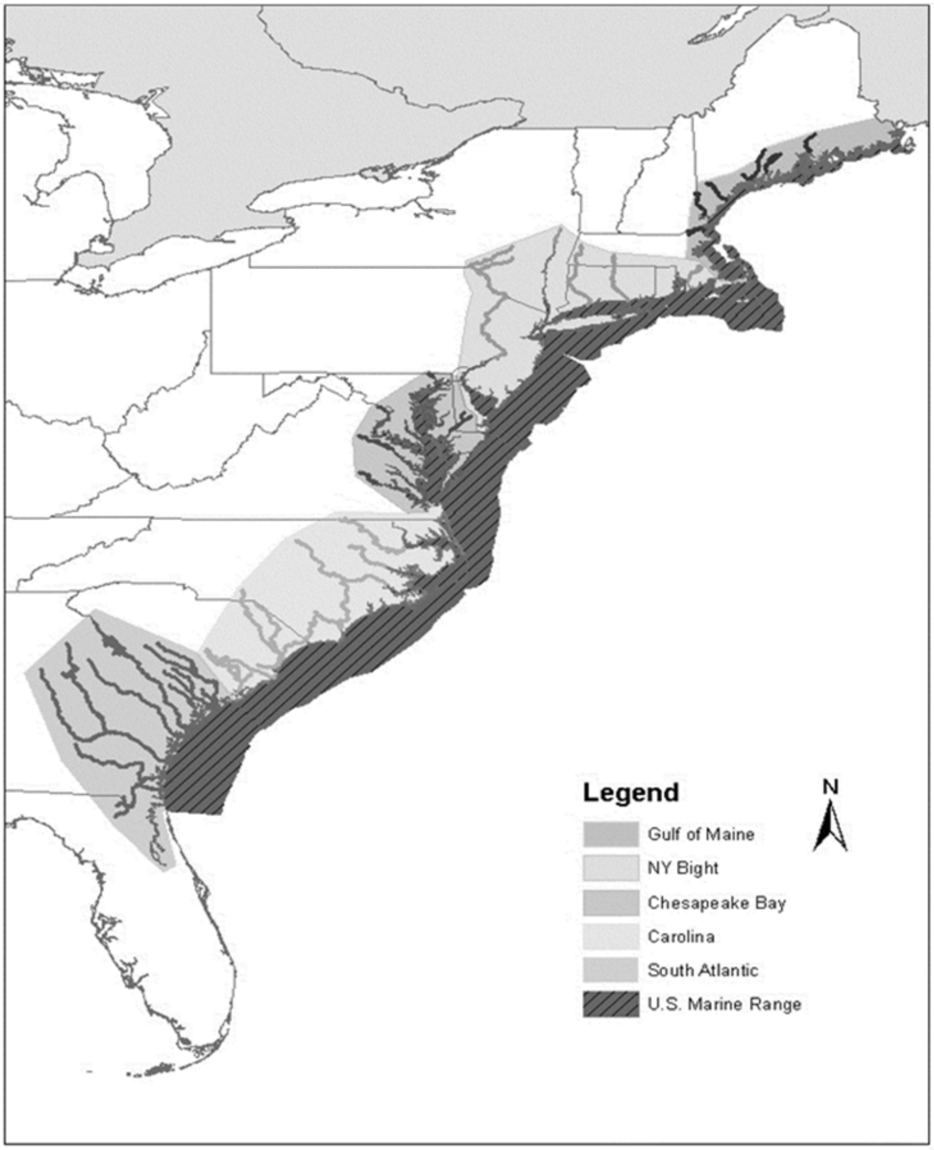


Figure 1. The five distinct population segments (DPS) for the Atlantic sturgeon. Source: NOAA Fisheries Final Rule, 77 FR 5880.

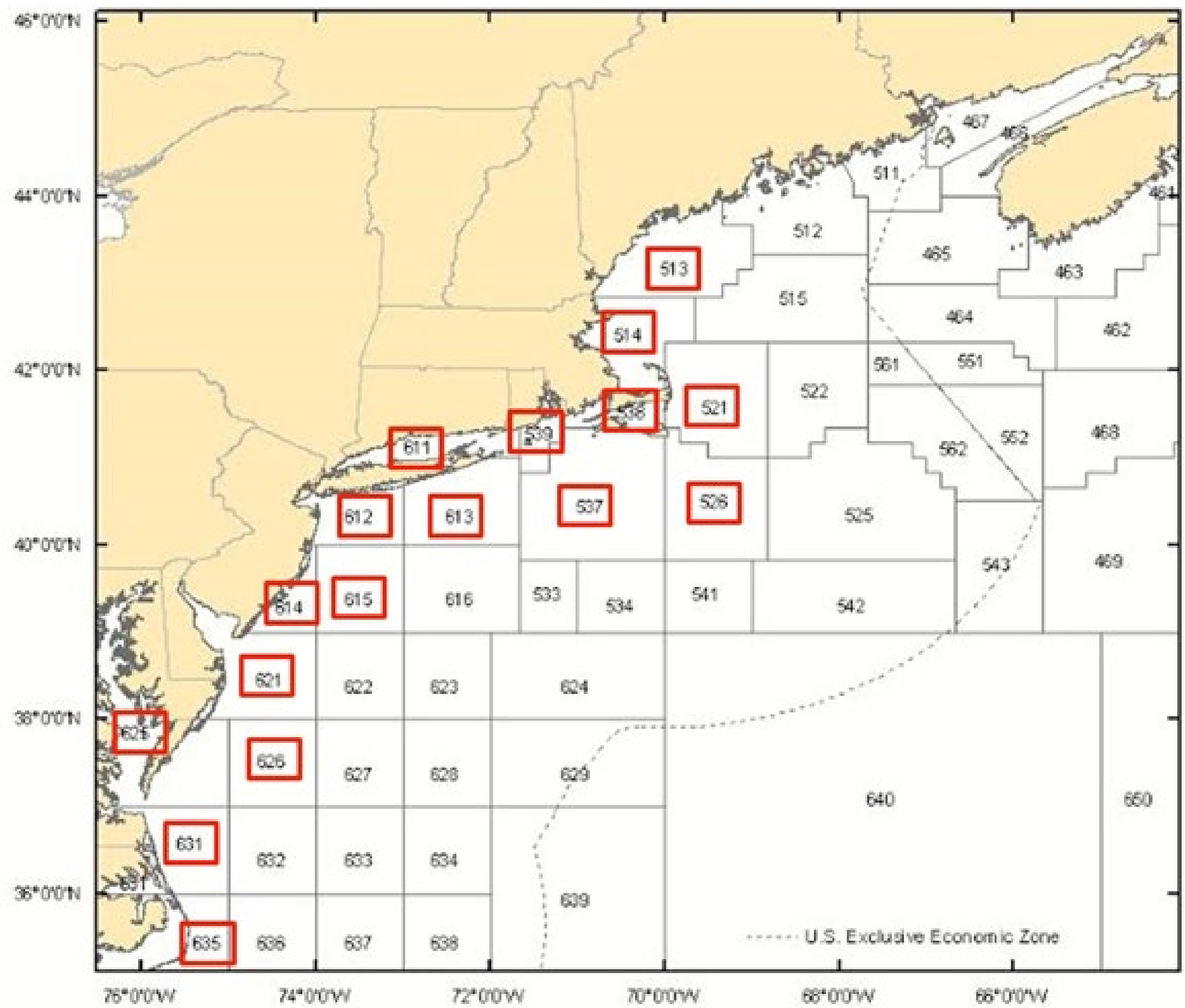


Figure 2. Observed trips used in the estimation of bycatch included coastal statistical areas 513, 514, 521, 526, 537, 538, 539, 611, 612, 613, 614, 615, 621, 625, 626, 631, and 635.

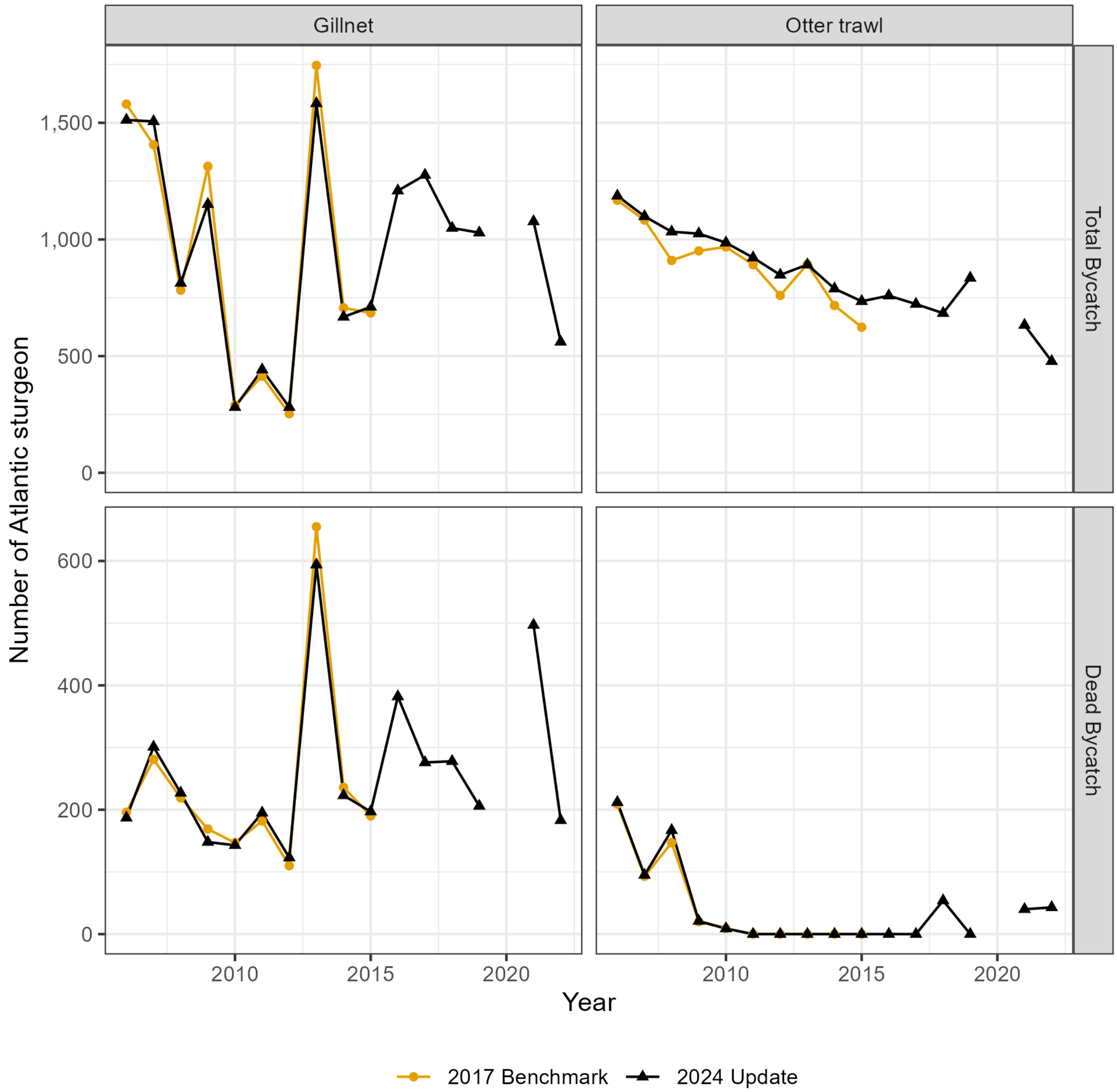


Figure 3. Estimates of total Atlantic sturgeon bycatch and dead bycatch by gear from the 2024 update compared to the 2017 benchmark assessment.

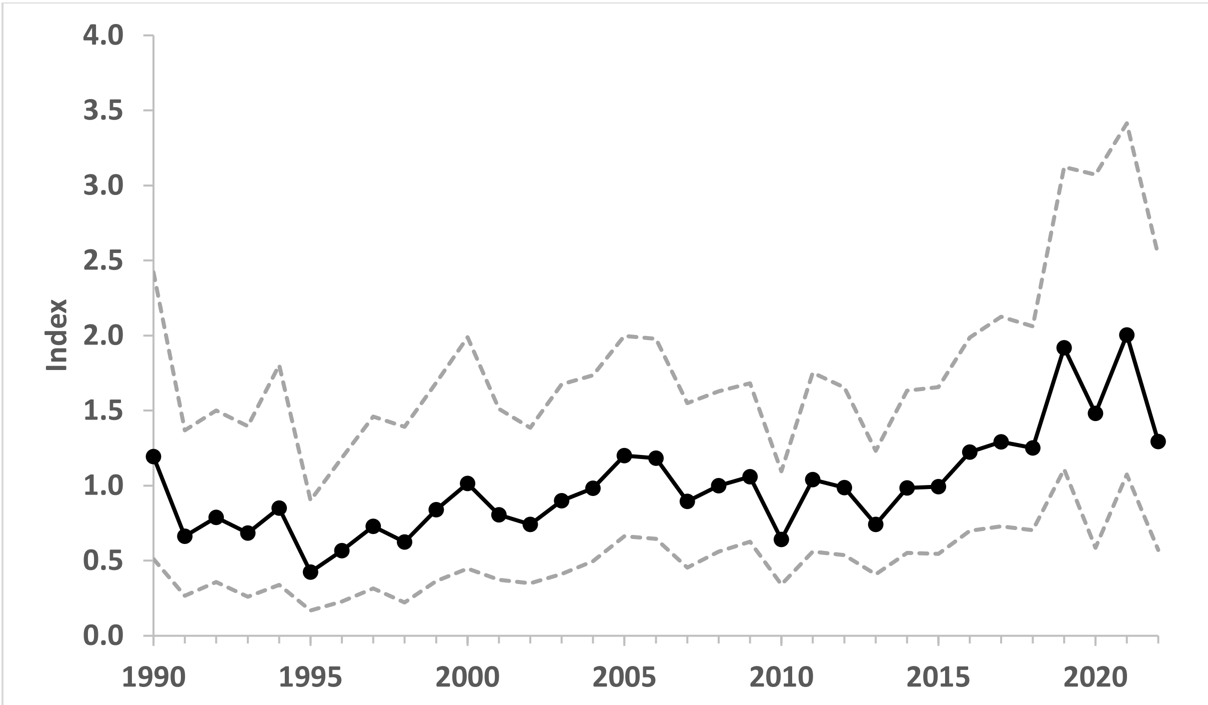


Figure 4. Time series of coastwide juvenile and adult Atlantic sturgeon relative abundance using Conn (2010) with 95% credible intervals.

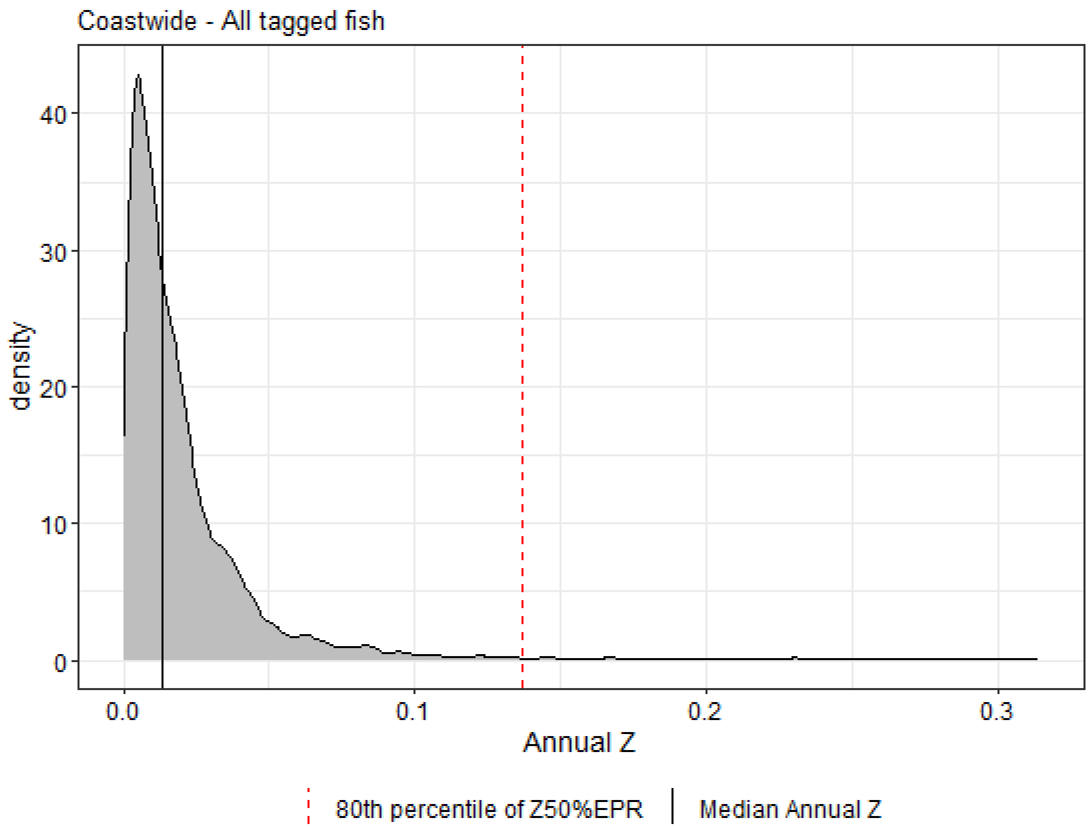


Figure 5. Distribution of annual *Z* estimate from the tagging model for the coastwide population (all tagged fish), plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

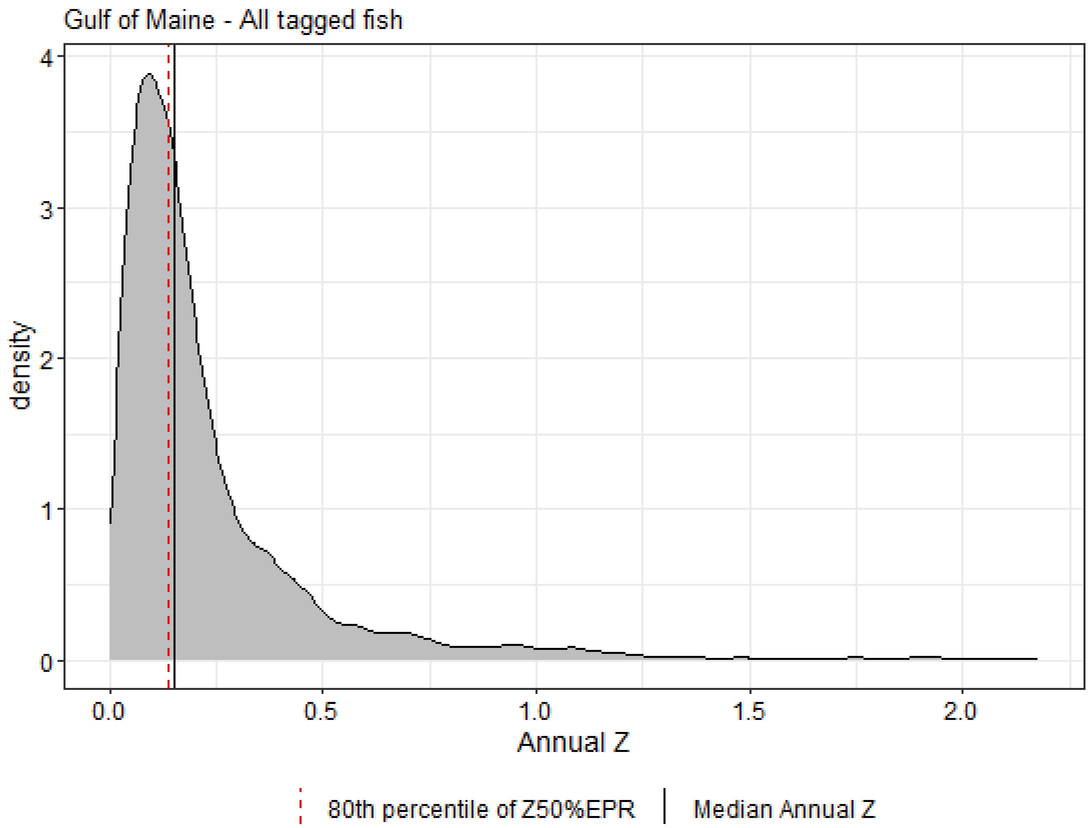


Figure 6. Distribution of annual *Z* estimate from the tagging model for all tagged fish assigned to the Gulf of Maine DPS, plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

