Atlantic States Marine Fisheries Commission

Atlantic Striped Bass Management Board

October 23, 2024
1:30 – 5:00 p.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 *(M. Ware)*	1:30 p.m.
2. Board Consent • Approval of Agenda • Approval of Proceedings from August 2024	1:30 p.m.
3. Public Comment	1:35 p.m.
4. Review Report from Work Group on Recreational Release Mortality *(C. Batsavage)* **Possible Action** • Technical Committee Report on Release Mortality and No-Targeting Calculations Task *(T. Grabowski)*	1:45 p.m.
5. Consider 2024 Atlantic Striped Bass Stock Assessment Update • Presentation of Stock Assessment Report *(G. Nelson)* • Technical Committee Report on Considerations for 2025 Management Measures *(T. Grabowski)* • Consider Management Response **Action**	2:30 p.m.
6. Other Business/Adjourn	5:00 p.m.

The meeting will be held at The Westin Annapolis (100 Westgate Circle, Annapolis, MD; 888.627.8994) and via webinar; click here for details.

MEETING OVERVIEW

Atlantic Striped Bass Management Board
October 23, 2024
1:30 – 5:00 p.m.

Chair: Megan Ware (ME) Assumed Chairmanship: 1/24	Technical Committee Chair: Tyler Grabowski (PA)	Law Enforcement Committee Rep: Sgt. Jeff Mercer (RI)
Vice Chair: Chris Batsavage (NC)	Advisory Panel Chair: Vacant	Previous Board Meeting: August 6, 2024
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, NMFS, USFWS (16 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 2024

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. Report from Work Group on Recreational Release Mortality (1:45-2:30 p.m.) Possible Action
Background • In May 2024, the Board established a Board Work Group (WG) to discuss recreational release mortality and approved four WG tasks addressing no-targeting closures, gear restrictions, stock assessment work, and public scoping. • The WG presented initial recommendations to the Board in August 2024 on the stock assessment and public scoping tasks. • The WG met four times in September 2024 to discuss no-targeting closures and gear restrictions, as well as continued discussion on public scoping **(Briefing Materials)**. • The WG developed a report to the Board summarizing all WG conclusions and recommendations on all WG tasks **(Briefing Materials)**. • Per the WG's August recommendation, the Board tasked the Technical Committee (TC) with calculations on reducing release mortality and quantifying the reduction associated with no-targeting closures. The TC met in September and October 2024 to address those tasks **(Supplemental Materials)**.
Presentations • Overview of Work Group conclusions and recommendations by C. Batsavage

• Technical Committee Report on requested release mortality calculations and quantifying no-targeting closures by T. Grabowski
Possible Board action for consideration at this meeting • Consider Work Group recommendations

5. 2024 Stock Assessment Update (2:30-5:00 p.m.) Action
Background • The 2024 stock assessment update was completed in October 2024 **(Briefing Materials)**. • The Technical Committee and Stock Assessment Subcommittee met in September and October 2024 to discuss different projection scenarios and considerations for management response **(Supplemental)**.
Presentations • Assessment overview by G. Nelson • Technical Committee and Stock Assessment Subcommittee Report on Considering Projections and Management Response by T. Grabowski
Board action for consideration at this meeting • If necessary, consider management response to the 2024 stock assessment update

6. Other Business/Adjourn (5:00 p.m.)

Atlantic Striped Bass

Activity level: High

Committee Overlap Score: Medium (TC/SAS/TSC overlaps with BERP, Atlantic menhaden, American eel, horseshoe crab, shad/river herring)

Committee Task List

- TC – June 15: Annual compliance reports due
- TC-SAS – Conduct 2024 stock assessment update
- TC-SAS calculate potential management options if the assessment indicates a reduction is needed to achieve stock rebuilding by 2029
- TC-SAS review size-bag-season analysis methods

TC Members: Tyler Grabowski (PA, Chair), Michael Brown (ME), Gary Nelson (MA), Nicole Lengyel Costa (RI), Kurt Gottschall (CT), Caitlin Craig (NY), Brendan Harrison (NJ), Margaret Conroy (DE), Alexei Sharov (MD), Luke Lyon (DC), Ingrid Braun (PRFC), Brooke Lowman (VA), Charlton Godwin (NC), Jeremy McCargo (NC), Peter Schuhmann (UNCW), Tony Wood (NMFS), John Ellis (USFWS), Katie Drew (ASMFC)

SAS Members: Michael Celestino (NJ, Chair), Gary Nelson (MA), Alexei Sharov (MD), Brooke Lowman (VMRC), John Sweka (USFWS), Margaret Conroy (DE), Katie Drew (ASMFC)

Tagging Subcommittee (TSC) Members: Angela Giuliano (MD), Beth Versak (MD), Brendan Harrison (NJ), Chris Bonzek (VIMS), Gary Nelson (MA), Ian Park (DE), Jessica Best (NY), Victoria Lecce (USFWS), Julien Martin (USGS), Katie Drew (ASMFC)

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

ATLANTIC STRIPED BASS MANAGEMENT BOARD

The Westin Crystal City
Arlington, Virginia
Hybrid Meeting

August 6, 2024

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

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INDEX OF MOTIONS

1. **Approval of agenda** by consent (Page 1).

2. **Approval of Proceedings of May 1, 2024** by consent (Page 1).

3. **Move to approve the Atlantic Striped Bass FMP Review for the 2023 Fishing Year and State Compliance Reports** (Page 5). Motion by Mike Luisi; second by Emerson Hasbrouck. Motion passes by consent (Page 5).

4. **Move to approve Tom Fote representing New Jersey and Will Poston representing the District of Columbia to the Striped Bass Advisory Panel** (Page 19). Motion by Dennis Abbott; second by Joe Cimino. Motion passes (Page 19).

5. **Move to adjourn** by consent (Page 20).

ATTENDANCE

Board Members

Megan Ware, ME, proxy for P. Keliher (AA)
Steve Train, ME (GA)
Rep. Allison Hepler, ME (LA)
Cheri Patterson, NH (AA)
Doug Grout, NH (GA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Nichola Meserve, MA, proxy for D. McKiernan (AA)
Raymond Kane, MA (GA)
Rep. Sarah Peake, MA (LA)
Jason McNamee, RI (AA)
David Borden, RI (GA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Justin Davis, CT (AA)
Bill Hyatt, CT (GA)
Craig Miner, CT proxy for Rep. Gresko, CT (LA)
Marty Gary, NY (AA)
Emerson Hasbrouck, NY (GA)
Jim Gilmore, NY, proxy for Assbly. Thiele (LA)
Joe Cimino, NY (AA)
Jeff Kaelin, NJ (GA)
Adam Nowalsky, proxy for Sen. Gopal (LA)
John Clark, DE (AA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Michael Luisi, MD, proxy for L. Fegley (AA)
Robert Brown, MD, proxy for R. Dize (GA)
David Sikorski, MD, proxy for Del. Stein (LA)
Pat Geer, VA, proxy for J. Green (AA)
Chris Batsavage, NC, proxy for K. Rawls (AA)
Jerry Mannen, NC (GA)
Chad Thomas, NC, proxy for Rep. Wray (LA)
Ronald Owen, PRFC
Daniel Ryan, DC, proxy for R. Cloyd
Rick Jacobson, US FWS
Max Appelman, NOAA

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

Ex-Officio Members

Tyler Grabowski, Technical Committee Chair
Mike Celestino, Stk. Assmnt. Subcommittee Chair
Sgt. Jeff Mercer, Law Enforcement Committee Rep.

Staff

Bob Beal
Toni Kerns
Tina Berger
Madeline Musante
Caitlin Starks
Jeff Kipp
Tracy Bauer
James Boyle
Emilie Franke
Katie Drew
Kristen Anstead
Jainita Patel
Chelsea Tuohy

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

The Atlantic Striped Bass Management Board of the Atlantic States Marine Fisheries Commission convened in the Jefferson Ballroom of the Westin Crystal City Hotel, Arlington, Virginia, via hybrid meeting, in-person and webinar; Tuesday, August 6, 2024, and was called to order at 1:00 p.m. by Chair Megan Ware.

CALL TO ORDER

CHAIR MEGAN WARE: Good afternoon, everyone. We're going to call together the Striped Bass Board.

APPROVAL OF AGENDA

CHAIR WARE: We'll start with Approval of the Agenda. Are there any additions or modifications to the agenda? Seeing none; your agenda is approved by consent.

APPROVAL OF PROCEEDINGS

CHAIR WARE: We'll move on to Approval of the proceedings from May, 2024. Are there any edits to the proceedings? Seeing none; the proceedings are approved by consent.

PUBLIC COMMENT

CHAIR WARE: We'll now move into Public Comment. This is for items that are not on the agenda. We'll look for raised hands both in the room and on the webinar. We do have some folks interested in public comment, Des Kahn, I see your hand raised.

MR. DESMOND KAHN: I guess I've been called on then, is that correct?

CHAIR WARE: Yes, Des, we're ready to hear your comment. We have a three-minute timer for you.

MR. KAHN: Great, thank you. Well, I appreciate the chance to comment. I am speaking today about an issue that I don't believe the Board is fully aware of, but it has a major impact on coastwide abundance, and that is the Salem Nuclear Reactor on the Delaware River. This is an old-style reactor with once through cooling, and it pulls in over three billion gallons of water a day from the Delaware River estuary.

It is one of the largest, if not the largest industrial water intake in the world, and it kills millions to billions of fish every year, including in many years they provide estimates of the numbers killed by life stage. In the case of striped bass, I remember their estimate for 2002 sticks in my mind, was 400 million larvae and early juvenile.

I have been working on this ever since 1999, when I worked for the state of Delaware. I was also a member of the Striped Bass Technical Committee for years, and was even Chair for a while. But this issue has not come up. I have estimated using equivalent recruit analysis, which is a standard method for gauging the impact of entrainment and impingement, that this plant kills about on average among years on average a third of all the Delaware River striped bass that are produced. Now, this is highly variable. Some years the estimates show the plant killed over 80 percent of all striped bass produced in the river, and we partly gauge this using the data from the New Jersey Marine Fisheries Delaware River haul seine survey for striped bass that they do every year. That is part of the analysis, and it allows us to estimate the total mortality rate.

I think when you look at the last estimate of the Delaware River stock it was estimated to contribute 15 to 20 percent to the coastwide stock, and at least a third of it is being killed by Salem. That means the stock is being reduced by 10 percent due to Salem. There are efforts underway to try to change this, and I would suggest that the Commission might want to look into this and possibly support those efforts. Thank you.

CHAIR WARE: Thank you, Des, for your comment. Much appreciated. I think those were all the hands we had raised for public comment today.

CONSIDER APPROVAL OF FISHERY MANAGEMENT PLAN REVIEW AND STATE COMPLIANCE FOR THE 2023 FISHING YEAR

CHAIR WARE: We'll move on to Agenda Item 4, which is Approval of our Fishery Management Plan Review and State Compliance Reports for 2023. I will pass it over to Emilie.

MS. EMILIE FRANKE: Great, thank you, Chair. I will go over the components of the FMP Review, hitting some highlights, as well as the Plan Review Team comments and recommendations. Then the Board action for consideration today is to consider approving the 2024 FMP Review and State Compliance Reports.

Starting with the status of the stock. We are still operating under the 2022 Striped Bass Stock Assessment Update, which found the stock is overfished but not experiencing overfishing. As a reminder, this stock assessment incorporated data through 2021, and as we all know the next stock assessment, the 2024 Stock Assessment Update is currently in progress.

We will be getting those stock assessment results in just a few months. Moving on to status of the FMP. Last year, 2023, Amendment 7 was in place until the 2023 Emergency Action was implemented to reduce harvest of the 2015-year class. That action was approved on May 2nd of last year, and all states had to implement that action by July 2nd.

State implementation dates ranged from mid-May all the way until that July 2nd deadline. Then for this year in 2024 that Emergency Action was replaced by Addendum II, which was required to be implemented by May 1st. Here is the figure of total striped bass removals by sector in number of fish. You can see at the bottom commercial harvest and discards relatively stable, the quota managed fishery.

Then in the green is recreational harvest, and the purple is recreational release mortality. At the end of the time series, you can see that spike in 2022, and then a decrease we saw last year in recreational removals. In 2023, total striped bass removals across both sectors were 5.6 million fish. This is about an 18 percent decrease from 2022 removals.

You can see on the screen here the proportion of removals by source of mortality. As in recent years, the commercial sector accounts for about 11 percent of the total mortality, and then the recreational sector accounts for about 89 percent of those fishery removals. As far as the commercial fishery, last year in 2023 harvest was estimated at about 4.2 million pounds. This is very similar to harvest in the previous year, 2022, only a 2 percent decrease by weight. Then as far as commercial quota utilization, in 2023 the ocean utilized about 74 percent of the quota. Again, that underutilization of the ocean quota is due to the lack of availability of striped bass in North Carolina waters, as well as the four states that do not allow commercial fishing.

But all of the states that do allow commercial fishing, the ocean region used almost all of their quotas, between 94 to 98 percent of their quotas. The Chesapeake Bay used about 84 percent of their quota in 2023. Overall, neither the state quotas in the ocean nor the Chesapeake Bay quota was exceeded.

For the recreational fishery last year, harvest was estimated at 2.6 million fish. This is a 24 percent decrease from recreational harvest in 2022. About 26 million fish were released alive with our 9 percent release mortality rate. We assume that 2.3 million of those fish are assumed to have died, and that is about a 12 percent decrease in live releases from 2022.

When you look at these trends by region and by mode, you can sort of pick out a few things the PRT wanted to highlight. In 2023 we saw a larger decrease in harvest and directed trips in the ocean, as compared to the Chesapeake Bay. The PRT noted, you know this is likely, partly due at least to the Emergency Action, which had more of an impact in the ocean than the Bay, with that 31-inch maximum size limit.

When you are looking at private and shore harvest, those modes decreased pretty similarly both tin the ocean and the Chesapeake Bay. When you look at the for-hire modes there was a larger for-hire decrease in the ocean region, and actually a slight increase in for-hire harvest in the Chesapeake Bay.

In this year's FMP Review, the PRT included a breakdown of recreational harvest by Wave. The PRT anticipated there might be some questions or interest in considering the potential impact of the Emergency Action in 2023. The PRT, you know obviously caveat that not only is the harvest and catch impacted by the Emergency Action, but also by changes in fish availability, effort, et cetera.

But nonetheless, here are the Wave data. You can see for Wave 4 and Wave 5, in particular in the ocean, we saw pretty significant decreases in harvest in 2023, relative to 2022. For the Chesapeake Bay we saw a pretty big decrease in Wave 5. Again, the PRT notes that there are several factors that contribute to the level of harvest in both sectors.

Again, we have year class availability, those 2015s pretty available to the fishery in 2022 and '23. Then of course that Emergency Action in '23 to reduce harvest in angler behavior, overall stock abundance, whether the fish are available nearshore. You know all these factors contribute to the changes in harvest.

Another point from the FMP Review is the recruitment trigger. The Amendment 7 recruitment trigger is if any of the 4 juvenile abundance indices used in the assessment fall below 75 percent of the values from our high recruitment period for 3 years, then we have to use the low recruitment assumption when we're calculating our reference points. The recruitment trigger has been tripped; I think the past 2 years. It has been tripped again. We reviewed the '21, '22 and 2023 JAI values, and we had 3 states that tripped the trigger. What that means is the 2024 stock assessment update will continue to use that low recruitment assumption. Again, we did use the low recruitment assumption in the 2022 assessment, so it will continue to be used in the 2024 assessment.

Here on the screen, I know it's pretty small, but are the 4 JAIs used in the stock assessment. In the top left corner, you have the New York Hudson River. The top right is the New Jersey Delaware River, you can see circled in red is what trips the trigger. Bottom left is the Maryland JAI. You can see 5 years of recruitment below the trigger level, and then the Virginia JAI on the bottom right also tripping the trigger this year.

As far as the PRTs comments, the PRT found that in 2023 all states implemented management consistent with the provisions of the FMP and with the Emergency Action, and there are no de minimis requests. The PRT had previously noted in last year's FMP review some difference in regulatory language for the Amendment 7 gear restrictions that were required to be implemented in 2023.

That is the prohibition on gaffing, and the need to release striped bass caught on any unapproved method of take without unnecessary injury. The PRT had noted a couple of differences last year. The Board did not express any concern last year, but I just wanted to point it out again. Then as far as PRT recommendations, the PRT just continues to emphasize the importance of commercial tag accounting, and the PRT recommends that we continue to follow up with states as needed.

Then the PRT also recommends the Board task the PRT with a review of the commercial tagging program, just to review the program components. This isn't necessarily intended to change the program requirements, but instead review how the programs have been operating, identify any issues that states have encountered, how they resolved them.

It would also be important to include the Law Enforcement Committee. Another thing the PRT just wants to make sure the reporting for the tagging programs is streamlined. Right now, there is some duplicative reporting in the tagging reports and the compliance reports. Then one additional comment.

The PRT continues to leave this in the FMP Review just to highlight it, that the New York spawning stock monitoring in the Hudson does not provide an index of abundance. This was identified as a high priority recommendation in the last benchmark, but I think it could be considered potentially in the next benchmark. That's it, I'm happy to take any questions.

CHAIR WARE: Thank you very much, Emilie. Just a programming note. I was told that Captain Newberry, you had raised your hand as we were transitioning to the FMP Review for public comment. If we have time at the end of our agenda today, I will look to you for your public comment. But for now, we're going to continue on with our agenda. We will see, are there any questions for Emilie on the FMP Review? Emerson Hasbrouck.

MR. EMERSON C. HASBROUCK: Maybe I missed it in the presentation, but what was it that triggered the PRT to ask the Board to task them with review of commercial tagging program? Were there some issues with that? Then I have follow-up.

MS. FRANKE: Thanks, Emerson, there weren't any specific issues, just that the PRT realized in the past few years that it's been over a decade since the commercial tagging program was implemented, and you know states have had various issues come up that they've been able to resolve with that sort of reviewing how the program has been going, and also sort of giving states the chance to collaborate could be beneficial.

MR. HASBROUCK: Then are you looking for two separate motions from the Board, one to task the PRT and another to approve the review? Madam Chair, how do you want to proceed? I'm ready to make either or both motions.

CHAIR WARE: Thanks, Emerson, we don't need a motion for the tasking, so if that is the will of the Board, we can indicate that that is a task for the PRT and the Law Enforcement, or some members of the Law Enforcement Committee. I would just note, we have a really busy October ahead of us.,

I wanted expectations of timing, because there are some things we will try to address ahead of the annual meeting. If anyone has concerns about tasking the PRT with the tagging program, I think now would be an opportunity to speak up. But Nichola, I had seen your hand. You can comment on something else.

MS. NICHOLA MESERVE: I was just going to lend my support for the PRT to undertake that as time permits, recognizing the staffing and state resources to do that are less of a priority than the assessment and any lead-up management action to it.

CHAIR WARE: Great, thanks, Nichola. Any other questions? Yes, Mike.

MR. MICHAEL LUISI: I was curious, I think the last slide that was presented referenced the fact that New York, or the work they do in New York is not a relative abundance index. What would be required? I mean what would have to happen for them, for the state of New York to have an index that would be identified as an abundance index or relative abundance index?

DR. KATIE DREW: I think the issue with the New York work is that it is a tagging program, so it is focused on tagging those spawning fish, and as a result there is not really a systematic design, so it is basically, you go out and you try to find the fish to tag them, and so you can't really use it as index of abundance.

I think there is potentially some statistical work that the TC could maybe look into, to see if we could standardize it a little from that side, but I think the flip side would also then be working with New York to actually transition that, if they were so inclined, to a formal statistical design survey, and not through the more opportunistic tagging approach that it is right now.

CHAIR WARE: Marty, would you like to comment on that?

MR. MARTIN GARY: Yes, thanks, Madam Chair. I think to that point, where Katie mentioned New York's intent is to work with academic partners, to use that data from our tagging for the spawning stock to develop that index of relative abundance, you know for the spawning stock in the Hudson River. That is our intent, and we would hope to have that ready for the 2027 Benchmark.

CHAIR WARE: Not seeing any other hands, we would be looking for a motion to approve the FMP Review and State Compliance Reports. Mike Luisi, do you want to read that motion in, please?

MR. LUISI: Sure, **move to approve the Atlantic Striped Bass FMP Review for the 2023 Fishing Year and State Compliance Reports**.

CHAIR WARE: Great, motion by Mike Luisi, we have a second from Emerson Hasbrouck online**. Is there any objection to this motion? Seeing none; the motion is approved by unanimous consent**.

CONSIDER INITIAL RECOMMENDATIONS FROM WORK GROUP ON RECREATIONAL RELEASE MORTALITY

CHAIR WARE: We'll move on to Agenda Item Number 5, which is Considering Initial Recommendations from our Work Group on the Recreational Release Mortality.

I want to just give a shout out to Chris Batsavage, Nichola Meserve, Marty Gary, Adam Nowalsky, Mike Luisi, Dave Sikorsky and Max Appelman. It's been a really great Work Group so far. I appreciate the time you guys have taken to work through a pretty difficult topic. We're going to look to Chris Batsavage, who has been chairing that Work Group for an update.

MR. CHRIS BATSAVAGE: Yes, let's go ahead right into the presentation. Just a quick background. This Work Group was formed by the Board at their last meeting to discuss recreational release mortality issues, and there are four tasks that the Work Group was given to look at. Just quickly go through them again is to review the existing non-targeting closures, including effort and enforceability, review the Massachusetts DMF study and other hook and line studies, to evaluate gear restrictions.

Identify stock assessment work to inform our discussion on recreational release mortality, and to consider public scoping on measures to address release mortality. As Megan mentioned, here is the roster of Work Group members, so I just won't repeat them again. Just a kind of timeline of where we are now versus a couple months ago and where we're going.

I already mentioned that this all started back in May. The Work Group held meetings in June and July, to primarily discuss the stock assessment and public scoping task that is Number 3 and 4. Of course today, we're providing our initial recommendations to the Board on the stock assessment and public scoping tasks, and also for full consideration of the Work Group's recommendations.

Looking ahead for late summer into October, we'll have a couple more Work Group meetings to discuss the non-targeting closures and gear restrictions, and revisit Task 3 and 4 as needed, and then we'll wrap things up with a final report that will be presented to the Board at their meeting in October. I'll cover the discussions the Work Group had on the stock assessment work, so Task 3. This task was to identify stock assessment sensitivity runs on how low release mortality must get to see a reduction in total removals. This task considered the tradeoff between reducing the recreational mortality rate and reducing overall number of recreational releases. The Work Group reviewed the past Technical Committee work that explored how different release mortality rates throughout the time series would impact the stock assessment results.

This task is to understand how reducing recreational release mortality in the future will impact the stock. After that discussion the Work Group recommends the following items for the TC to analyze. The first one is, if a reduction is needed to keep rebuilding, determine how low the release mortality rate would need to be, to achieve that entire reduction through the release mortality rate alone.

If the number of live releases ins constant, what would the release mortality rate need to be to achieve reduction? The second task is, if a reduction is needed to achieve rebuilding, determine the percent reduction of live releases needed to achieve the entire reduction through live releases alone. Using the current 9 percent release mortality rate, how many fewer live releases would there need to be to achieve the reduction?

These tasks are looking at the extreme cases for reducing recreational release mortality, with the first one looking at the release mortality rate, and the second one looking at the number of released fish. Both of these assume constant recreational harvest, but each of these has different iterations for the commercial fishery.

One has the constant commercial harvest, and the other is for an equal reduction of commercial harvest. The third item we're asking the TC to look at is, if a reduction is needed to achieve rebuilding, determine the percent reduction and number of live releases needed under the current 9 percent mortality rate, assuming there is an associated reduction in recreational harvest due to no-targeting closures.

This assumes a no-targeting closure will release harvest and live releases. The TC will need to determine how best to quantify release reductions during no-targeting closures. The Work Group recommends TC input on the timing of the no-targeting closures, and like the other tasks this one will also have two iterations for the commercial fishery, one with a constant harvest, another with an equal reduction in commercial harvest.

The fourth item that we're asking for the TC to look at is to identify the tradeoffs of implementing no-targeting closures at different times of the year, with different assumed release mortality rates to help inform when and where implementing no-targeting closures would result in highest reduction.

Factors could include water temperature and salinity, which with the assumption that the release mortality rate is higher when the water temperature is high, and the salinity is low. The Work Group understands that reductions from no-targeting closures depend on where and when they occur, so TC guidance would be very helpful for this task.

Just to sum things up for Task 3, the Work Group recommends tasking the TC as described, to address these things during the ongoing 2024 stock assessment. Next, I will cover the Work Group's discussions on public scoping. Just a reminder, this task is for if the Board considers taking action by a Board vote instead of an addendum, if the upcoming stock assessment indicates additional reductions are needed for stock rebuilding. The Work Group supports an online survey approach to get public input on the different issues regarding recreational release mortality, but we're concerned that conducting the survey prior to October isn't going to give us enough time to have a well-developed survey to roll out to the public.

This is a very important opportunity to inform management beyond just the next stock assessment, so we want to take a little more time on this, and with that the additional time for the survey development would be beneficial for us, and also the fact that as was mentioned a few times, none of the Work Group members are trained in survey design.

We at least want to be careful in how we craft these questions. With that, if we could, we would like to consult with the Commission's Committee on Economic and Social Sciences, their membership, maybe look at potential external survey experts, and also look for industry input on the Striped Bass Advisory Panel.

Based on these concerns and any considerations, the Work Group recommends the Board extend the timeline for the public survey on release mortality. The survey could be conducted soon after the annual meeting, which could inform Board action later in 2024. Before you do this, it would require a special meeting for the Board, or a survey can be conducted in 2025.

The Board could still take action without the survey results if the upcoming stock assessment indicates a reduction is needed. I won't do a full stop on what we were thinking about possibly doing after we get the assessment. The Work Group thinks it is important for input from survey experts and the Advisory Panel before releasing the survey out to the public.

The Work Group also identified need for an outreach strategy for disseminating the survey, to make sure we canvas and get as much input from the public as possible. That summarizes the last two Work Group meetings. Again, I want to thank special thanks to Emilie and the Work Group. I think it's been very productive meetings we've had, and also thanks to the public participating. We provide some opportunity for the public comment, and they had some very helpful comments to kind of guide us along the way.

CHAIR WARE: Thank you very much, Chris, and thank you for chairing the Work Group. We're going to start with any questions for the Work Group. We'll talk about their recommendations on the stock assessment sensitivity runs and public scoping next, but we'll just start with questions. Okay, no questions. We'll go to their recommendations. We'll start with the stock assessment sensitivity runs.

We have four sensitivity runs that the Work Group is recommending, so this would be an opportunity if folks have modifications or additions, deletions to that list to let us know. If not, then we will work to task the TC and SAS. Okay, great. We were going to collectively task the TC and SAS with those four sensitivity-runs, and we look forward to seeing that at the October meeting. We'll move on to the public scoping and the development of a survey. We have a Work Group recommendation to take a little more time to develop that survey. I think it would be helpful if folks around the table have thoughts on whether that survey should be ready to go by the October board meeting. If some time in 2025 is okay that might help prioritize the workload of staff and the Work Group members as we move forward. Are there any thoughts on the timing of the survey or if folks are still interested in a survey that would be helpful to hear as well. Yes, Jay.

DR. JASON McNAMEE: I agree with what was in the report, I think. The benefit of having that would have been to get some, like we have some standard things we think about with respect to what we can do to decrease release mortality. But it would have been good to get, I don't know, like larger scope on that, like get some ideas maybe we haven't heard yet.

That is an attribute of the survey, however, I agree to create a survey to actually get like actionable good pieces of information from it takes time and thought. I'm in agreement, you know and working on that a little longer and delaying the survey. Nice job on all this. It was a really thoughtful document. I appreciated it.

CHAIR WARE: I have Jim Gilmore and then Bill Hyatt.

MR. JAMES J. GILMORE: Just in terms of practicality, and I agree 100 percent on the survey. It should be delayed a bit from experience from last year, when we ran a survey and the original parameters for it were delayed, and we ran the survey very late, very short period of time. It was reported in the newspaper that 56 percent are opposed to this change, whatever, but then the reality was they didn't report we only reached 2 percent of the fishing community. It was a useless survey, but the danger of misusing numbers like that becomes an important issue. Do it right, so delay it a little bit and I think it will be more useful.

CHAIR WARE: Bill Hyatt.