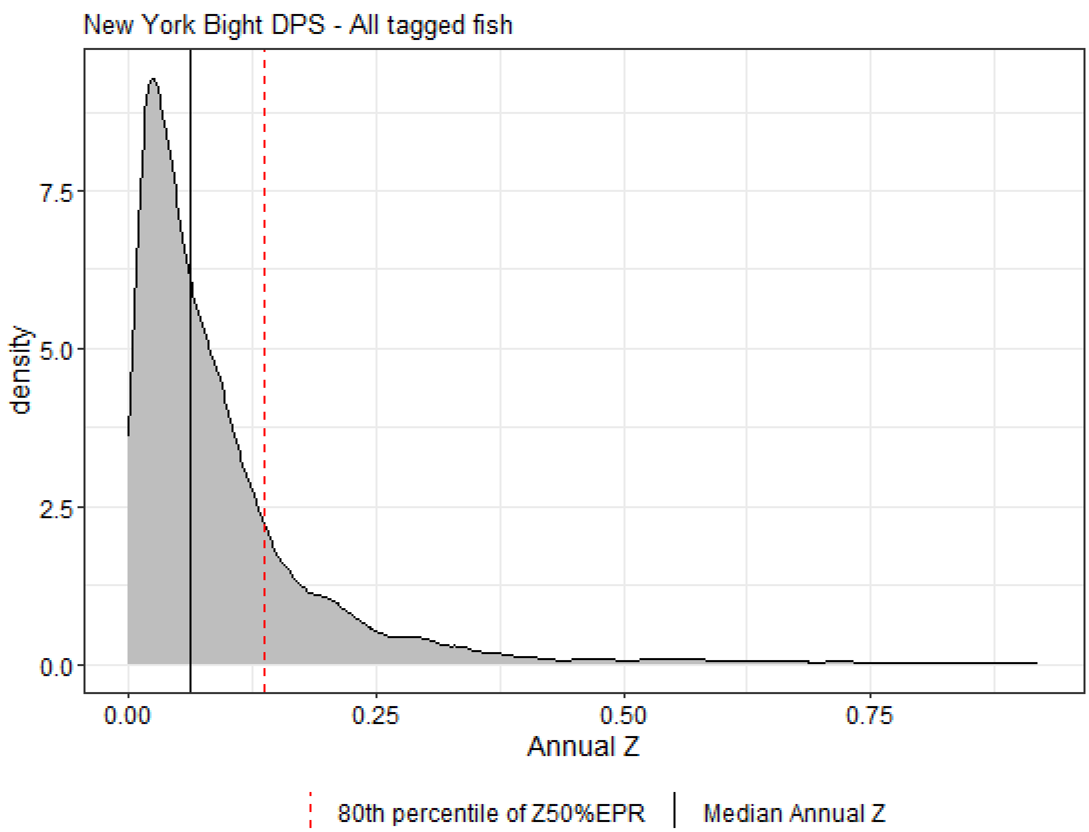


Figure 7. Distribution of annual *Z* estimate from the tagging model for all tagged fish assigned to the New York Bight DPS, plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

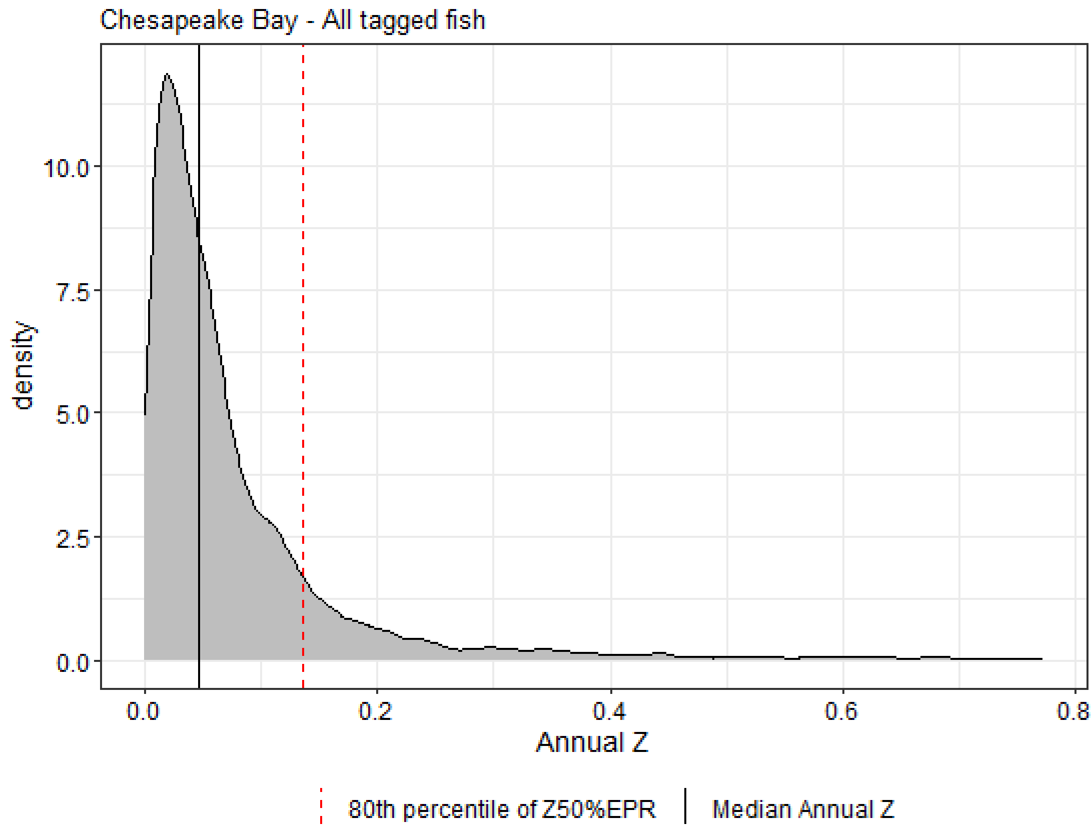


Figure 8. Distribution of annual *Z* estimate from the tagging model for all tagged fish assigned to the Chesapeake Bay DPS, plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

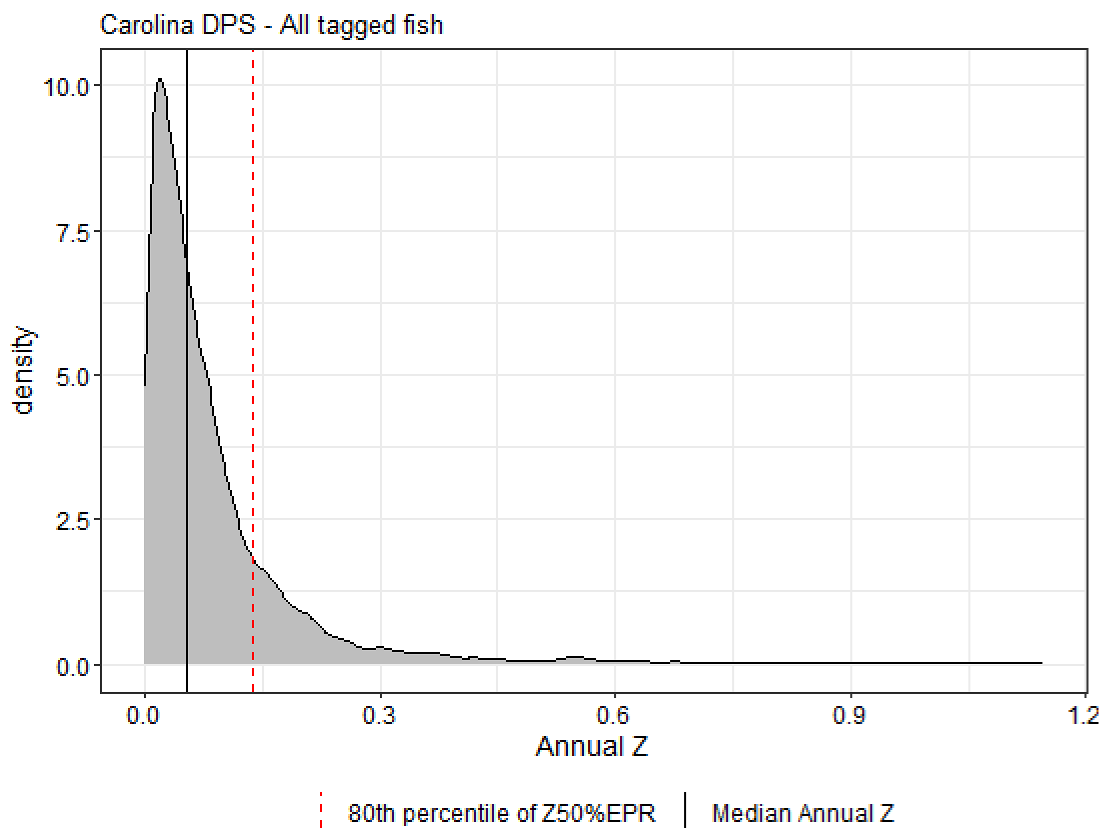


Figure 9. Distribution of annual *Z* estimate from the tagging model for all tagged fish assigned to the Carolina DPS, plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

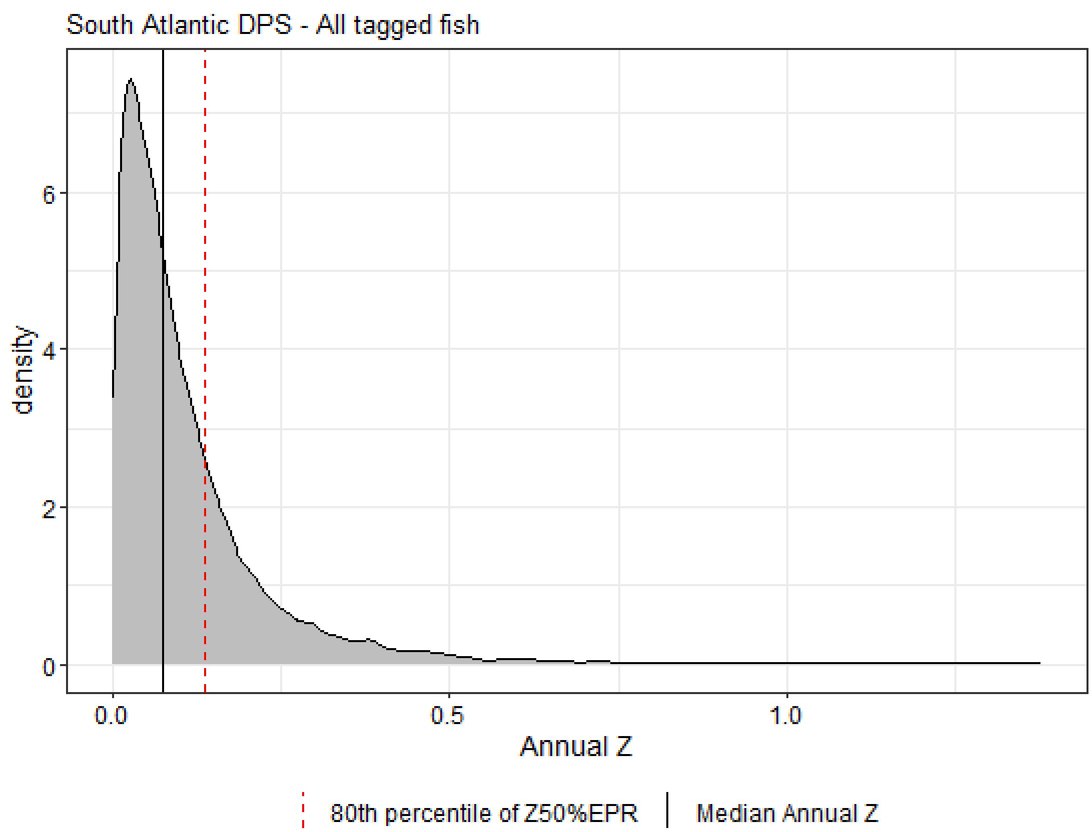


Figure 10. Distribution of annual *Z* estimate from the tagging model for all tagged fish assigned to the South Atlantic DPS, plotted with the median annual *Z* and the *Z* reference point. The x-axis has been truncated to exclude the highest 0.5% of *Z* estimates to show detail.

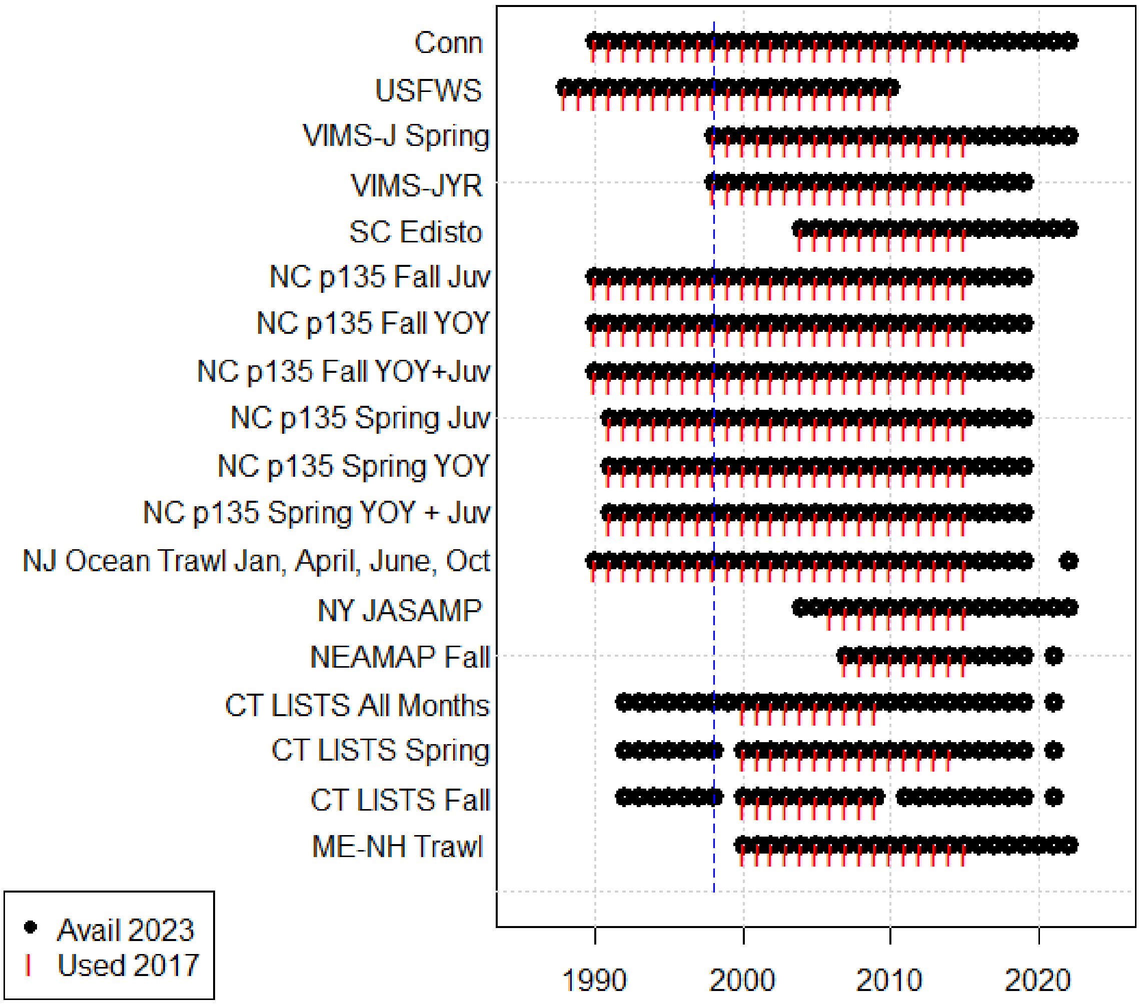


Figure 11. Visualization of the years of data available for 2023/2024 ARIMAs and those used for 2017 ARIMAs (ASMFC 2017). A blue vertical dashed line is added at 1998. Index values for the VIMS survey was not used in the final ARIMAs due to changes in the gear, net location, and effort.

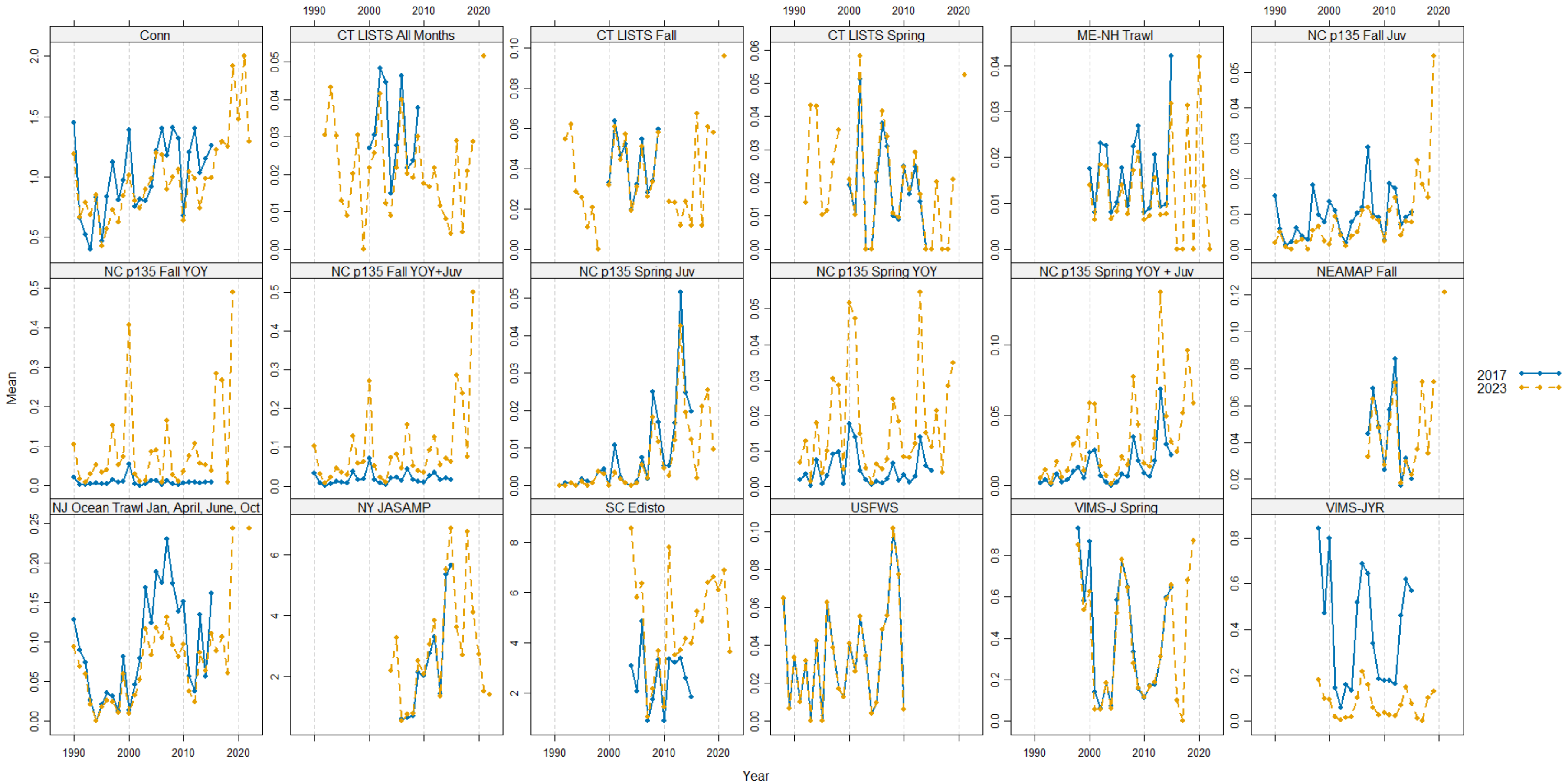


Figure 12. Plot of raw indices used in 2017 and 2023 ARIMAs.