MR. WILLIAM HYATT: Yes, I also support the additional time, particularly for getting some expert consultation on the construction of the survey. The idea that it's going to be online adds additional bias. They might think any type of consultation you get on the wording and the format, to make sure an online survey is as accurate as possible is for long term benefit.

CHAIR WARE: Great, so what I am hearing so far for feedback is continued interest in the survey, wanting to make sure we're developing it correctly. I would say encouraging the Work Group to consult with the staff as they can, and continuing on, and we'll see where we get by October. I'll look to Work Group members and make sure folks feel like that is enough feedback for you guys. Yes, okay, great.

MR. ERIC REID: Sorry, Madam Chair, I'm late to the game. I did hear a comment about socioeconomics. One reason to delay is to make sure we get good socioeconomic response, based on how the survey is conducted. I guess I want to make sure socioeconomics are included in the survey. I think that's an easier way to say it.

MS. FRANKE: Just from a sort of staff perspective, could you expand on that a little bit? I mean I think in terms of the survey distribution, you know if the Board is looking to reach as many people as possible, of course the Commission will push the survey through our channels, but I think we would look to the Board members to make sure that the stakeholders in their states are receiving the survey. But if you are interested in specific type of questions on the survey related to socioeconomics that would be great.

MR. REID: No, I'm not going to even dare to recommend any specific questions. I just want to make sure we reach out to a wide variety of stakeholders. I think a wider variety versus a lot of surveys in general is more important. How do you pinpoint your target audience, and make sure you get all the different user groups in the response? It is important.

CHAIR WARE: David Borden.

MR. DAVID V. BORDEN: I just wanted to follow up on Eric's point about economics and soliciting a broad group. If we are going to consider gear changes at some point, which we might want to. Some constituents are already advocating that. Then I think it's important to get the direct input from the gear manufacturers, particularly on the issue of lead time to change lures and those types of consideration. Whether that is done as part of the committee or an individual on the committee then goes and talks to them directly. But I think their input is important at this stage.

CHAIR WARE: Any other comments on the survey? Yes, John Clark and then Ray Kane.

MR. JOHN CLARK: I'm just trying to be clear on the timeline of these various tasks going on. In other words, we would be looking at the first and second, which would be kind of estimating how much of a reduction in recreational mortality we would have to see. Then we would be coming up with ideas as how we could reduce it, and then the survey would take a while to develop. When the survey is actually out, is it going to have specific ideas in the survey, or is it going to be the whole kind of long list of possible methods that can be used to reduce recreational mortality?

MS. FRANKE: I can start the answer, and Work Group members feel free to jump in. But I think because the survey is not directly tied to a management document with management options, it will be a little bit more general, trying to encompass, you know recreational release mortality as a whole, including a list of potential ways to address it. I think also asking for feedback from the public on ways to address it. It won't be Option A, Option B, Option C, it will be marginal.

CHAIR WARE: Ray Kane.

MR. RAYMOND W. KANE: Madam Chair, this has to do with Emilie's presentation. I don't want to take you off track. If I could get this question now. On tasking the TC under Number 2, it closed out the Working Group recommends 2 iterations for each scenario, one with constant commercial harvest and one with an equal reduction of commercial harvest. What are the thoughts about that? I mean we just, commercial fishermen just took a cut of 7 percent. Can you give me some background why you would be tasking the TC with this once again?

MS. FRANKE: Right, so that detail is just sort of how to parameterize the projections the TC would be running for these four tasks. For these four tasks, like there are four sources of removals; release mortality, recreational harvest, and then commercial harvest and discards. The focus of these tasks and resulting TC projections would be figuring out what that reduction in release mortality would look like.

Then the question is, how do we parameterize the other variables in those projections? We would assume recreational harvest is constant, because we are trying to focus on that recreational release mortality, and then the point about 2 iterations for the commercial fishery, one assuming constant commercial harvest, and the other assuming equal reduction in commercial.

It's just getting to the fact that the Board has had discussions before about how to split reductions, which we'll get to in the next agenda item as well. But I think that just covered all of the bases, so it would provide sort of a range of results, as far as those scenarios. It's not a specific management option, it's just different ways to parameterize those reductions.

CHAIR WARE: Last call on any comments on the survey, otherwise we'll have the Work Group continue working. You've gotten some feedback on things to consider. I've also heard feedback just on a Work Group call that I do think we want to keep this manageable for the public. I just want to set expectations on all the topics that we can cover in a survey and still be effective.

I am hearing we have a member of the public that wants to comment. We're going to keep trucking along here on our agenda, but if we do have time at the end I will go to a member of the public.

PROGRESS UPDATE AND BOARD GUIDANCE ON 2024 STOCK ASSESSMENT UPDATE

CHAIR WARE: Next, we have Agenda Item Number 6, an Update on the 2024 Stock Assessment and Board Guidance. I'll turn it over to Katie Drew.

TIMELINE AND PROGRESS OVERVIEW

DR. DREW: I will be presenting on essentially a quick update on where we are with the assessment, and then turn to you guys for a request for guidance on some of the things that we're working on with this assessment. In terms of the assessment update timeline, all of the data have been submitted, which is great.

We are in the period now doing some initial model runs, with input from the staff as needed. September 4 to 5 we will be having an in-person TC and staff meeting to discuss the final model runs, and discuss potential management measures if a reduction is needed to achieve rebuilding. After that meeting, we will finalize the report and have it ready for the Board during the week of October 21, during annual meeting.

As you perhaps recall, Addendum II specified that if an upcoming stock assessment prior to the rebuilding deadline of 2029 indicates that the stock is not projected to rebuild by 2029, with a probability greater than or equal to 50 percent, the Board can respond via Board action, essentially by changing management measures via a vote to pass a motion, as opposed to an addendum or an amendment.

This is different from the Emergency Action process, but this was specifically written into Addendum II to allow the Board to respond more quickly to a finding that the rebuilding had been delayed and additional action needed to be taken. Essentially, what will happen is that in 2024 the assessment update will be presented at annual meeting in October. At this point we will tell you stock status, so whether we are overfishing and whether or not we are overfished, and then we will also report on the set of projections that we have done to determine what level of harvest and what level of removals is necessary to ensure that we will be rebuilt by 2029.

If the projections indicate there is a less than 50 percent probability of rebuilding by 2029 under the current F rate and the current regulations, the TC would then calculate new management options to present concurrently with the assessment. We would say, here is the percent reduction that we need, in order to rebuild by 2029.

Here are the options that will achieve that, so that the Board can consider this altogether and make a decision in October, as opposed to traditionally we will generally present you with stock status and the percent removals, and then we would be tasked with developing options, and that you would review at the next meeting, and then et cetera.

In this case the TC will come up with some options to present with the assessment if a reduction is necessary. If a reduction is needed, the TC could consider quota reductions for the commercial sector, and changes to the size, bag and season for the recreational sector. However, keep in mind the range of viable recreational options may be limited.

There is not a lot we can do that we have not already done on that front. Keeping that in mind, to ensure that the TC develops viable options for the Board, we are looking for guidance on the following questions. Number one, how should any potential reductions be allocated across sectors? Number two, what types of recreational options should be considered?

In terms of how should potential reduction be allocated across sectors, I think some of the things we're looking for are things like should all sectors take an equal percent reduction, or just one sector takes more or less of a reduction? If you want unequal reduction, how do you want that split out? That kind of guidance you would like right now, because that will allow us to provide more concrete, more viable options for you.

Then, if the recreational sector can't achieve the required reduction exactly, so for example, if we need a X percent reduction but we can only get a Y percent or a Z percent, you're a little above or you're a little below. How should that difference be handled? For example, would you allow the recreational sectors to sort of undershoot that reduction and have the rest of it made up by the commercial sector?

Would you prefer that the recreational sector overshoots their reduction, that is take a higher reduction, and then have the commercial sector take the same flat required reduction, or sort of the commercial sector then gets the leftover reductions and take a lower reduction if the rec side overshoots their percent reduction?

This would be more on how are we allocating the reduction across the sectors, and then Question 2, what types of recreational options should be considered? Are there specific things that you want to see the numbers run for? Some things would be are you more interested in; I think seasons? Obviously, that may be one of our few options left that has some flexibility. Is the Board more interested in a no-targeting or a no harvest type of closure? Then secondarily, is the Board interested in maybe a moving or a non-fixed slot limit or a size limit to protect a 2018-year class for more years? Just the 2018-year class, it was not as strong as the 2015, but it was above average, one of the few above average ones we've had in a while. In 2025, when these measures will take place, they will be in the same position that the 2015s were in 2023, so they will be 8 years old and entering that ocean slot.

If we move the slot up to protect 2025, it's going to move into it in 2026. Is the Board interested in some kind of measure that would change over time to protect the 2018-year class for more years? Generally, when the TC has presented options, the

Board has put a lot of emphasis on management stability, and so we have presented sort of one option that does not change into the future.

If the Board is interested in revisiting that emphasis on management stability, and would be more interested in pursuing maybe something closer to what was done during the original rebuilding plan for striped bass, where that size limit or that slot moved to protect a strong year class. Now would be a good time for the Board to request us to look into that, and we could consider that going forward.

Those are the two specific aspects that we would like guidance on, and additionally for additional recreational options, if there is something specific the Board wants, make sure that we look at, now would be a great time for you to tell us. I would be happy to take any questions, and of course happy to take any guidance from the Board.

CHAIR WARE: I know those are some challenging questions, particularly in the absence of knowing what the assessment says. I also suspect there are some varying opinions around the table as to how to answer those. I think we're going to just open it up and see what Board member's thoughts are. I'm not planning to take any motions, and we'll see how the discussion goes. Robert Brown, did you have your hand up?

PROVIDE GUIDANCE TO THE TECHNICAL COMMITTEE FOR MANAGEMENT OPTIONS TO CONSIDER IF THE ASSESSMENT INDICATES REDUCTION IS NEEDED FOR REBUILDING

MR. ROBERET T. BROWN: Yes. The commercial industry heard talk about possibly another reduction if it was necessary. We just took a 7 percent reduction, and on top of that 7 percent reduction it wasn't given to us in time, and our quotas were already given to us in our tags for the year. Now we may possibly be facing as much as an extra 7 percent if we happen to go over that 7 percent.

I don't think it's justified at this time for the TC to even consider the commercial fishery a reduction of any kind at this time. The last reduction that the recreational had they took a slot limit. A slot limit doesn't work, because number one, it causes more dead discards, and it also, they really didn't take a cut. They can go out every day that the season is open and catch one fish per person per day, and that has to be addressed.

CHAIR WARE: Next I have Chris Batsavage.

MR. BATSAVAGE: I guess to be consistent with what I've said in the past, it's kind of hard to think about reductions in general. I'm more in favor of equal reductions for the commercial and recreational sectors, or at least close to equal, to account for potential recruitment. We know that the recreational catch is overall higher than the commercial, but that is with the percent of commercial recreational in a given area varies by state and by region. I think that's important, and also how we've done reductions for the commercial fishery in the past, it's a reduction in quota not in landings, so it's a little different than what we did while we were hoping to reduce harvest or catch for the recreational fishery. In terms of things to look at, yes, I mean I think harvest season closures is kind of one of the last remaining things we have available to us.

I think that should be explored, understanding that there still could be some catch and release fishing going on, which will result in mortality, but I think we've seen at least in North Carolina, we've seen when we've had closed seasons or closed days for the recreational fishery, that there is less overall effort during those times where that is the case. In the rest of the coast, I don't know.

Then I guess there is a consideration for the TC if there is like an X percent reduction needed. Instead of trying to hit that number on the mark exactly, we know there is a lot of inherent uncertainty in recruitment and things like that. If the TC would, if they think it's prudent to recommend aiming a little higher than that to ensure that we actually get the reduction we hope, because we are running out of time with 2029 rebuilding not too far away from now. If we continue to fall short, we may not get to where we need to be by the stock rebuilding schedule.

CHAIR WARE: Next we have Marty Gary.

MR. GARY: Question for Katie and a possible follow up or comment for her. Katie, could you characterize for us at the Board how the assessment model will be presented to us? I guess I'll put it in this this context. I'm getting personally a lot of questions about if and how the chasm of 6 weak year classes in Chesapeake Bay will be captured in this next upcoming assessment, or if it will be captured in the upcoming assessment.

If those year classes are projected into the model, how far out do you take it? I guess we have a sense that we know, as you just sort of said, we have several year classes, '11, '14, '15, '17, '18 that are probably lifting our biomass toward that target rebuild in 2029, but then we have this dearth of year classes, weak year classes coming in afterwards.

I guess really the question is, does the model, output you are going to present to us in October going to capture part of that, all of it? I guess if it isn't, I'm curious if we have options, the Board has options to ask the TC to see if we could capture some of that to better inform us.

DR. DREW: Sure, so we will have new information on recruitment. We will be able to include the 2022 indices for a 2023 terminal year. We start our model with Age 1, so we're sort of always a year behind on the recruitment. We will be able to use the 2023 value in the projections going forward. That period of weak recruitment will be encompassed, or it will be folded into the projections through, I think right now we are very focused on 2029 as the rebuilding year.

I think we will see that those strong year classes of 2015, 2018, 2014 and '17 to a lesser extent, are supporting that rebuilding, but they will be replaced by even weaker year classes. That will sort of show the trajectory that if those year classes were average, we would probably be rebuilding faster. But then when we get to 2029, that is when they are going to be starting to fully mature. The 2021-year class will be Age 9, 8 or 9 will be fully mature at that point in 2029, and what is coming behind them to continue to support that SSB is going to be those weaker year classes. I think we will be able to rebuild or we will be able to develop calculations to rebuild to 2029, and then a question of what happens after we rebuild is probably one that the Board should start thinking about. I think we are thinking of 2029 as sort of the end goal, and it's an important goal, it's mandated by the FMP.

But biologically what is going to happen after 2029 is there is not going to be a sudden miraculous, even if there were a sudden miraculous flip the switch and recruitment went back to the long-term average or the boom years. It is still going to take years for those strong year classes to propagate through the population.

What happens after rebuilding, after we get to that benchmark is definitely something the Board should maybe start thinking about. If the Board would like to start thinking about it during this assessment, we could extend our projection timeline a few years, so if we hit 2029, great. What's going to happen after that?

Are we going to be able to continue at that level or are we going to decline below the target again as the poor year classes come through and the stronger year classes die off? I think that is not clear, you know what that would look like from a fishing mortality or fishery perspective, but for sure, what we have sort of in the bank is not promising for being able to fish at the levels that we fished at during Amendment 6.

If the Board would like to task the TC with maybe looking out beyond the rebuilding horizon, we could, obviously recognizing that that gets more uncertain as you go forward. But if the Board would like to start thinking about that now, I think we could. If the Board would like to make that a bigger focus of the next benchmark assessment, which we will have to start working on, basically as soon as this assessment update is done, that could also be a directive from the Board.

CHAIR WARE: Follow up, Marty.

MR. GARY: Just very quickly. Thank you, Katie, that helped a lot. I don't know how the Board guidance would be, but I think my concern is in October the public sees that rising spawning stock biomass based on the way you characterized it, but doesn't see the longer-range picture.

I guess my personal feeling is that I know the confidence intervals start getting a little bit less favorable for penny and dam specifics, but I would like to see, I guess another couple of years built into those projections. I'm not sure how the other Board members feel, but I don't know if you need formal guidance on that in front of a motion or something. But I would like to see how other Board members feel about that as well.

CHAIR WARE: Next I have John Clark.

MR. CLARK: I agree with Chris and Marty about looking at all the recreational options. I would just like to add and disagree with Chris. I would like to see, in terms of the sector breakdown to do it proportionally also, to look at reduction where each sector would be taking a reduction based on the proportion of removals, they are responsible for in the stock. As long as we are looking at the rebuilding, I would also once again be curious as to just where the rebuilding would look if the target was closer to the threshold as the reference point. As I've stated before, I just think the target is extremely high, very difficult to reach, and I don't know if that's a possibility, but I know that based on the Amendment we're kind of stuck with these reference points. But I just think they are setting us up for continual crisis here.

DR. DREW: I think we can, obviously we're not changing reference points at this point, but when we do the projections, we always show the probability of being above the threshold, as well as the probability of being above the target. We can continue to show that as well. Then I think as for your proportional reduction question.

Just to be clear, I think it would be something along the lines of what we talked about during one of our last actions, where for example, if you need an 18 percent reduction that the commercial sector makes up 10 percent of the overall catch, the commercial sector would take a 1.8 percent reduction, and the rest of the reduction would come from the recreational. Okay.

CHAIR WARE: Next I have Jason McNamee.

DR. McNAMEE: Thanks, Katie for the presentation, and kind of seeding the thoughts there. I always appreciate that. I have a couple of things for you. Just a confirmation, maybe. I like the idea that you offered about trying to move that slot limit a little bit and seeing the effects. I don't know if there is some way to kind of optimize that kind of find a slot limit that optimizes reductions or rebuilding.

Maybe both of those could be looked at if they are not the same. It's something that we had talked about, you know when we developed a slot limit, this notion that slot limits perform best when they are dynamic, in particular when we're trying to protect very specific year classes. By its nature then you'll have to move to do that as the fish grow.

That was one idea. Another one, which I'm guessing might spark a little more conversation around the table, is investigating some split mode options. Peeling off the party and charter sector separately and dealing with them. I'm not saying not to have them take reductions as well, but to kind of treat them separately, so that whatever reductions would need to take place could be different than the overall recreational fishery. I was wondering, you guys have a lot to do and we just gave you a bunch more, but here is another.

I know it's an update and what I'm about to suggest can't be done for determining stock status and things like that. I recognize that. But I wonder if you could actually treat party/charter as a separate fleet in the model, because I think when we talk about these things we are sort of talking about the management aspect. But I don't think we've had a lot of information or any information on the effects to the population by doing this change. That could help that.

I'm fine if the answer is no, we don't have time to do that. But maybe that could be like a longer-term task as well, to kind of split out party and charter. I think the information should be there, right? We have information to inform selectivities and things like that, because most of the sampling information is from the party and charter sector anyways, and then MRIP has separate removals. I think it can be done, but maybe I'm wrong. But it's just a thought. Then one more to the discussion you just had a moment ago, I think it was with Marty. But longer term, so I'm not talking about now. But kind of future thinking, maybe during the benchmark process. I do think it makes a lot of sense to start looking at some sustainable management options under a low recruitment future.

I think we all kind of think of these things as all right, we've just got to get the population back, then we can get back to the good old days, and maybe the good old days are not going to be here maybe for a while, so it might be smart if our slot limits in the future here, do we need to get comfortable with them, and then what does that look like? Things like that. Yes, thanks, happy to take any feedback as well. But thanks for the time.

DR. DREW: I think in terms of the pulling the party/charter fleet out as a separate fleet within the model. We can't do that, well we could, but I think that would be such a significant change that it would warrant a benchmark. Right now, we do not have the sectors as specific fleets, we have a Bay fleet and an ocean fleet.

We would need to do basically a Bay charter and an ocean charter fleet. I think it would be a pretty significant change to model structure, as well as the data input that we could accomplish in an update. But we could look at the mode split option as one of the options that we do for if a reduction is needed, what would a different reg for the for-hire fleet look like.

DR. McNAMEE: Just a quick follow up, Madam Chair. Thank you for that, I appreciate the comment. It just sparked another thought. Thinking ahead to the benchmark, yes. A reconstruction of the fleet structure might make a lot of sense this go around, and particularly some of the discussions we have about the commercial sector.

Now I think the way the model works is the selectivity. It's because of the predominantly recreational fishery that it is mostly like a rod and reel type selectivity. But I think there is enough difference now, in particular with the slot limit that peeling out the commercial as a fleet as well, and doing like logistic selectivity or something like that maybe makes sense. I don't know that it will do anything, but just kind of future through idea.

CHAIR WARE: Justin Davis.

DR. JUSTIN DAVIS: If you'll allow me, I've got a question and then some follow up comments. The question is for Dr. Drew and it relates to the current slot limit. Will the current 28–31-inch slot limit in the ocean fishery be protective of the 2018-year class for like at least next year, probably, and then maybe even the year after, based on the size of the fish in that year class?

DR. DREW: We have some slides on this. This is basically the size distribution of the 2018-year class in 2025, 2026, and 2027 with the current slot limit on it now. Similar to this, this is basically just a length distribution, it's not about abundance, but it's about how that population is distributed over those length bins.

What you can see is that in 2025 it is basically moving into, like 2024 it's starting to move in there right now, 2025 it's going to basically be hitting the peak of them, and then slowly start moving out. This is kind of where if we were to adjust the slot limit in the hopes of taking a reduction, you know one option on the table would be to move that up for 2025. But obviously as you can see, as you move that up, they are just going to move into it. I don't know if we would want to move it down, but from like as you said, a biological reproductive standpoint.

But maybe the option is instead, have a higher limit that continues to move with them, as opposed to a single constant option. But basically, this is right now on the status quo regulations this is how that plus that 2018-year class will move through the slot for the next few years.

DR. DAVIS: Okay, thanks, that is helpful. Some general comments on the various questions that were posed bout what we should look at. The topic of how to allocate the reduction across sectors, I mean that has been a topic of debate in the last three management actions we've done, and there is no way we are going to any kind of agreement today around the table about that.

I don't think we should really have the debate today. I think the best thing to do would be for whatever options the TC develops for us to consider in October, that we kind of have two sets, one if the commercial sector takes no reduction and one if the commercial sector takes an equal percent reduction to the recreational sector, because that at least sort of puts guardrails on it.

Then we can potentially pick something in the middle. I think harvest closures are the obvious option here, and I remember in Amendment VII, I think it was, we kind of had a suite of harvest closure options that we ultimately voted to take out of the document. I think that is what we need to return to and look to as potential options to adopt in October.

I do remember that there was a lot of options in there, in terms of regional splits, and then also where to place those closures. I think there is a lot of potential variation in there. Then especially if you're going to develop two sets, one for no commercial reduction, one for equal percent commercial reduction. That seems like a lot of work.

I don't know, it might be possible between now and October to put that information back in front of the Board, even by e-mail, and try to gather some input on what sort of regional splits people would be willing to consider. I remember that was a really tricky issue with those closures, maybe that is possible.

No -targeting closures, from my standpoint I still feel like those are an option of last resort. I would not be comfortable with adopting any sort of coastwide no-targeting closure option in October by Board action, without going through our normal addendum process, particularly because we're not going to have the benefit of any public scoping or public survey on that question ahead of that action.

That is just where I am on the no-targeting closure issue. The last thing I'll say is I'm totally in agreement with the idea of extending out the stock assessment projection timelines, maybe to 2034, to better show that impact of that big gap in the stock that is coming with that recruitment failure.

DR. DREW: This is related to the point about the region to emphasize. Under our current Amendment 7, conservation equivalency is not allowed for these recreational options. What we pick in October is what everybody is, there are a few limited exceptions in the Delaware Bay and the Hudson River, and in Pennsylvania, for a very limited. But otherwise, what you pick for the Bay and what you pick for the ocean is what everybody is going to be stuck with for the future.

CHAIR WARE: Thanks, Katie. I have Doug Grout, then Nichola Meserve, Mike Luisi and then Emerson Hasbrouck, and then at the end of that list I think we're going to assess time and see where we're at. Next, I have Doug Grout.

MR. DOUGLAS E. GROUT: I would like to agree with Jason McNamee that to look at some kind of method of optimizing the slot limit, whether it's a 3- or 5-inch slot limit, how can we optimize the reduction we would get from a slot limit. I'm certainly in favor of all sectors taking some kind of a reduction, not necessarily equal, but some kind of a reduction, if we do have to take it.

The other concept I am going to throw out here, and I'm not sure how the Technical Committee could address this. There are many states that have five-wave fisheries, some even longer. There are other states, particularly the states of Maine and New Hampshire that have less than, about a two-wave fishery, essentially four months of fishing.

Taking reductions from a seasonal closure, if we're looking from seasonal closures, is a very difficult thing to get down to, depending on what kind of percentages we're going to have to get. To be honest with you, when you look at New Hampshire and Maine's fisheries, and how much they are contributing to the overall harvest, harvest and catch-and-release fishery, they are very, very small compared to a lot of the major producer states.

If there is some way that we can have some flexibility in seasonal closures when you have such a short season already, I would appreciate if the Board could take that or the Technical Committee could come up with something that would take that into consideration. Am I being clear about what I'm looking for here? Do you understand?

DR. DREW: I guess are you thinking of something along the lines of the regional approach that was proposed last time, where it' s like states in these regions will close during these specific weeks to actually, you know if you were closed during March that affects you not at all, versus you know when would you get the best reduction for an effective reduction according to the height of the fishery in different regions.

I think that is possible, that is we could tailor when and how long those reductions are in each region, in order to get sort of the effective reduction that we're looking for, or are you talking about different reductions in different states, based on the timing of your fisheries?

MR. GROUT: What you had come up with before, for the previous regional reductions. The only ones that looked reasonable to me were the Maine and New Hampshire one. But even within that, because again, we have such a short season that fish are actually available to us. That getting down to, you might have to take a week reduction some place, and that is really, excuse my language, kind of a crap shoot when you pick it. The other aspect I'm looking at is, can different regions that have lower contributions to the overall mortality rate have less seasonal reductions, proportional reductions that they would have to take. Those are my two concepts that I'm hoping might be able to get in there. But that might make things too complicated.

DR. DREW: I mean it would definitely be complicated, but I think there is a larger, it sounds like basically you are asking for your state to take a smaller reduction than other states, like in terms of, so it's a required reduction of 18 percent then you guys would ask to take a smaller reduction than that, because it would require closing your season too long if you were to achieve an 18 percent reduction.

That is more of, that is like now we're getting to state-by-state allocation. I think the TC could do it if you were interested in it, but I feel like we would need to see specifically have to look at that, and probably giving some guidance on what constitutes, how much less of a reduction do you get to take, versus other states?

CHAIR WARE: Next I have Nichola Meserve.

MS. MESERVE: The issue that Doug just brought up and the seasonality of our fisheries, makes me think about how the comment that Dr. Davis made about no-targeting closures being something that he wouldn't be comfortable doing without an addendum. I think I would put harvest closures in that as well.

It's just such a complex item that I struggle to see the Board being able to take an action without an addendum and public comment on that process. But I actually had a question about the projections for Dr. Drew. There is going to be an assumption made about the 2024 catch in those projections that will of course incorporate our management measures that were implemented this year in them.

I'm wondering what type of assumptions the TC will make about catch in future years out. We talked about how you have the five-years of poor recruitment are going to influence the abundance in the spawning stock in those projections. As numbers decline, what kind of assumptions will be made about recreational catch? Catch in total, but recreational catch in particular, we know it's not a one-to-one liner response of angler effort to abundance.

DR. DREW: Right, the 2024 will be using sort of our best prediction of what catch is going to be under the new regulations for 2024. We'll incorporate sort of the expected reductions on the actions taken into 2024. The Striped Bass Technical Committee also has a work group that is working on trying to do a better job of predicting total catch, total removals under different management scenarios, under different abundance scenarios into the future. Some things, like the recreational demand model that has been developed for some Mid-Atlantic species.

But more tailored to striped bass, probably not as fancy, because we're just starting working out on this. But something similar of trying to predict what catch will be taking in to account the actual abundance, and how that effects effort or availability, as well as different management approaches. We'll look at our suite of like constant catch on the task as well, but we'll also be trying to develop some better projections of what we think X could be, based on what we've seen in the past.

CHAIR WARE: Mike Luisi, you're next.

MR. LUISI: I want to thank you for allowing the Board the opportunity to provide input to this process to the TC. We're going to be sitting around this table in October, it will be in Annapolis. We'll be having this discussion again. As much as I appreciate all the thoughts and comments, I think it's clear to me, and these are complicated issues.

Earlier just this afternoon, an hour and a half ago, we kind of came to the conclusion that even something as simple as a survey requires a little extra thought and time to prepare in a way that is going to be meaningful. I think that, and I agree, and I had a running list in my head with all the people who have spoken about what I agree with them on, but I've lost that since it started, that was a while ago.

But I do agree with a lot of what has been said. I think the proportional reductions, whether they are recreational or commercial, I think is something to consider, to bring back into the fold. I like the idea that Jason brought up about the sectors, and possibly exploring some type of split mode options for moving into the future.

What I find to be challenging, and I'm sitting here thinking, okay over the last hour we've heard a number of really good ideas. But in reality, in October, if the Board decides to move forward with something, it's going to have to be pretty simple. Nothing that I've heard today is very simple. Even some of the things that I would assume to be simple, for those comments regarding seasonal closures that may be more challenging than what I have the background and knowledge to understand.

I don't want to go on and on about the decisions we have to make down the road. But I'm challenged right now in thinking about how we're going to take this discussion today, with all the other work that the Technical Committee and staff need to do, to prepare for the presentation of the assessment update, and then follow that up with management actions that I would assume would be expected to be taken in 2025. We're going to be facing some challenges.

To back up and to say that I think exploring the things that have been brought up today is a great idea. Again, I think it was good to ask the Board for that feedback. In reality though, I think what we are going to look at in October are going to have to be some pretty simple concepts, if we decide to take action without going through the normal addendum process, which we can do, based on our decisions earlier this year.

I just want to make sure that for the public's expectation on what we might be able to do. I think we're going to find some challenges in being able to do it all together. I think that is without the conservation equivalency dynamic that we've had in the past, I think there are going to be some challenges. But I'll look forward to seeing what the Technical Committee comes up with, and be ready to go in October.

CHAIR WARE: Emerson Hasbrouck, Steve Train, and then we are going to move on to our next agenda item. Emerson Hasbrouck.

MR. HASBROUCK: Thank you, Dr. Drew for your presentation. My thoughts on options in October. What my thoughts are on options that we're going to have to choose in October, including my thoughts on no-targeting, are going to be guided by what we just, an hour or two ago, tasked the TC with doing, you know with those four sensitivity-runs.

I'm anxious to see what the results of those four sensitivity runs are going to show, and that is going to help me decide how I would like to go forward in October. Also, I agree with John Clark that we need to take a look at proportional reductions. I agree with Jay Mac about split-mode options, and I agree with Marty Gary about long term projections.

You know our horizon should not be only 2029. We have to get a sense of what is going to happen after that. Then I have a process or procedural question. That is, can we both take action in October if it's warranted, take some action in October if it's warranted, as well as initiate another addendum at that time, for perhaps some options that are a little bit more complicated?

MS. FRANKE: Thanks, Emerson, yes. The Board can take action via Board action if the assessment shows the stock has a less than 50 percent probability of rebuilding, and of course the Board can always initiate an addendum.

CHAIR WARE: Steve Train and then David Borden has assured he is very quick.

MR. STEPHEN TRAIN: Thank you, Madam Chair, I'm good. Everything I wanted to say has been said.

CHAIR WARE: Thanks, Steve, David Borden.

MR. BORDEN: I'll be very brief. Emerson raised the issue of targeting and non-targeting, and so my question is, has the Enforcement Committee every reviewed the experience that some of the states have had with that, Maryland, and if not, is it possible to get the Enforcement Committee to review the experience that some states have had, and then provide us whatever guidance they could provide us. I think that would be useful in anticipation, if we're going to consider the concept.

MS. FRANKE: As part of the Board Work Group on release mortality, enforceability is something the work group is reaching out to the states with current closures, as well as NOAA Fisheries about, so that should be included in the Work Group Report.

CHAIR WARE: All right, that was a great discussion. I thank everyone for their participation. I agree with Mike Luisi, this is quite daunting, and a lot of this is going to depend on what we see in October. We will be prepared and take it as it comes. Our next agenda item is an update on the 2024 Winter Striped Bass Tagging Cruise. I believe Sig VanDrunen is going to provide us some update.

MS. FRANKE: Sig, if you're speaking, we can't hear you.

REVIEW AND POPULATE ADVISORY PANEL MEMBERSHIP

CHAIR WARE: While that gets flipped on, I'm actually going to go to Addendum Item Number 8, the Advisory Panel, Tina Burger. We'll do those and then we'll come back and see if Sig's audio is working.

MS. FRANKE: Yes, for the Advisory Panel nominations, there are two nominations, Tom Fote from New Jersey, a recreational angler from New Jersey, as well as Will Poston, recreational angler from the District of Colombia.

CHAIR WARE: Great, so Dennis Abbott, you're willing to make that motion. Can you read it into the record, please?

MR. DENNIS ABBOTT: **Move to approve Tom Fote representing New Jersey and Will Poston representing the District of Columbia to the Striped Bass Advisory Panel.**

CHAIR WARE: Great, so a motion by Dennis Abbott, I saw a second by Joe Cimino. Is there any opposition to this motion? Yes, you would like to speak to the motion, Dennis?

MR. ABBOTT: I recognize the familiar name at the top of the list. I'm sure that he will be able to add a lot to the Advisory Panel, and I'm sure they will enjoy his presence there.

CHAIR WARE: Thank you, Dennis. I'll try again**, is there any opposition to the motion? Seeing none; the motion is approved by consent**.

UPDATE ON 2024 WINTER STRIPED BASS TAGGING CRUISE

CHAIR WARE: All right, we're going to try Sig's audio again, and see if we are able to hear.

MS. SIGNE VANDRUNEN: Do we have anything?

MS. FRANKE: Yes.

MS. VANDRUNEN: Awesome. That was really weird. I didn't really do anything to fix it. Apparently, it just decided. Today I am going to talk about the Striped Bass Cooperative Winter Tagging Cruise. To get everyone on the same page, Maryland Fish and Wildlife Conservation Office, North Carolina DEQ and then Maryland DNR, coordinate and carry out the Atlantic Striped Bass Cooperative Tagging Program, which targets the offshore winter migratory stock.

These surveys began as trawl surveys from 1985 to 2010, and switched to a hook and line survey in 2011. This year in 2024, I acted as the U.S. Fish and Wildlife Coordinator for the survey, but our coordinator position will switch over to our new database coordinator and biologist Victoria Lecce for 2025 on. This is the 13th consecutive year of offshore hook and line striped bass tagging collections. Captain Ryan and the Midnight Sun crew, fishery staff and volunteer anglers carried out a total of 12 surveys from January 15 to February 6.

Trips launched from Virginia Beach on January 15, 16 and 22. The team departed Virginia Beach and fished up the coast as they traveled to Ocean City, where staff fished from January 24, 26 and 27. Then the Midnight Sun would make its return to Virginia Beach to target rockfish on January 31 and then February 1st, 2nd, 4th, 8th and 9th.

Poor weather conditions prevailed throughout our season, and it delayed the initial start date set for January 1, and reduced consistent public reports of migrating fish. Some public reports we received on striped bass came from New Jersey, and mostly the Chesapeake Bay. On January 24, our team collected 39 fish and tagged 38 of the 39, while fishing offshore of Ocean City, and all remaining trips did not yield fish. Since 2011, the ASMFC has caught 8,601 fish and has tagged 8,439 of these fish over the course of 136 survey trips. This slide shows the movement of tagging trips, beginning in '85 with our trawl surveys, and going on to the hook and line surveys. Unfortunately, they do not have the year displayed, but I just want to draw attention to this northern movement of our surveys to find fish. This tagging program is the only program that targets and tags the overwintering offshore migratory stock of striped bass, excluding the crew of the Midnight Sun, but including our data collection and fishing to win team about 75 anglers signed up for fishing slots over the course of the season.

Not all of our anglers were able to attend fishing trips, due to weather cancellations and other factors. The total cost incurred by our Fish and Wildlife Service for this year's tagging survey was $3,916.00. This total included boat trips, boat fuel, travel for employees, coordinator salary, Fish and Wildlife Services gas, and then supplies.

The 35K of NOAA provided ACFCMA funds, covered the cost of the hook and line survey. However, this left Fish and Wildlife Service to cover all the other costs incurred by the MDFWCO related to the management of the coastwide striped bass, horseshoe crab, and sturgeon tagging databases.

The cost to run those programs is around $36,000.00 in supplies posted, et cetera, but does not cover any of the staff salaries. I just have one more slide next that shows a breakdown of the hook and line survey sites versus the trawl sites. With that we can start discussion.

CHAIR WARE: Thank you very much, Sig. Marty Gary had actually requested this be put on the agenda, so Marty, I'll go to you if you want to make any comments. But the funding for this has always been year to year, so I think we wanted to flag this for the Board, just so folks are aware of the data that is being collected. Marty, do you want to comment?

MR. GARY: Thanks, Madam Chair, and I think everyone around the table knows I've been a pretty strong advocate for the continuity of the survey. I'll ask the obligatory question, Katie, because I know I've asked you before. Could you characterize the value of this now, it's pushing toward a 40-year dataset for us. Thank you, and I might have one follow up.

DR. DREW: This information is not currently used directly in the assessment. I think it is our goal for the next benchmark assessment to be able to use these tagging data from this program and from the state tagging program, more directly into a more spatially structured model, or potentially incorporate it.

We do the estimates of total mortality during the benchmark process from these surveys, and so I think we haven't fully recognized the potential benefits of this information, and we've been held back by our modeling framework. But we continue to develop that, and hopefully we will be able to more fully utilize and leverage these data in the assessment going forward.

I think it's not fully clear yet from our analyses, you know what is the value of the winter tagging cruise on the offshore mixed populations versus the state-specific tagging programs that also continue. But it is as Sig pointed out, kind of a unique dataset, or a unique timing of when those fish are tagged and what we are able to get from that going forward. I hope that is helpful.

MR. GARY: Thanks, Katie, and I'll just simply say, you know we have this discussion every year, usually it's in October, as we approach the deadline to determine whether or not we have the funding to go forward. Again, it's a dataset that is pushing toward 40 years, only data we collect on the wintering grounds, which as we saw in Sig's presentation is dramatically changed. Not only are the fish further north, but they are further offshore.

I just put it out there, I'm hoping instead of having the conversation every year and pleading to see if we can somehow come up with the money, we as a Board somehow with all of our collective partnership, we could figure out a way to fund this. I guess my next step if we don't get that is I'll start a Go Fund Me campaign and everybody can contribute. I'll turn it back to you, Madam Chair.

CHAIR WARE: I would encourage folks to discuss this between now and October. If folks want a call let me know, I'm happy to set one up if that would be helpful. Any other burning questions or comments? Okay, I did say I would provide Captain Newberry an opportunity for a quick public comment at the end of our meeting today. Captain Newberry, if you are on, I will need two minutes for your comment.

MS. TONI KEARNS: Captain Newberry, if you are on, can you please raise your hand.

ADJOURNMENT

CHAIR WARE: Okay, with that I think we are at Other Business. Is there any other business before this Board? Otherwise, I look for a motion to adjourn. So moved by Ray Kane, second by, I think Steve Train raised his hand. Thank you.

(Whereupon the meeting adjourned at 2:30 p.m. on Tuesday, August 6, 2024)

Atlantic States Marine Fisheries Commission

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

Striped Bass Board Work Group on Recreational Release Mortality
Report to Striped Bass Management Board

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

October 2024

In May 2024, the Atlantic Striped Bass Management Board established a Board Work Group (WG) to discuss recreational release mortality (RRM) and address four specific tasks . The WG met via webinar six times from June through September 2024 to discuss these tasks. An interim report was provided to the Management Board in August 2024. This report summarizes the WG's conclusions and recommendations for each task, and the enclosed meeting summaries provide more detail on the information reviewed by the WG and the WG discussions.

Task 1: No-Targeting Closures

Review existing no-targeting closures in state and federal waters, including any information on impacts to striped bass catch and effort as well as their enforceability. Identify potential angler responses/behavior change to those closures.

The WG reviewed information on existing no-targeting closures for striped bass and freshwater species in several jurisdictions (see Table 1), including general insight on compliance, enforcement, and how anglers may have responded to the closures. The WG also reviewed information previously provided by the Law Enforcement Committee (LEC) regarding enforceability of no-targeting closures.

Based on the information reviewed and subsequent discussions, the WG developed the following conclusions:

1) **It is difficult to isolate the effects of no-targeting closures on catch and effort alone.** For example, while Marine Recreational Information Program (MRIP) data suggest that catch (harvest and live releases) and effort declined in the Maryland portion of the Chesapeake Bay after a no-targeting closure was implemented in 2020, other factors like fish size, year-class strength, and other coinciding management changes (e.g., private angler trip limit reduction from 2 fish to 1 fish) are likely contributing to the decline. Additionally, it is difficult to isolate the effect on catch and effort from the no-catch-and-release part of the closure versus the no-harvest part; i.e., no-harvest closures are likely to dissuade some level of effort (although unlikely enough to offset the increase in releases from a no-harvest closure).

2) **The effect of no-targeting closures on catch and effort will vary based on angler responses to the new measures**. The WG noted that Maryland anglers appeared to target other species more heavily during the striped bass no-targeting closure, and to target striped bass more heavily in the weeks before and after the no-targeting closure. A shift in targeting to other species during a closure may diminish the expected reduction in striped bass releases if the fishing methods are similar. Shifting the timing of effort rather than reducing it would similarly affect the expected reduction in striped bass releases but could still meet a management objective to shift releases to a time period where environmental conditions are more favorable for survival post-release. Overall, because there is limited information on how anglers respond to no-targeting closures, the added savings (in terms of releases) from prohibiting targeting are difficult to calculate and predict.

3) **Compliance with no-targeting closures seems to be best achieved through early and frequent communication, where strong stakeholder support exists, and as the closure continues into the future (i.e., remains in effect year after year).** In every example, effective communication with stakeholders to garner buy-in and support for the no-targeting closure, including the perceived problem/rationale and management objectives, were key to success. The WG discussed that stakeholder buy-in may vary by state, constituent group, and closure objective/rationale. There are potentially higher initial costs in the first years of implementation to ensure communication materials are reaching angling communities, however, compliance tends to improve as awareness and general acceptance increases over time, and thus decreasing costs.

4) **Although compliance appears to be good in all examples, no-targeting closures are widely considered difficult and resource intensive to enforce; they are generally viewed as more enforceable when implemented in discrete times and areas, and where there are few other species to target or the closure is for fishing in general.** This was evident in the Kennebec River and Hudson River examples where the extent and timing of the striped bass no-targeting closures coincides with generally low effort and/or few other species for anglers to target. In most other cases, targeting violations are issued largely in conjunction with retention violations, demonstrating the challenge with proving angler intent to target without possession or verbal admission. The enforcement of no-targeting closures that overlap with other fisheries may be aided by concurrent gear restrictions where feasible (e.g., prohibiting the possession of certain terminal tackle that demonstrates an intent to fish for striped bass). Although it is difficult to successfully adjudicate no-targeting violations in many situations (due to the need to demonstrate angler intent), the WG discussed that repeated verbal warnings alone can achieve desirable enforcement outcomes.

5) **Although no-targeting closures may be difficult to enforce, they are not without merit and should not be rejected as an effective tool to reduce release mortality (or total fishing mortality) solely due to enforcement concerns**. There is certainly a tradeoff between conservation gains and enforceability, which is ultimately a policy decision. Regardless of how enforceable a management measure might be, the WG supports exploring "every tool

in the toolbox," especially considering the limited tools available to further reduce striped bass fishing mortality, if necessary.

6) **No-targeting closures may not be a "one size fits all" approach.** The Atlantic coast states vary widely in the seasonality of their striped bass fisheries, spatial area, degree to which multiple recreational fisheries overlap, environmental conditions affecting release mortality rate, enforcement resources, and stakeholder interests, among other factors. This inherent variability between striped bass fisheries across the coast presents certain inequities (real or perceived) and feasibility concerns with mandatory no-targeting closures -- whether at the coastwide, regional, or state-level. There have also been concerns about the inequity of implementing only no-harvest closures (i.e., allowing catch-and-release fishing) since a no-harvest closure would likely only impact removals from fishing trips from anglers who intend to harvest striped bass. No-targeting closures would likely reduce removals from catch-and-release trips as well as harvest trips. This range of stakeholder values is another aspect for the Board to consider.

Recommendation: **Overall, the WG finds that no-targeting closures have been successfully applied in some circumstances to achieve fishery management objectives, including reducing recreational releases. However, the mandatory implementation of no-targeting closures would have varying degrees of effectiveness, enforceability, and compliance across states. If further reductions in fishing mortality are needed, the WG supports the consideration of seasonal closures to reduce recreational effort and catch, but recommends that no-targeting closures only be pursued in a flexible manner**.

One such approach could provide a state/region the option to select between implementing a seasonal closure as either no-harvest or no-targeting to meet a certain required reduction according to standardized methods, whereby a no-targeting closure can be shorter in duration due to the additional conservation benefit of prohibiting catch-and-release fishing. Importantly, this approach would rely on the use of standardized methods to estimate the reduction from both types of closures. As of October 2024, after reviewing the outcomes of Maryland DNR's no-targeting closures implemented in 2020, the Technical Committee agreed that the method used by Maryland during the Addendum VI process to estimate the reduction from no-targeting closures is a reasonable method to apply more broadly if the Board were to consider that type of management option. Further, some WG members would support adding an uncertainty buffer to any proposed no-targeting closure options to address uncertainty around angler response to closures (i.e., noncompliance and effort shifts). Alternatively, the Board could adopt no-harvest closures but encourage states to implement them as no-targeting closures where fishery conditions are favorable or environmental conditions warrant it. However, unless there is some additional incentive to states, this option may not advance no-targeting as a means of reducing recreational releases in striped bass fisheries.

See enclosed WG meeting summary from September 3 for more detail.

Table 1. Summary Information on Compliance and Enforcement of No Targeting Closures Reviewed by Workgroup

Spp.	Area	Closure Dates	Years	Impetus	Perception of Compliance	Perception of Enforceability
Striped bass	Maine Kennebec watershed	Dec 1 – Apr 30	1990+	Spawning protection	High b/c strong stakeholder buy-in, long-term rule, and low seasonal fishing effort in general.	Enforceable b/c small spatial area, limited species availability. Labor intensive to detect, but summonses have been successfully adjudicated.
	New York Hudson River (above Cuomo Bridge)	Dec 1 – Mar 31	1983+	Unknown	Generally good b/c long-term rule/good awareness; note lag in compliance when closure dates changed.	Enforcement benefits from few other species available to target in the area at time of closure.
	New Jersey all non-ocean waters	Jan 1 – Feb 28	1991+	Protection of overwintering fish	Difficult to determine b/c mixed fishery area.	Very difficult. Largely enforced in conjunction with no-harvest violation.
	New Jersey Delaware River and tributaries	Apr 1 – May 31	1991+	Spawning protection		
	Maryland Chesapeake Bay	Apr 1 – Apr 30 Jul 16 – Jul 31	2020+	Reduction in removals (through CE)	Generally good. Supported by data suggesting reduction in fishing effort, directed trips, harvest, and releases (note likely influence of other variables e.g., year-class strength, bag limit reduction).	Challenging. Largely enforced in conjunction with no-harvest violation.
	Potomac River	Jul 7 – Aug 20	2020+	Reduction in removals (through CE)	Difficult to determine b/c mixed fishery area; possible decrease in vessel activity.	Very difficult. Largely enforced in conjunction with no-harvest violation.
	Exclusive Economic Zone (EEZ)	All Year	1990+	Rebuilding measure/ precautionary management	Generally good, aside from bad actors and hot spots, b/c long-term rule. WG note worse when large aggregations of fish in EEZ near the 3-mile line.	Largely enforced in conjunction with no-harvest violation.
Small/large-mouth bass	Pennsylvania Susquehanna and Juniata Rivers	May 1 – mid-June	2012-2017	Spawning protection (not intended to be permanent)	Complaints of violations and unenforceability (in addition to stock status improvement) led to repeal of closure.	
All species	North Carolina multiple discrete freshwater times/areas of concern for a particular freshwater species		various	various	Due to overlapping species/fishing techniques and inability to enforce a species-specific no targeting closure, complete fishing closures were implemented in discrete times/areas although concern was for a particular freshwater species.	

Note: Maryland also has spring no-targeting closures on spawning grounds that have been in place since the late 1980s. The WG did not discuss these closures.

Task #2: Gear Modifications

Review the MA DMF discard mortality study and other relevant reports to evaluate the efficacy of potential gear modifications.

The WG reviewed information on studies from the Massachusetts Division of Marine Fisheries (MA DMF) and the University of Massachusetts-Amherst (UMASS-Amherst) on evaluating post-release mortality of striped bass in the recreational fishery and received an overview of key findings regarding gear type (other than circle hooks) and release mortality for past studies on striped bass and other species. The WG also received input from the ASMFC's Law Enforcement Committee (LEC) on the enforceability of recreational gear regulations and method of take.

Overall, the WG finds that the type of gear used to catch striped bass can impact post-release mortality, gear modifications have the potential to reduce post-release mortality of striped bass, and regulations on recreational gear types and methods of take are moderately enforceable.

Specific WG conclusions include:

1) **Recent studies by MA DMF and UMASS-Amherst suggest lure-hook and bait-hook configurations impact post-release mortality and could be an area for education and/or regulation.** The results from the MA DMF study suggest that post-release mortality was highest using baited circle hooks followed by lures, while flies had the lowest post-release mortality rate. Among lures, those with a single hook had the lowest mortality rate and those with double treble hooks had the highest mortality rate. The UMASS-Amherst study had similar results with some differences possibly attributed to sample sizes and the different survey design than the MA DMF study.

2) **There are many variables to consider regarding gear modifications to reduce post-release mortality, and it is hard to isolate one particular gear to get the most impact (e.g., how often is a gear configuration used by anglers?).** Fight time, handling time, water and air temperatures, angler experience, and fish size also impact the post-release mortality rate and some of these variables are correlated to each other. Further analysis is needed to better understand these interrelated variables. The relative use of different gear configurations in the striped bass fishery is currently unknown, so the impact of particular gear modifications on overall post-release mortality is also unknown. However, MA DMF is conducting a tackle configuration survey in 2025 to understand how often different gear configurations are used by striped bass anglers, which should inform the impact gear modifications can have on post-release mortality.

3) **The recent study by UMASS-Amherst suggests that striped bass anglers largely support adopting science-based catch and release best practices, and adequate enforcement of the regulations.** The study also found that striped bass anglers often employ best angling practices such as proper and limited handling of fish, minimizing the fight time and using circle hooks and barbless hooks. Although it is uncertain if these results apply to the entire

striped bass recreational fishery, the study revealed fishing practices and attitudes that currently exist among at least a portion of the recreational fishery. Strong stakeholder buy-in facilitates acceptance of best management practices and compliance with regulations if gear modification regulations are considered.

4) **The Board should consider the impacts to the industry of any potential gear modification from the perspective of manufacturer, retailer, tackle store, etc.** Gear modification regulations would impact the sale of gear types that are no longer allowed for striped bass fishing and would also impact anglers and for-hire captains who possess gear types that can no longer be used for striped bass fishing. In addition, some fishing tackle manufacturers are already modifying fishing lures for striped bass that support survival of released fish.

5) **The Board should consider enforceability and how these types of gear restrictions would interact with management of other species but should not rule out gear restrictions based on enforceability alone.** The LEC's Guidelines for Resource Managers on the Enforceability of Fishery Management Measures rates gear regulations and method of take as moderately enforceable. To facilitate enforcement, the regulations must be clearly written, relatively easy for anglers to adopt (align well with fishing practices), should be in place for a long time period, and should include concerted outreach and education efforts. The regulations need to standardize gear requirements, measurement procedures, equipment, and techniques across all appropriate jurisdictions and time periods. Prohibiting the possession of gear types where feasible would also facilitate enforcement. In some cases, enforcement can consider other gear and fishing techniques to determine whether an angler is targeting a species that requires a certain gear. However, this is challenging if anglers target a variety of species in an area as opposed to anglers targeting only a few species. Although there may not be many citations written for all gear restrictions, enforcement also provides compliance assistance to help anglers understand the regulations and learn how to come into compliance instead of issuing a citation.

6) **Regardless of whether the Board chooses gear modifications as a management measure, education and outreach efforts should continue to ensure that anglers use best management practices for striped bass fishing.** Amendment 7 to the Striped Bass FMP recommends states continue to promote best striped bass handling and release practices by developing public education and outreach campaigns. Results from the MA DMF post-release mortality studies should be incorporated into best management practices states and jurisdictions communicate to their anglers.

7) **States can implement gear restrictions as they see fit (e.g., statewide, area/time-specific) without Board action.** Some states already do this for striped bass and other species. This allows for specificity for gear restrictions in a state or jurisdiction that addresses concerns about enforcement and any interactions with other recreational fisheries. However, this could also result in gear restriction regulations that are not consistent along the coast, which could minimize the impact of reducing post-release mortality of striped bass coastwide, complicate enforcement, and create regulations that are confusing to anglers. If

states choose to implement gear restrictions for their recreational striped bass fishery, then the WG recommends that they communicate with ASMFC and neighboring states and jurisdictions to minimize the inconsistency in gear restrictions in areas fished by anglers from multiple states.

If the Board considers additional recreational gear modifications as management measures, then **the WG recommends they consider modifications that support the survival of released striped bass based on release mortality study results, are easy for anglers to adopt, are consistent among states and regions, and understand that any reduction in post-release mortality is currently unquantifiable. The WG also recommends that the Board should consider impacts to the recreational anglers and fishing tackle industry, current efforts by the fishing tackle industry to produce/promote gear that supports post-release survival, potential enforcement challenges, and the uncertainty in the results from post-release mortality studies.**

See enclosed WG meeting summaries from September 12 and September 24 for more detail.

Task #3: Stock Assessment Work to Inform RRM Discussions

Identify assessment sensitivity runs which may inform Board discussion around release mortality (e.g., how low would you have to reduce the release mortality rate in order to see a viable reduction in removals with the same level of effort?). Consider the tradeoff of reducing the release mortality rate vs. reducing the number of releases overall.

The WG reviewed past work by the Technical Committee (TC) in late 2020 to explore the sensitivity of the stock assessment model to different recreational release mortality rates (TC Memo M21-04). The WG noted this past TC work was valuable to understand how different constant RRM rates impact the historical time series. Notably though, none of the scenarios simulated a midstream shift in the RRM during the historical time series, such as might result from hypothetical management changes. **Given the Board's current interest in understanding how actions to reduce RRM would impact the stock moving forward, the WG recommended tasking the TC as follows. The Board approved this tasking in August 2024.**

These tasks are intended to help the Board understand the tradeoff between reducing the release mortality rate vs. reducing the number of releases overall. The WG recommends the TC address these tasks as part of the ongoing 2024 Stock Assessment.

1) If a reduction is needed to achieve rebuilding, determine how low the release mortality rate would need to be to achieve that entire reduction through the release mortality rate alone. In other words, if the number of live releases is constant, what would the release mortality rate need to be to achieve the reduction?

2) If a reduction is needed to achieve rebuilding, determine the percent reduction in number of live releases needed to achieve the entire reduction through live releases alone. In other words, using the current 9% release mortality rate, how many fewer live releases would there need to be to achieve the reduction?

   TC Tasks 1 and 2 represent the two extremes of reducing RRM. Task 1 focuses entirely on reducing the RRM rate to achieve a reduction (i.e., decreasing mortality from the fishing interaction), while Task 2 focuses entirely on reducing the number of live releases (i.e., controlling effort). These are hypothetical scenarios, which are not necessarily realistic for management implementation but would help characterize the tradeoff between the two management approaches to reduce RRM. Recreational harvest would be assumed constant for these scenarios in order to isolate the reduction to RRM. Considering commercial harvest in the overall calculation for the reduction, the WG recommends two iterations for each scenario: one with constant commercial harvest and one with an equal reduction for commercial harvest.

3) If a reduction is needed to achieve rebuilding, determine the percent reduction in number of live releases needed under the current 9% mortality rate, assuming there is an associated reduction in recreational harvest due to no-targeting closures.

   TC Task 3 assumes the implementation of no-targeting closures would result in a reduction in both harvest and live releases. The TC would need to determine how to best quantify the reduction in live releases from no-targeting closures, which depends on several assumptions including how many striped bass are still caught and released as incidental catch when targeting other species. The WG again recommends two iterations for each scenario to account for commercial harvest in the calculations: one with constant commercial harvest and one with an equal reduction for commercial harvest. The WG recommends the TC also comment on how potential reductions from no-targeting closures could vary depending on season, as catch varies throughout the year and by region.

4) Identify the tradeoffs of implementing no-targeting closures at different times of the year with different assumed release mortality rates to help inform when and where implementing no-targeting closures would result in the highest reduction. Factors could include water temperature and salinity, with the assumption that the release mortality rate is higher when the water temperature is high and the salinity is low.

   TC The WG acknowledges that a reduction associated with specific no-targeting closures depends on several factors including assumed release mortality rate, length of closure, current level of harvest and releases, angler behavior, etc. Any guidance from the TC on the best use of no-targeting closures to achieve reductions would be helpful.

See enclosed WG meeting summary from July 17 for more detail.

Task 4: Public Scoping
Consider public scoping on measures to address release mortality (e.g., online public survey ahead of the October Board meeting).