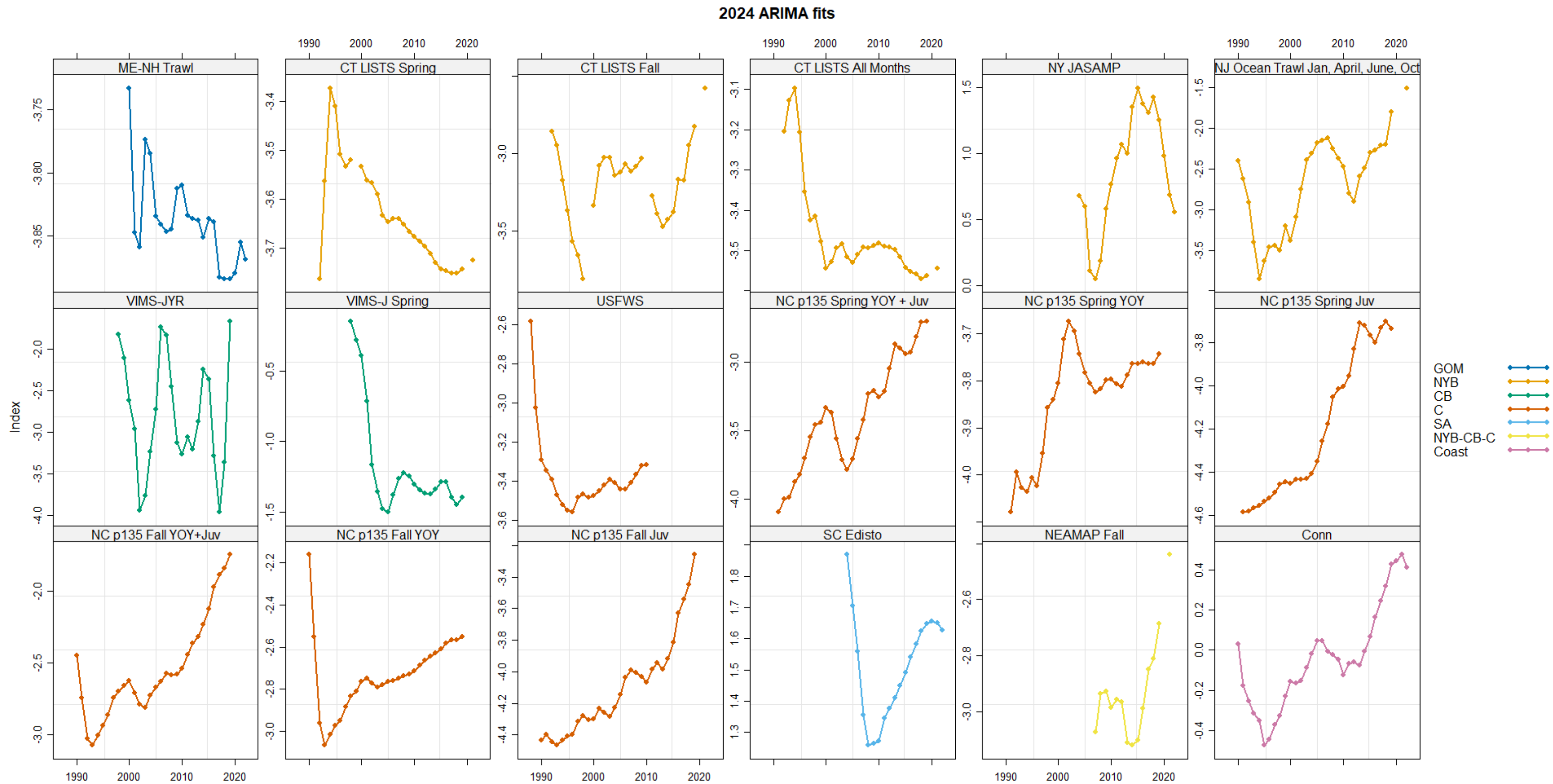


Figure 13. ARIMA fitted indices plotted on individualized y-axes. See Table 12 for results of trend analysis.

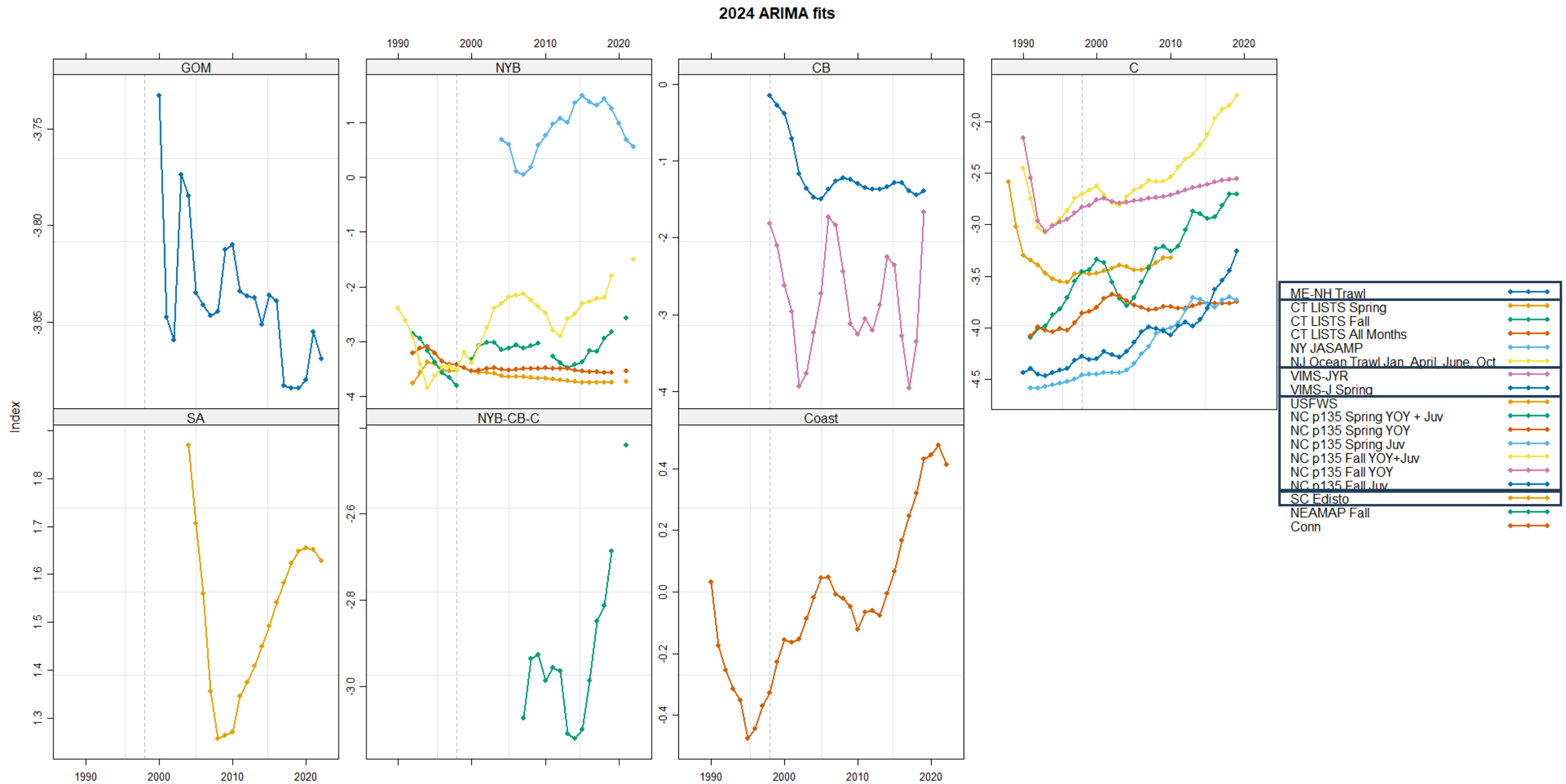


Figure 14. ARIMA fitted indices grouped by DPS plotted on separate y-axes. Boxes are drawn around surveys within DPSs. See Table 12 for results of trend analysis.

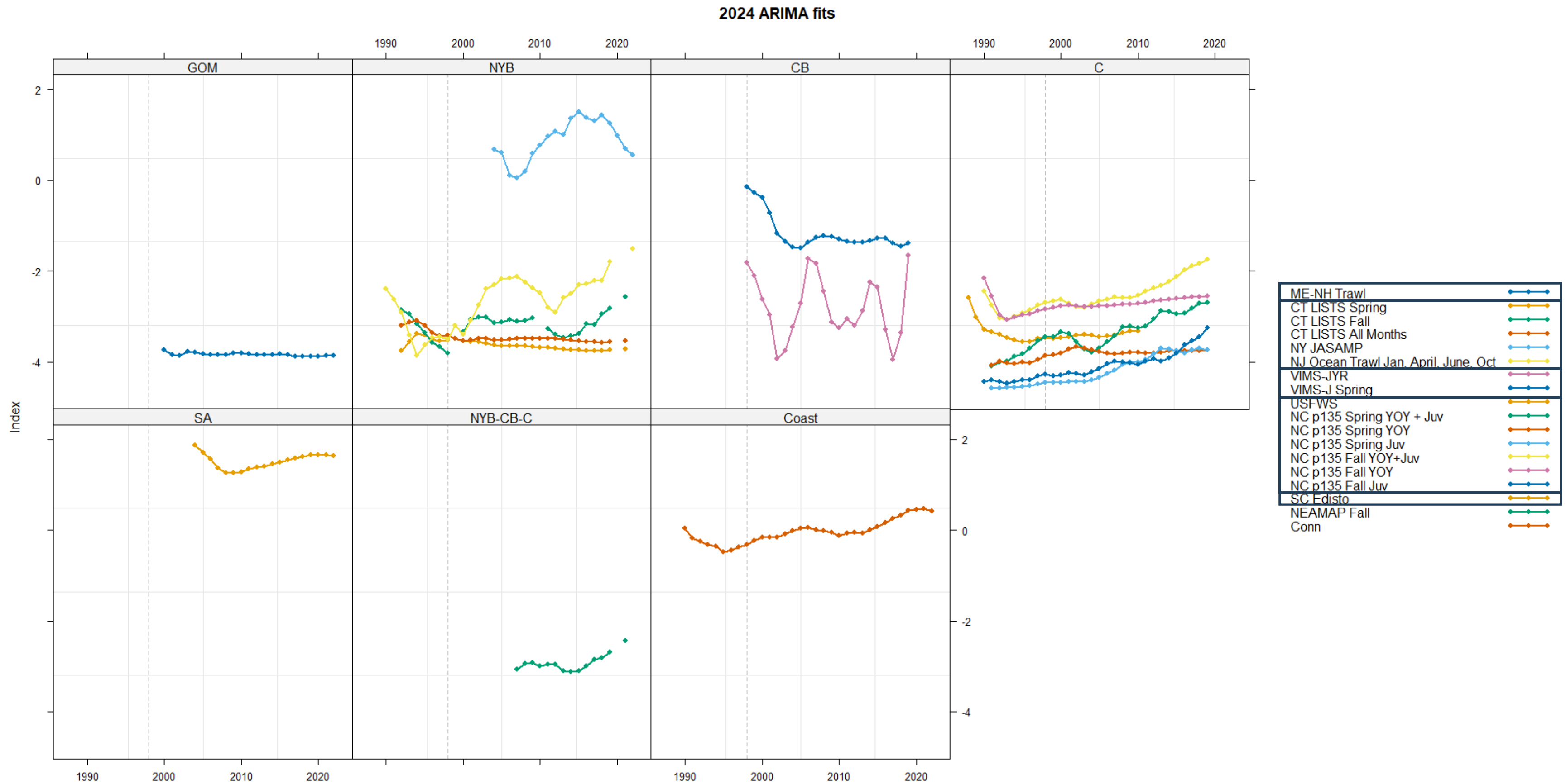


Figure 15. ARIMA fitted indices grouped by DPS plotted on a common y-axis. Boxes are drawn around surveys within DPSs. See Table 12 for results of trend analysis.

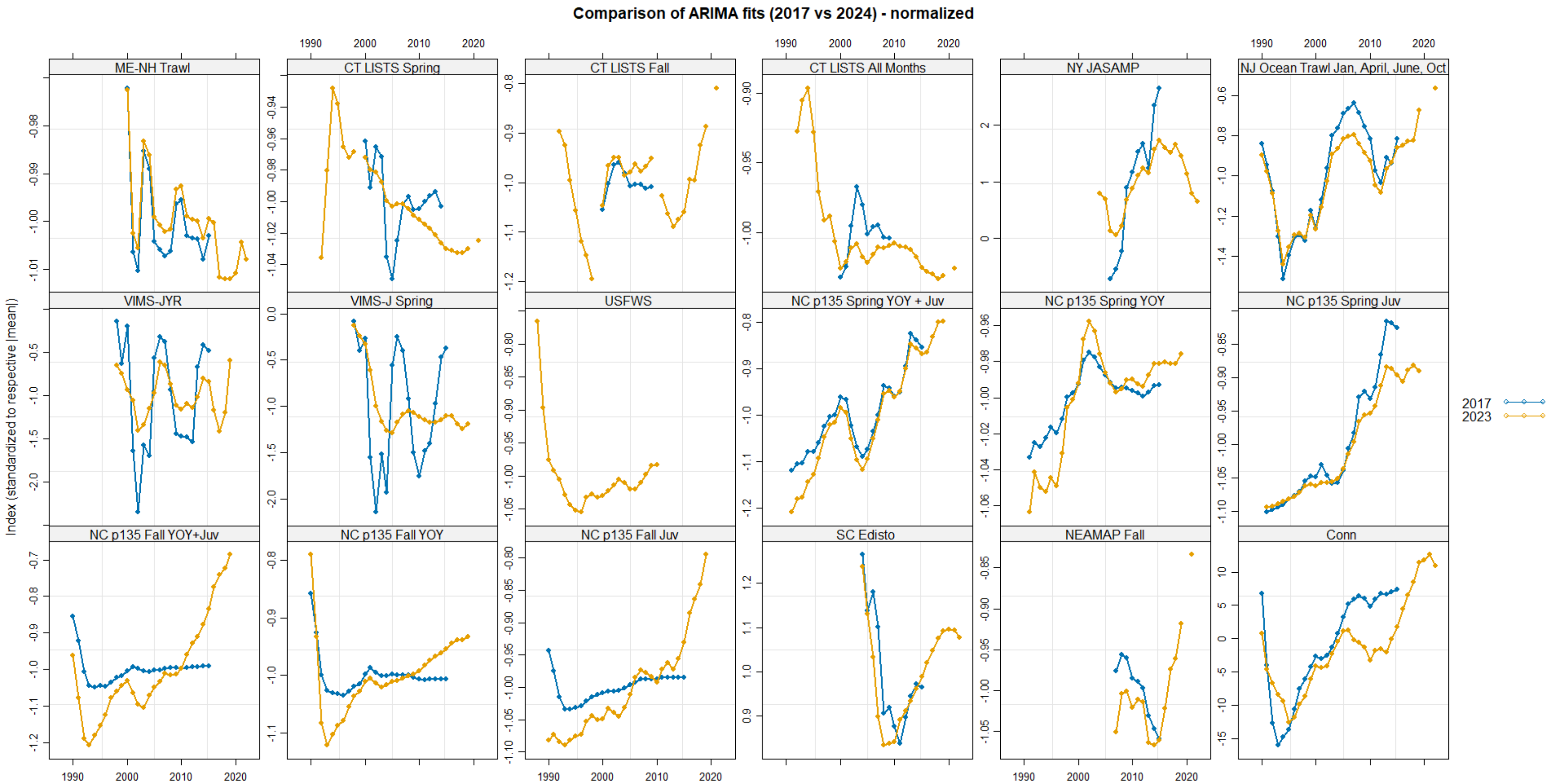


Figure 16. ARIMA fits from indices fit in ASMFC (2017) with those fit in 2024 (labelled 2023). Indices have been scaled to the absolute value of their respective mean. Note that USFWS index was 100% unchanged from ASMFC (2017) due to the termination of that timeseries in 2010.

Figure 17. Probabilities that the terminal year of a given index is greater than the 25th percentile of its time series. The plotted point represents the probability that the terminal year of the index is greater than the 25th percentile of the index assuming the survey started in the plotted year. A dotted horizontal line is added at probability = 0.50 (min credible probability). A red box is drawn around indices where credibility of terminal year being above the 25th percentile of a given time series changes with start year, suggesting some sensitivity of the results to the survey start year.

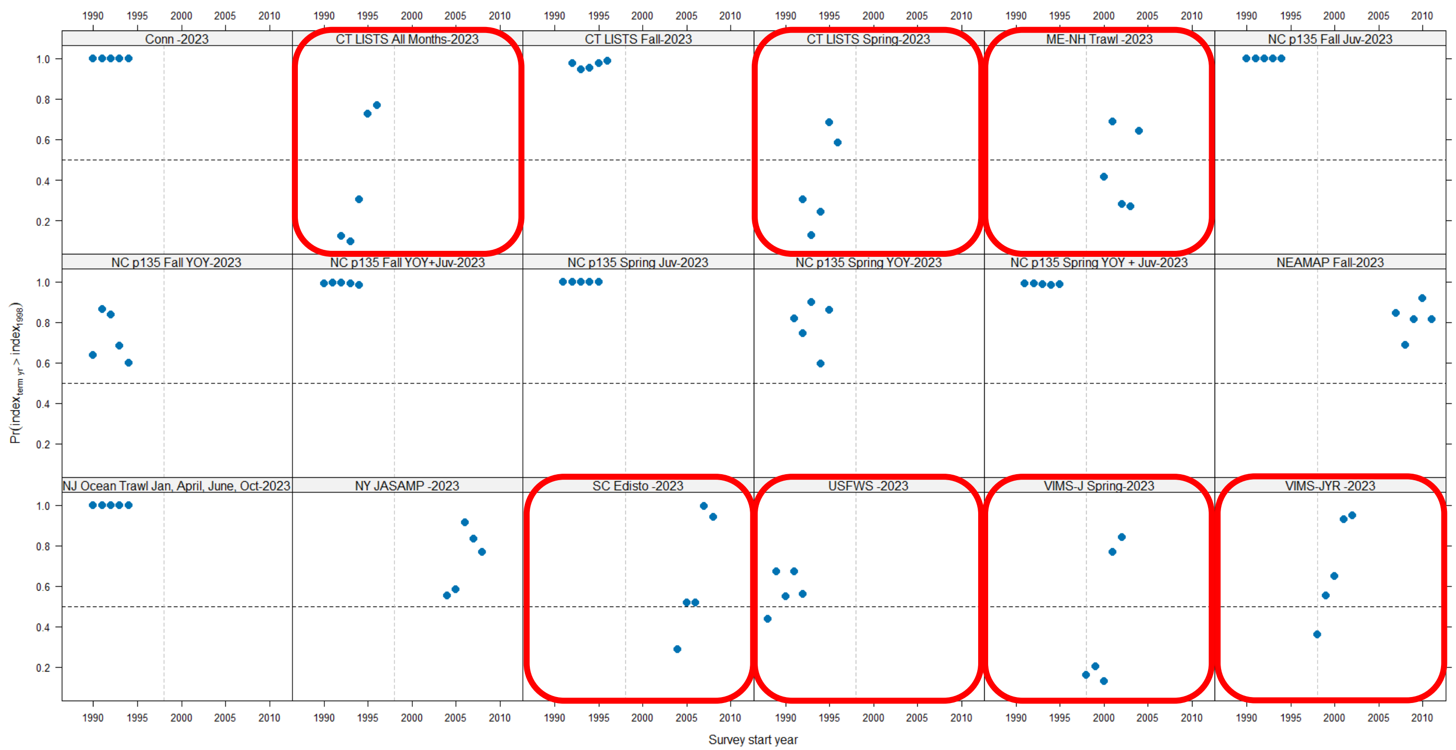


Figure 18. Probabilities that the terminal year of a given index is greater than the index value in 1998*; a vertical dotted line is added at 1998. The plotted point represents the probability that the terminal year of the index is greater than the index value in 1998* assuming the survey started in the plotted year. A dotted horizontal line is added at probability = 0.50 (min credible probability). A red box is drawn around indices where credibility of terminal year being above the 1998 index value of a given time series changes with start year, suggesting some sensitivity of the results to the survey start year. * For surveys that started after 1998, what is plotted is the probability that the terminal year is greater than the index in the plotted year, so that in those cases, the comparisons are against a moving set of years [e.g., SC Edisto: Pr(2023 index > 2004 index = 0.29 (assuming index started in 2004), …, Pr(2023 index > 2007 index = 0.94 (assuming index started in 2007)].

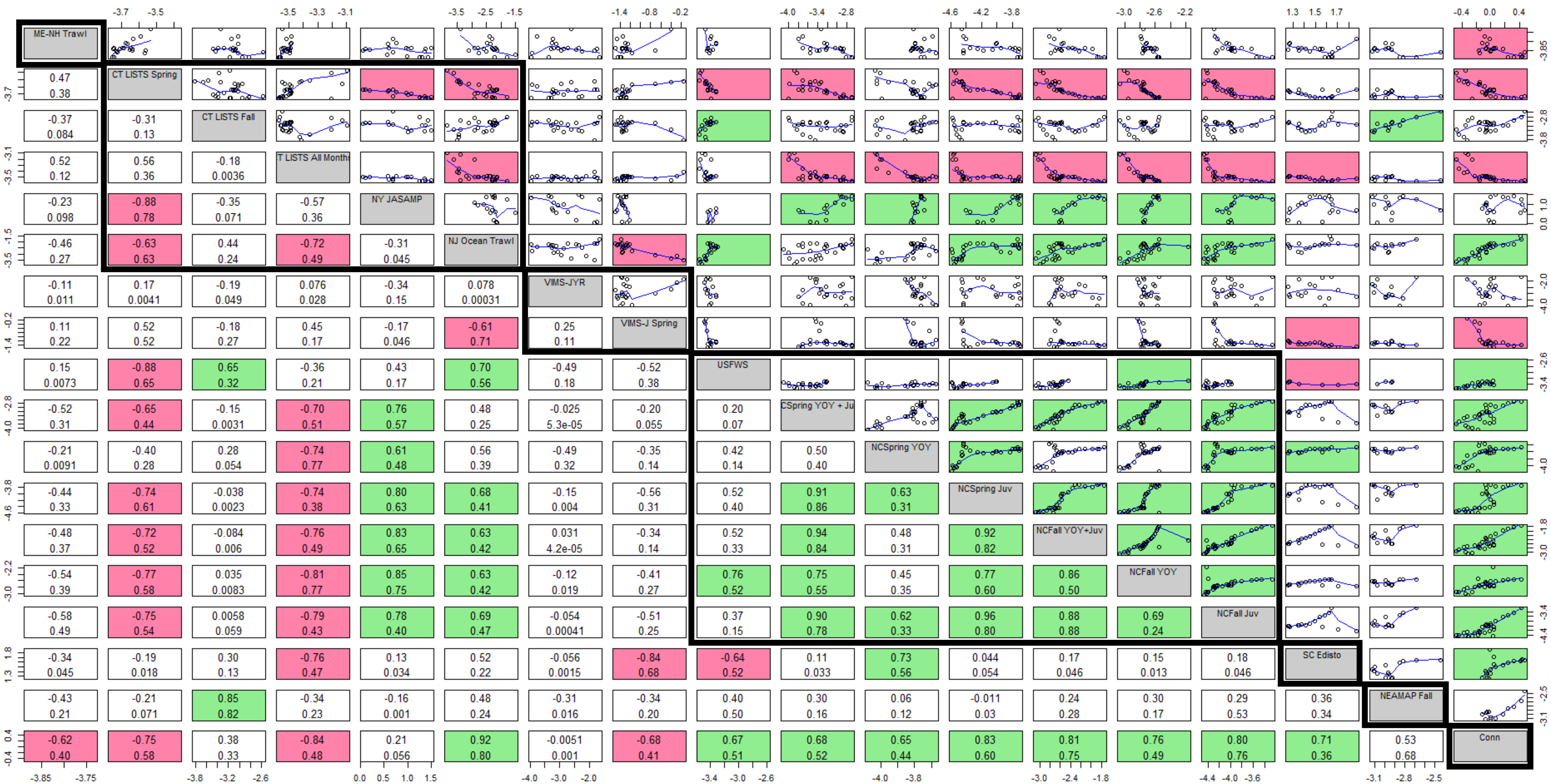


Figure 19. Correlation matrix of ARIMA fits to surveys. Spearman correlations below diagonal (top row), notable correlations (≥ 0.60 or ≤ -0.60) are indicated in green or red, respectively; r^2 below diagonal (bottom row). Lowess smoother added to scatterplots above the diagonal. Index name along the diagonal. Black boxes are drawn around surveys within a single DPS to help illustrate trends within a DPS or regional index (e.g., NEAMAP, Conn).

APPENDICES

a. Tagging Model Supplemental Results

Table A1. Results of Cormack-Jolly Seber model for all size Atlantic sturgeon for all DPSs. The mean and percentile *S* values are presented, along with mean *P* estimates. The mean *S* estimates were reported for the benchmark assessment, but due to skewness in the posterior distributions, the peer review panel recommended using median values for the *S* estimates (bold). Estimate of *P* are the mean or range of monthly means depending on if the preferred model for that DPS used the single or monthly *P* estimate.

DPS	N	TL Range (cm)	Mean	sd	2.50%	25%	50%	75%	97.50%	*P*
GM	224	29-237	0.81	0.16	0.34	0.76	**0.86**	0.92	0.98	0.02-0.34
NY	534	26-268	0.91	0.10	0.63	0.88	**0.94**	0.97	1.00	0.31
CH	464	25-240	0.93	0.09	0.67	0.91	**0.95**	0.98	1.00	0.09-0.49
CA	489	30-265	0.92	0.10	0. 63	0.90	**0.95**	0.98	1.00	0.42
SA	364	28-267	0.90	0.12	0.60	0.87	**0.93**	0.97	1.00	0.12-0.54
All	2,075	25-268	0.98	0.03	0.89	0.98	**0.99**	0.99	1.00	0.11-0.47

Table A2. Results of Cormack-Jolly Seber model for Atlantic sturgeon < 1300 mm for all DPSs. The mean and percentile *S* values are presented, along with mean *P* estimates. The mean *S* estimates were reported for the benchmark assessment, but due to skewness in the posterior distributions, the peer review panel recommended using median values for the *S* estimates (bold). Estimate of *P* are the mean or range of monthly means depending on if the preferred model for that DPS used the single or monthly *P* estimate.

DPS	N	TL Range (cm)	Mean	sd	2.50%	25%	50%	75%	97.50%	*P*
GM	55	29-129	0.56	0.25	0.09	0.37	**0.58**	0.76	0.96	0.29
NY	144	26-129	0.82	0.16	0.41	0.75	**0.86**	0.93	0.99	0.33
CH	74	25-128	0.77	0.18	0.27	0.69	**0.82**	0.90	0.98	0.15-0.50
CA	208	30-129	0.86	0.13	0.47	0.82	**0.90**	0.95	0.99	0.37
SA	133	28-124	0.81	0.17	0.33	0.74	**0.86**	0.93	0.99	0.21-0.51
All	614	25-129	0.94	0.08	0.71	0.92	**0.96**	0.98	1.00	0.34

Table A3. Results of Cormack-Jolly Seber model for Atlantic sturgeon > 1300 mm for all DPSs.The mean and percentile *S* values are presented, along with mean *P* estimates. The mean *S* estimates were reported for the benchmark assessment, but due to skewness in the posterior distributions, the peer review panel recommended using median values for the *S* estimates (bold). Estimate of *P* are the mean or range of monthly means depending on if the preferred model for that DPS used the single or monthly *P* estimate.

DPS	N	TL Range (cm)	Mean	sd	2.50%	25%	50%	75%	97.50%	*P*
GM	169	130-237	0.77	0.19	0.22	0.69	**0.82**	0.91	0.98	0.04-0.31
NY	390	130-268	0.86	0.13	0.55	0.81	**0.89**	0.94	0.99	0.30
CH	390	130-240	0.90	0.10	0.60	0.87	**0.93**	0.97	1.00	0.33
CA	281	130-265	0.87	0.12	0. 57	0.82	**0.90**	0.95	0.99	0.47
SA	231	130-267	0.83	0.16	0.38	0.77	**0.88**	0.94	0.99	0.09-0.55
All	1,461	130-268	0.96	0.05	0.83	0.96	**0.98**	0.99	1.00	0.31

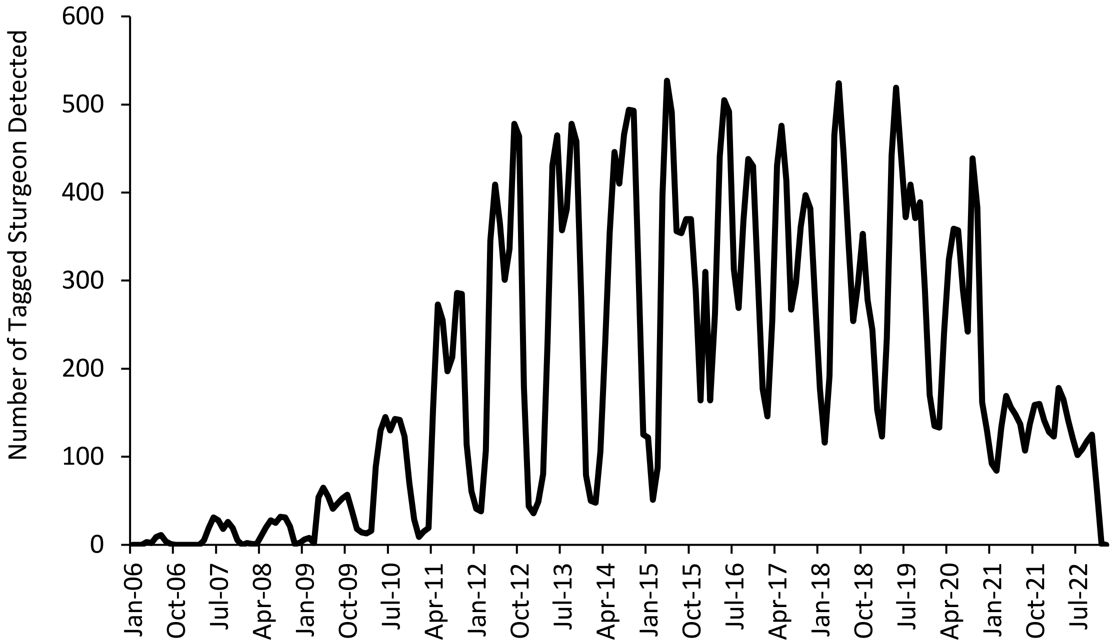


Figure A1. Total number of tagged sturgeon detected weekly over time for all DPSs.

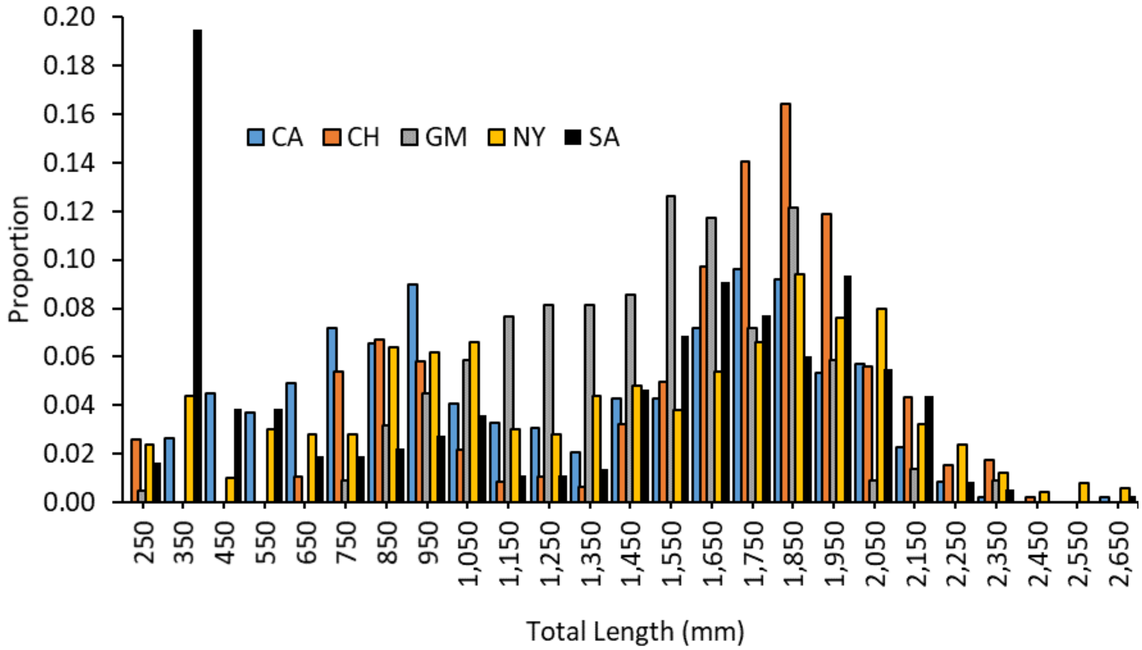


Figure A2. Length-frequency of all tagged Atlantic sturgeon by assigned DPS.

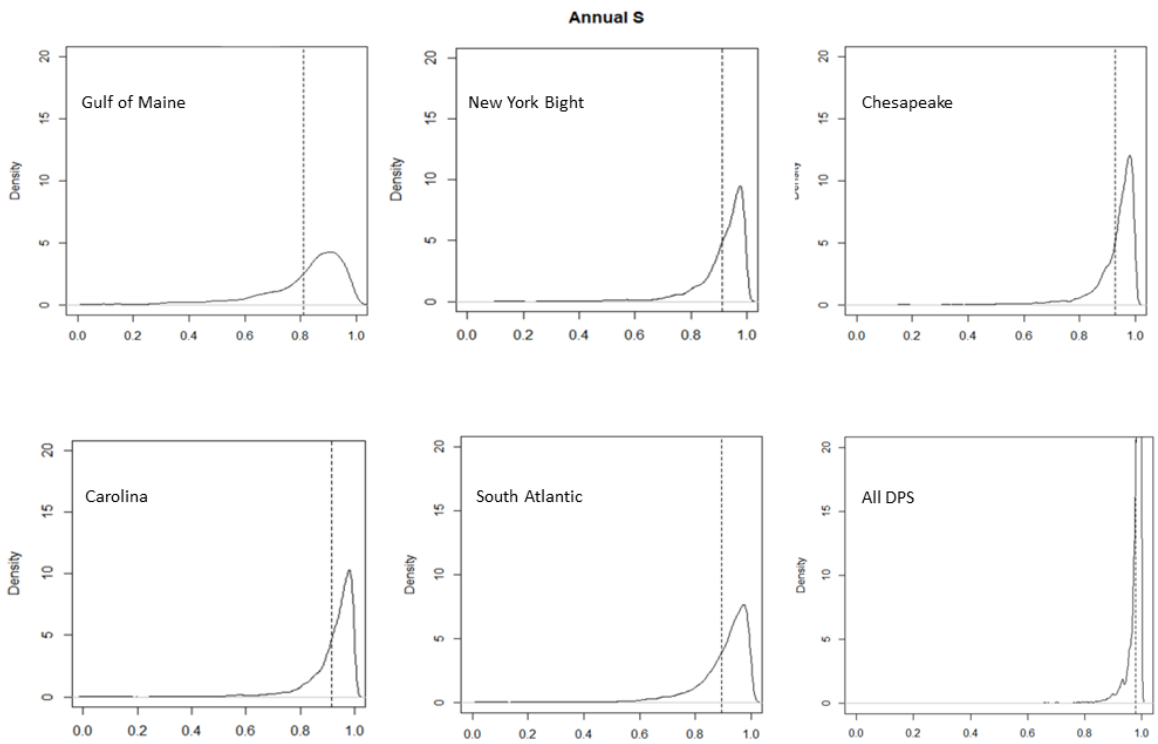


Figure A3. Posterior distributions for estimates of *S* for all sized tagged Atlantic sturgeon. Results are for the best model for each DPS. Dotted vertical line represents the mean *S* estimate.

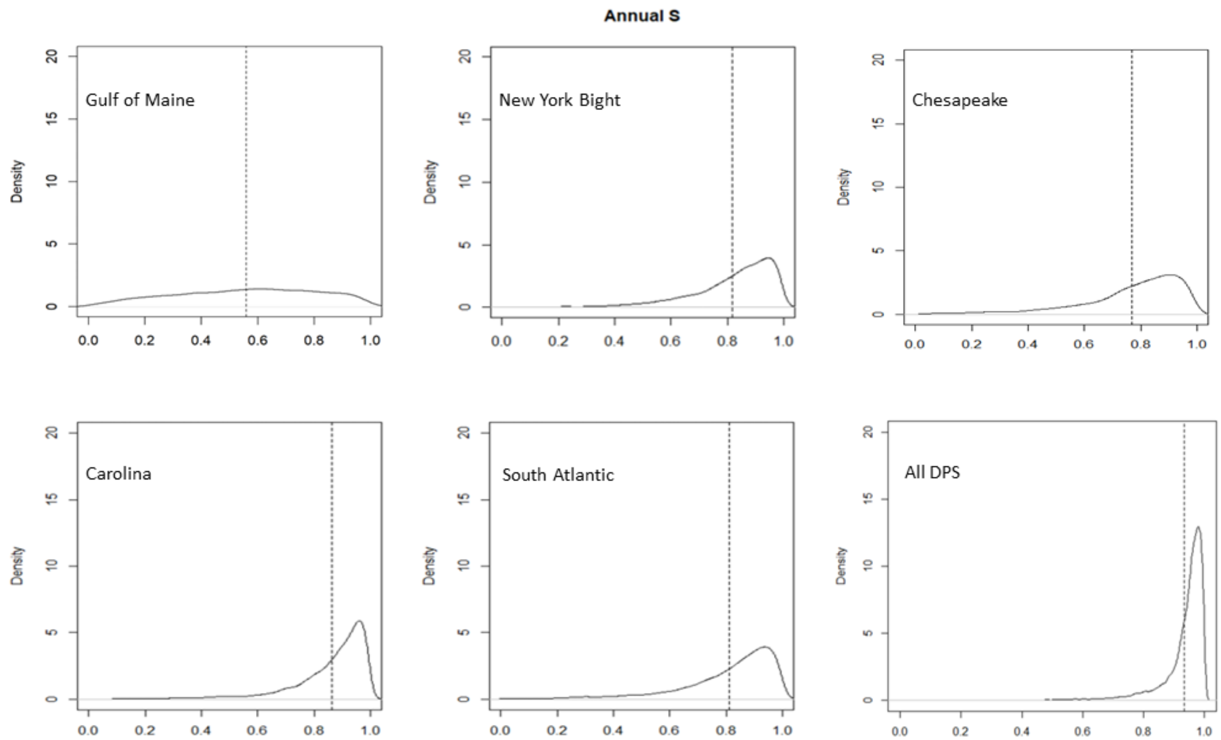


Figure A4. Posterior distributions for estimates of *S* for tagged Atlantic sturgeon < 1300 mm. Results are for the best model for each DPS. Dotted vertical line represents the mean *S* estimate.