The WG discussed the scope of a potential survey of stakeholders on measures to reduce recreational release mortality. After the Board's August 2024 decision to delay survey development in order to get input from survey experts (as recommended in the WG's interim report to the Board), members from the Committee on Economics and Social Sciences (CESS) provided guidance to the WG on general survey approaches to consider (open survey, randomized survey, focus groups), as well as high-level comments on the WG's first-draft survey questions. The WG considered what type of information different survey approaches would provide, and the benefits, challenges, and resources required for each. The WG agreed to the following conclusions:

1) A survey does not seem feasible to adequately gather all the complex information on stakeholder responses to management measures, nor will a survey meet the original timeline at this point of gathering public input ahead of potential Board action in late 2024 in response to the stock assessment update. The absence of a survey or other ASMFC-led public scoping does not prevent states and/or Board members from gathering stakeholder input to understand their perspectives through state processes or other channels in advance of a potential Board action. Additionally, public comment opportunities are expected at any Board meeting when Board action is being considered.

2) If the Board is interested in public input beyond this next management action, focus groups of stakeholders representative of the recreational striped bass fishery could be a useful approach to 1) paint the landscape of potential stakeholder responses to measures being considered to address release mortality (e.g., no targeting closures, gear modifications) and 2) discuss outreach on best fishing and handling practices for striped bass.

3) Conducting an open survey could also be considered, but the inherent biases would need to be acknowledged. Survey fatigue should also be considered. For example, there is currently an open survey of striped bass stakeholders being conducted by Virginia Tech on stock structure and migration patterns, and MADMF is planning to conduct a survey on terminal tackle use in 2025.

Ultimately, if the Board wants to gather public input on stakeholder buy-in and potential responses to management measures to address release morality outside of the public comment processes associated with an addendum or amendment, the WG recommends focus groups as the best approach to collect that information.

If the Board were to proceed with focus groups in the future, the Board would need to address logistics, including who would be leading the focus groups and identifying stakeholders to participate. A focus group approach would likely require significant State staff time on these logistics and planning. CESS members noted they could advise the process, and the Board could consider the benefits of leveraging a graduate student(s) in the process. Additionally, depending on the timing of focus groups, the Board could consider adding other topics for stakeholder input (e.g., assessment-related topics ahead of the next benchmark stock assessment).

See enclosed WG meeting summary from September 20 for more detail.

Atlantic States Marine Fisheries Commission

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

Striped Bass Board Work Group on Recreational Release Mortality Meeting Summary

Webinar
June 24, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

ASMFC Staff: Emilie Franke, Kurt Blanchard

Public: Allison Colden, Andy Danylchuk, Armando Guerrero, Caitlin Craig, Chris Scott, Corrin Flora, Jeff Mercer, Jessica Best, Justin Pellegrino, Lucas Griffin, Olivia Dinkelacker, Sascha Clark Danylchuk, Will Poston

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the first time on June 24 via webinar. The WG Chair reviewed the four WG tasks approved by the Board and reviewed the WG timeline. The WG has two meetings scheduled for the summer and will provide a progress update and initial recommendations to the Board at the 2024 Summer Meeting in August. The WG will meet a few more times in August and September to continue working on the WG tasks and develop final WG recommendations. The WG will provide a report to the Board at the 2024 Annual Meeting in October with a summary of all tasks and any recommendations on how the Board should address recreational release mortality based on the findings of those tasks.

<u>WG Tasks Approved by the Board</u>

1. Review existing no-targeting closures in state and federal waters, including any information on impacts to striped bass catch and effort as well as their enforceability. Identify potential angler responses/behavior change to those closures.
2. Review the MA DMF discard mortality study and other relevant reports to evaluate the efficacy of potential gear modifications.
3. Identify assessment sensitivity runs which may inform Board discussion around release mortality (e.g., how low would you have to reduce the release mortality rate in order to see a viable reduction in removals with the same level of effort?). Consider the tradeoff of reducing the release mortality rate vs. reducing the number of releases overall.
4. Consider public scoping on measures to address release mortality (e.g., online public survey ahead of the October Board meeting).

Tasks #3 on the stock assessment and task #4 on public scoping are time-sensitive and require Board input at the 2024 Summer Meeting, so the WG's progress report at the Summer Meeting will cover those two tasks.

Task #4: Public Survey

The WG first discussed Task #4 on public scoping, which emerged from the possible scenario of the Board considering management action via Board vote (i.e., no addendum process) in October 2024, or shortly after, if the 2024 Stock Assessment Update indicated a reduction to achieve rebuilding was necessary. If that were to occur, public scoping completed prior to October could provide the Board with public input on measures to address RRM as the Board considered that action. A survey would need to be conducted from about mid-August to mid-September in order to gather and process the information prior to the October Board meeting.

ASMFC staff provided a summary of previous public comments gathered through the Amendment 7 process in 2022 on measures to address recreational release mortality. Draft Amendment 7 included options for gear restrictions and options for no-targeting closures for which the public provided comments. Ultimately, the Board implemented some gear restrictions in Amendment 7 but did not implement any no-targeting closures.

The WG noted support for conducting a survey to gather input on release mortality measures and that it would be informative to the Board. The WG discussed what topics potential survey questions could cover and discussed how the survey could be conducted. The WG suggested numerous topics for potential inclusion in a survey, which are listed below. ASMFC staff categorized all the WG suggestions following the call.

<u>Suggested Survey Topics and WG Rationale</u>

Current Measures/Socioeconomic

- What have the impacts been with the narrow slot limit? How has this slot limit affected trips? What are anglers/captains seeing on the water as far as how release rates are going up?
    - Gather socioeconomic data on impacts on the effect of the narrow slot limit on trips. This is new ground for the Board and is the Commission's role to dig into this.
    - The greatest interest about narrow slot is getting information from people and hearing the potential change of perspective. Before the recent narrow slow limit, there were public comments opposing no-targeting closures. Now with the narrow slot, there could be a potential change of perspective about measures to address release mortality.
    - Management measures (i.e., narrow slot) have changed in the past couple of years, and therefore angler perspective may have also changed. Do we want to be more specific about no-targeting closures? Changing perception among anglers?

  - Some WG members were unsure about addressing the current slot limit in the survey, and noted the focus should be on the future rather than asking about the current measures.
  - Wave-specific data was used for Maryland closures, and it is important to look at the effects across time of year. For example, during the no target closure a tackle shop lost significant business. Need to look at what fish we are saving vs. the impacts on communities.

- What is causing people's catch and release (preference versus regulations)? This could help inform socioeconomic considerations.

Big-Picture

- When we talk about doing things that are more difficult to enforce or quantify, there seems to be a reaction from the Board with some hesitancy to implement unquantifiable measures. Does the public need us to quantify the result and are we accountable as a Board? For release mortality measures, is it as important to meet a percent reduction or just to reduce overall effort? Is the public comfortable reducing effort without being able to pinpoint reduction?
  - We are at a point in management where we need to stretch to see a reaction from the stock. How willing would the public be with going forward to reduce effort without an estimated reduction in removals?

- From a policy perspective, what level of release mortality is too much for this fishery? Release mortality has been high for decades and is only recently getting a lot of attention. Is the high attention due to poor stock status? How much is too much? Is stock status connected to the perception that release mortality is too high?

- Question to catch-and-release fishery participants: how can you be part of the solution? How can this segment of the fishery participate in reducing release mortality?

Seasonal Closures

- How would the public respond to a no-targeting closure; 1-week, 2-week, 3-week, etc.? Not go fishing, target other species, go to another state?
  - This information would be very informative to no-targeting closures
  - Data is missing on how anglers would respond to seasonal closures; great first step; not sure how the Striped Bass Technical Committee (TC) would analyze seasonal closures. TC could weigh in on how to collect this data to fold into those calculations.

- Do we want more feedback on focused no-targeting closures? Closures when water/air temperatures are warm? Certain months and location? Certain parts of a waterbody, e.g. estuaries instead of ocean?
  - Easier to implement and enforce closures in a specific area/time of year. Anglers still have the opportunity to fish elsewhere.

- Have opinions on seasonal closures changed since Amendment 7? What is the goal of the closures that people would support? What times of year would reduce effort the most? Or are closures based on environmental conditions? Should we be balancing this? If people support temperature-based closure, how do you balance that up north in areas like New England where the temperatures are not as high?
  - No-targeting closures were implemented in Maryland and the Potomac River Fisheries Commission (PRFC) to both meet the reduction and due to environmental conditions. Recreational management and environmental conditions continue to change and we need to understand behavior along the coast.
- If we consider no-targeting closures, there has to be information gathered about the impacts on different sectors. There is one group of the fishery that won't be impacted by a no-harvest closure, while everyone would share the burden with a no-targeting closure. Have to discuss fairness issues.
- Between ME and NC there are major differences in fishing practices. If environmental conditions are such that it makes sense to reduce targeting during time periods when fishing mortality can be extreme (i.e., actions in the Chesapeake Bay to expand no-targeting closures), in order to be fair/equitable, what in addition to action in the Bay could happen on the coast in areas when the environmental conditions aren't as poor? How can we balance the recreational impact by not focusing on one particular area? If environmental conditions aren't a concern of New England fishermen, what would the stakeholders be willing to do to reduce mortality while other states have no-targeting?
  - Not sure we can apply a broad brush. Trying to think outside of conventional approaches.

Gear Restrictions

- Could be open-ended question to collect input on what individuals do or see on the water to reduce release mortality.
  - There are a lot of different ideas, views, and perspectives about tackle. Close to receiving information from Massachusetts Division of Marine Fisheries (MADMF) (e.g. two treble hooks are the worst). First DMF report may be available later in 2024. MADMF study doesn't look at everything (e.g., doesn't look at barbless hooks).
- How comfortable is the public going to be with measures that we don't have data for, but it is perceived to have a reduction factor?
- What do you do with a fish boatside?
  - Akin to tarpon regulations in Florida. Exposure to air and temperature components affect survivability. For example, un-hook the fish in the water. States have general language, release without undue harm; handling is a big part of it.

- Should state agencies be regulating fishing gear, or should changing gear be part of education/outreach/best management practices? Would best management practices as outreach be enough vs. regulation?
- Support a question about wire line (discussed during Draft Amendment 7 process), but specifically in the vein of how do you believe it will impact mortality? This is probably the fastest way to get the fish to the boat which may be beneficial, but people may be opposed to it because it's not the most "sporty" way to catch striped bass.
- In general, could ask why you support a gear restriction and why it would decrease release mortality.

The WG generally discussed other points about the survey. The WG noted the survey should be focused and keep the questions to a point that is reasonable. The survey should focus on questions about future actions, which may not be conventional management measures. Non-conventional measures (no-targeting, expansion of current gear restrictions) are not things managers often address. A WG member noted gear restrictions don't necessarily benefit all species. The NC Marine Fisheries Commission asked about requiring circle hooks for all species. While it would benefit some species, it would impact other species that are hard to catch with a circle hook or won't have the expected benefit for some species. Another WG member noted educating the public about release mortality is challenging, and there are better ways to communicate how the 9% rate works.

Regarding the survey format, the WG noted the survey would likely be conducted via an online survey link. There was some concern about participation in an online-only survey and the value of proactive outreach like port meetings or webinars to collect information. There was also concern about not getting enough feedback via a survey. There should be background information provided with link to the survey with the same information presented to everyone that fills out the survey. And the WG should carefully consider how folks are identified/grouped in different sectors. Given the time constraints of conducting the survey in the next few months, an online survey makes sense to cover the diversity of stakeholders and how they fish for striped bass.

The WG acknowledged there would not be sufficient time to consult experts on survey design. Logistically, ASMFC could host the survey on an online survey platform and compile/analyze the results. The Board members would be responsible for distributing the survey to ensure stakeholders have the opportunity to participate. Regarding timeline, if the Board approved the survey effort in August, the survey could be live for about a month from mid-August to mid-September. ASMFC staff would then process the responses for WG review prior to the October Board meeting.

Next Step: Three WG members (N. Meserve, D. Sikorski, M. Gary) will draft an initial set of survey questions based on WG input today, and will provide the draft for discussion at the next WG meeting.

Task #2: Gear Restrictions
The WG then discussed task #2 on gear restrictions and the need to identify any other studies, in addition to the MADMF study, that should be considered in the discussion of gear restrictions.

As background, ASMFC staff reviewed the Board's past consideration of gear restrictions in the FMP (Addendum VI and Amendment 7).

The WG noted the MADMF study seems to indicate the conservation benefit may not be as clear for circle hooks as expected. In the late 1990s, early 2000s, Maryland conducted release mortality studies showing benefits of circle hooks based on incidence of deep hooking. Hooks are very complicated, and the style of circle hooks is different than what was used in earlier studies. Bait types and terminal tackle are also different along the coast. WG members will send ASMFC staff the past Maryland studies for reference.

From the MADMF study, treble hooks seem to have the highest mortality rate. A single treble hook on a lure had a lower mortality rate, but double treble hook lures had the highest mortality rate. One question to consider is are there states that have rules on the maximum number of hooks on a lure (maybe just during the spawning season)? There was also worse survival at water temperatures above 75 degrees Fahrenheit. Bait fishing also had a higher mortality rate. The WG noted there is a wide range of predicted mortality from the different lures. The challenge is what is available for anglers to purchase. Barbless hooks are easier on the fish and the angler.

The WG also noted that release mortality also depends on environmental conditions, not just hook type. Even if the hook was set in the lip, there still could be a high mortality rate if water and air temperatures are high.

WG members will identify additional studies on gear restrictions and send to ASMFC staff. The WG will return to the gear restrictions discussion at a later WG meeting.

Task #1: No Targeting Closures
The WG briefly discussed no targeting closures and the potential type of information available from enforcement agencies. M. Appelman will be talking with NOAA Office of Law Enforcement (OLE). The WG suggested reaching out to Caleb Gilbert from OLE who provides reports to the Mid-Atlantic Council and has referred to no-targeting violations. The WG also asked whether contacting the US Coast Guard was needed.

The WG is interested in how many tickets are written for targeting striped bass. However, based on initial information, it seems like enforcement interactions regarding no-targeting violations alone are verbal and not necessarily written citations.

Next Step: WG will request information from MDDNR, PRFC/VMRC, NOAA on no-targeting closures to be discussed at a later WG meeting.

Public Comments

- Will Poston (ASGA) – There is a fine line between asking the recreational community too much on the survey. Focus on the key questions. Focus on the tradeoffs associated with no-targeting vs. no-harvest and public opinions on gear restrictions. Be as specific as possible for the survey.
- Jeff Mercer (RIDEM, Law Enforcement Committee rep for Striped Bass Board) – Coast Guard violations go through NOAA OLE. State enforcement also works in EEZ, and there are a lot of violations for possession and often verbal warnings. The Law Enforcement Committee recently ranked management measures on how enforceable they are, and no-targeting closures were last on that list (i.e., least enforceable). Not sure if any cases have been made in the Northeast on the targeting prohibition. There are challenges with prosecuting this and proving intent.
- Andy Danylchuk – Conducting a UMass lab study on how striped bass respond to capture and handling. This is the second year of data collection, and data should be available on capture-handling. There was also an angler survey distributed from Carolinas to Canada related to perceived threats to striped bass fishery.

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703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

Striped Bass Board Work Group on Recreational Release Mortality Meeting Summary

Webinar
July 17, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

ASMFC Staff: Emilie Franke, Katie Drew, Kurt Blanchard

Other Board Members: Megan Ware (ME, Board Chair), Ray Kane (MA)

Public: Allison Colden, Angela Giuliano, Corrin Flora, Daniel Herrick, Michael Woods, Mike Waine, Ralph Vigmostad, Ross Squire, Tony Friedrich, Will Poston

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the second time on July 17 via webinar. The WG Chair reviewed the four WG tasks approved by the Board and reviewed the WG timeline. After this meeting, the WG will provide a progress update and initial recommendations to the Board on Task #3 on the stock assessment and Task #4 on public scoping at the 2024 Summer Meeting in August. The WG will meet a few more times in August and September to continue working on the WG tasks and develop final WG recommendations. The WG will provide a report to the Board at the 2024 Annual Meeting in October with a summary of all tasks and any recommendations on how the Board should address recreational release mortality based on the findings of the WG tasks.

Task #3 Stock Assessment and Release Mortality

Task #3. Identify assessment sensitivity runs which may inform Board discussion around release mortality (e.g., how low would you have to reduce the release mortality rate in order to see a viable reduction in removals with the same level of effort?). Consider the tradeoff of reducing the release mortality rate vs. reducing the number of releases overall.

ASMFC Staff, K. Drew, reviewed past work by the TC in late 2020 to explore the sensitivity of the stock assessment model to different recreational release mortality rates (TC Memo M21-04). The TC ran the assessment model under five RRM scenarios:

- Base case: 9% rate for all regions and seasons
- Low rate: 3% for all regions and seasons
- High rate: 26% for all regions and seasons
- Seasonal rates: 5% for Jan-June, 12% for July-Dec for both regions
- Regional rates: 16% for the Chesapeake Bay, 9% for the ocean for all seasons

Overall, changing the release mortality rate assumption for the entire time series of the stock assessment changed the scale of the estimates of female spawning stock biomass (SSB), fishing mortality (*F*), and recruitment but did not change the overall trend, or change stock status in 2017. Significant changes to the release mortality rate (i.e., going from 9% to 3% or 26%) resulted in significant changes to the scale of the population, but did not affect the final stock status determination. The higher release mortality rate did result in a stock trajectory where striped bass became overfished earlier in the time series than the other scenarios, but the 2017 stock status was consistent across all scenarios.

The seasonal and regional release mortality rates, which the TC felt were the more realistic scenarios, had minimal impacts on the estimates of SSB, *F*, and recruitment, and minimal impacts on stock status. Therefore, the TC concluded that the model is somewhat sensitive to major misspecifications of release mortality rate, but less sensitive to smaller scale misspecifications. Refining the overall coastwide estimate to reflect regional and/or seasonal differences can be pursued for the next benchmark assessment; it would likely not result in significant changes to population estimates or stock status but could produce minor improvements in the estimates.

To address the Board's interest in the tradeoff between reducing the release mortality rate vs. reducing the number of live releases, ASMFC staff presented three potential questions that the TC could address during the 2024 stock assessment. The WG could recommend the Board task the TC with these (or other) questions related to RRM.

Potential Questions for TC

1. If a reduction is needed to achieve rebuilding, how low would the release mortality rate need to be to achieve that entire reduction through the release mortality rate alone? In other words, if the number of live releases is constant, what release mortality rate applied to those live releases would achieve the reduction?

2. If a reduction is needed to achieve rebuilding, what percent reduction in number of live releases is needed to achieve the entire reduction through live releases alone? In other words, using the current 9% release mortality rate, how many fewer live releases would there need to be to achieve the reduction?

3. If a reduction is needed to achieve rebuilding, what percent reduction in number of live releases under the current 9% mortality rate is needed, assuming there is an associated reduction in recreational harvest due to no-targeting closures?

Staff noted Questions 1 and 2 represent the two extremes of reducing RRM. Question 1 would rely entirely on reducing the RRM rate to achieve a reduction (i.e., decreasing mortality from the fishing interaction), while Question 2 would rely entirely on reducing the number of live releases (i.e., controlling effort). These are hypothetical scenarios which are not necessarily realistic for management implementation but would demonstrate the tradeoff between the two approaches to reduce RRM. Recreational harvest would be assumed constant for these scenarios in order to isolate the reduction to RRM. For all three questions, two iterations could be run for each scenario to account for commercial harvest in the calculations: one with constant commercial harvest and one with an equal reduction for commercial harvest.

The WG asked staff to clarify the difference between the past TC work on sensitivity runs and the RRM rate and the first question regarding how low the RRM rate would need to be to achieve a reduction. Staff clarified that the past TC sensitivity runs looked back in time and applied different RRM rates to the historical time series to address the scenario of if the RRM rate was different in the past, how stock status would be affected over time. These three potential questions for the TC look to the future assuming management occurs to reduce the RRM and by how much RRM would need to be reduced in the next several years to achieve the reduction. The 9% assumption for the historical time series would not change.

For question 3, the TC would need to determine how to best quantify the reduction in live releases from no-targeting closures, which depends on several assumptions including how many striped bass are still caught and released as incidental catch when targeting other species. The WG noted that harvest and effort is not constant throughout the year, so a no-targeting closure (question 3) would have different potential reductions depending on the time of year. Staff noted this is something the TC would have to consider in determining the estimated reduction overall ,and how effort might change under a no targeting closure. It's possible the TC could present a range of estimated reductions depending on assumptions about effort, timing, etc.

Staff also clarified that it's difficult to tease apart why live releases might decrease in the future, either from management or from reduced effort due to reduced availability from weaker year classes entering the populations (i.e., poor recruitment). However, the projection scenarios are hypothetical and a reduction in live releases is achieved to compare to reducing the RRM rate.

The WG supports moving the three proposed questions forward to the Board for potential tasking to the TC. The WG noted these questions would be useful. Staff also clarified this would be a realistic task for the TC to complete during the 2024 assessment, and there is a sub-group of TC members working on the challenge of quantifying estimated reductions from no-targeting closures.

The WG added one additional question to bring to the Board:

> 4. Identify the tradeoffs of implementing no-targeting closures at different times of the year with different assumed release mortality rates. Generally, when/where would implementing a no-targeting closure result in the highest reduction? Factors could include water temperature and salinity with the assumption that the release mortality rate is higher when the water temperature is high and the salinity is low.

For example, if we close during a time when RRM is less than 3%, is it worth a closure during that time? If we close during a time when RRM is high, are there more savings? The WG noted any guidance from the TC on the best use of no-targeting closures to achieve reductions and the different factors to consider would be helpful. Staff noted the TC may not be able to provide a perfect answer but could perhaps provide a tool to understand different factors like length of closure, time of year, and associated RRM and what may be feasible management options. A WG member noted past Maryland conservation equivalency proposals applied methodologies to quantify the impact of no-targeting closures and circle hook implementation and could be used as a starting point.

Next Step: Recommend the four questions to the Board for potential TC tasking via WG memo for August meeting.

Task #4: Public Survey

The WG continued discussion on this task from the June 24 WG call. Staff reviewed the origin of this task again, which emerged from the possible scenario of the Board considering management action via Board vote (i.e., no addendum process) in October 2024, or shortly after, if the 2024 Stock Assessment Update indicated a reduction to achieve rebuilding was necessary. If that were to occur, public scoping completed prior to October could provide the Board with public input on measures to address RRM as the Board considered that action. A survey would need to be conducted from about mid-August to mid-September in order to gather and process the information prior to the October Board meeting.

Since the first WG call on June 24, three WG members drafted survey questions for WG discussion. The draft survey questions incorporated several issues associated with these types of measures into the questions, including angler response to closures, voluntary vs. mandatory gear restrictions, equity, enforceability, ability to quantify impacts, and general level of support for these types of measures. The survey questions also asked for information about survey participants such as where they fish, what type of recreational stakeholder they identify as, how frequently they target striped bass, and why they release striped bass (preference vs. regulation).

WG members generally supported the progress on the survey questions and continue to support the idea of a survey but expressed additional concerns about the proposed fast timeline to potentially conduct a survey starting in August. The WG noted they are not survey design experts, and this is a very important issue that the Board may want additional input on to develop the best survey possible before taking it out to the public. The WG noted this is a critical, valuable opportunity to gather input from the public on RRM, and the survey should be done right.

WG members suggested potentially extending the timeline for this survey and conducting it this fall, potentially after the October meeting but before the Board takes any action, or a longer-term timeline of conducting the survey in 2025. The Board should also develop an outreach plan to make sure states have a plan in place with resources to distribute the survey to stakeholders.

WG members suggested getting input from the ASMFC Committee on Economics and Social Science (CESS), which may have some members who are experienced with similar surveys, as well as input from the Striped Bass Advisory Panel. If funds are available, the Board could also consider consulting an outside expert on survey design.

The WG decided to pause work on further developing the survey questions until the Board provides guidance on the timeline and other committees/experts can be involved in the process. The WG decided the Board should decide on the timeline and process first, and then the draft survey questions can be further developed and shared with others at that time. The WG did have initial feedback on the first set of survey questions as follows:

- Need for email validation and/or gather additional personal information from participants to ensure only one reply per person. Could ask for name, city, state. Validating emails would be the most effective.
- Original goal of 15 minutes for a participant to complete, but this might be too long. Consider a goal of 5-10 minutes. We want to be comprehensive but unrealistic to try and collect a complete view of what people think of the fishery. Shorter is better. Focus on the areas where we want impact.
- Concern about leading questions. For example, the questions state there is a concern about enforcement rather than letting the participant express their concerns about no-targeting closures.
- Emphasize that MRIP data are estimates of harvest and release numbers. They are not absolute, these are estimates.
- We should think intentionally about how we ask stakeholders to identify themselves (private, for-hire, shore-side).
- The topics of fish handling and gear restrictions should be separate.
- Question about how angler behavior would change with a no-targeting closure is difficult because the answer could depend on when the no-targeting closure would occur. If striped bass were the only species available, that would mean one answer. But if there were other species available to target, the answer might be different.

Next Step: WG recommend the Board extend the survey timeline and identify people to involve in the process (possibly CESS, AP, outside experts if Board desires and funds allow).

Public Comments

- Will Poston (ASGA) - Appreciate including the broader industry (e.g., tackle shops), in addition to people who are actually fishing. Consider asking the broad question of if a reduction is needed, what is the preference/trade-off of the ability to target striped bass throughout the year vs. the ability to harvest at certain times.

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703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

Striped Bass Board Work Group on Recreational Release Mortality
Meeting Summary

Webinar
September 3, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

Other Board Members: Megan Ware (ME, Board Chair)

Public: Abby Remick, Angela Giuliano (MDDNR), Chris Moore, Jeff Mercer (RIDEM), Lynn Fegley (MDDNR), Mike Waine, Ross Squire, Tony Friedrich, Will Poston

ASMFC Staff: Emilie Franke, Toni Kerns

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the third time on September 3 via webinar. The WG Chair reviewed the four WG tasks and the WG timeline. The WG will meet three more times during September and compile the WG report to the Board for the October 2024 Board meeting. The WG report will include a summary of all tasks, and any recommendations on how to address recreational release mortality for Board consideration.

TASK #1 STOCK ASSESSMENT AND RELEASE MORTALITY

Task #1. Review existing no-targeting closures in state and federal waters, including any information on impacts to striped bass catch and effort as well as their enforceability. Identify potential angler responses/behavior change to those closures.

The WG was presented with information from several jurisdictions that currently have no targeting closures in place for striped bass (Table 1). Each jurisdiction was asked to provide information on their no targeting closures, including the number of tickets written for targeting (if available), general insight on compliance and enforcement, and how anglers have responded to the closure (e.g., switched to other species, not fishing).

The Law Enforcement Committee (LEC) also provided information to the WG regarding their evaluation on the enforceability of no targeting closures, and their insight on how enforcement would identify a trip as targeting striped bass.

For other species, Pennsylvania provided information on a previous no targeting closure for smallmouth and largemouth bass.

Table 1. No targeting closures currently in place for striped bass.

Area	No Targeting Closure Dates
Maine Kennebec watershed	December 1 – April 30
New York Hudson River (above Cuomo Bridge)	December 1 – March 31
New Jersey all marine waters except Atlantic ocean	January 1 – February 28
New Jersey Delaware River and tributaries	January 1 – February 28 April 1 – May 31
Maryland Chesapeake Bay	April 1 – April 30 July 16 – July 31
Maryland spawning grounds	March 1 – May 31
Potomac River Fisheries Commission	July 7 – August 20
EEZ	All Year

Maryland Spring and Summer Closures

M. Luisi presented the following information at the WG meeting. In 2020 as part of Addendum VI conservation equivalency, Maryland DNR implemented no targeting closures for striped bass from April 1 through April 30 (half of Wave 2) and 16 days during Wave 4. In 2020, the Wave 4 closure was August 16 through August 31, and from 2021 onward, the closure is July 16 through July 31. In addition to these closures, Maryland implemented additional recreational management changes: shortened trophy season by delaying start until May 1 instead of mid-April; last day of season changed to December 10 from December 15; private angler bag limit reduced to 1 fish from 2 fish; charter bag limit maintained at 2 fish for charter captains enrolled in the charter electronic reporting system.

DNR reviewed MRIP data for striped bass directed trips, harvest, and live releases to compare effort and removals in Wave 2 and Wave 4 for the five years prior to the no targeting closures (2015-2019) to the four years since the no targeting closures were implemented (2020-2023). Data indicates there was a substantial drop in directed fishing effort for striped bass in Maryland's Chesapeake Bay after No Targeting Closures were established in 2020, as well as more modest increases in directed trips in the adjacent waves. Striped Bass harvest, live releases and total removals estimates also declined after the no targeting closures were implemented, however, other factors (e.g., fish availability, year-class strength, and private angler trip limit changing from 2 fish to 1 fish) are likely influencing these results. It is difficult to determine if anglers were fishing in other states/jurisdictions during the summer closure, however, the two other Bay jurisdictions were also closed to harvest during the Maryland summer closures and. Further PRFC was also closed to targeting. The data do indicate that other Bay species were targeted more heavily during the closures as compared to prior to the closures when striped bass was the most targeted species; the proportion of angler intercepts that indicated "no target species" also increased, and some striped bass targeting still occurred. DNR notes enforcement of the no targeting closures is occurring, but primarily in conjunction with violations of retention. DNR Natural Resources Police (NRP) agrees with ASMFC's LEC that enforcement of no-targeting provisions is challenging.

WG Questions: The WG was interested in how much of a role the 'no targeting' aspect of the closures played in reducing effort vs. if the closures had been only no harvest (i.e., how much does the inability to keep a fish dissuade fishing?).

Regarding the MRIP data, the WG noted there was a higher percent of angler intercepts indicating "no target species" during the years with the closures vs. the years prior to closure implementation. The WG also noted the potentially high PSE of these Wave-specific data and curiosity about the number of intercepts. DNR staff noted there is uncertainty, but the use of MRIP data has been consistent throughout this process.

The WG asked about displacement of effort and the potential for effort to be displaced to other times of year due to these closures. DNR noted the analysis did not look at trips by wave for the entire year, but noted the summer closure is only two weeks in the middle of a two-month wave so anglers could still take their trip during Wave 4 even if displaced by the closure.

Potomac River Summer Closure

A law enforcement Officer from the Virginia Marine Police provided written correspondence to ASMFC staff with insight on the Potomac River summer no targeting closure (also implemented in 2020), which is summarized here. It is difficult at times to determine compliance because other game fish can be caught using similar methods. Enforcement is not seeing a lot of boats actually trolling like they would see during normal seasons. Closures are affecting the law abiding anglers who follow the rules. The Officer does not believe it has any effect on those who are frequent violators or those who are knowledgeable enough to avoid detection. The Officer noted that no targeting closures are nice on paper, but are next to impossible to enforce. Anglers who know the area can state that they are fishing for other species using the same methods. All summonses were the result of direct confessions when approached by the officers. These anglers were usually from outside the area and claimed ignorance of the law. The Officer again noted it is a very difficult to enforce.

Maine Winter/Spring Spawning Closure

M. Ware presented the following information on Maine's no targeting closure in the Kennebec River watershed during winter and spring. The closure was established in 1990 to protect the spawning population of striped bass in Maine's Kennebec River. The no targeting closure is from December through April. From May to June, catch and release is allowed using hook/line with a single artificial lure, and during this period, it is unlawful to possess or use bait while hook and line fishing for *any* finfish species (and possession of this gear with bait is prima facie evidence of violation). It is important to note the closure is primarily in the winter and early spring, so recreational effort is low at that time. The closure is also in a specific river system, where species diversity is relatively low (i.e., striped bass is the primary target), and there is strong public buy-in to the measure. DMR enforcement communicated that the recreational community has demonstrated an awareness of the closure so there have been very few violations. DMR enforcement also communicated that the measure has been overall relatively enforceable, and summonses have been written and successfully adjudicated in the past. The strong public buy-in has been very important.

New York Winter/Early Spring Spawning Closure
M. Gary provided insight on the New York Hudson River closure during the winter and early spring. The Hudson River no targeting closure for striped bass is north of Cuomo Bridge. DEC staff noted the closure has been in place for a long time, although staff have been recently emphasizing it. Compliance generally seems good, and the Hudson is unique in that there aren't other similar species to fish for during the closure. Anglers could maybe say they were fishing for catfish or carp, but enforcement officers would know better based on their techniques. When the Hudson season was shortened in 2015 to an April 1 start date from the previous March 15 start date (i.e., extending the no targeting closure until April 1), most folks complied with the new rules readily. New regulations always take some time to "kick in" as people were used to the same regulations for decades. DEC staff noted if new no-targeting rules are to be effective, they would have to be widely publicized so there is a foundation of familiarity and community support and for the rules to be effective quickly. Easy-to-understand public outreach explaining the actions would help.

DEC noted any enforcement charges would be for either illegally taking or illegally possessing protected fish. There are multiple enforcement regions covering parts of the River depending on how far upstream you are. DEC also noted the genesis of the closure was from inland fisheries, and other inland species have similar closures as well.

New Jersey Winter and Spring Spawning Closure
New Jersey DEP staff coordinated with New Jersey Bureau of Law Enforcement (BLE) to provide written correspondence to ASMFC staff with insight on the winter and spring closures in New Jersey. Since 1991, the no targeting closure has been in place from January 1 through February 28 for all non-ocean waters, and from April 1 through May 31 for the spawning closure in the Delaware River. BLE reported that compliance on the take of striped bass during the closure is generally good, but compliance for not targeting striped bass is hard to determine since proving intent is very difficult. Due to the difficulty of proving intent, BLE generally issues warnings for targeting, whereas summons for possession during the closed season range from 1–19 per year since 2018. BLE reiterated how difficult it is to enforce no-targeting closures because people still fish during the closure and can say they are fishing for other species. This is very common, especially on nice weather days during the January-February closure and/or after a long winter during the spawning ground closure. BLE noted that no-targeting closures may sound good on paper but out on the front lines it is a different matter altogether.

NOAA Fisheries Year-Round Exclusive Economic Zone Closure
M. Appelman presented the following update on information gathered from NOAA Fisheries Office of Law Enforcement (OLE) on the EEZ closure. After discussions with OLE Officer Caleb Gilbert, who also provides enforcement updates to the Mid-Atlantic Council, there don't seem to be any striped bass "fishing" violations being issued where "possession", "harvest", or

"retention" wasn't also identified. In other words, written violations for targeting alone without possession seem very rare. The WG could pursue a FOIA request to obtain a more comprehensive history of striped bass violations over a specific time period, but this does not seem worth pursuing. It was acknowledged that some illegal targeting and harvest is taking place in the EEZ, but input from both state and federal officers indicate that compliance is good overall, aside from some bad actors and a few hot spots. The general sentiment among officers is anglers know the rules by now, since the ban has been in place for nearly 35 years, which greatly improves compliance.

WG Questions: The WG noted that state law enforcement officers are deputized to enforce federal waters regulations, and all reports from state officers and the US Coast Guard are sent to NOAA Fisheries OLE for potential charging. So NOAA Fisheries is the data source for all federal waters violations. The WG also noted the period during the early 2000s when there were many federal waters violations for striped bass when striped bass were schooling tightly off the mouth of the Chesapeake Bay, and that scale of striped bass availability in the same area is not the same as it used to be.

Pennsylvania Closure for Smallmouth/Largemouth Bass

C. Batsavage presented a summary of the Pennsylvania no targeting closure for smallmouth and largemouth bass provided by PA Board member K. Kuhn. From 2012-2018, a no targeting closure for smallmouth and largemouth bass was in place from May 1 through mid-June in the Susquehanna and Juniata Rivers and tributaries. The no targeting closure was intended to reduce angling related stress during the spawning period. The no targeting closure was removed in 2018. It was noted that the closure was not intended to be permanent, and the Pennsylvania Fish and Boat Commission received a number of complaints stating that anglers are violating the closed season and the regulation is largely unenforceable. Additionally, new data indicated that species recovery benchmarks had been met allowing removal of the closed season regulations.

Law Enforcement Committee (LEC) Input

The LEC provided written correspondence to the WG summarizing their evaluation on the enforceability of no targeting closures, and their insight on how enforcement would identify a trip as targeting striped bass.

The LEC noted their *Guidelines for Resource Managers on the Enforceability of Fishery Management Measures* lists targeting prohibitions as the least enforceable of the 27 measures considered in the Guidelines with an average overall rating of 1.87 (1=least enforceable; 5=most enforceable). A targeting prohibition is defined as a regulation that prohibits the act of fishing for a particular species, to the exclusion of effort to catch other species. Further, the Guidelines note that enforcement would require a level of physical observation and surveillance beyond the scope of most agencies. Any regulation that requires law enforcement to prove the "intent" of a fisher is less enforceable and difficult to prosecute.

The WG Chair asked the LEC how enforcement identifies a trip as targeting striped bass, especially when there is overlap in fishing techniques and locations for other species. LEC consensus is that any regulations that prohibit the targeting of a marine species are resource intensive. The ability to prove the intent of an angler when the techniques used are the same as for other species in a shared location is nearly impossible.

Individual LEC member comments emphasized the near impossibility of enforcing no targeting without a verbal admission from the angler. It was noted that people who know they are illegally targeting striped bass are prepared to say they are targeting other species, and that those who might admit they are targeting striped bass are not the intentional violators who enforcement is most focused on catching. LEC members noted examples of the difficulty of proving intent for other species like great white sharks in MA and goliath grouper in FL.

Individual WG Member Comments
The WG discussed key takeaways from the above updates from states, NOAA, and the LEC. Individual WG members noted the following:

- The importance of stakeholder buy-in on compliance rates with no targeting closures. The level of buy-in may differ based on the rationale for the no-targeting closure (e.g., discrete time/area closures to protect spawning fish or address times of higher release mortality vs. more general closures to reduce fishing mortality). Survey questions (WG Task #4) about these rationales could be informative. Having no targeting closures in place as a long-term management measure also benefitted compliance.

- No targeting closures are viewed as more enforceable when there are fewer other species to target and the closures are in discrete times and areas. The ability to implement discrete time-area closures when few other species are available would vary across states.

- The difficulty of teasing out the difference in impacts on the number of releases between no targeting closures compared to if they were no harvest closures. No targeting closures try to address the number of releases directly, but some amount will still occur from targeting other species and non-compliance. No harvest closures do not directly address releases and will convert all catch to releases (except for non-compliance) but likely may reduce some level of effort (and hence catch). The MDDNR data suggest that their no targeting closures have reduced effort, releases, and harvest (again noting the additional impacts of the other regulatory changes). How would those reductions have differed if the closures were no harvest instead of no targeting?

- MDDNR noted their intention to continue exploring no targeting closures given changing water quality and environmental conditions. There are concerns that the FMP won't give credit for no targeting closures beyond that given for no harvest closures. MDDNR is concerned with how to move forward with no targeting closures to get credit without other states having to also implement them. In Maryland waters, the benefits of no targeting closures seem to be worth it and have a measurable effect. No targeting closures may not be for everyone, but seem to be working in Maryland.

- That there are specific places and times where no targeting closures are useful, and there seems to be a difference between compliance and enforcement. The state updates indicate compliance is pretty good, but it cannot be enforced. The WG is interested in exploring what type of language would help enforcement, and is interested in Maine DMR's language about terminal tackle (if tackle X is onboard, then you can be charged). However, this will not be effective in areas like the ocean when there are other species that could be targeted.

- In areas with less diverse fisheries, no targeting closures are easier to apply.

- How labor-intense it is to enforce no targeting closures.

- The Board may not want to be labeled as a group pursing management measures that are not enforceable, but we cannot use that as an excuse to ignore angler actions. A regulation may not need to be enforceable. We are on a precipice with striped bass, and in that particular instance we need every available tool to reduce mortality. Regardless of how enforceable something should be, we should endorse the concept of putting forward every tool in the toolbox. Something could be unenforceable but still have a benefit in reducing mortality because there is a portion of the angling community that wants to follow the law and will comply. There will also be anglers that aren't following the rules, but a large number of anglers may still stop targeting there would be a reduction in mortality. Even if regulations are unenforceable, they still might have a positive benefit of reducing mortality. The question is for the Board, but the idea should not be thrown out entirely, regardless of enforceability.

- The importance of considering displacement of effort, which there was some evidence of in the MDDNR presentation. If effort is displaced to a time period when the release mortality rate is improved, there is a benefit. But if increasing effort is displaced to a period with a worse or the same release mortality rate, there is not as much benefit from the closure.

WG Next Step: C. Batsavage, M. Appelman, and N. Meserve will start drafting report content on Task #1.

UPDATE ON TASK #4

Regarding Task #4 on public scoping, members from the Committee on Economics and Social Sciences (CESS) will provide input on draft survey questions as well as discuss the survey approach overall. Currently, the approach is similar to a public comment process but in survey format. This could result in input on no targeting questions, but it would not be a random sample of the angling population at large so we could not draw any quantitative or population-level conclusions. The CESS members will outline other possible approaches (e.g., random survey) and pros/cons/resources/timeline on the September 20th call. Materials will be sent around prior to the call.

UPCOMING CALLS AND TIMELINE

- Thursday, September 12 from 1:00pm-3:30pm: Task #2 gear restrictions, MADMF study summary, other studies; continue Task #1 no targeting discussion as needed
- Friday, September 20 from 9:30am-12:00pm: Task #4 survey, CESS survey experts
- Tuesday, September 24 from 9:30am-12:00pm: Wrap-up on all tasks and WG recommendations
- Friday, September 27 internal WG deadline for report to review
- October 4 deadline for Main Meeting Materials

Atlantic States Marine Fisheries Commission

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

Striped Bass Board Work Group on Recreational Release Mortality Meeting Summary

Webinar
September 12, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

Public: Ben Gahagan (MADMF), Micah Dean (MADMF), Jeff Mercer (RIDEM, LEC striped bass representative), Brendan Harrison (NJDEP), Corrin Flora (MEDMR), Jesse Hornstein (NYDEC), Maxwell Kleinhans, Michael Woods, Mike Waine, Tony Friedrich, Will Poston

ASMFC Staff: Emilie Franke, James Boyle

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the fourth time on September 12 via webinar. The WG Chair reviewed the four WG tasks and the WG timeline. The WG will meet two more times during September and compile the WG report to the Board for the October 2024 Board meeting. The WG report will include a summary of all tasks, and any recommendations on how to address recreational release mortality for Board consideration.

TASK #2 GEAR MODIFICATIONS

Task #2. Review the MA DMF discard mortality study and other relevant reports to evaluate the efficacy of potential gear modifications.

The WG was presented with a review of the Law Enforcement Committee's input on gear restrictions, an overview of the release mortality study currently being conducted by Massachusetts Division of Marine Fisheries (MADMF), and a summary of key findings related to gear restrictions (other than circle hooks) and release mortality from past studies on striped bass and other species.

Law Enforcement Committee (LEC) Input

The LEC's *Guidelines for Resource Managers on the Enforceability of Fishery Management Measures* rates gear regulations and method of take as 3.42 and 3.37, respectively, on a scale of 1 as least enforceable and 5 as most enforceable. Gear regulations are regulations in which specific gear types or gear modifications are restricted or prohibited. A method of take regulation stipulates a particular type of gear or fishing operation for legally harvesting a species. For both types of measures, the LEC recommendations note that when considering specific gear restrictions within the recreational sector, such as terminal tackle in a hook and line fishery or prohibited use of a "gaffing" type device to retrieve a specific species of fish, officers must prove use of said equipment. The possession is not typically a violation unless possession on board a vessel or possession while fishing is articulated in the regulation.

For gear regulations, the LEC recommendations also include the need to standardize gear requirements, measurement procedures, equipment, and techniques across all appropriate jurisdictions and time periods.

For the WG's consideration, the LEC also emphasized that regulations should avoid frequent changes. When a change does occur, there must be a concerted outreach and educational effort to adequately inform the public. This principle especially applies to recreational angling. As an example, the Striped Bass Board just went through this process for circle hooks and needed to define bait and exemptions to the rule (i.e. "Tube and Worm") after the regulation had been implemented. The LEC also emphasized that effective regulations should promote rather than hinder voluntary compliance.

In addition to the LEC input, C. Batsavage relayed information gathered from North Carolina's enforcement representative on gear restrictions that are currently implemented for other species (e.g., circle hooks required to harvest shark species; single, barbless hooks required in the Roanoke River to protect striped bass spawning, circle hooks required in the Pamlico Sound adult red drum fishery). In addition to the specific gear being used, enforcement can consider other gear and fishing techniques to determine whether an angler is targeting a species that requires a certain gear. NC enforcement emphasized the need for straightforward regulations that are clearly written, and noted the longer regulations are in place, the easier it is for enforcement. Although there may not be many citations written for all gear restrictions, enforcement also provides compliance assistance to help anglers understand the regulations and learn how to come into compliance instead of immediately issuing a citation. NC enforcement cautions managers to consider certain types of gear restrictions, notably any requirements for hook size since hook sizes are not uniform across brands and manufacturers. They also caution regulations that are resource-intensive for enforcement (i.e., require a lot of time for enforcement to determine whether an angler is in compliance).

WG Question: Why is having to prove intent/targeting not specifically included as a component of the LEC guidelines on gear requirements?

- J. Mercer noted targeting is a concern when determining compliance with using circle hooks and bait when fishing for striped bass. There are the same challenges discussed with no targeting closures regarding difficulty to prove intent. It is easier to enforce this requirement for possession. The Amendment 7 requirement that striped bass caught on any unapproved method of take must be returned to the water immediately without injury gives an 'out' for catch-and-release fishermen who catch striped bass with a non-circle hook; they can release the striped bass and say it was incidental catch.

MADMF Study on Release Mortality

B. Gahagan presented an overview of the MADMF study on evaluating post-release mortality for striped bass. The study includes three phases to develop a release mortality rate for striped bass:

1. Telemetry study, which tagged 350 striped bass over two years 2020-2021 to quantify difference in J-hook and circle hook mortality. They developed a model to estimate the probability of mortality based on a condition score ranging from no injury to dead fish. Guidelines were developed to keep condition scoring consistent.
2. Citizen science study to determine what factors affect condition, knowing that condition influences mortality. Conducted 2023 and 2024. Several variables are being considered, including biological characteristics of the fish, what type of fishing, and environmental factors. Many of these variables are interrelated.
3. Angler Tackle Configuration Survey coming in 2025 to describe variables for the fishery.

For the citizen science dataset, over 6,000 fish were reported for the study. Most fish reported were from Massachusetts anglers, and vast majority of fish from New England. Anglers have reported various tackle types, with a majority spread between bait, midwater lures, and surface lures. Other tackle types used were bottom lures and flies. There is variability in bait and tackle use by region, and the prevalence of different bait types and tackle along the coast is important to consider. Certain bait types have higher mortality rates, like mackerel, for example, which is only typically used from MA north. The future angler survey will be important to understand how often these different tackle types and baits are used.

There are three main factors that affected release condition: vitality (swimming ability upon release), injury (like amount of blood), and hooking location (mouth, body, esophagus, stomach, and gill). Release condition is the worst for fish hooked in the stomach or gills. Mortality is higher for fish in a worse condition.

Each of the three main factors is influenced by several variables, and the interaction of these variables needs to be considered. The first key takeaway is tackle and lure choices impact release mortality. Bait has the highest mortality rate, followed by surface lures; flies have the lowest mortality rate. For lure-hook configuration, a single hook lure had the lowest mortality and double treble hooks had the highest mortality. Fishing stress seems to be an important factor with mortality increasing as fight and handling time increase. Increasing fish length and water temperature indicate increasing mortality, but there are several interrelated variables to consider. For example, swimming ability is also impacted by water temperature, and fight time and handling time both increase with fish size.

Regarding project timeline, the citizen science data collection ends in December. Analysis of mortality rates is expected to occur in early 2025. Tackle configuration survey expected to occur in 2025 over 5-6 states. The telemetry portion of the study was recently published (Dean et al., 2024). Additional publications are expected for 2026.

These are preliminary results with more data incoming and statistical analysis to be conducted. Overall, the study found mortality rate is directly related to release condition. Release condition appears to be influenced by fight and handling times, hook number, type, location, and water temperature. There are a lot of correlated variables, and analysis is required to tease apart effects. Regulations may not be most effective tool for all factors (e.g., handling time). Information and outreach can effectively be applied to all important factors. Mortality rates decrease as angler experience increases, so outreach and education is important to change behaviors.

WG Questions: Several questions were asked by WG members and MADMF staff provided the following clarifications and information:

- Anglers participating in the study do receive information on how to classify striped bass condition, and reviving fish is being attempted by anglers.

- Regarding lighter tackle and fish time, fly has the lowest mortality rate, which includes variables like fight time and handling time. It does not appear that fighting and handling time makes a certain gear a higher risk choice.

- Difficult to separate impacts like gear type on fish size. The key theme is there are a lot of variables to consider simultaneously, and this gets more difficult with smaller sample sizes. For fish caught on fly, the upper size classes are missing as most observations are 15-30 inch fish. For other tackle types, larger fish were caught.

- Fight time is somewhat longer for flies (avg = 95 sec) than other lures (avg = 83 sec) in the MADMF dataset, but bait had the longest fight time (100 sec).

- A separate component of the MADMF study was the telemetry tagging study to model release mortality. 350 striped bass were tagged over two years to model release mortality and what factors affect release mortality rate. They can apply the model to any tackle choice.

- Fish that were marked as dead in the tagging study were confirmed to be dead.

- No matter the hook choice, multiple hooks on lures are more harmful to fish. Mortality increases with double hook lures compared to single hook lures. The greatest increase in mortality is seen from double treble hook lures. The second largest increase is between a single hook lure and a single treble hook lure. Results indicate that having one hook on your lure is best, and double treble hooks is worst.

- Cannot define statistical significance as this point. Analysis is forthcoming. There are many correlated variables. For example, the relationship between lure size and size of fish, and large fish and fight time. MADMF staff need to tease apart the marginal effect of a hook beyond fight time or handling time. These results are being shared at this point to communicate back to the community who participated in the study.

Past Studies on Gear Restrictions

E. Franke presented an overview of key findings regarding gear type (other than circle hooks) and release mortality for past studies on striped bass and other species. This was not a full literature review. As a starting point, staff reviewed studies that had been previously referenced in ASMFC documents and then reviewed other related studies to identify key findings regarding gear type. Findings related to circle hooks were not summarized since the FMP circle hook requirement is already implemented. Staff noted that gear type is only one factor affecting release mortality. Several other factors affect striped bass release mortality including hooking location on the fish (often related to gear type), temperature, salinity, and angler experience (Diodati & Richards 1996, Lukacovic & Uphoff 2007, Millard et al. 2000, Millard & Mohler 2005, Nelson 1998, RMC 1990).

A summary of key findings from other studies regarding gear type and release mortality are enclosed as an Appendix to this meeting summary.

Current Ongoing Study at UMass Amherst

At the June 2024 WG meeting, Dr. Andy Danylchuk (University of Massachusetts Amherst) made a public comment noting his current work on striped bass release mortality. They study is led by Dr. Danylchuk and Dr. Lucas Griffin of UMass Amherst. The objective of the study is to quantify the short-term activity patterns, behavior, and mortality of striped bass caught in Massachusetts across a range of angling techniques, environmental settings, and life history stages. The study is using a rapid assessment approach that combines quantifying detailed metrics of angling events, indices of reflex impairment once striped bass are landed, and measuring short-term activity patterns and mortality following release. The study is applying the 'Research Angler' model working side by side anglers to do the science. Currently, the second year of project data are being analyzed.

In addition to the release mortality study, Dr. Danylchuk also recently conducted a survey of recreational anglers to learn about perceptions and beliefs about the striped bass fishery.

The project team is tentatively planning to provide a brief presentation to the WG at the September 24 WG meeting.

Individual WG Member Comments

The WG discussed key takeaways from the release mortality studies and discussed factors the Board should consider regarding gear restrictions and lessons learned from implementing the circle hook requirement. Individual WG members noted the following:

- Recent study information suggests considering management measures for lure-hook configurations. Maryland already prohibits using bait on a treble hook, as an example of this type of measure already in place in other states.
- The MADMF study has not completed the formal statistical analysis to determine significance, so there should be caution on what conclusions are brought to the full

Board at this time. There should be an understanding that the current results may not have the statistical backing after analysis is complete. The Board should make decisions on sound science and not something that has not been fully analyzed.

- There are a lot of variables to consider, and it is hard to isolate one particular gear to get the most bang for buck. The Board should consider bang for buck for potential gear restrictions. For example, if only a small number of users employ a particular gear type, is that type of regulatory requirement worth the effort?

- Implementation was not as simple as we thought for circle hook requirement and we had to spend time dealing with the fallout.

- Treble hooks are most problematic. Could support eliminating treble hooks altogether. Maryland has already eliminated treble hooks with bait, but has not eliminated treble hooks with artificial lures.

- Recognize that new gear restrictions are not going to change the release mortality rate used now, and we may not be able to quantify the regulations. However, not using treble hooks with bait would be an improvement.

- Could not support mandating removing a single treble hook and replacing it with a single J hook. Management decisions cannot be based on the preliminary results of this study and just a 'feel-good' mentality.

- Any WG recommendation does not preclude states from implementing gear restrictions as they see fit in states/areas. The WG can note this in the report.

- Torn between waiting until final completion of the MADMF study to consider gear measures, as the findings are compelling.

- Board should consider the impacts to the industry of any potential gear modification from the perspective of manufacturer, retailer, tackle store, etc. There may be more to consider from these perspectives.

- Potential restrictions that could be discussed are prohibiting treble hooks with bait, prohibiting treble hooks overall, or prohibiting double treble hooks.

- Board should consider enforceability and how these types of gear restrictions would interact with management of other species. Anglers may be fishing for multiple species and it could be difficult to have restrictions that only apply to one species.

During the WG discussion, MADMF staff commented that their current study results are beyond raw data. The study has applied the peer-reviewed model to the citizen science data that has been collected, but statistical significance tests have not been done yet. They noted the difference between hooks is real, and they have good sample sizes. It may not take much of a difference between mortality rates to have significant results.

WG Discussion on Potential Consensus Statement

The WG attempted to develop a consensus statement to provide to the Board on gear restrictions, but consensus was not reached. Some WG members support the following statement: *If the Board were to consider additional gear restrictions, hook configuration on a lure is a good place to start for management.* Rationale included that this is a logical starting point based on the current MADMF study results to reduce release mortality. It was noted that for any management measure considered, all implications must be considered (e.g., impacts to tackle industry).

However, some WG members do not support that statement. They noted they could support continued focus on data for hook-lure configurations from studies, but they could not support management consideration of new gear restrictions at this time. Rationale included the preliminary nature of the MADMF study results without statistical significance analysis and the unknown bang-for-buck associated with specific gear restrictions at this point (i.e., only a small portion of anglers may employ a certain hook-lure configuration).

The above comments from individual WG members indicate a difference of opinion on the value of pursuing gear restrictions via regulatory requirements at this time.

Next Step: A. Nowalsky, M. Luisi, and C. Batsavage begin drafting the WG report content for this task. Follow-up discussion on future WG call as needed.

UPCOMING CALLS AND TIMELINE

- Friday, September 20 from 9:30am-12:00pm: Task #4 survey with CESS members
- Tuesday, September 24 from 9:30am-12:00pm: Potential presentation from UMass Amherst on release mortality study; wrap-up on all tasks and WG recommendations
- Friday, September 27 internal WG deadline for report to review
- October 4 deadline for Main Meeting Materials
- October 11 deadline for Supplemental Materials (if needed)
- October 23 Striped Bass Board Meeting

PUBLIC COMMENTS

Mike Waine from the American Sportfishing Association (ASA) noted gear restrictions are a topic of interest for ASA, particularly for gear manufacturers and retailers. The Board has previously discussed education campaigns to try to improve release mortality from an education standpoint. He asked the WG whether this will be part of the WG report? If there isn't a firm recommendation for making gear changes, is there plans to make a recommendation around education campaign that would help anglers understand what the status of the science is and consider making some of those gear changes on their own? If the Board is not ready to make a regulatory change and the science is not ready to support that, perhaps education, outreach and awareness is the way to go. If a regulation is implemented, you'll need a ton of education and outreach to get the outcome that you want to achieve. Do not see any issue starting sooner rather than later on outreach, and the industry would rally around that.

- M. Luisi noted support for including a point on education and outreach in the report. He noted that in addition to the Board potentially considering a terminal tackle or gear modification as a management action, this information from the release mortality studies is good information for states and ASMFC to consider advocating best management practices.
- C. Batsavage and E. Franke noted the WG may revisit this topic if desired at the upcoming WG meetings.

Will Poston from the American Saltwater Guides Association (ASGA) noted ASGA is already conducting outreach based on the results of the MADMF study and working with fishing tackle manufacturers.