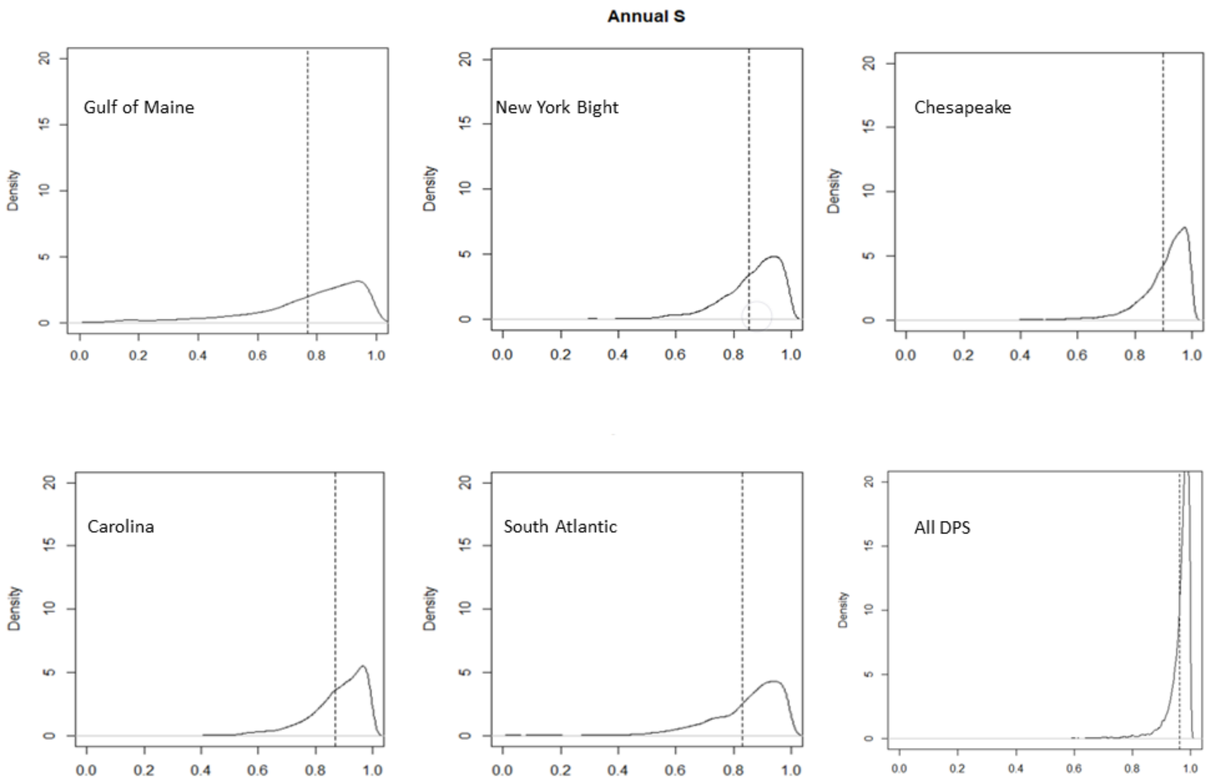


Figure A5. Posterior distributions for estimates of *S* for tagged Atlantic sturgeon >1300 mm. Results are for the best model for each DPS. Dotted vertical line represents the mean *S* estimate.

b. Standardized Indices of Abundance

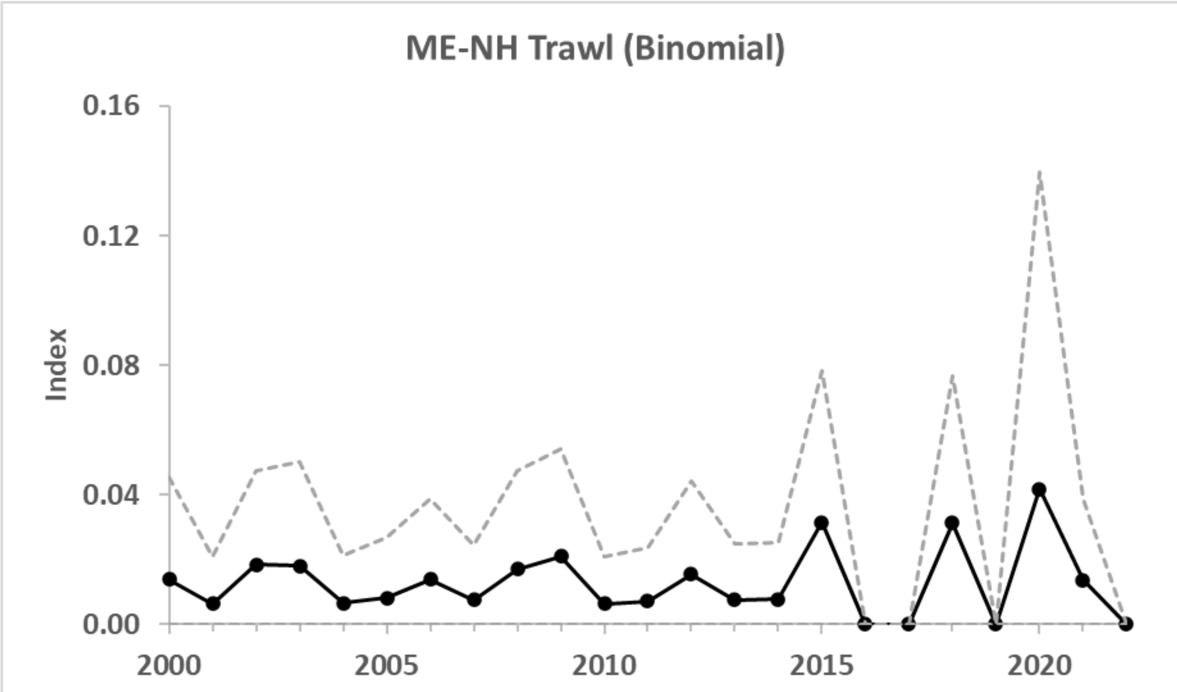


Figure A6. Standardized index of relative abundance of Atlantic sturgeon developed from the Maine-New Hampshire Trawl Survey with 95% confidence intervals.

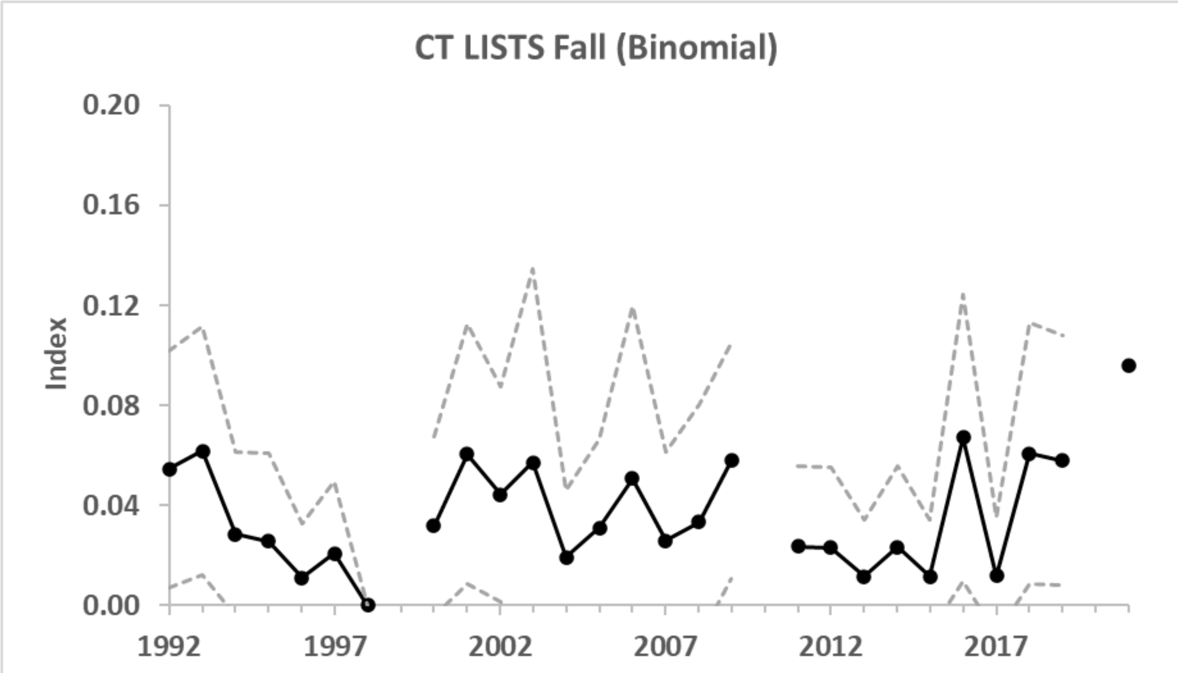


Figure A7. Standardized index of relative abundance of Atlantic sturgeon developed from the Connecticut Long Island Sound Trawl Survey in the fall with 95% confidence intervals.

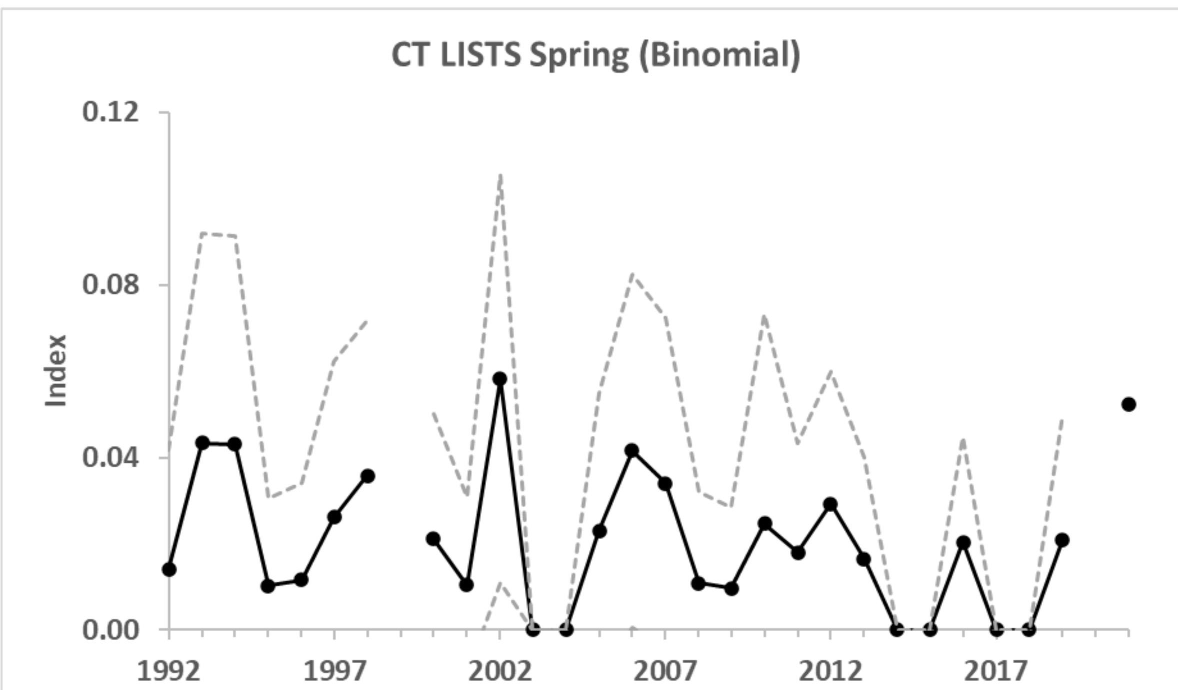


Figure A8. Standardized index of relative abundance of Atlantic sturgeon developed from the Connecticut Long Island Sound Trawl Survey in the spring with 95% confidence intervals.

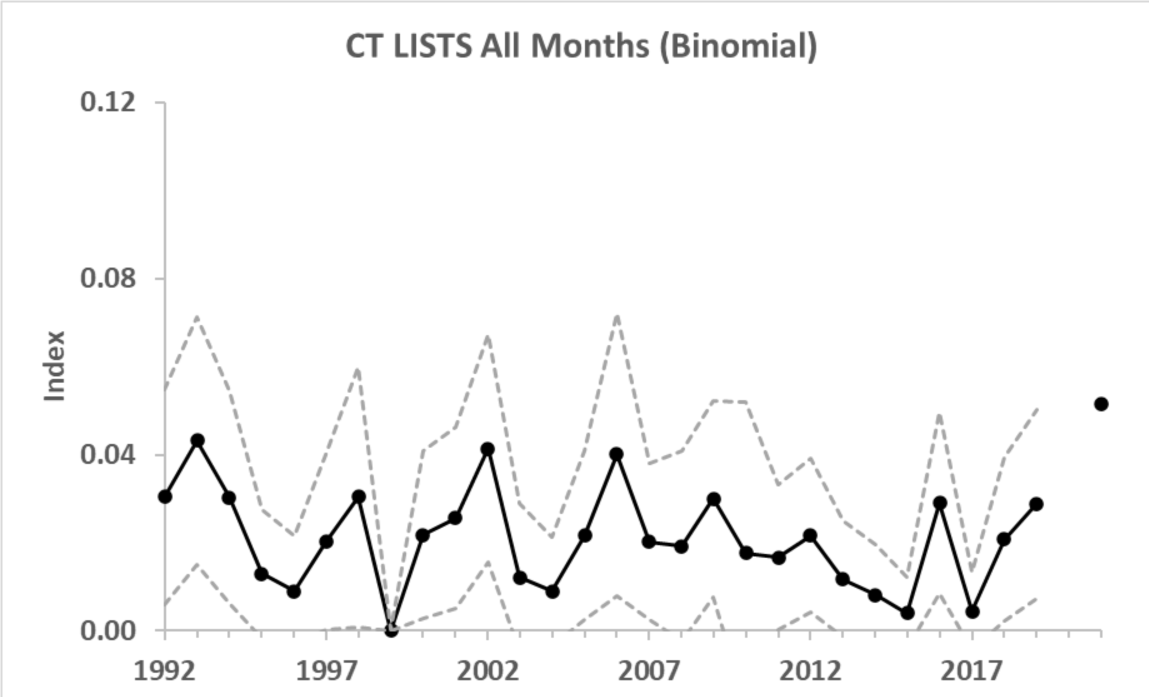


Figure A9. Standardized index of relative abundance of Atlantic sturgeon developed from the Connecticut Long Island Sound Trawl Survey for all months with 95% confidence intervals.

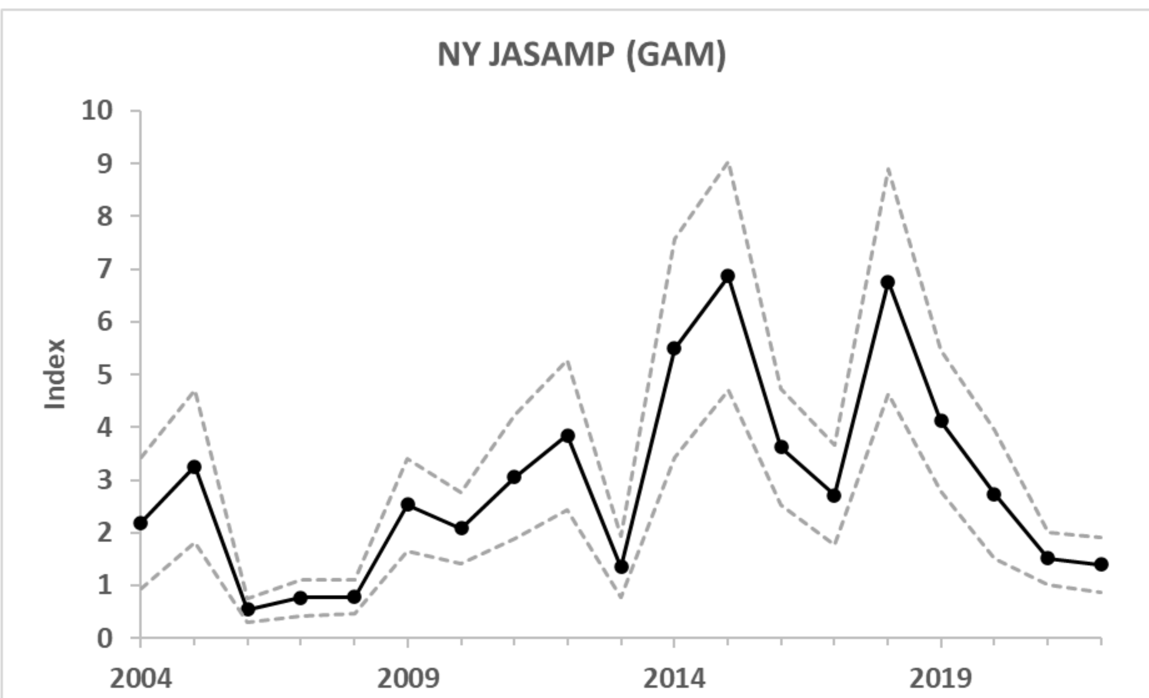


Figure A10. Standardized index of relative abundance of Atlantic sturgeon developed from the NYDEC JASAMP survey with 95% confidence intervals.

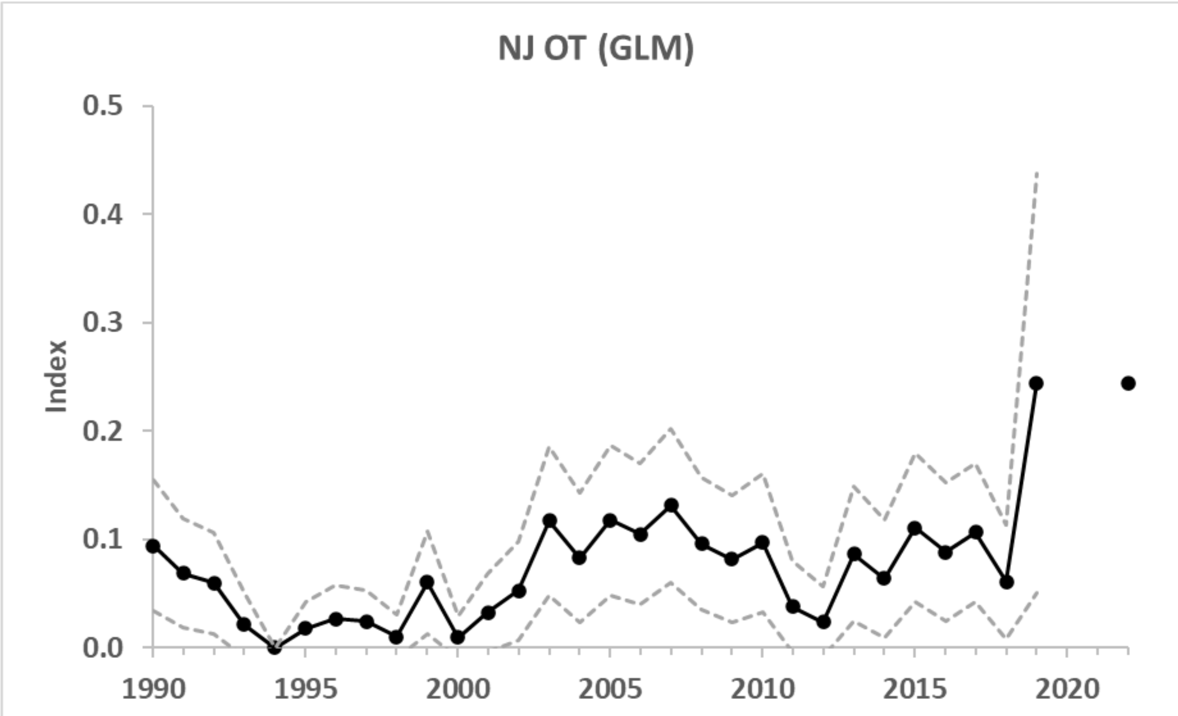


Figure A11. **Standardized index of relative abundance of Atlantic sturgeon developed from the New Jersey Ocean Trawl Survey with 95% confidence intervals.**

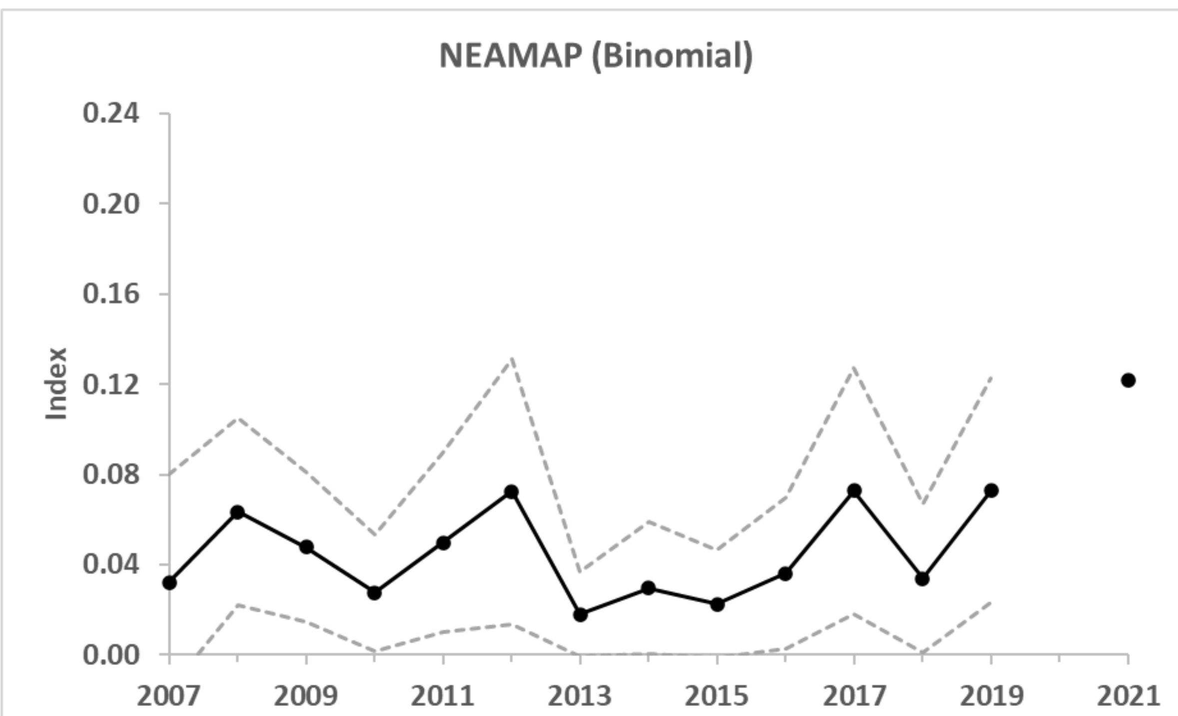


Figure A12. **Standardized index of relative abundance of Atlantic sturgeon developed from the NEAMAP Survey in the fall with 95% confidence intervals.**

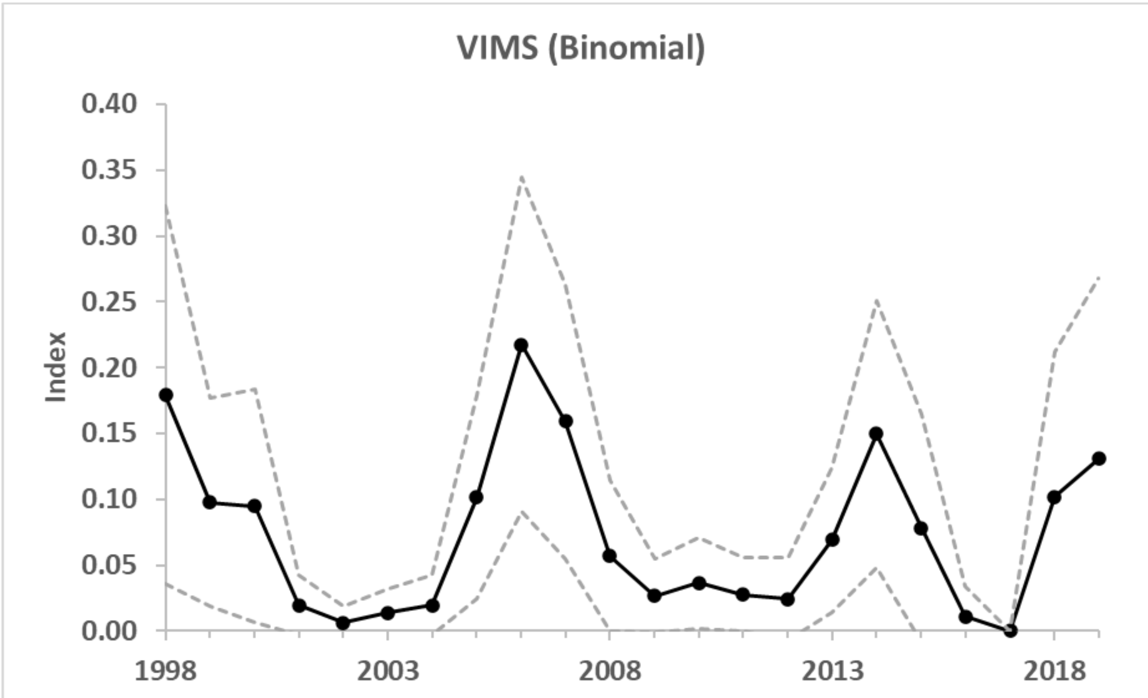


Figure A13. **Standardized index of relative abundance of Atlantic sturgeon developed from the VIMS Shad and River Herring Monitoring Survey with 95% confidence intervals.**

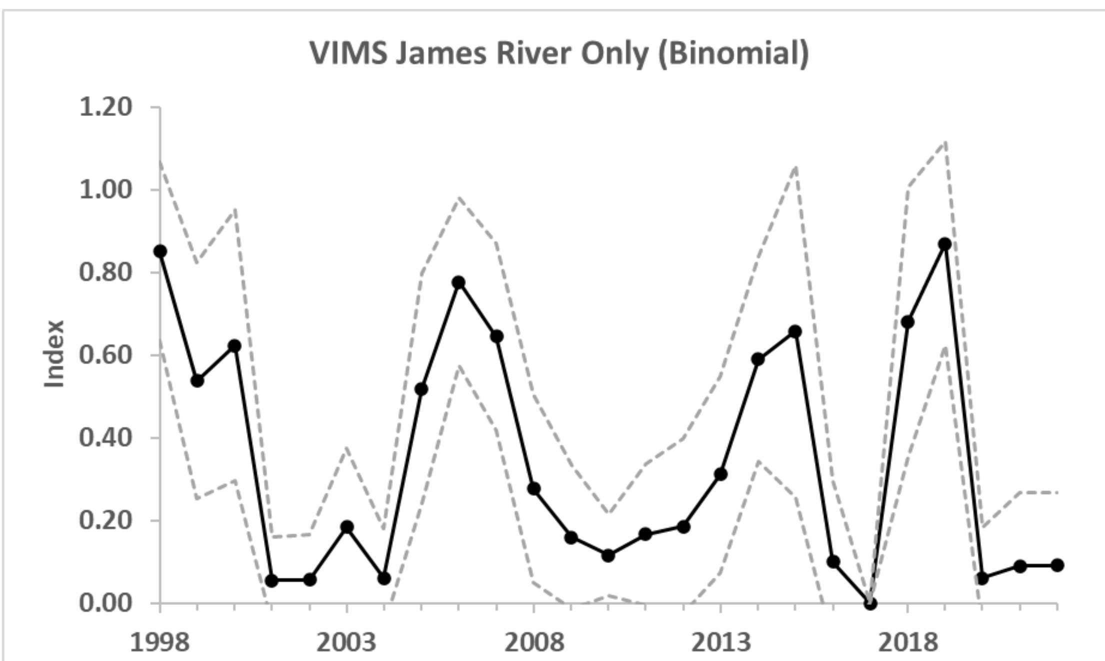


Figure A14. **Standardized index of relative abundance of Atlantic sturgeon developed from the VIMS Shad and River Herring Monitoring Survey for the James River only with 95% confidence intervals.**

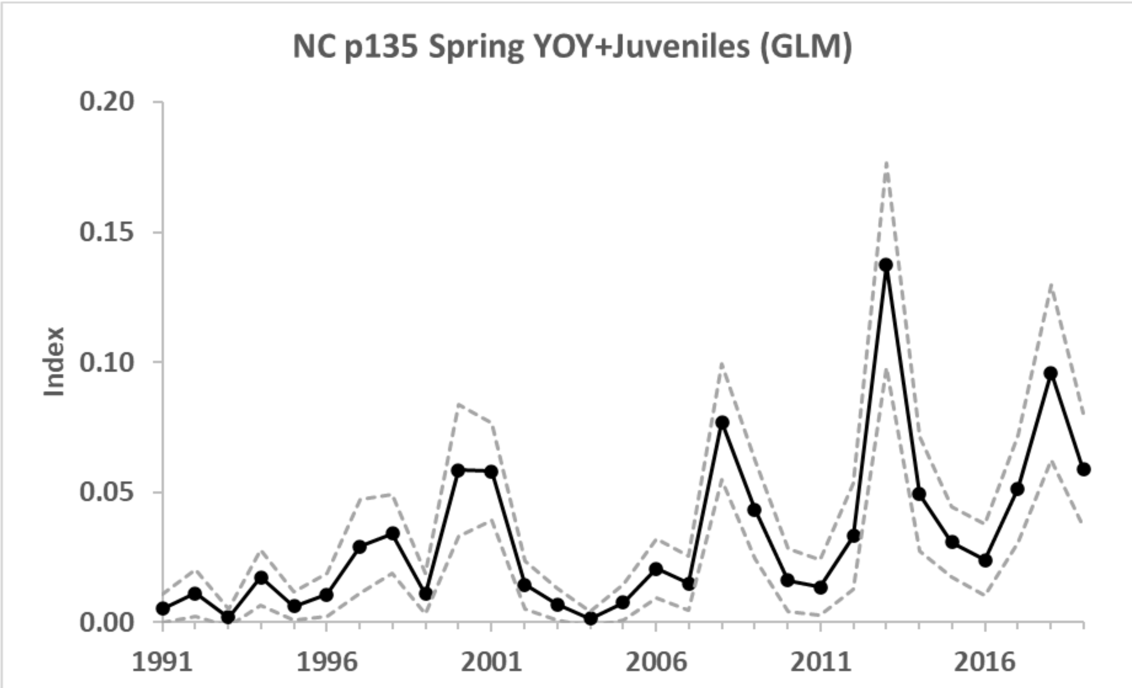


Figure A15. **Standardized index of relative abundance of Atlantic sturgeon developed from the spring component of the NC p135 Survey for YOY and juveniles with 95% confidence intervals.**

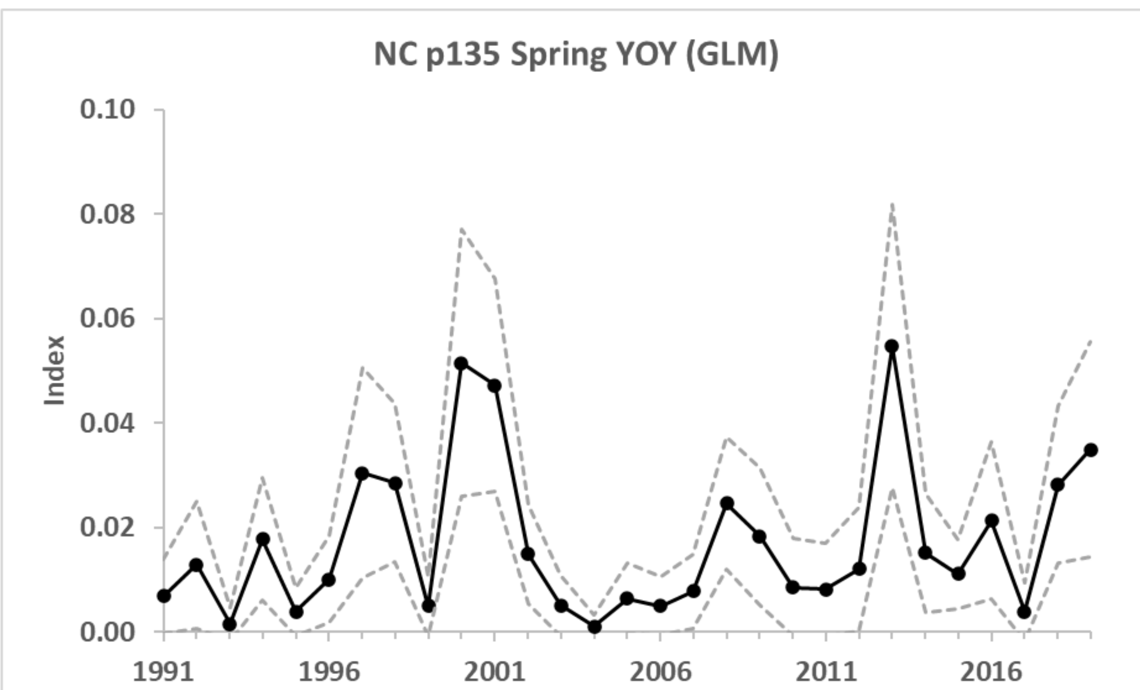


Figure A16. **Standardized index of relative abundance of Atlantic sturgeon developed from the spring component of the NC p135 Survey for YOY with 95% confidence intervals.**

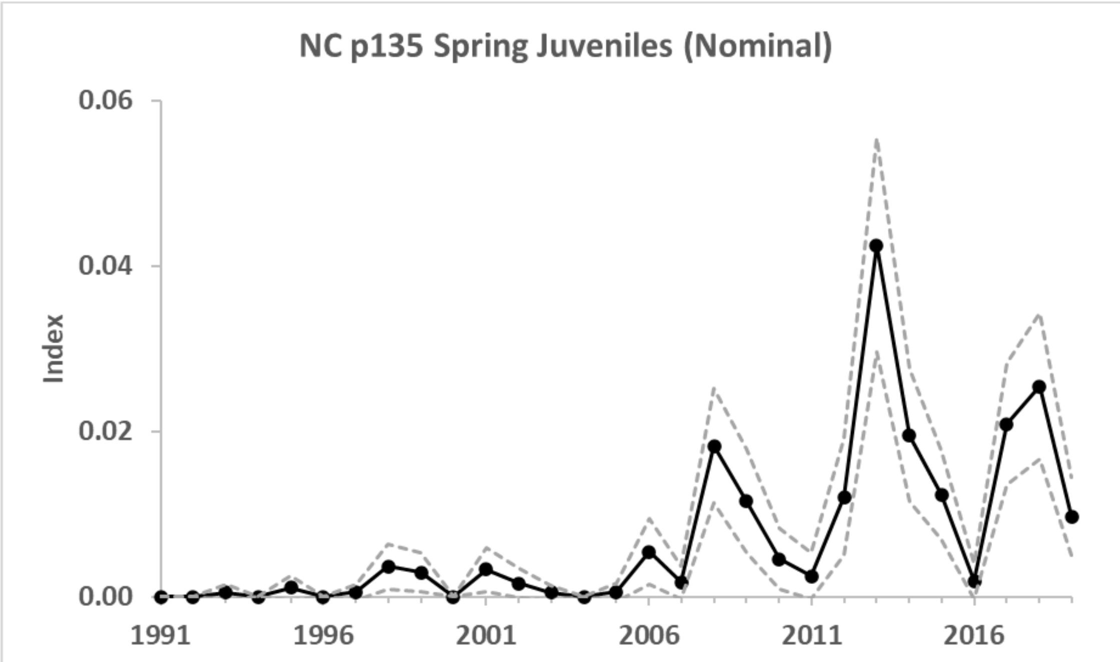


Figure A17. **Standardized index of relative abundance of Atlantic sturgeon developed from the spring component of the NC p135 Survey for juveniles with 95% confidence intervals.**

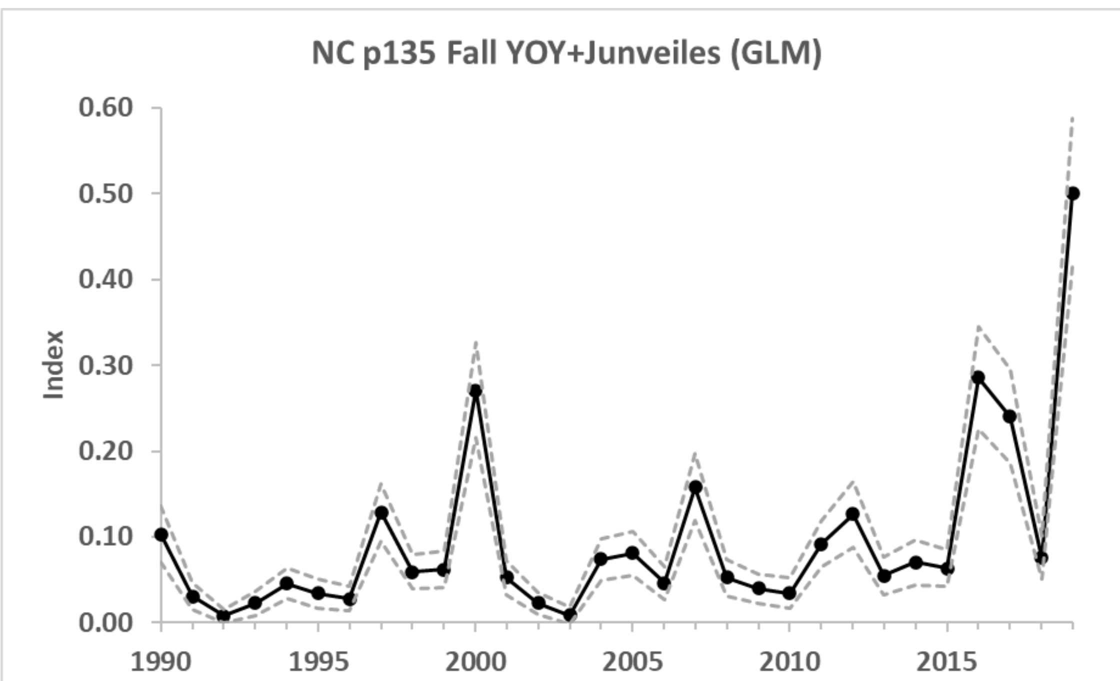


Figure A18. **Standardized index of relative abundance of Atlantic sturgeon developed from the fall component of the NC p135 Survey for YOY and juveniles with 95% confidence intervals.**