Appendix. Key Findings from Past Studies on Gear Types (other than circle hooks) and Release Mortality

Note: This is not a comprehensive overview of all findings from each study. This description highlights findings from each study specifically related to the impacts of gear type and fish handling on release mortality.

Studies on Striped Bass

Diodati and Richards (1996) conducted a study on striped bass in Massachusetts. They found gear type (1-3 treble hooks on lures vs. single hooks with bait or jig), anatomical site of hooking, depth of hook in oral cavity, and angler experience to be significantly related to release mortality. The highest mortality was associated with single hooks, hooks deep in the oral cavity, and inexperienced anglers. They found hook size, handling technique, release technique, and time from hook to release were not significantly related to mortality. However, it was noted that handling/release was correlated with angler experience.

Nelson (1998) conducted a study on striped bass in the Roanoke River, North Carolina. He found hooking location and water temperature to be significantly related to mortality. Hooking location was significantly different between gear types, with 14% of fish caught on live bait hooked in sensitive locations (e.g., esophagus, gills) vs. 3% of fish caught on artificial lures hooked in sensitive locations. The study notes this suggests increased mortalities when live bait is used. There was no significant difference in mortality between live bait and artificial lures. Combined landing and handling time was not significantly different between bait and lures, although the results suggest some influence of handling time on mortality. If there are different fight or handling times between gears, this can confound observed mortality differences between gear types. The study did not find a significant relationship between mortality and fish length. The study encourages fishing methods with low incidence of deep hooking to reduce injury-related mortality.

Wilde et al. 2000 conducted a meta-analysis of seven striped bass release mortality studies in freshwater. Two studies were striped bass in the Susquehanna River/Flats (RMC 1990, Lukakovic & Florence 1998) and one study was striped bass in the Roanoke River, NC (Nelson 1998). The remaining four studies were conducted in lakes or reservoirs across Tennessee, Texas, Oklahoma, and South Carolina. The study modeled the effects of bait type and water temperatures on mortality and found both variables to be significant, with water temperature explaining more variation than bait type. Mortality was higher for natural baits vs. artificial tackle. There was a small mortality difference between bait and artificial at lower temperatures, but that difference increased rapidly at higher temperature above 16 degrees C. The study found no significant relationship between fish length and mortality. The authors encourage fishing/handling techniques to minimize stress and note the need to inform anglers on using natural bait vs. artificial.

Studies on Other Species

Muoneke & Childress 1994 conducted a review of many studies for several taxa on multiple factors impacting release mortality. They found mortality was high when fish are hooked in vital organs. Single hooks with natural baits had higher mortality than treble hooks, but some there was some variability across studies and some studies indicated no difference at all. Natural baits are often swallowed more deeply, so they are associated with higher mortality than artificial lures and flies. The impacts of barbed vs. barbless hooks had varying results for different species. The degree of handling depends on many factors including fish size, angler experience, terminal gear, etc., and environmental conditions also affect mortality, notably high water temperature and low dissolved oxygen.

Taylor & White (1992) conducted a meta-analysis of eighteen studies for non-anadromous trout. They found higher hooking mortality for bait vs. artificial flies or lures, and higher hooking mortality for barbed hooks vs. barbless hooks. There was a significant correlation between fish hooked in critical locations and mortality. There was only a few percentage point difference in mortality for barbed hooks vs. barbless hooks when on a lure or fly, but a larger difference for barbed vs. barbless hooks when using bait. They did not find a significant relationship between mortality and the number and size of hooks.

Nuhfer & Alexander (1992) conducted a study on brook trout in Michigan. They found a higher hooking mortality for treble vs. single hooks, and noted it took more time to unhook treble hooks and those hooks resulted in more tissue damage. Of fish hooked in the gills or esophagus, over 70% caught with treble-hook lures died as compared to 50% of those caught with single hooks. They noted the probability of hooking in gill/throat, heavy bleeding, and mortality increase with larger fish. They also found higher mortality with higher water temperatures, especially if heavy bleeding occurred.

Schaefer & Hoffman (1992) conducted a multi-species study off the coast of St. Petersburg, Florida in the Gulf of Mexico. The majority of species caught were sand perch, blue runners, grunts, and grey triggerfish. They found mortality was influenced by anatomical hook placement, severity of injury or bleeding, and hook extraction times. In comparing barbed vs. barbless hooks, they found barbed hooks landed more fish but barbed hooks had longer unhooking time. They did not find a difference between barbed and barbless hooks for anatomical hook placement and bleeding since most fish in the study were hooked in the jaw. They found that barbless hooks reduced unhooking injuries. Overall for their study fishery, they noted barbless hooks may confer only slight benefits at the expense of reduced catches. They also noted the small sample sizes and narrow size range of fish in their study.

Matlock et al. (1993) conducted a study on red drum and spotted seatrout in Texas Bays. They compared single barbed hooks vs. treble hooks, and natural vs. artificial baits. They found no significant difference in mortality between hook types or bait types for both species. They did note overall low hooking mortality for both species.

Malchoff & Heins (1993) conducted a study on weakfish in Great South Bay, New York. They compared single barbed hooks with natural bait vs. single barbed hook with artificial lures. They found no significant difference between bait and artificial lures. They noted that the study used small hooks on small fish.

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Atlantic States Marine Fisheries Commission

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

Striped Bass Board Work Group on Recreational Release Mortality
Meeting Summary

Webinar
September 20, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

Committee on Economics and Social Sciences Members: Robert Murphy (NOAA), Jorge Holzer (UMD), Syma Ebbin (CT Sea Grant)

Other Board Members: Megan Ware (ME, Board Chair)

Public: Beth Versak, Charisma Daniel, Corrin Flora, Delmarva Fisheries Association, Harry Hornick, Jesse Hornstein, Jim Uphoff, Jordan Zimmerman, Micah Dean, Mike Waine, Ross Squire, Sarah Cvach, Shannon Moorhead, Tony Friedrich

ASMFC Staff: Emilie Franke, Katie Drew, Kurt Blanchard

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the fifth time on September 20 via webinar. The WG Chair reviewed the four WG tasks and the WG timeline. The WG will meet one more time during September and compile the WG report to the Board for the October 2024 Board meeting. The WG report will include a summary of all tasks, and any recommendations on how to address recreational release mortality for Board consideration.

TASK #4 PUBLIC SCOPING

Consider public scoping on measures to address release mortality (e.g., online public survey ahead of the October Board meeting).

The WG revisited Task #4 following the Board's August decision to delay the timeline for developing a survey to allow for input from survey experts. Three members of the Commission's Committee on Economics and Social Sciences (CESS) provided guidance to the WG on general survey approaches to consider, as well as high-level comments on the WG's first-draft survey questions.

R. Murphy presented three possible survey approaches for the WG to consider to gather input from stakeholders on measures to address recreational release mortality. Each approach has different benefits and challenges, and the most appropriate approach will depend on what the WG's objective is with the survey.

Possible Survey Approaches

Approach 1 is an open survey, which is also referred to as convenience sampling. This is the WG's current approach to conduct a survey open to any striped bass stakeholders. This approach would provide focused survey responses from striped bass stakeholders on addressing recreational release mortality. The benefits of this approach would be gaining more information on the suite of perspectives across stakeholders relatively quickly with existing resources. This approach could also reach stakeholders who are not necessarily licensed anglers, like tackle shops, for example. Questions could be added to the survey to characterize respondents to some extent (demographics, fishing experience, etc.). The challenge of this approach is the Board could not draw conclusions about the angling population at-large since the survey respondents would not be a representative sample of the population. Respondents will likely be those that typically participate in striped bass public comment periods and follow the management process closely (i.e., specialized striped bass anglers). This approach would be a relatively short-term approach requiring Commission staff time and use of the Commission survey platform; however, potentially significant staff time may be required to process the responses.

Approach 2 is a randomized survey, which would be similar to Approach 1 with the distinction of surveying a random sample of stakeholders, likely a random draw of people who are registered saltwater fishing license holders. The benefit of this approach is the Board would be able to draw some quantitative conclusions that would be more representative of the population than Approach 1, since Approach 2 uses a random sample. One major challenge is that not all anglers have a license and not all states have available license databases (and some license databases may not have email addresses). Additionally, this approach would not cover all stakeholder groups (e.g., tackle shops). The literature has found that electronic survey respondents can be biased toward younger, Caucasian anglers with more specialized experience. This approach would be medium to long-term, depending on how rigorous the survey methodology is, and would require a social scientist to conduct the survey and process the results.

CESS members clarified that one of the primary differences between Approach 1 and 2 is the ability to generalize to the population at-large. You could still get some quantitative information from Approach 1 (i.e., the proportion of survey respondents who support closures), but that result could not be generalized to the larger population because the open survey sample is not representative of the population. For example, responses of those who respond after seeing the survey through a social media blast vs. those who are randomly sampled would be different. Social media is important to consider here and how that will impact who responds to the survey. Approach 2 would be more representative, but there would still be limitations and drawing conclusions to the population at-large would still not be perfect. For example, response rates could be low and there could still be bias in those that do respond to the survey. CESS members also highlighted potential survey fatigue if stakeholders are being asked to complete multiple striped bass surveys for different survey efforts. For example, MADMF is planning to conduct a comprehensive stakeholder survey on terminal tackle use in 2025, so it may be beneficial to not conduct a survey at the same time as the MADMF survey.

Approach 3 is stakeholder focus groups, which would provide comprehensive input from a representative group of stakeholders. The benefits of this approach are focus groups can capture more context from participants as compared to responses to narrow survey questions. The focus groups would paint the landscape of potential stakeholder responses to various regulatory changes. There is potential for some quantitative analysis but would mostly be qualitative analysis. The sample would not be necessarily representative, but the focus groups could try to engage people from major stakeholder groups to capture the range of opinions and possible responses to management measures of interest. One major challenge of this approach is the coordination and execution of focus groups and ensuring a representative group of participants. This approach would be medium to long-term and would require someone to conduct the focus groups and process the input. The person(s) conducting the groups could be advised by CESS members and others.

WG Questions and Discussion

The WG acknowledged there is no perfect approach to capture the complexity of potential stakeholder input, and each approach has its benefits and challenges for gathering information from striped bass stakeholders. CESS members also noted it can be difficult to capture the regional differences in perspectives of striped bass stakeholders, and the need for future work to understand fishing motivations. CESS members noted recreation demand models (RDMs) are an important and powerful tool being used for other species and could be considered for striped bass. A choice experiment survey would inform RDMs, and the past striped bass choice experiment survey could be updated in the future.

The WG discussed that if achieving a representative sample of stakeholder is difficult, it may be more important to get a better understanding of the range of stakeholder responses to these types of management measures. CESS members commented that the initial draft survey questions were written in a way that would be hard for potential respondents to follow, but they could potentially be reframed to Likert style questions (Agree, Disagree) that would be easier to understand.

The WG discussed some concern about an open survey and the potential for respondents to submit multiple responses and the impact of many responses from large interest groups weighting the results. One WG member noted they would not support the use of an open survey as the only approach but could support it if used in conjunction with another approach. One WG member also noted the concern about the randomized survey not capturing all stakeholders may not be a huge issue, as most people in the industry (like tackle shop owners) participate in the fishery, and for-hire captains could provide insight on their customers' perspectives.

CESS members noted that if a survey was conducted prior to focus groups, the survey could ask respondents whether they would be willing to participate in a focus group and provide their contact information to do so. This could help identify more diverse focus group participants that would be harder to find otherwise.

The WG noted the focus group approach would be useful to identify the universe of stakeholder responses to specific measures and to allow for nuanced discussion and responses from participants. For example, understanding angler responses to no targeting closures is a critical piece of information that may be best captured through stakeholder discussion in focus groups instead of a survey. The survey, as currently framed, may not provide as much value since its initial intent was to provide quick input to the Board ahead of potential action in Fall 2024. At this point, there is not enough time to conduct a survey, and narrow survey responses may not provide the understanding of these complex issues the Board is considering. There was also concern that no matter how many caveats are provided around survey results, the results may be misconstrued.

The focus groups could have multiple objectives, including painting the landscape of stakeholder responses to potential management measures and input on how to conduct communication and outreach around those measures. Additionally, if focus group meetings are far enough ahead of the benchmark stock assessment, the Board could consider whether the focus groups should also cover any assessment-related topics the Board is seeking input on (e.g., reference points).

WG Conclusions and Recommendations

The WG agreed on the following conclusions regarding gathering public input on potential management measures to address recreational release mortality:

- A survey does not seem feasible to adequately gather complex information on stakeholder response to management measures, nor will a survey meet the original timeline at this point of gathering public input ahead of potential Board action in late 2024 in response to the stock assessment.

- If the Board is interested in public input beyond this next management action, focus groups could be a useful approach to 1) paint the landscape of potential stakeholder responses to measures being considered to address release mortality (e.g., no targeting closures, gear modifications) and 2) discuss outreach on best fishing/gear/handling practices.

- Conducting an open survey could also be considered, but the inherent biases would need to be acknowledged. Survey fatigue should also be considered. For example, there is currently an open survey of striped bass stakeholders being conducted by Virginia Tech on stock structure and migration patterns, and MADMF is planning to conduct a survey on terminal tackle use in 2025.

- In response to the 2024 stock assessment, and for any management actions, states should continue to do their own internal scoping through their established state processes to understand perspectives from their stakeholders, separate from focus groups.

Ultimately, if the Board wants to gather public input on stakeholder buy-in and potential responses to management measures to address release morality, the WG recommends focus groups as the best approach to collect that information.

If the Board were to proceed with focus groups in the future, the Board would need to address logistics, including who would be leading the focus groups and identifying stakeholders to participate. A focus group approach would likely require significant State staff time on these logistics and planning. CESS members noted they could advise the process, and the Board could consider the benefit of involving a graduate student(s) in the process. Additionally, depending on the timing of focus groups, the Board could consider adding other topics for stakeholder input (e.g., assessment-related topics ahead of the benchmark stock assessment).

UPCOMING CALLS AND TIMELINE

- Tuesday, September 24 from 9: 00 am-12:00 pm: Potential presentation from UMass Amherst on release mortality study; wrap-up on all tasks and WG recommendations
- Friday, September 27 internal WG deadline for report to review
- October 4 deadline for Main Meeting Materials
- October 11 deadline for Supplemental Materials (if needed)
- October 23 Striped Bass Board Meeting

PUBLIC COMMENTS

No public comments.

Striped Bass Board Work Group on Recreational Release Mortality
Meeting Summary

Webinar
September 24, 2024

Work Group Members: Chris Batsavage (NC, WG Chair), Nichola Meserve (MA), Marty Gary (NY), Adam Nowalsky (NJ), Mike Luisi (MD), David Sikorski (MD), Max Appelman (NOAA)

Public: Olivia Dinkelacker (UMass Amherst), Brendan Harrison, Corrin Flora, Evan D, Jesse Hornstein, Michael Woods, Mike Waine, Stephanie Ruiz, Tony Friedrich, Will Poston

ASMFC Staff: Emilie Franke

The Striped Bass Board Work Group (WG) on recreational release mortality (RRM) met for the sixth time on September 24 via webinar. The WG Chair reviewed the four WG tasks and the WG timeline. The WG will compile the WG report to the Board for the October 2024 Board meeting. The WG report will include a summary of all tasks, and any recommendations on how to address recreational release mortality for Board consideration.

TASK #2 GEAR MODIFICATIONS

Task #2. Review the MA DMF discard mortality study and other relevant reports to evaluate the efficacy of potential gear modifications.

O. Dinkelacker from the University of Massachusetts Amherst presented an overview of a striped bass release handling and mortality study that has been ongoing for the past two years in Massachusetts. In addition, an angler survey was conducted to better understand social norms in the fishery that drive individual angler behavior and willingness to adopt best practices and management strategies. The survey had over 1,600 respondents, ranging from New England to the Mid-Atlantic. The results of the studies are intended to help inform targeted education and outreach programs on best practices to increase the probability of survival of striped bass, and to close knowledge-action gaps to promote adoption of science-based best practices when striped bass intended for release are handled.

The field assessment quantified the response of striped bass after capture, handling, and release based on five reflexes measured (at the time of landing and immediately following handling) and the use of accelerometer biologgers to measure activity after release across various angling types and locations. Note that the reflexes used in the study are used quite often in similar studies and have been validated against physiological stresses imposed by angling on fish. The study applied the Research Angler approach with the researchers working alongside the anglers, in comparison to more typical citizen science models of data collection.

Initial results from the studies are as follows. Please note these are preliminary results that will be submitted for publication in the near future. As fight time and air exposure increases, striped bass were more physiologically impaired based on the reflexes assessed. Interestingly, the angler survey revealed that although the science indicates air exposure has a negative impact on striped bass, many anglers do lift their fish from the water.

The results indicate that the cumulative reflex score decreases with larger fish and when striped bass are caught at warmer temperatures. The angler survey indicated that when asked about which factors negatively impact survival, anglers indicated fish size and water temperature were considered least influential. This is another example where the knowledge-action gap can be closed with adequate education and outreach.

Although the sample sizes for fish hooked in the gills and the gut were relatively low, results indicate that fish hooked in the gills were more impaired than fish hooked elsewhere, with gill-hooking most commonly occurring with single J-hooks. For fish hooked in multiple locations, those hooked in the stomach were more impaired, and all of those gut-hookings were caused by double treble hooks. External injuries resulting from foul hooking (outside the body) were most common with double treble hooks (for hook location 1 and 2). While external hooking did not result in lower reflex scores, it may have long-term lethal or sublethal effects.

The results indicate fish with longer air exposure times had lower levels of activity after release. Longer fight times also resulted in the lower the activity levels following release. Fish exposed to air for longer times took longer to recover. Interestingly, fish had higher activity levels during the first minute after release as compared to 3-6 minutes, which is consistent with the fight or flight response. After the short burst, striped bass displayed lower activity levels, especially for those air exposed for longer durations. This initial high activity may be misleading to anglers thinking the fish is okay when it still may be injured.

The survey results indicate most survey respondents rate the commercial fishery as a high threat to the fishery. There seems to be a misconception here since the commercial fishery is a relatively small part of the fishery. Many survey respondents also indicated non-compliance as being as issue. There was strong support among survey respondents for enforcement of regulations, implementing appropriate management measures, a science-based understanding of the striped bass population, and implementing science-based catch-and-release practices.

Regarding agreement with the 2023 emergency action, the survey indicates that over 50% of respondents who fish with conventional gear agree with the emergency action, while 75% of fly fishers agree with the emergency action.

WG Questions: A WG member asked how to interpret the survey results since it seems like most survey participants are catch-and-release fishers and may not represent all striped bass anglers (some who value harvest, and some who value catch-and-release). O. Dinkelacker noted that half of the respondents (51.6%) reported to release all striped bass they catch (even if those fall within the slot limit), while others reported to harvest at least some of their catch. As such, there seems to be a balanced representation of different angler preferences in the survey.

A WG member asked about the potential conflict between the conservation mindset of catch-and-release fishing with the potential for lighter tackle/fly fishing to result in longer fight times. O. Dinkelacker noted that they observed some catch-and-release anglers using heavier tackle to reel fish in faster, so that tension does not exist among all catch-and-release anglers. Approaching this issue both from the regulation side (e.g., requiring heavy tackle for tournaments) and from and outreach side to communicate the impacts of different tackle is important. Another WG member noted anecdotal observations of fly fishing resulting in shorter fight time due to fly fishers' high level of technical skill.

A WG member asked about the survey results indicating respondents perceive the commercial fishery as a primary threat to the stock. O. Dinkelacker noted the important role of education and outreach for recreational anglers to understand their role in conservation. The survey also included a question about responsibility for protecting the stock, and some anglers did indicate they have responsibility themselves. Another WG member noted anglers may not realize the scale of the striped bass recreational fishery, and the additive effect of that effort on the stock.

A WG member asked about how single hook lures can cause so much injury, possibly related to the way striped bass gulp feed. O. Dinkelacker noted that because single hooks are so small, they can end up in the gill rakers where they get stuck and cause serious injury. A treble hook, which is much bigger, may get stuck sooner in the jaw before getting to the gill rakers.

TASK #1 NO TARGETING CLOSURES AND TASK #2 GEAR MODIFICATIONS

The WG reviewed and discussed draft conclusions and possible WG consensus statements for task #1 on no targeting closures and task #2 on gear modifications. That discussion is reflected in the conclusions and recommendations presented in the WG report.

TIMELINE

- Friday, September 27 internal WG deadline for report to review
- October 4 deadline for Main Meeting Materials
- October 11 deadline for Supplemental Materials (if needed)
- October 23 Striped Bass Board Meeting

PUBLIC COMMENTS

Will Poston from the American Saltwater Guides Association noted concern about the WG's draft conclusion about the effectiveness of no-targeting closures. The presentations from the WG calls seem to indicate only circumstantial effectiveness of no targeting closures. For Maryland closures, it is hard not to conflate the lack of abundance of striped bass in the Bay with a reduction in fishing effort. Recognize the difficulty of parsing out the impacts of fish availability compared to the regulatory effects but suggest caution to the WG about making strong statements on the effectiveness of closures based on the WG discussions.

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

MEMORANDUM

TO: **Striped Bass Management Board**

FROM: **Striped Bass Technical Committee and the Stock Assessment Subcommittee**

DATE: **October 9, 2024**

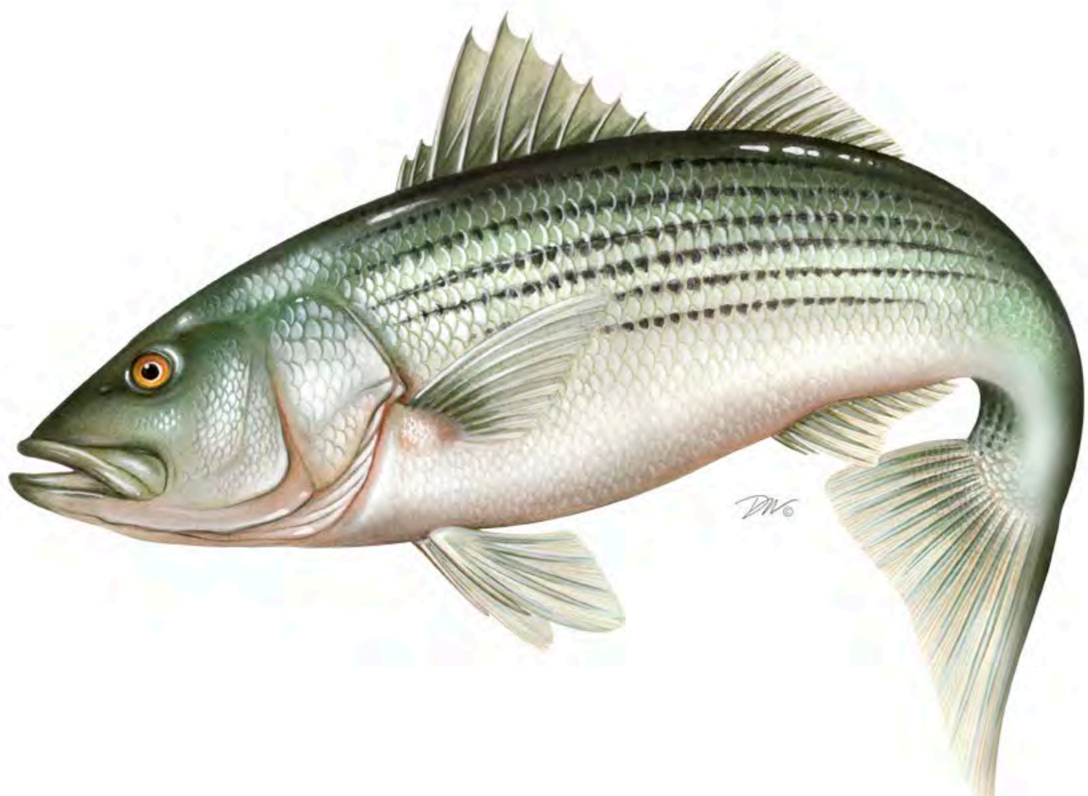
SUBJECT: **2024 Stock Assessment Update and Range of Projections**

The 2024 Stock Assessment Update Report is enclosed. The assessment presents a range of projections to convey uncertainty and different assumptions about what could happen in the future. The Technical Committee and Stock Assessment Subcommittee recognize this presents a challenge for managers, and will provide a summary of TC-SAS discussion on the likelihood of various projection scenarios and the implications for rebuilding in Supplemental Materials ahead of the October Board meeting.

M24-82

Atlantic States Marine Fisheries Commission

2024 Atlantic Striped Bass Stock Assessment Update Report



Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission

Atlantic Striped Bass Stock Assessment Update

Prepared by the
ASMFC Striped Bass Stock Assessment Subcommittee
Mike Celestino, Chair, New Jersey Department of Environmental Protection
Margaret Conroy, Delaware Division of Fish and Wildlife
Brooke Lowman, Virginia Marine Resources Commission
Gary Nelson, Massachusetts Division of Marine Fisheries
Alexei Sharov, Maryland Department of Natural Resources
John Sweka, US Fish and Wildlife Service
Katie Drew, Atlantic States Marine Fisheries Commission

and the

ASMFC Striped Bass Technical Committee
Tyler Grabowski, Chair, Pennsylvania Fish and Boat Commission
Ingrid Braun, Potomac River Fisheries Commission
Michael Brown, Maine Department of Marine Resources
Margaret Conroy, Delaware Division of Fish and Wildlife
Nicole Lengyel Costa, Rhode Island Department of Environmental Management
Caitlin Craig, New York Department of Environmental Conservation
John Ellis, US Fish and Wildlife Service
Charlton Holloman Godwin, North Carolina Division of Marine Fisheries
Kurt Gottschall, Connecticut Department of Energy and Environmental Protection
Brendan Harrison, New Jersey Department of Environmental Protection
Luke Lyon, District of Columbia Department of the Environment
Jeremy McCargo, North Carolina Wildlife Resources Commission
Steve Minkkinen, US Fish and Wildlife Service
Gary Nelson, Massachusetts Division of Marine Fisheries
Alexei Sharov, Maryland Department of Natural Resources
Tony Wood, NOAA Fisheries

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EXECUTIVE SUMMARY

The time series of striped bass removals and indices from the 2022 assessment update were extended to include data from 2022-2023. Total removals from 2022-2023 averaged 6.18 million fish, a 20% increase from 2021, the terminal year of the last assessment. From 2022-2023, recreational release mortality made up 40% of total removals, with recreational harvest making up 49%, commercial harvest making up 10%, and commercial discards making up 0.5% of the total. This is a change from 2018-2021, where recreational release mortality made up 50% of total removals and recreational harvest accounted for 37%.

The single-stock statistical catch-at-age (SCA) model was updated through 2023. The model parameterization was the same as in the 2022 assessment update, including the new selectivity block starting in 2020 in the Bay and Ocean fleets to account for the regulation changes from Addendum VI to Amendment 6. A sensitivity run was conducted to look at the effect of adding a new selectivity block for 2023 to account for the Emergency Action, but the estimated selectivity curves for the 2023 block did not align with the expected change in selectivity based on the regulation changes, likely due to the difficulty in estimating the selectivity pattern from a single year of data. For the reference points and the projections, an empirically-derived selectivity curve was used to better capture the effects of the Emergency Action in 2023 and Addendum II in 2024.

Because the recruitment trigger in Amendment 7 was tripped based on 2021-2023 data for the New Jersey, Maryland, and Virginia juvenile abundance indices, the biological reference points were calculated using the low recruitment regime assumption. This resulted in a lower *F* target and *F* threshold compared to the benchmark assessment.

In 2023, the Atlantic striped bass stock was overfished. Fishing mortality was above the *F* target, but below the *F* threshold, indicating overfishing was not occurring. Female spawning stock biomass in 2023 was estimated at 86,536 metric tons (191 million pounds) which is below the updated SSB threshold of 89,513 metric tons (197 million pounds), and below the updated SSB target of 111,892 metric tons (247 million pounds). Total fishing mortality in 2023 was estimated at 0.18 which is below the updated *F* threshold of 0.21 per year, but above the updated *F* target of 0.17 per year. Although the stock is not experiencing overfishing, these results trip the *F* target trigger in Amendment 7 since *F* has exceeded the *F* target for two consecutive years while SSB is below the SSB target.

The retrospective pattern remained moderate to low in magnitude for the 2024 assessment update, with the model underestimating *F* and overestimating SSB in the most recent peels. The retrospective-adjusted estimates of *F* and SSB were within the 90% confidence intervals of the unadjusted estimates, so correcting for retrospective pattern was not necessary for status determination or projections.

Projections were run to determine the probability of SSB being at or above the SSB target by 2029, the rebuilding deadline. If *F* is reduced to the *F* target by 2025, and *F* target is maintained through 2029, there is less than a 5% chance that the stock will be rebuilt in 2029.

The *F* rate necessary to have a 50% chance of being above the SSB target in 2029 ($F_{rebuild}$) depends on the extent of the reductions realized by Addendum II, implemented in 2024. The TC initially predicted that the Add. II measures would result in a 13.7% reduction in total removals relative to 2022, equivalent to 5.86 million fish, slightly higher than the 2023 total removals. In this scenario, *F* in 2024 is estimated to be 0.20, while $F_{rebuild}$=0.11 for 2025 onward. To achieve $F_{rebuild}$ in 2025, total removals would have to be reduced to 3.16 million fish, a 46% reduction from the predicted removals in 2024. However, the preliminary MRIP numbers for 2024 Waves 2-3 are 36% lower than the Waves 2-3 numbers for 2023. Expanding the preliminary 2024 Waves 2-3 estimates to the full year, based on the proportion of total landings that occurred in those waves in earlier years, and accounting for a 7% decrease in commercial removals relative to 2023 due to the quota reduction, resulted in estimated total removals of 3.89 million fish in 2024. In this scenario, *F* in 2024 is estimated to be 0.13, and fishing at this rate each year through 2029 would result in a 50% probability of being above the SSB target in 2029. In order to maintain this *F* rate in 2025, a 4% reduction from estimated 2024 removals would be needed. The TC considers the low 2024 removals scenario based on preliminary MRIP numbers to be more likely than the high 2024 removals scenario.

However, in 2025, the above-average 2018 year-class will be age-7, the same age the strong 2015 year-class was in 2022, and just entering the 28-31” slot in the ocean fishery. When the 2015 year-class entered the ocean slot, total removals increased by 32% from 2021 to 2022, and *F* in 2022 was 39% higher than 2021. Although total removals decreased in 2023, *F* in 2023 under the Emergency Action slot limit was still 17% higher than in 2021. If *F* in 2025 increases by the same percentage seen in 2022 or 2023 and remains there, the probability of rebuilding under that *F* rate is well under 50%. Historically, an increase in *F* due to a strong year-class recruiting to the fishery has been followed by a decrease in subsequent years, although the rate of change has been variable. If *F* increases only in 2025 and decreases to the level estimated for 2024 as the 2018 year-class moves out of the slot, the probability of rebuilding by 2029 is 43%.

The level of removals and *F* in 2024, 2025, and subsequent years is a major source of uncertainty in these projections. Although predicted removals for 2024 based on preliminary 2024 MRIP data for Waves 2-3 can support rebuilding by 2029, it is likely that removals will increase in 2025 and the Board should be prepared to respond to this eventuality.

	Target	Threshold	2023 Value	Status
Fishing Mortality	0.17	0.21	0.18	Not overfishing
Female SSB	111,892 mt (247 million lbs)	89,513 mt (197 million lbs)	86,536 mt (191 million lbs)	Overfished

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TERMS OF REFERENCE (TOR) REPORT

TOR 1. Update fishery-dependent data (landings, discards, catch-at-age, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

The time series of striped bass recreational and commercial removals from the 2022 assessment update (ASMFC 2022) was extended to include data from 2022-2023. This included recreational harvest, recreational release mortalities, commercial harvest, and commercial discards.

Total removals from 2022-2023 averaged 6.18 million fish, a 20% increase from 2021, the terminal year of the last assessment (Table 1, Figure 1). Approximately 76% of the removals came from the ocean fleet over that time period, while 24% came from the Chesapeake Bay fleet, which is a higher than average percentage from the ocean fleet, reflecting the availability of the strong 2015-year class in the ocean and the weak year-classes available to the Chesapeake Bay fleet (Table 1, Figure 1).

From 2022-2023, recreational release mortality made up 40% of total removals, with recreational harvest making up 49%, commercial harvest making up 10%, and commercial discards making up 0.5% of the total (Figure 2). This is a change from 2018-2021, where recreational release mortality made up 50% of total removals and recreational harvest accounted for 37%.

The MRIP CPUE index of abundance was updated with data through 2023. The index was developed using the same species associations identified in the previous benchmark. Imputed records were excluded from the intercept data pull for 2020. The index declined somewhat from 2018-2021 but was relatively stable from 2022-2023 (Figure 3).

TOR 2. Update fishery-independent data (abundance indices, age-length data, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

Where possible, the fishery independent age-1+ and recruitment indices used in the most recent benchmark assessment (Table 2) were updated through 2023.

The assessment used seven fishery independent indices of age-1+ abundance: the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), the Maryland Spawning Stock Survey (MDSSN), the Delaware Spawning Stock Electrofishing Survey (DESSN), the Delaware 30' Bottom Trawl Survey (DE30), the New York Ocean Haul Seine (NYOHS), the New Jersey Bottom Trawl Survey (NJTRL), and the Connecticut Long Island Sound Trawl Survey (CT LISTS). The NJ Trawl did not operate from 2019-2021 due to COVID and vessel issues, but operated as usual for 2022-2023. ChesMMAP changed vessels in 2018 and the calibration process was completed in time for this assessment update, so calibrated estimates were available for the full time-series. Age-1+ surveys with data through 2023 showed mixed trends, with some surveys increasing since 2021 and some decreasing (Figure 3).

The assessment uses four age-0 juvenile abundance indices (JAI) and two age-1 indices as recruitment indices: the MD, VA, NJ, and NY JAIs and the MD and NY age-1 indices. The MD and VA JAIs were combined into a single composite JAI for Chesapeake Bay using the Conn (2010) method. The NJ, MD, and VA JAIs all tripped the recruitment trigger based on 2021-2023 data, with each index having three consecutive years below the Amendment 7 recruitment threshold[1].

TOR 3. 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.

Model equations are shown in Appendix 1 Table 1. The model parameterization was the same as used in the 2022 assessment update (ASMFC 2022), including the new selectivity block starting in 2020 in the Bay and Ocean fleets to account for the regulation changes from Addendum VI (Table 3). A sensitivity run was conducted to look at the effect of adding a new selectivity block for 2023 to account for the Emergency Action.

Re-weighting of survey indices was required with the addition of two years of removal data and missing index data for several surveys. Survey CVs were adjusted to bring the RMSE close to one and effective sample sizes were adjusted once by using the Francis multipliers (Francis 2011). The RMSEs, CV weights and effective samples from the 2019 benchmark and 2022 assessment models are given in Table 2 in Appendix 1. The largest change in CV weight occurred for the NJ Trawl survey, where the correct CV time series was substituted for the incorrect values input in the benchmark.

No changes were made to the life history information used in the assessment (Table 4).

TOR 4. 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.

Model Fit

The model fit the observed total catches and catch age compositions of all fleets well (Appendix 2). The model fit the MDYOY (1970-1981) and MD & VA composite indices very well and the MD Age-1, NYOHS, and MDSSN poorly. It fit the other indices reasonably well (Appendix 2).
The predicted trends matched the observed trends in age composition of survey indices reasonably well for NYOHS, MDSSN, MRIP, CTLIST, and ChesMMAP. The model fit the age composition of NJTrawl, DESSN, and DE30FT survey adequately. Resulting contributions to total likelihood are listed in Table 3 of Appendix 2. Estimates of fully-recruited fishing mortality for each fleet and total fishing mortality, recruitment, parameters of the selectivity functions for

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[1] Threshold = 25th percentile of respective JAI from 1992-2006.

the selectivity periods, catchability coefficients for all surveys, and parameters of the survey selectivity functions are given in Table 4 of Appendix 2.

Estimates of the catch selectivity patterns for each fleet showed that, although the patterns varied over time with changes in regulation, selectivity was dome-shaped for Chesapeake Bay and primarily flat-topped for the Ocean over time (Figure 6). There was a steep shift in the descending limb of the selectivity pattern in 2020-2023 for Chesapeake Bay compared to the previous selectivity block, and a shift in the selectivity for the Ocean to a more dome-shaped pattern, as would be expected with the implementation of a slot limit for 2020-2023 (Figure 6).

Fishing Mortality

Fully-recruited annual fishing mortality in 2023 for the Bay and Ocean was 0.05 and 0.15 (Figure 7), and peaked at ages 5 and 7, respectively (Appendix 2 Table X5). Total fully-recruited *F* in 2023 was 0.18 (Table 5, Figure 7) and peaked at age 7. Coefficients of variation indicated region-specific and total fishing mortality estimates were precise (CVs mostly less than 0.20) (Appendix 2 Table X4).

Recruitment

Recruit numbers increased steadily through 1993 (Figure 8). Large recruitment events occurred in 1994, 1997, 2002, and 2004 as the large Chesapeake Bay 1993, 1996, 2001 and 2003 year-classes became age-1. Average to below-average year-classes were produced during 2004-2010, which resulted in a decline of age-1 numbers. Subsequently, strong year-classes were produced in 2011 and 2015. After 2016, recruit abundance fluctuated slightly and has averaged 112.6 million age-1 fish (Table 5, Figure 8). Six of the last seven year-classes since 2015 have been below average, although generally not as low as the levels seen in the 1980s; the 2018 year-class was above average (Table 5, Figure 8). The below-average 2022 and 2023 recruits will start contributing to female SSB in 2029 and 2030 as those fish approach full maturity.

Population Abundance (January 1)

Striped bass abundance (ages 1+) increased steadily from 1982 through 1997 when it peaked around 423.5 million fish (Table 5, Figure 9). Total abundance fluctuated without trend through 2004. From 2005-2009, age 1+ abundance declined to about 187.1 million fish. Total abundance spiked again in 2012 and 2016 as a result of two large year-classes (2011 and 2015) entering the age-1+ population (Table 5, Figure 9). Total abundance declined from 2019-2022, but ticked upward slightly in 2023 to 177.9 million fish (Figure 9).

Abundance of striped bass age 8+ increased steadily through 2004 to 17.2 million fish, but then declined to 11.9 million fish through 2010 (Table 5, Figure 9). A small increase in 8+ abundance occurred in 2011 as the 2003 year-class became age 8 (Table 5, Figure 9). Abundance of age 8+ fish declined steadily through 2018 but has increased recently to 11.6 million fish in 2023 as the 2011 and 2015 year-classes recruited to the age-8+ group (Table 5, Figure 9).

Spawning Stock Biomass and Total Biomass

Female SSB grew steadily from 1982 through 2003 when it peaked at about 120,000 metric tons (Table 5, Figure 10). Female SSB declined steadily from 107,053 metric tons in 2010 to 60,808 metric tons in 2018, but in recent years, has steadily increased (Table 5, Figure 10). SSB in 2023 was 86,536 metric tons. Estimates of female spawning stock biomass were very precise (CVs less than 0.14; Table 8 of Appendix 2).

Exploitable biomass (January 1) increased from 36,012 metric tons in 1982 to its peak at 341,699 metric tons in 1999 but declined steadily through 2015 (Figure 10). Since 2016, exploitable biomass steadily increased albeit at a slow pace.

Retrospective Analysis

Moderate retrospective patterning was evident in the more recent estimates of fully-recruited total *F* and female SSB (Figure 11). The retrospective pattern suggested that fishing mortality is likely slightly under-estimated by 2.5% and female spawning biomass is over-estimated by less than 10%. Recruitment appeared to be over-estimated in most years, although underestimation did occur in a few years (Figure 11). The Mohn's rho values for fishing mortality, female SSB and recruitment were estimated to be -0.025, 0.007 and 0.09, respectively.

The current retrospective trends are consistent with the 2022 update, but are different from what was observed in the 2019 benchmark and earlier assessments (NEFSC 2019). The past retrospective patterns showed that female SSB was typically under-estimated and fishing mortality was over-estimated.

Sensitivity Runs

An additional sensitivity run was made to explore the effects of adding a new selectivity block in 2023 to account for the changes due to the Emergency Action. In this run, the Ocean fleet had a new selectivity block for 2020-2022 reflecting Addendum VI changes, and a new block in 2023, while the Bay fleet had a single block from 1996-2022, since no size limit changes were implemented through Addendum VI, and a new block in 2023. Full results and diagnostics for this sensitivity run is presented in Appendix 2. Overall, diagnostics were very similar for both runs. The sensitivity run results were similar to the base run, with a higher estimate of *F* in 2023 and slightly lower estimates of SSB from 2020-2023 (Figure 12). The TC did not consider the estimated selectivity curves for the 2023 block reliable, as they did not align with the expected change in selectivity based on the regulation changes. For both the Ocean and the Bay fleet, the 2023 selectivity curve was significantly lower for ages 13-15+, even though the majority of those fish were already outside of the 28-35" slot in the ocean and thus not likely to be affected by the change to a 28-31" slot or the imposition of a 31" maximum size in the Bay (Figure 13). In addition, for the Ocean fishery, the selectivity on fish ages 3-7 was lower in the 2023 block than in the 2020-2022 block, even though the Emergency Action did not change the minimum size in the ocean (Figure 13). This was likely due to the difficulty in estimating the selectivity pattern from a single year of data.

Comparison of Results from the 2019 Benchmark Assessment and the 2022 Assessment Update with the 2024 Assessment Update

Fully-recruited fishing mortality and female spawning stock biomass estimates from the 2024 update, the 2022 update, and benchmarks assessment are shown in Figure 14 and are generally very similar. The 2024 assessment produced lower estimates of fishing mortality from 1996-2017 compared to the benchmark and 2022 updates, and slightly higher estimates of female spawning stock biomass from 1992-2010 compared to the benchmark and 2022 update. From 2015 onward, the 2024 update estimate of SSB was lower than the benchmark but higher than the 2022 update.

TOR 5. Update the biological reference points or trend-based indicators/metrics for the stock. Determine stock status.

The fishing mortality and spawning stock biomass reference points were updated using the same methods as the benchmark assessment (NEFSC 2019), with the exception of the selectivity curve. Because the estimates of the selectivity curve for 2023 as a separate block were considered unreliable, a hybrid selectivity pattern (Appendix 3) was developed for 2024 and subsequent years based on the selectivity curve estimated for 2020-2022 and the regulations for 2024, which includes the extension of the Emergency Action regulations for the Ocean fleet and a more restrictive slot for the Bay fleet. The spawning stock biomass threshold is the 1995 estimate of SSB from the current assessment and the SSB target is 125% of the threshold. The fishing mortalities associated with the SSB target and threshold in the long term were determined using a stochastic projection method. Empirical estimates of recruitment, selectivity, and the starting population came from the SCA model results. The selectivity pattern used in the projections was the empirically derived hybrid selectivity pattern (Figure 15). Estimates of recruitment were restricted to 2008-2023 to represent the "low" recruitment regime. The population was projected for 100 years and fully-recruited *F* was adjusted until the median of the projected SSB reached the SSB target or threshold.

The updated SSB reference points and associated fishing mortalities are:

$SSB_{threshold}$ = 89,513 metric tons	**$F_{threshold}$ = 0.21**
SSB_{target} = 111,892 metric tons	**F_{target} = 0.17**

Status of the Stock

Before stock status can proceed, analyses must be done to determine if the estimates of F and SSB in 2023 should be corrected for the apparent pattern observed in the retrospective analyses. Here we used the National Marine Fisheries Service standard procedure in which the estimates are adjusted for the retrospective pattern using Mohn's rho values (average of proportion differences over five-year peels) and then compared to the unadjusted estimates and their associated 90% confidence intervals. If either retrospective-adjusted value falls outside an unadjusted value's 90% confidence intervals, then the retrospective-adjusted values are used. If not, the unadjusted values are sufficient for stock determination. Figure 16 shows a bivariate plot of the unadjusted estimates and their associated 90% confidence interval along with the retrospective-adjusted values. Because the retrospective-adjusted values fall within the 90% confidence intervals, retrospective adjustment is not needed.

In 2023, the Atlantic striped bass stock was overfished. Fishing mortality was above the *F* target, but below the *F* threshold, indicating overfishing was not occurring. Female spawning stock biomass in 2023 was estimated at 86,536 metric tons (191 million pounds) which is below the updated SSB threshold of 89,513 metric tons (197 million pounds), and below the updated SSB target of 111,892 metric tons (247 million pounds) (Table 6, Figure 17). When accounting for the uncertainty in these estimates, there is a 60% probability that the 2023 female SSB estimate is below the SSB threshold and a 99% probability that the 2023 estimate is below the target.

Total fishing mortality in 2023 was estimated at 0.18 which is below the updated F threshold of 0.21 per year, but above the updated *F* target of 0.17 per year (Table 6, Figure 17). There is a 26% probability that the 2023 fully-recruited fishing mortality is above the fishing mortality threshold, and a 63% probability that *F* is above the F target.

The estimate of *F* in 2023 was higher for the sensitivity run with a new selectivity block in 2023, equal to the *F* threshold. However, stock status relative to the *F* triggers in the FMP was the same for both runs: *F* was above the target in both of the last two years and the stock was overfished in both years.

TOR 6. Conduct short term projections when appropriate. Discuss assumptions if different from the benchmark and describe alternate runs.

The projections used the same methods as the benchmark assessment (NEFSC 2019), with the exception of the use of the hybrid selectivity pattern to better account for the management changes in 2023 and 2024, and the application of the “low” recruitment regime. Because the retrospective adjusted values of *F* and SSB fell within the 90% confidence intervals of the unadjusted estimates, retrospective-adjustment was not needed.

The model begins in year 2023 with the estimates of January-1 abundance-at-age and associated standard errors from the SCA assessment model. The observed 2023 catch-at-age and natural mortality at age are used to calculate the 2024 January-1 abundance-at-age for ages 2-15+; recruitment in 2024 is predicted from the MD young-of-year survey value for 2023. The predicted 2024 total removals, the hybrid selectivity pattern, and natural mortality are used to calculate the 2025 January-1 abundance-at-age. For the remaining years, the January-1 abundance-at-age is projected and is calculated by using the previous year’s abundance-at-age, the scenario fully-recruited F, and natural mortality following the standard exponential decay model. Female spawning stock biomass is calculated using the average Rivard weights-at-age from 2019-2023 along with proportion of female by age and maturity-at-age.

The TC initially predicted that the Add. II measures adopted by the Board would result in a 13.7% reduction in total removals relative to 2022, equivalent to 5.86 million fish in 2024, slightly higher than the 2023 total removals (high removals scenario). However, the preliminary

MRIP numbers for Waves 2-3 are 36% lower than the Waves 2-3 numbers for 2023. Expanding the preliminary Waves 2-3 estimates to the full year, based on the proportion of total landings that occurred in those waves in earlier years, and accounting for a 7% decrease in commercial removals relative to 2023 due to the quota reduction, results in estimated total removals of 3.89 million fish in 2024 (low removals scenario). The TC considers the low removals scenario based on preliminary MRIP numbers to be more likely than the high removals scenario for 2024. Projections were run for both the high and low 2024 removals scenarios assuming the *F* in 2024 was maintained each year through 2029.

Another source of uncertainty for the rebuilding trajectory is the effect of the above-average 2018 year-class becoming age-7 in 2025 and entering the 28-31" slot in the ocean fishery. When the strong 2015 year-class was age-7 in 2022, total removals increased by 32% from 2021 to 2022, and *F* in 2022 was 39% higher than 2021 (Table 7). With the implementation of the Emergency Action slot limit in 2023, total removals in 2023 decreased relative to 2022, but were still 8% higher in 2023 than in 2021 and *F* was 17% higher in 2023 than in 2021. Additional projections were conducted with a constant *F* for 2025 forward assuming *F* increased from 2024 (low removals scenario) to 2025 by either the rate seen in 2023 relative to 2021 (17%) or the rate seen in 2022 relative to 2021 (39%), reflecting the potential progression of the 2018 year-class through the fishery in 2024-2025 (Table 8). Historically, an increase in *F* due to a strong year-class recruiting to the fishery has been followed by a decrease in subsequent years, although the rate of change has been variable. Therefore, a fourth projection was done where *F* in 2025 increased by the rate seen in 2023 relative to 2021, but then decreased to F_{2024}.

For each year of the projection, the probability of SSB being above the SSB target and threshold reference points was calculated from 10,000 simulations using function *pgen* in R package *fishmethods*.

Projection Results

The base run with the single 2020-2023 selectivity block and the sensitivity run with a new selectivity block in 2023 produced similar results, with both models having a low probability of rebuilding by 2029 under F_{2023} or under F_{target} (Appendix 2).

The *F* rate necessary to have a 50% chance of being above the SSB target in 2029 ($F_{rebuild}$) depended on the extent of the reductions realized by Addendum II, implemented in 2024. In the high 2024 removals scenario, *F* in 2024 is estimated to be 0.20, which would have a less than 1% chance of rebuilding by 2029 (Table 9, Figure 18) if that rate was maintained in subsequent years. For the high 2024 removals scenario, $F_{rebuild}$=0.11; to achieve $F_{rebuild}$ in 2025, total removals in 2025 would have to be reduced to 3.16 million fish, a 46% reduction from the predicted removals in 2024 (Appendix 3 Table 6). In the low 2024 removals scenario, *F* in 2024 is estimated to be 0.13, and fishing at this rate would result in a 50% probability of being above the SSB target in 2029 (Table 9, Figure 18). In order to maintain this *F* rate in 2025, a 4% reduction from estimated 2024 removals would be needed. For both the low and high removal scenarios, fishing at F_{target} would have a less than 50% chance of rebuilding.

If *F* in 2025 increases by the same amount seen in 2022 or 2023 and remains there, the probability of rebuilding under that *F* rate is well under 50% (Table 10, Figure 19). If *F* increases in 2025 as the 2018 year-class enters the slot by the same amount seen in 2023, but then decreases to the F_{2024} and remains there, the probability of rebuilding by 2029 is 43% (Table 10, Figure 19). If *F* decreases further after 2025, the probability of rebuilding will be higher, but if it remains above 2024 levels, the probability will be lower.

The level of removals and *F* in 2024, 2025, and subsequent years is a major source of uncertainty in these projections. Although predicted removals for 2024 based on preliminary 2024 MRIP data for Waves 2-3 are sustainable and can support rebuilding by 2029, it is likely that removals will increase in 2025 and the Board should be prepared to respond to this eventuality.

TOR 7. 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.

The research recommendations identified in the benchmark assessment (NEFSC 2019) remain relevant, particularly the research recommendations on enhanced collection of life history and biological information including paired scale-otolith samples, migration rates, and sex ratio data. Additional work on refining migration rates and stock composition estimates as well as incorporating tagging data into the spatial statistical catch-at-age model will be required before the next benchmark assessment; modeling work on this is underway through Virginia Tech and University of Maryland, the results of which should be available to incorporate into the 2027 benchmark assessment.

Given the uncertainty around removals in 2024, 2025, and subsequent years, the TC recommended prioritizing improvements in methods to estimate removals as a function of regulations, year-class strength, and, to the extent possible, angler behavior, during the next benchmark, to better predict future removals and improve projections.

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Table 1. Total removals by fleet in numbers of fish

Year	Bay Fleet	Ocean Fleet	Total Removals
1982	228,561	676,621	905,183
1983	337,753	709,655	1,047,408
1984	478,219	357,273	835,492
1985	71,726	853,576	925,301
1986	133,255	306,878	440,133
1987	61,787	231,254	293,041
1988	122,906	331,754	454,660
1989	139,941	519,632	659,573
1990	663,107	570,887	1,233,994
1991	793,117	927,558	1,720,675
1992	996,912	1,245,235	2,242,148
1993	947,652	1,088,687	2,036,339
1994	1,336,923	1,580,166	2,917,089
1995	1,984,773	3,045,596	5,030,369
1996	2,512,795	3,757,970	6,270,765
1997	3,155,158	4,234,674	7,389,832
1998	2,944,305	4,980,353	7,924,657
1999	3,192,950	4,870,978	8,063,929
2000	3,434,057	4,953,092	8,387,149
2001	2,594,109	5,184,562	7,778,672
2002	2,680,649	5,517,119	8,197,768
2003	3,333,218	5,531,943	8,865,161
2004	3,324,511	6,196,845	9,521,356
2005	2,976,513	6,136,660	9,113,172
2006	4,092,180	6,983,100	11,075,279
2007	3,163,519	5,131,913	8,295,432
2008	2,627,393	5,591,747	8,219,139
2009	3,149,853	4,879,861	8,029,714
2010	2,937,163	5,433,710	8,370,873
2011	2,519,531	5,038,365	7,557,897
2012	2,677,220	4,413,404	7,090,624
2013	2,756,433	5,754,209	8,510,642
2014	3,230,107	3,840,484	7,070,591
2015	2,786,524	3,313,254	6,099,778
2016	3,593,612	3,598,628	7,192,240
2017	2,497,355	4,553,408	7,050,763
2018	2,366,960	3,419,948	5,786,908
2019	2,116,191	3,342,474	5,458,665
2020	2,013,480	3,075,104	5,088,584
2021	1,639,919	3,508,423	5,148,342
2022	1,577,381	5,215,422	6,792,803
2023	1,418,439	4,163,671	5,582,110

Table 2. Summary of indices used in the striped bass stock assessment model.

Index Name	Index Metric	Design	Time of Year	Years	Age
MRIP Total Catch Rate Index	Total catch per unit effort	Stratified random	Mar-Dec	1982-2023	1+
Connecticut Long Island Sound Trawl Survey (CTLISTS)	Mean number per tow	Stratified random	Apr-Jun	1984-2023	1+
New York Ocean Haul Seine (NYOHS)	Geometric mean per haul	Fixed station	Sep-Oct	1987-2006	1+
New York Young-of-the-Year (NYYOY)	Geometric mean per haul	Fixed station	Jul-Nov	1985-2023	YOY
New York Western Long Island Beach Seine Survey (NY Age-1)	Geometric mean per haul	Fixed station	May-Aug	1984-2023	1
New Jersey Bottom Trawl Survey (NJTRL)	Stratified mean per tow	Stratified random	April	1990-2023	1+
New Jersey Young-of-the-Year Survey (NJYOY)	Geometric mean per haul	Fixed station	Aug-Oct	1982-2023	YOY
Delaware Spawning Stock Electrofishing Survey (DESSN)	Geometric mean per tow	Fixed station	Apr-Jun	1996-2023	1+
Delaware 30’ Bottom Trawl Survey (DE30)	Geometric mean per tow	Fixed station	Nov-Dec	1990-2023	1+
Maryland Spawning Stock Survey (MDSSN)	Selectivity-corrected CPUE	Stratified random	Mar-May	1985-2023	1+
Maryland Young-of-the-Year and Yearlings Surveys (MDYOY and MD Age-1)	Geometric mean per haul	Fixed station	Jul-Sep	1954-2023	0-1
Virginia Young-of-the-Year Survey (VAYOY)	Geometric mean per haul	Fixed station	Jul-Sep	1980-2023	YOY
Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)	Stratified mean per tow	Stratified random	Mar-Nov	2002-2023	1+

Table 3. Model structure summary for the 2024 striped bass update.

	Value(s)
Years in Model	1982-2023
Size/Age Plus Group	15+
Fleets	2 (Bay and Ocean)
Selectivity blocks	Bay fleet: 1982-1984, 1985-1989, 1990-1995, 1996-2019, 2020-2023 Ocean fleet: 1982-1984, 1985-1989, 1990-1996, 1997-2019, 2020-2023

Table 4. Striped bass life history information used in the 2024 stock assessment update.

Age	Proportion Mature	Proportion Female	Natural Mortality
1	0	0.53	1.13
2	0	0.56	0.68
3	0	0.56	0.45
4	0.09	0.52	0.33
5	0.32	0.57	0.25
6	0.45	0.65	0.19
7	0.84	0.73	0.15
8	0.89	0.81	0.15
9	1	0.88	0.15
10	1	0.92	0.15
11	1	0.95	0.15
12	1	0.97	0.15
13	1	1	0.15
14	1	1	0.15
15+	1	1	0.15

Table 5. Population estimates from the 2024 striped bass assessment update.