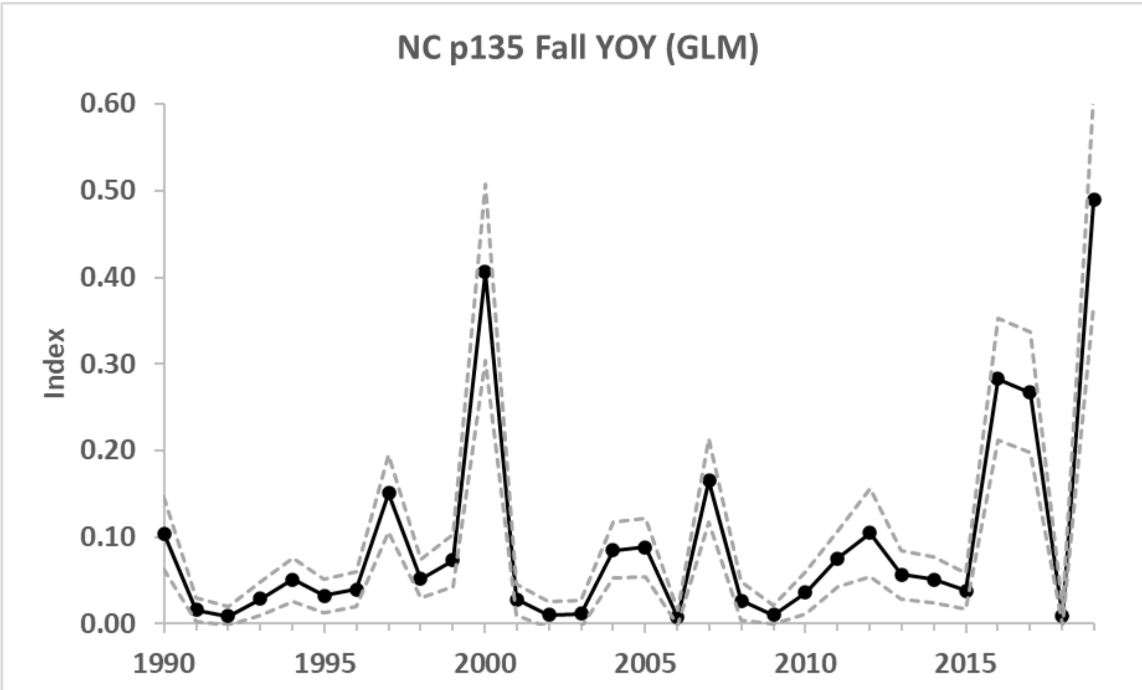


Figure A19. **Standardized index of relative abundance of Atlantic sturgeon developed from the fall component of the NC p135 Survey for YOY with 95% confidence intervals.**

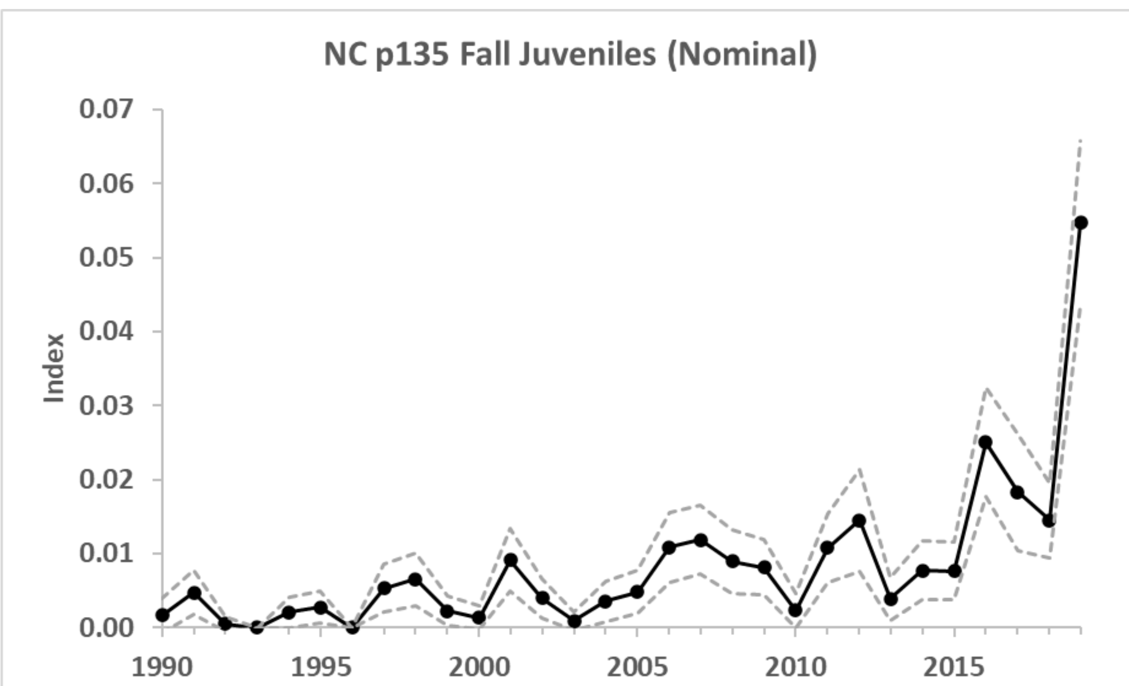


Figure A20. **Standardized index of relative abundance of Atlantic sturgeon developed from the fall component of the NC p135 Survey for juveniles with 95% confidence intervals.**

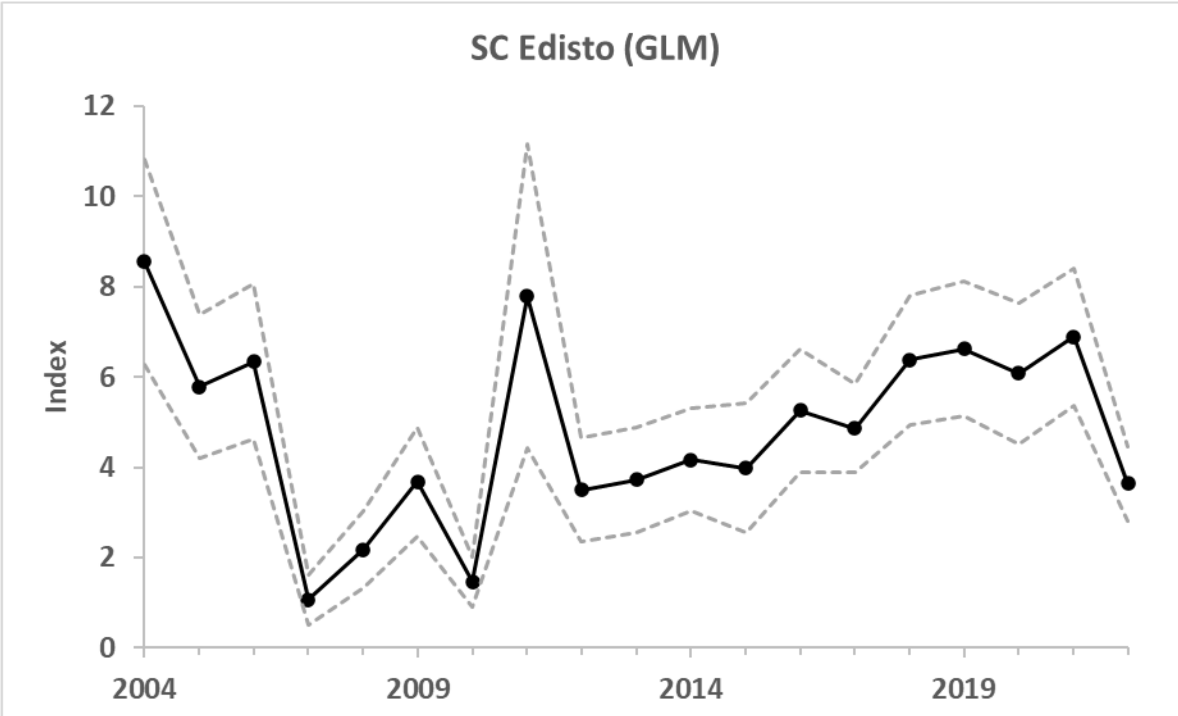


Figure A21. **Standardized index of relative abundance of Atlantic sturgeon developed from the SC Edisto Survey with 95% confidence intervals.**

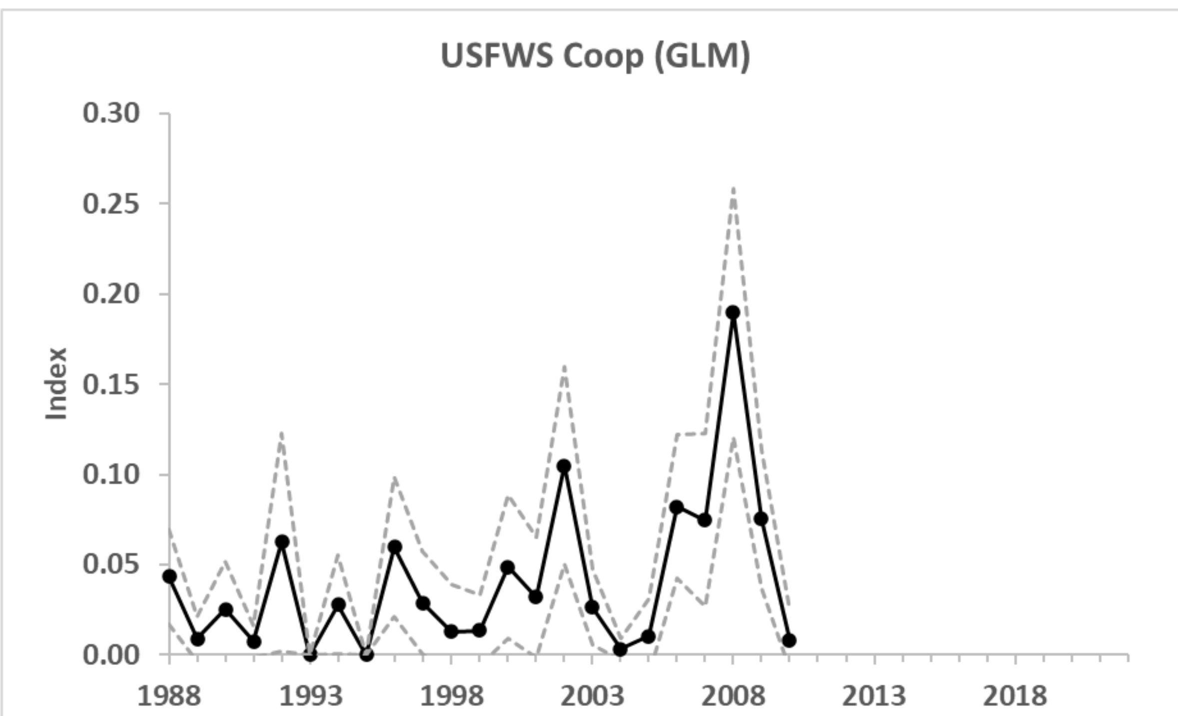


Figure A22. **Standardized index of relative abundance of Atlantic sturgeon developed from the USFWS Cooperative Cruise with 95% confidence intervals.**

c. Supplemental ARIMA Results

Gulf of Maine DPS

Maine-New Hampshire Trawl Survey

Descriptive statistics for the ME-NH Trawl Survey ARIMA are provided in Table 11. The fitted index started at the time series high value, has oscillated over time, generally decreasing, and ended the time series at a comparatively low level (Figure 13-Figure 15). The Mann-Kendall test did detect a significant (α = 0.05) declining trend in the time series. The terminal year index is credibly above the 25th percentile of the timeseries, but not the index value at the start of the timeseries (Table 12). The retrospective analysis suggests that conclusions regarding comparisons between terminal year and start year are sensitive to the start year of the survey, but not against the 25th percentile of the time series (Figure 17-Figure 18).

New York Bight DPS

Connecticut Long Island Sound Trawl Survey (Fall)

Descriptive statistics for the CT LIST Survey (fall) ARIMA are provided in Table 11. The fitted index starts the time series at a comparatively high level, oscillated over time and in recent years is trending upwards, with the terminal year at a time series high (Figure 13-Figure 15). The Mann-Kendall test did not detect a significant (α = 0.05) trend in the time series. The terminal year index is credibly above the 25th percentile of the timeseries and the fitted value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

Connecticut Long Island Sound Survey (Spring)

Descriptive statistics for the CT LIST Survey (spring) ARIMA are provided in Table 11. The fitted index starts at the time series low, increased rapidly, peaking in 1994, declined over time through about 2015, before starting a modest upward trend (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α= 0.05) downward trend in the time series. The terminal year index is credibly above the 25th percentile of the time series, but not the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are sensitive to the start year of the survey (Figure 17-Figure 18).

Connecticut Long Island Sound Survey (All Months)

Descriptive statistics for the CT LIST Survey (all months) ARIMA are provided in Table 11. The fitted index starts near the time series high, increased for 2 years before declining markedly through the late 1990s, after which the index stabilized through about 2013. The index declined after 2013 but has increased slightly in the most recent 2 years available (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) downward trend in the time series. The terminal year index is not credibly above the 25th percentile of the time series or the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are sensitive to the start year of the survey (Figure 17-Figure 18).

New York JASAMP

Descriptive statistics for the JASAMP Survey ARIMA are provided in Table 11. The fitted index has oscillated over time, with a declining trend in the most recent several years, ending the time series at a value near where it began (Figure 13-Figure 15). The Mann-Kendall test did not detect a significant (α = 0.05) trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value from the start of the time series (Table 12). Figure 13 shows that the point estimate of the terminal year index is below the index value from the first year of the survey, but the distribution of bootstrapped values validates the Table 12 conclusion. The retrospective analysis suggests that these conclusions are sensitive to the start year of the survey with respect to comparison against the 25th percentile, but not against the start year of the survey (Figure 17-Figure 18).

New Jersey Ocean Trawl

Descriptive statistics for the NJ Ocean Trawl Survey ARIMA are provided in Table 11. The fitted index declined through the mid-1990s (the time of commercial fishery closure in NJ) after which it increased, initially peaking in the mid-2000s, before dipping slightly and again rising to a time series high (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

Chesapeake Bay DPS

VIMS-James, York, and Rappahannock Rivers (Spring)

Descriptive statistics for the VIMS-JYR Survey (spring) ARIMA are provided in Table 11. The fitted index has oscillated over time, starting near the time series high, reaching a comparable level near the middle of the time series, and ending at the time series high (Figure 13-Figure 15). The Mann-Kendall test did not detect a significant (α = 0.05) trend in the time series. The terminal year index is credibly above the 25th percentile of the time series but not the fitted index value in 1998 (Table 12). The retrospective analysis suggests that conclusions regarding comparisons between terminal year and 1998 are sensitive to the start year of the survey, but not against the 25th percentile of the time series (Figure 17-Figure 18).

VIMS-James River (Spring)

Descriptive statistics for the VIMS-J Survey (spring) ARIMA are provided in Table 11. The fitted index started at the time series high, decreased dramatically through 2005, after which it varied without trend for the remainder of the time series (Figure 13-Figure 15). The Mann-Kendall test detected a significant ($\alpha = 0.05$) downward trend in the time series. The terminal year index is not credibly above the 25th percentile of the time series or the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are sensitive to the start year of the survey (Figure 17-Figure 18).

Carolina DPS

North Carolina p135 (YOY and Juvenile; Spring)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started at the time series low value but has generally increased over time (save a relatively steep decline between 2001-2004), ending at time series high value (Figure 13-Figure 15). The Mann-Kendall test detected a significant ($\alpha = 0.05$) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

North Carolina p135 (YOY; Spring)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started at the time series low value, generally increased through 2002, subsequently decline through 2007, before generally gradually increasing (Figure 13-Figure 15). The Mann-Kendall test detected a significant ($\alpha = 0.05$) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

North Carolina p135 (Juvenile; Spring)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started at the time series low value, increased through 2013, and has since oscillated (Figure 13-Figure 15). The Mann-Kendall test detected a significant ($\alpha = 0.05$) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

North Carolina p135 (YOY and Juvenile; Fall)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index declined over the first several years of the survey before generally increasing over time, ending at a time series high value (Figure 13-Figure 15). The Mann-Kendall test detected a significant ($\alpha = 0.05$) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

North Carolina p135 (YOY; Fall)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started at the time series high value, declined dramatically through 1993 before generally increasing over the remainder of the time series (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) increasing trend in the time series. The terminal year index is credibly above the 25^{th} percentile of the timeseries and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

North Carolina p135 (Juvenile; Fall)

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started near the time series low value, but generally increased over time, ending at a time series high value (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) increasing trend in the time series. The terminal year index is credibly above the 25^{th} percentile of the time series and the fitted index value in 1998 (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

USFWS

Descriptive statistics for this survey ARIMA are provided in Table 11. No additional years of data are available since ASMFC (2017), and so the results are identical to those reported there. In short, the fitted index started at the time series high value, decreased through 2006 before generally increasing over the remainder of the time series (Figure 13-Figure 15). The Mann-Kendall test did not detect a significant (α = 0.05) trend in the time series. The terminal year index is credibly above the 25^{th} percentile of the timeseries but not the fitted index value in 1998 (Table 12). The retrospective analysis suggests that conclusions regarding comparisons between terminal year and 1998 are sensitive to the start year of the survey, but not against the 25th percentile of the time series (Figure 17-Figure 18).

South Atlantic DPS

SC Edisto

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index started at the time series high value, decreased through 2008 before increasing through 2020; the index has since declined slightly (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) increasing trend in the time series. The terminal year index is credibly above the 25^{th} percentile of the time series but not the fitted index value from the start of the survey (Table 12). The retrospective analysis suggests that conclusions regarding comparisons between terminal year and start year are sensitive to the start year of the survey, but not against the 25th percentile of the time series (Figure 17-Figure 18).

NYB-CB-C DPSs

NEAMAP

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index oscillated over the first decade of the time series and has been increasing since, ending at a time series high value (Figure 13-Figure 15). The Mann-Kendall test did not detect a significant (α = 0.05) trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value from the start of the survey (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of the survey (Figure 17-Figure 18).

Coastwide (All DPSs)

Conn Index

Descriptive statistics for this survey ARIMA are provided in Table 11. The fitted index declined over the first several years before increasing through 2005; the index declined slightly for several years afterwards, before increasing to a time series high in 2021, and declined slightly in 2022 (Figure 13-Figure 15). The Mann-Kendall test detected a significant (α = 0.05) increasing trend in the time series. The terminal year index is credibly above the 25th percentile of the time series and the fitted index value from the start of the survey (Table 12). The retrospective analysis suggests that these conclusions are not sensitive to the start year of this index (Figure 17-Figure 18).

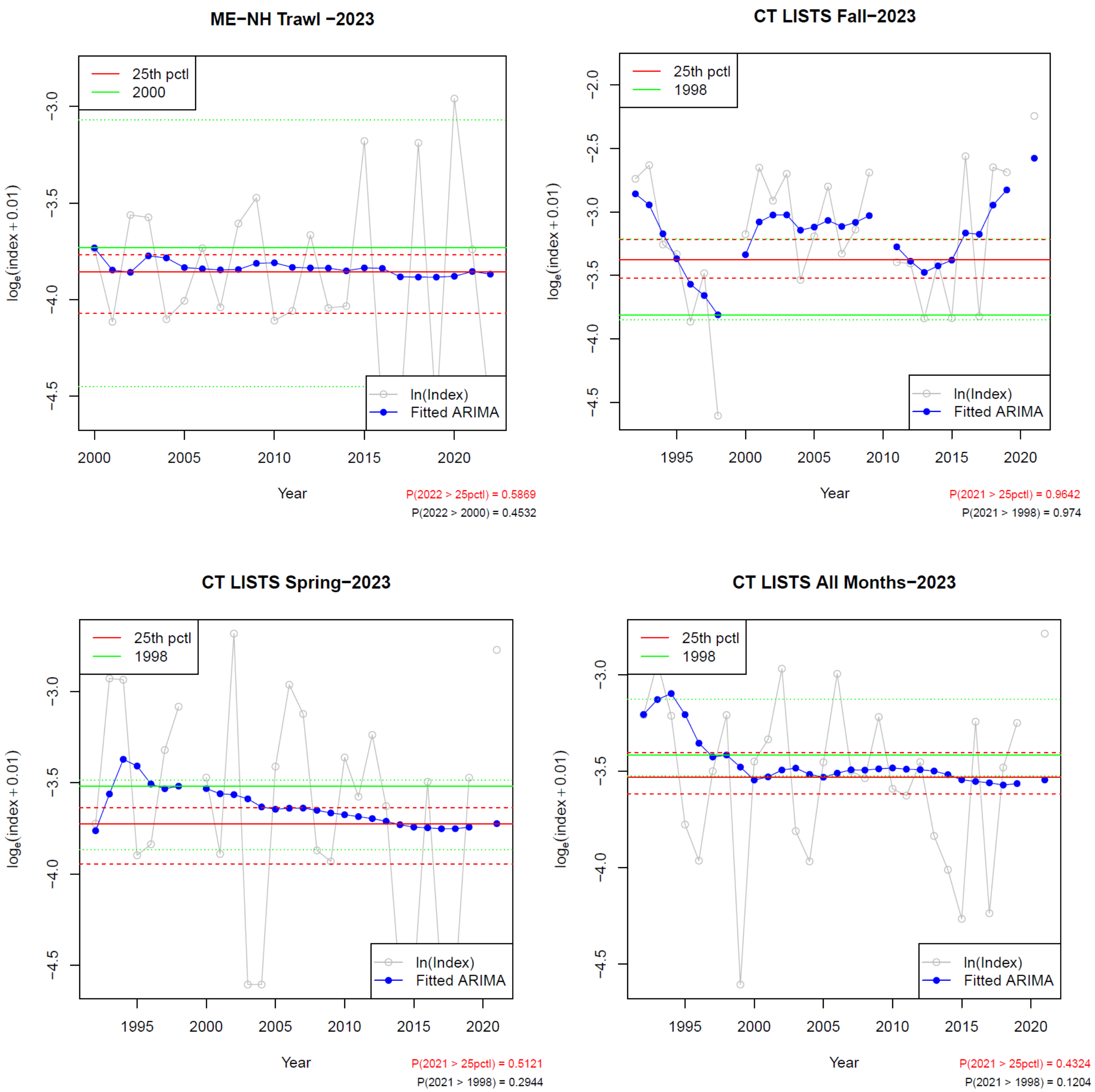


Figure A1. ARIMA-fitted indices used to establish stock status (solid blue line) plotted with the reference values. The dashed red and green lines represent the 80% confidence intervals around the reference values. The grey line with circles is the raw index input to ARIMA. Probability of exceeding reference points is provided in bottom-right margin of plots. Figures continue on the following pages.

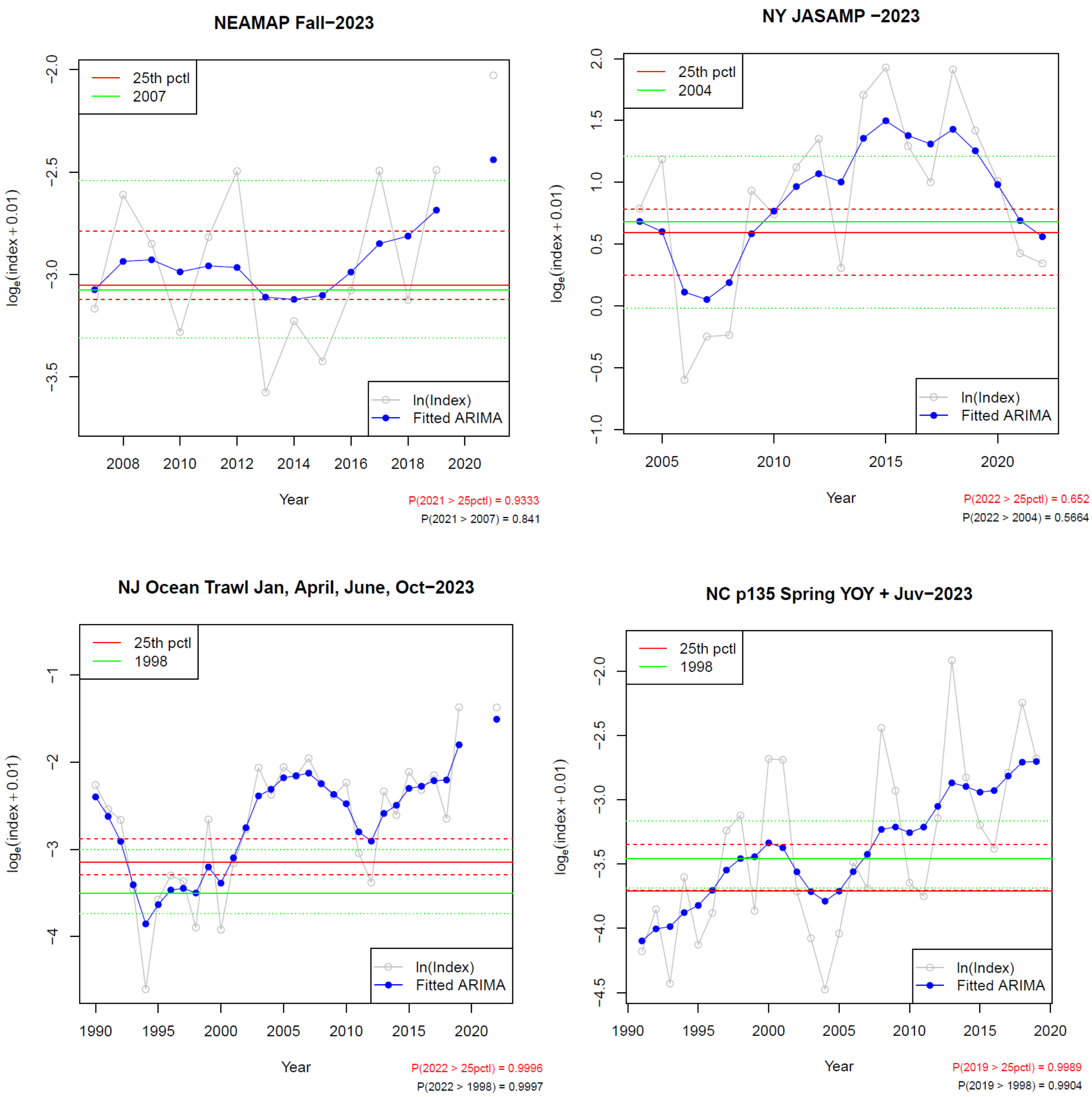


Figure A18 Continued.

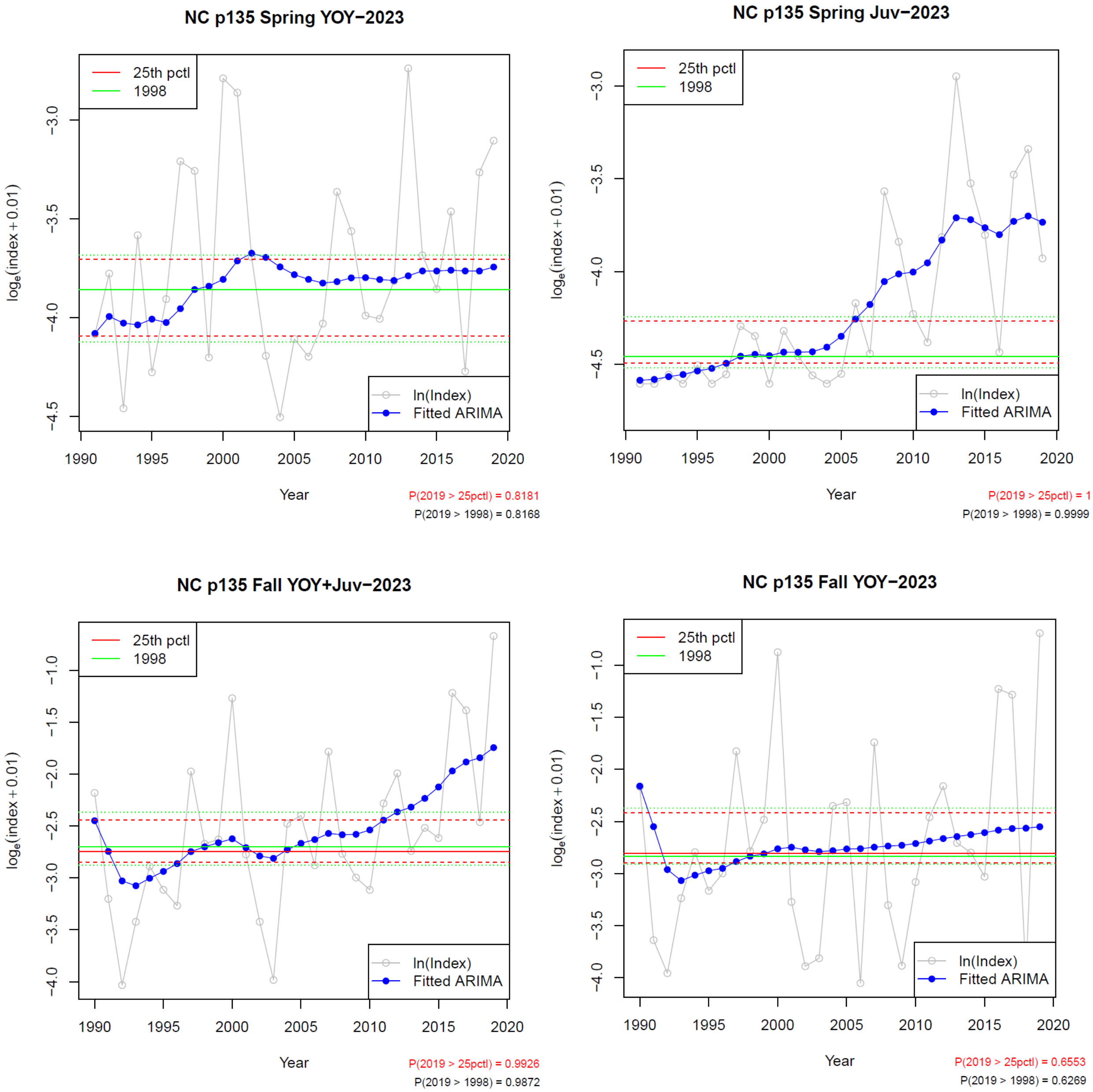
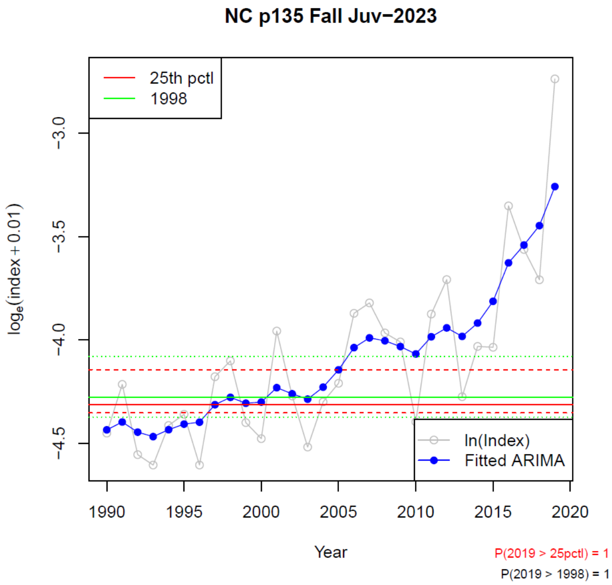
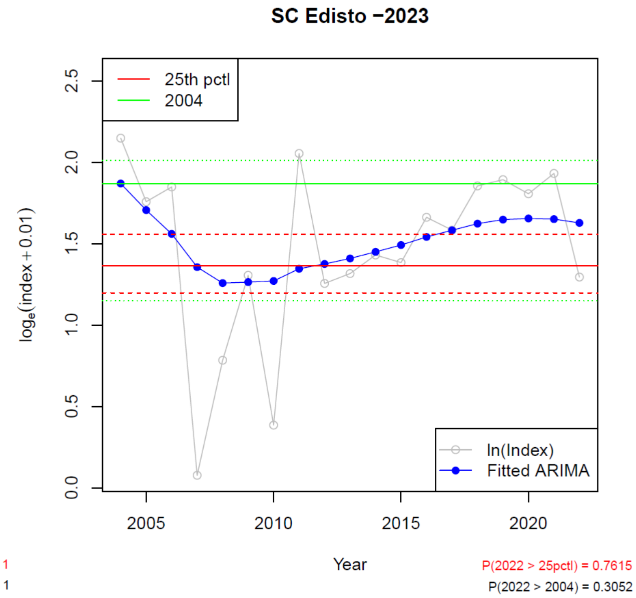


Figure A18 Continued.


NC p135 Fall Juv−2023
25th pctl
1998
ln(Index)
Fitted ARIMA
loge(index + 0.01)
Year
P(2019 > 25pctl) = 1
P(2019 > 1998) = 1


SC Edisto −2023
25th pctl
2004
ln(Index)
Fitted ARIMA
loge(index + 0.01)
Year
P(2022 > 25pctl) = 0.7615
P(2022 > 2004) = 0.3052

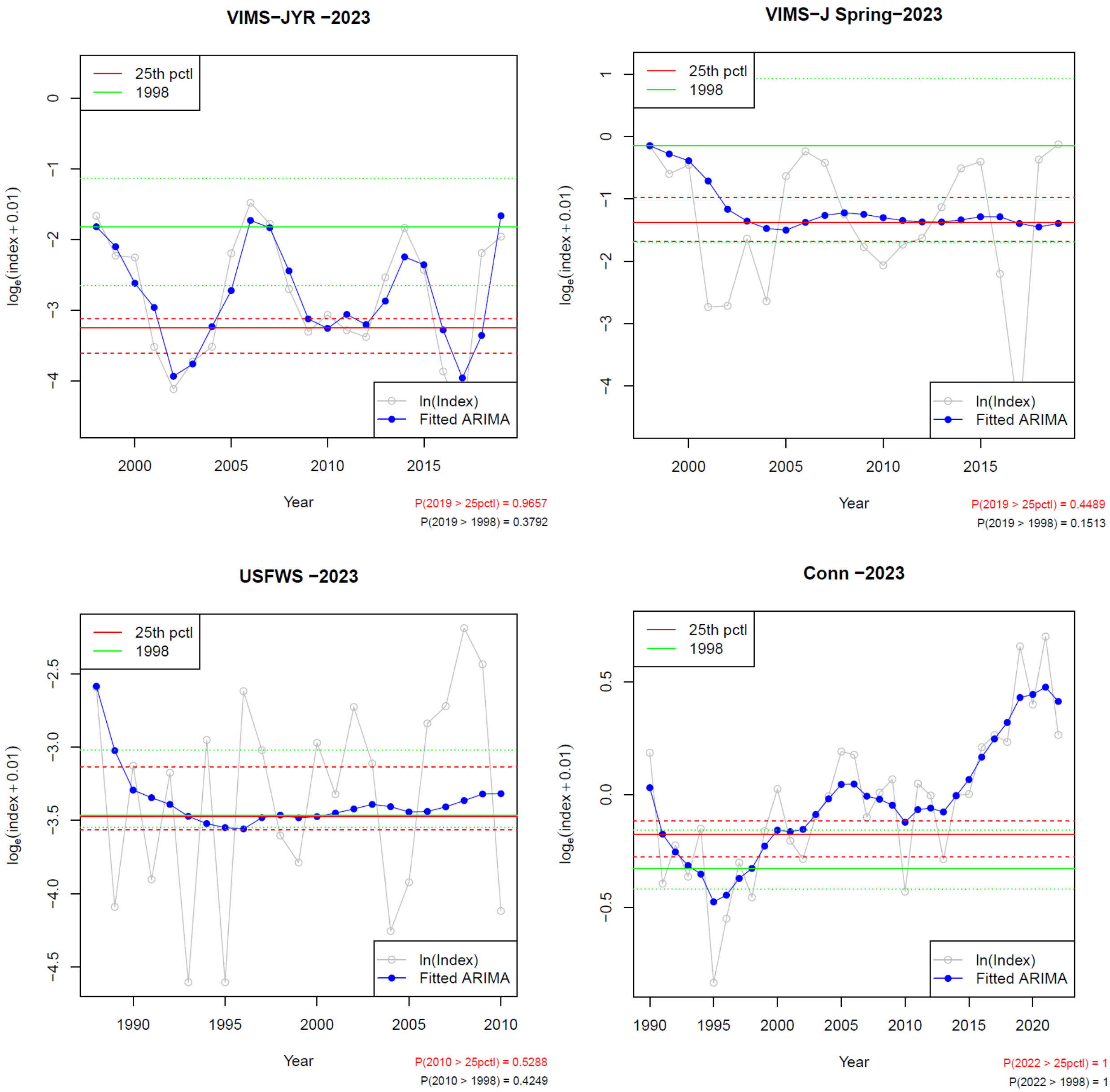


Figure A18 Continued.

d. 2017 Benchmark Research Recommendations

The following is the complete list of research recommendations from the benchmark assessment (ASMFC 2017).

Research recommendations have been categorized as future research, data collection, and assessment methodology and ranked as high or moderate priority. Recommendations with asterisks (**) indicate improvements that should be made before initiating another benchmark stock assessment.

Future Research

High Priority

Identify spawning units along the Atlantic coast at the river or tributary and coast-wide level.

**Expand and improve the genetic stock definitions of Atlantic sturgeon, including developing an updated genetic baseline sample collection at the coast-wide, DPS, and river-specific level for Atlantic sturgeon, with the consideration of spawning season-specific data collection.

Determine habitat use by life history stage including adult staging, spawning, and early juvenile residency.

Expand the understanding of migratory ingress of spawning adults and egress of adults and juveniles along the coast.

Identify Atlantic sturgeon spawning habit through the collection of eggs or larvae.

Investigate the influence of warming water temperatures on Atlantic sturgeon, including the effects on movement, spawning, and survival.

Moderate Priority

Evaluate the effects of predation on Atlantic sturgeon by invasive species (e.g., blue and flathead catfish).

Data Collection

High Priority

**Establish regional (river or DPS-specific) fishery-independent surveys to monitor Atlantic sturgeon abundance or expand existing regional surveys to include annual Atlantic sturgeon monitoring. Estimates of abundance should be for both spawning adults and early juveniles at age. See Table 8 in ASMFC 2017 for a list of surveys considered by the SAS.

**Establish coast-wide fishery-independent surveys to monitor Atlantic sturgeon mixed stock abundance or expand existing surveys to include annual Atlantic sturgeon monitoring. See Table 8 in ASMFC 2017 for a list of surveys considered by the SAS.

**Continue to collect biological data, PIT tag information, and genetic samples from Atlantic sturgeon encountered on surveys that require it (e.g., NEAMAP). Consider including this level of data collection from surveys that do not require it.

**Encourage data sharing of acoustic tagged fish, particularly in underrepresented DPSs, and support programs that provide a data sharing platform such as The Atlantic Cooperative Telemetry Network. Data sharing would be accelerated if it was required or encouraged by funding agencies.

**Maintain and support current networks of acoustic receivers and acoustic tagging programs to improve the estimates of total mortality. Expand these programs in underrepresented DPSs.

**Collect DPS-specific age, growth, fecundity, and maturity information.

**Collect more information on regional vessel strike occurrences, including mortality estimates. Identify hot spots for vessel strikes and develop strategies to minimize impacts on Atlantic sturgeon.

**Monitor bycatch and bycatch mortality at the coast-wide level, including international fisheries where appropriate (i.e., the Canadian weir fishery). Include data on fish size, health condition at capture, and number of fish captured.

Assessment Methodology

High Priority

**Establish recovery goals for Atlantic sturgeon to measure progress of and improvement in the population since the moratorium and ESA listing.

**Expand the acoustic tagging model to obtain abundance estimates and incorporate movement.

Moderate Priority

Evaluate methods of imputation to extend time series with missing values. ARIMA models were applied only to the contiguous years of surveys due to the sensitivity of model results to missing years observed during exploratory analyses.