Year	Full *F*	Recruitment (millions of age-1 fish)	Female SSB (mt)	Total Abundance (millions of fish)	Age 8+ Abundance (millions of fish)
1982	0.18	38.3	18,183	55.6	1.7
1983	0.15	77.3	15,260	99.6	1.5
1984	0.07	63.6	15,303	101.2	1.3
1985	0.20	69.3	15,889	110.8	1.4
1986	0.05	68.6	14,335	115.1	1.7
1987	0.03	73.9	17,833	124.1	1.9
1988	0.04	93.1	24,060	148.2	2.4
1989	0.05	107.2	36,685	171.8	3.3
1990	0.06	131.8	43,233	206.6	5.6
1991	0.09	105.3	51,104	193.9	6.8
1992	0.11	109.9	64,985	197.8	7.9
1993	0.09	134.8	73,416	224.9	8.4
1994	0.11	286.9	82,760	387.1	9.1
1995	0.21	187.6	89,513	342.0	10.0
1996	0.27	234.8	100,240	383.7	10.4
1997	0.20	259.5	95,367	423.6	10.7
1998	0.21	148.1	89,027	328.1	10.3
1999	0.19	153.1	88,543	306.5	10.0
2000	0.19	124.8	101,106	268.2	10.4
2001	0.19	196.9	104,898	325.2	14.3
2002	0.21	222.1	117,078	365.6	14.8
2003	0.22	127.9	118,927	285.5	16.0
2004	0.25	304.6	114,562	438.5	17.2
2005	0.24	158.2	113,787	337.3	15.0
2006	0.29	136.4	107,341	290.0	13.6
2007	0.22	89.2	105,029	223.5	11.4
2008	0.23	129.4	110,318	240.1	12.1
2009	0.22	76.4	108,198	187.1	13.1
2010	0.26	99.6	107,053	191.2	11.9
2011	0.27	128.6	99,623	216.6	14.4
2012	0.27	200.3	97,903	294.3	12.9
2013	0.36	68.9	87,353	188.3	11.3
2014	0.29	85.8	76,882	173.9	8.5
2015	0.25	157.1	67,520	237.1	7.8
2016	0.29	230.0	69,211	328.5	6.7
2017	0.32	111.2	62,436	240.9	6.1
2018	0.24	129.6	60,808	237.4	6.1
2019	0.21	164.8	62,544	270.7	7.9
2020	0.15	124.3	65,921	241.0	7.0
2021	0.16	86.7	69,791	196.4	7.2
2022	0.22	76.7	83,892	171.7	9.1
2023	0.18	94.9	86,536	177.9	11.6

Table 6. Updated biological reference points and 2023 estimates for *F* and female SSB compared with the estimates from the 2019 benchmark.

Metric	2019 Assessment Target	2019 Assessment Threshold	2024 Assessment Target	2024 Assessment Threshold	2023 Value
Fishing Mortality	0.20	0.24	0.17	0.21	0.18
Female SSB	114,295 mt (252 million lbs)	91,436 mt (202 million lbs)	111,892 mt (247 million lbs)	89,513 mt (197 million lbs)	86,536 mt (191 million lbs)

Table 7. Progression of the 2015 year-class through the slot limit, 2021-2023.

	2021	2022	2023
Ocean Slot limit	28-35”	28-35”	28-31” (mid-year)
2015 year-class age	6 years old	7 years old	8 years old
2015 year-class status	Most below slot	Within slot	Most above narrower slot
Fishing Mortality	0.16	0.22	0.18
Percent Change in F relative to 2021	--	+39%	+17%
Total Removals	5.15 million fish	6.79 million fish	5.58 million fish
Percent Change in Removals relative to 2021	--	+32%	+8%

Table 8. Potential progression of the 2018 year-class through the slot limit, 2024-2025.

	2024	2025
Ocean Slot limit	28-31”	(28-31”)
2018 year-class age	6 years old	7 years old
2018 year-class status	Below slot	Within current slot
Fishing Mortality	0.126 (low removals)	0.148 0.175
Percent Change in F relative to 2024	--	*Scenario 1:* +17% (same as 2021-2023) *Scenario 2:* +39% (same as 2021-2022)
Total Removals	3.89 million fish (low removals)	*Scenario 1:* 4.36 million fish *Scenario 2:* 5.10 million fish
Percent Change in Removals relative to 2024	--	*Scenario 1:* +12% *Scenario 2:* +31%
F rebuild	--	0.126
Removals under F rebuild	3.89 million fish	3.76 million fish

Table 9. Probability of SSB being at or above the SSB threshold or target under different constant *F* and estimated 2024 removals scenarios. Shaded row indicates 2029, the rebuilding deadline.

	High 2024 Removals Scenario				Low 2024 Removals Scenario			
Year	F	Catch	Probability of being above the SSB threshold	Probability of being above the SSB target	F	Catch	Probability of being above the SSB threshold	Probability of being above the SSB target
2024	0.20	5,862,189	34%	0%	0.13	3,890,793	37%	0%
2025	0.20	5,408,210	55%	0%	0.13	3,757,347	81%	2%
2026	0.20	5,153,984	61%	1%	0.13	3,646,236	96%	12%
2027	0.20	5,147,266	58%	1%	0.13	3,716,509	99%	30%
2028	0.20	5,350,692	47%	0%	0.13	3,885,103	100%	42%
2029	0.20	5,546,570	35%	0%	0.13	4,098,339	100%	50%
2030	0.20	5,689,808	24%	0%	0.13	4,235,455	100%	57%
2031	0.20	5,762,085	22%	0%	0.13	4,299,751	100%	64%
2032	0.20	5,824,269	19%	0%	0.13	4,361,570	100%	69%
2033	0.20	5,850,744	20%	0%	0.13	4,416,924	100%	73%
2034	0.20	5,863,982	22%	0%	0.13	4,432,941	100%	77%

Table 10. Probability of SSB being at or above the SSB target under different constant *F* scenarios if *F* increases in 2025. Shaded row indicates 2029, the rebuilding deadline.

	Low 2024 Removals Scenario							
	F=2023 Increase		*F*=2022 Increase		*F* Increase in 2025 Only		$F=F_{2024}$	
Year	F	Probability of being above the SSB target	F	Probability of being above the SSB target	F	Probability of being above the SSB target	F	Probability of being above the SSB target
2024	0.13	0%	0.13	0%	0.13	0%	0.13	0%
2025	0.15	2%	0.18	2%	0.15	2%	0.13	2%
2026	0.15	9%	0.18	5%	0.13	9%	0.13	12%
2027	0.15	16%	0.18	6%	0.13	24%	0.13	30%
2028	0.15	19%	0.18	5%	0.13	36%	0.13	42%
2029	0.15	19%	0.18	3%	0.13	43%	0.13	50%

FIGURES

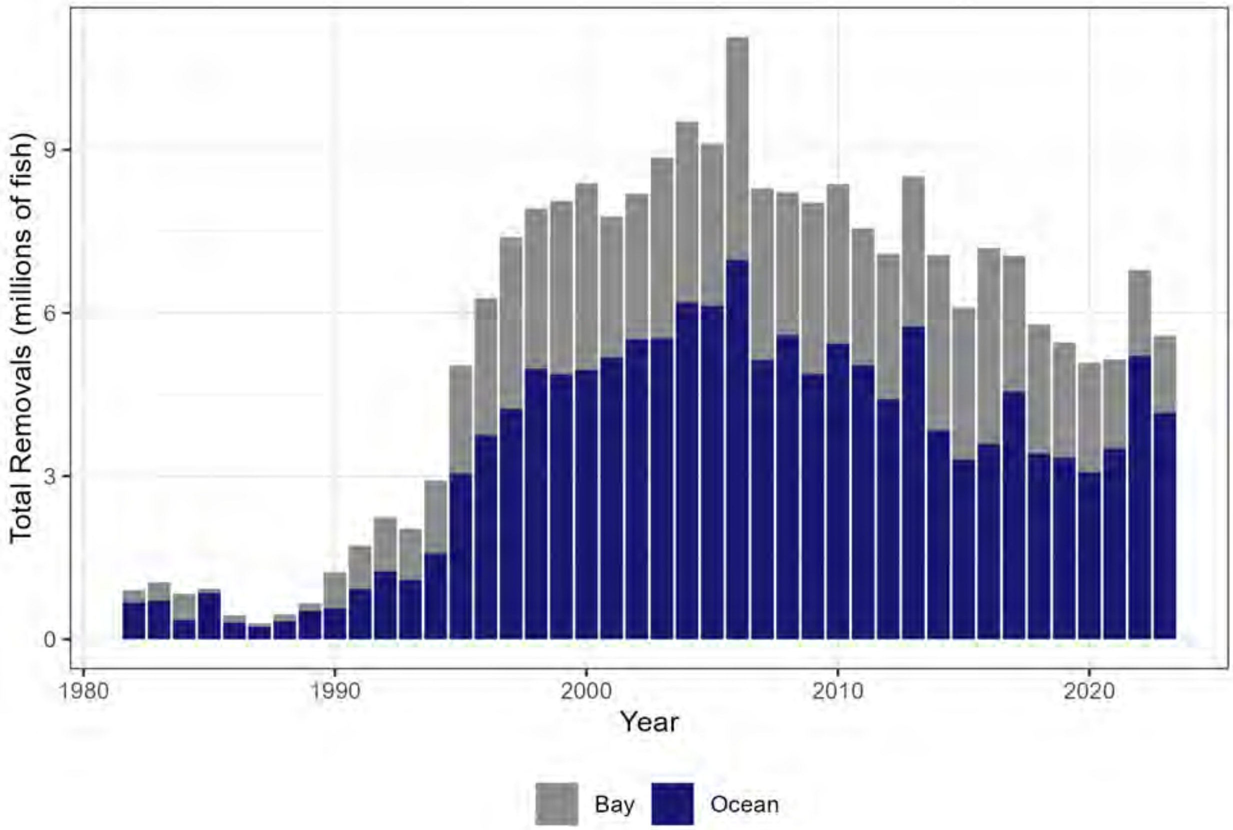


Figure 1. Total striped bass removals by fleet.

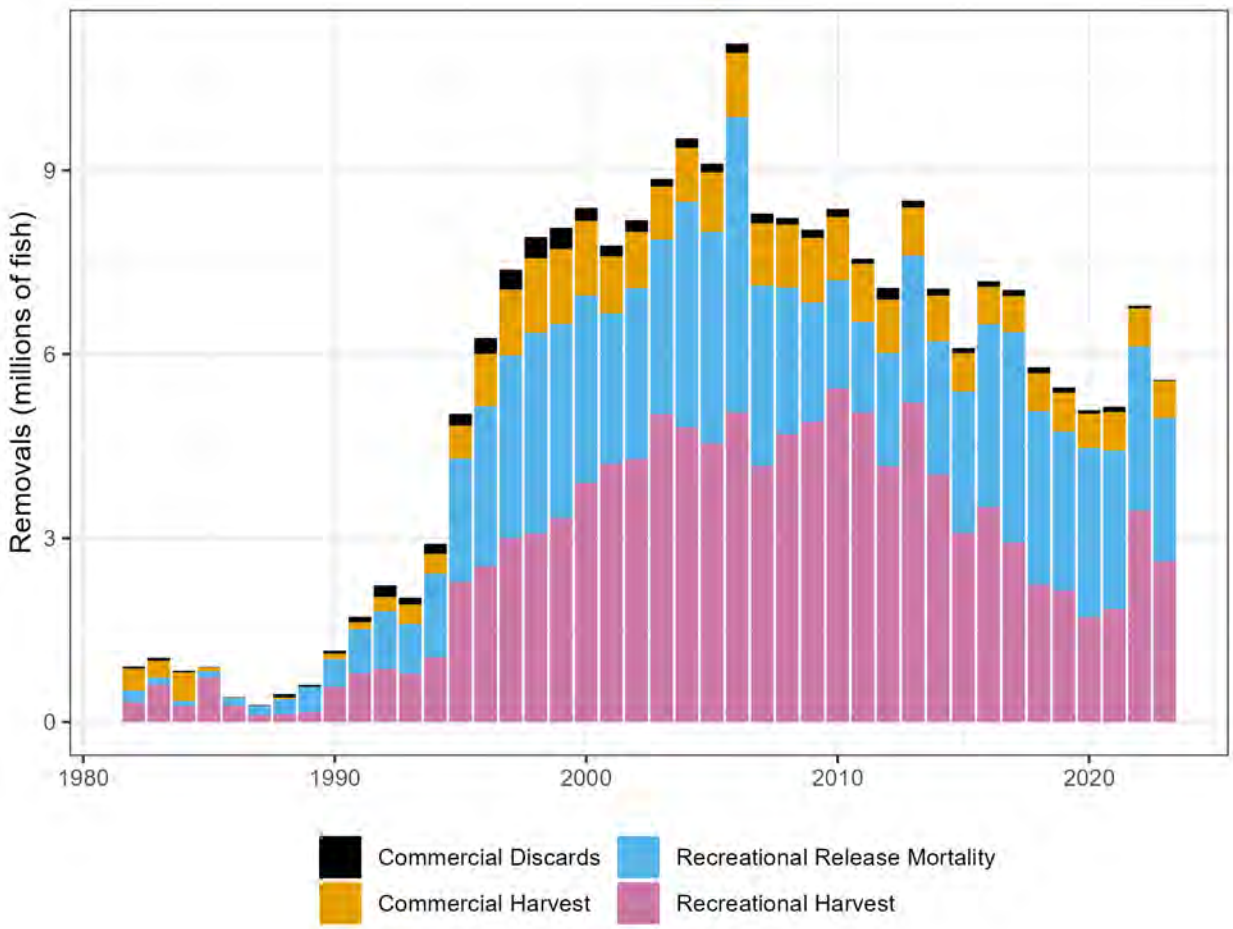


Figure 2. Total striped bass removal by sector, 1982-2023.

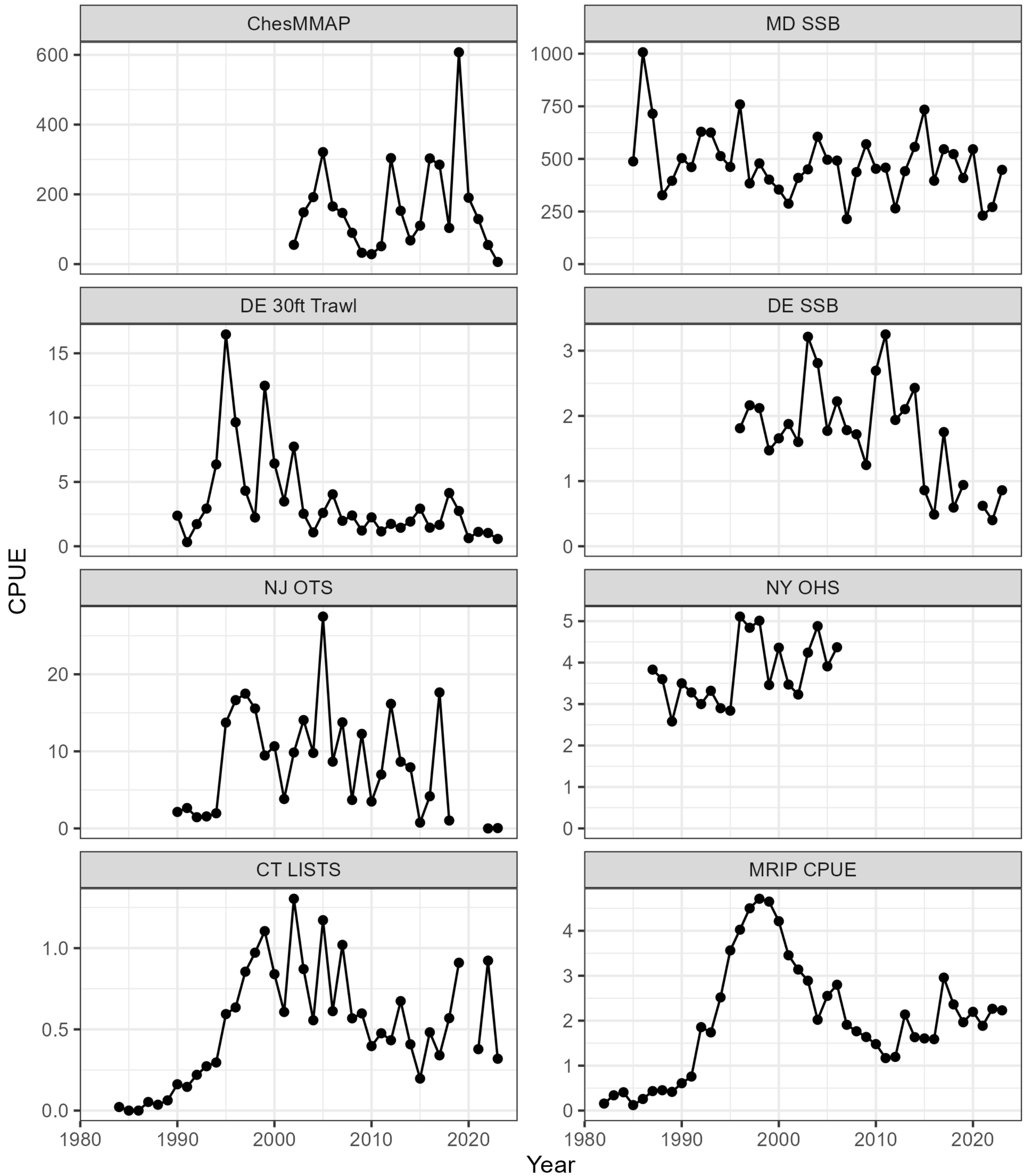


Figure 3. Indices of age-1+ abundance for striped bass, 1982-2023.

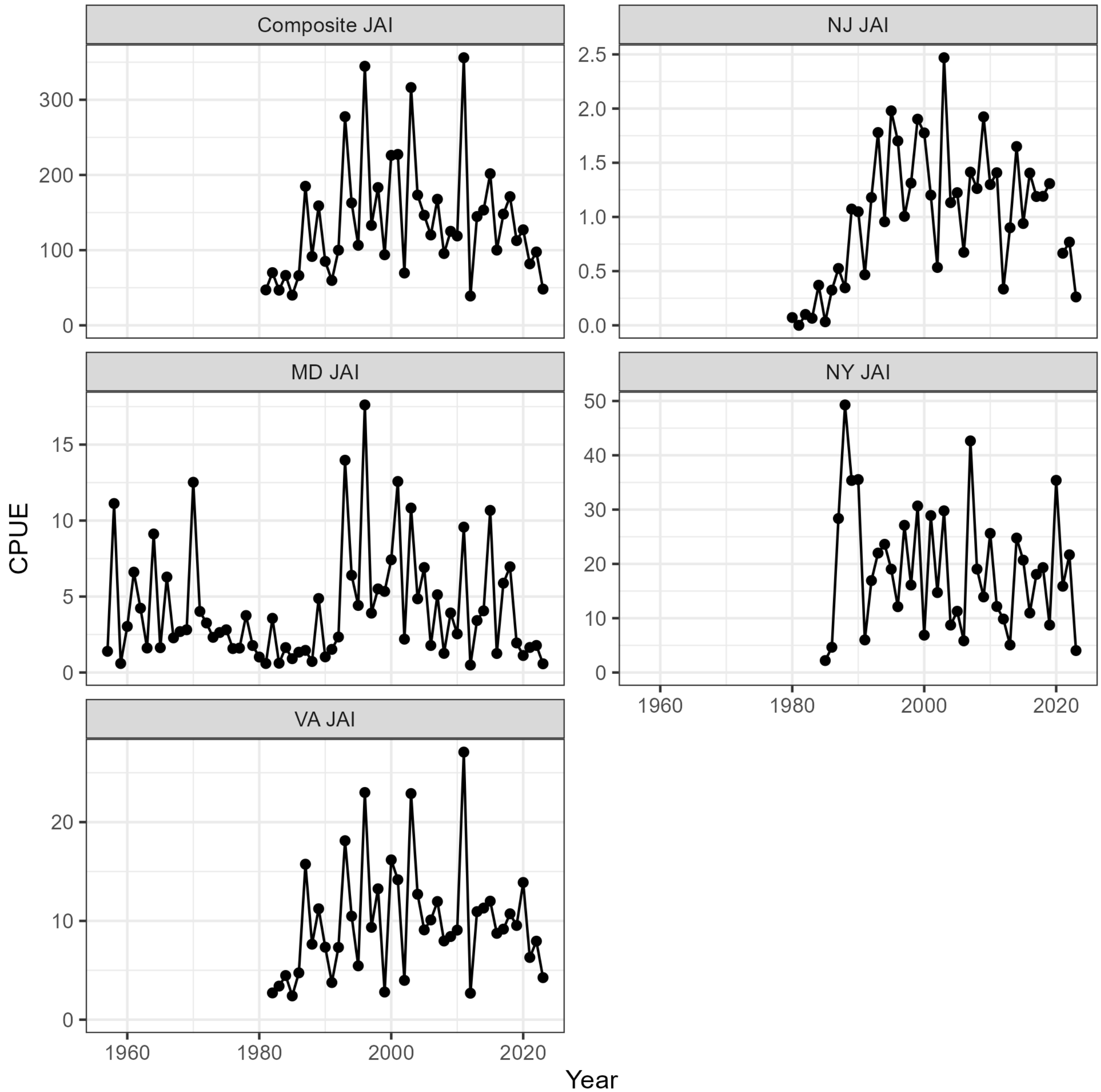


Figure 4. Striped bass juvenile abundance indices, including the composite Chesapeake Bay index (MD-VA), 1954-2023.

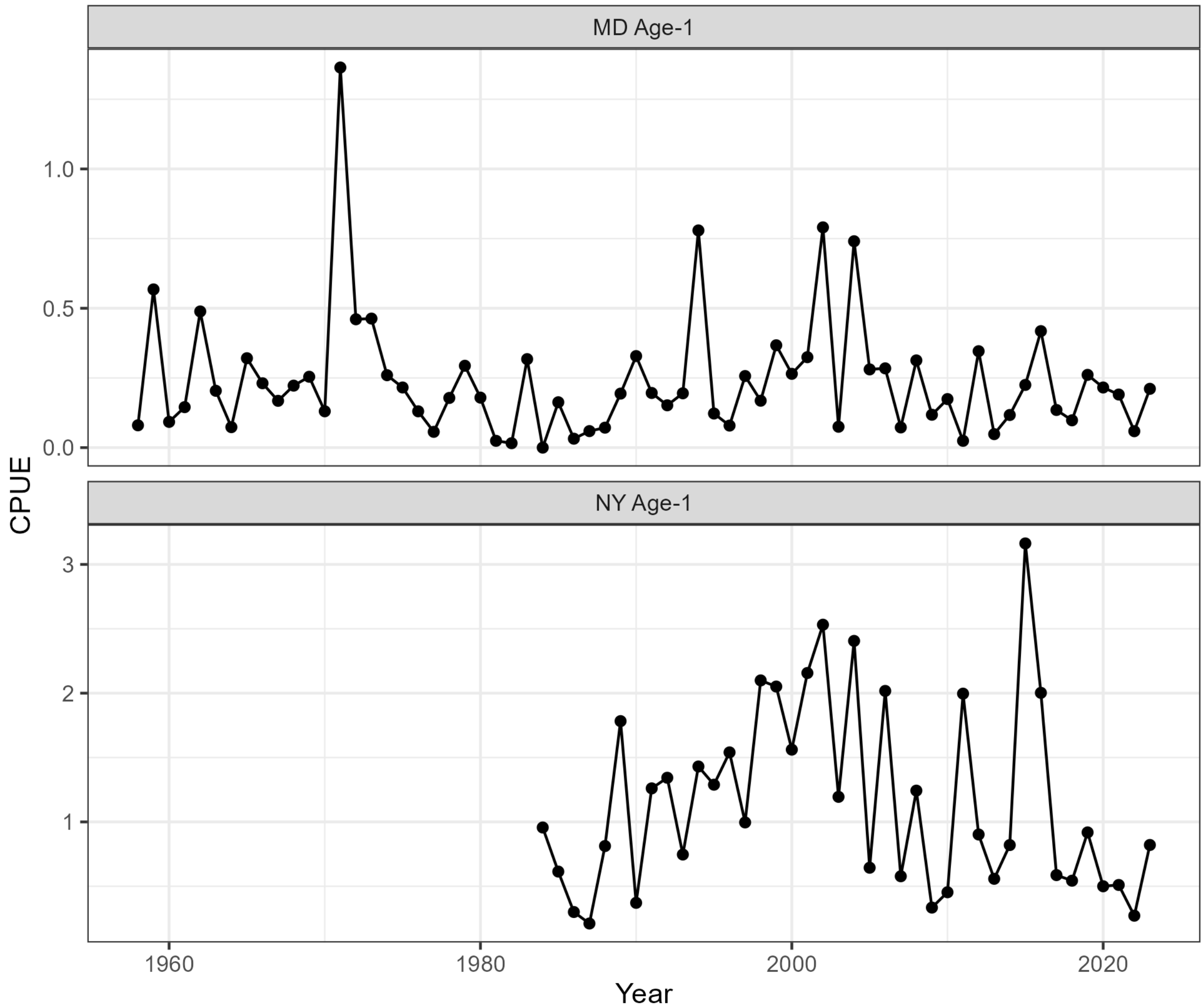


Figure 5. Age-1 recruitment indices for striped bass, 1954-2023.

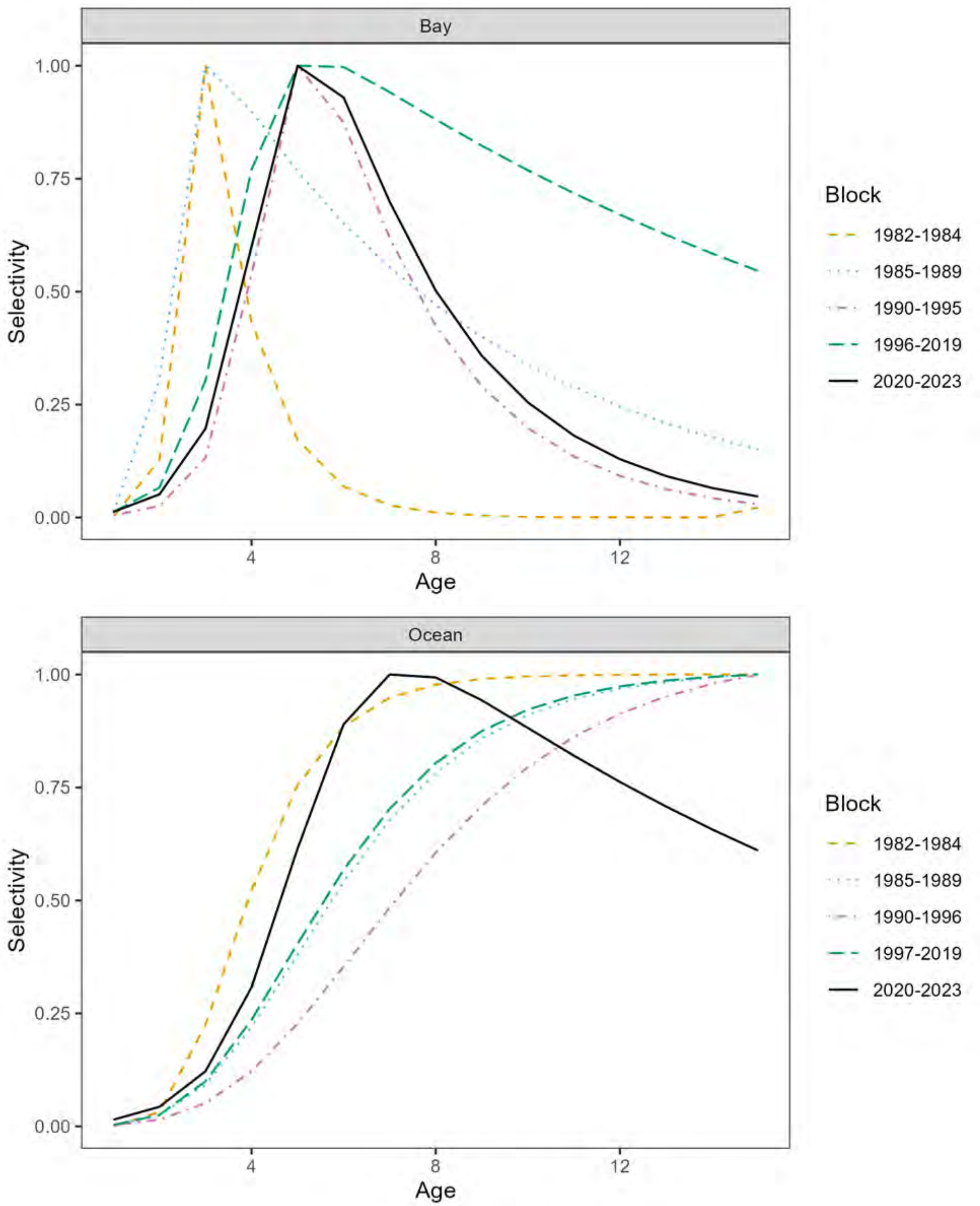


Figure 6. Selectivity patterns for the Bay fleet (top) and the Ocean fleet (bottom).

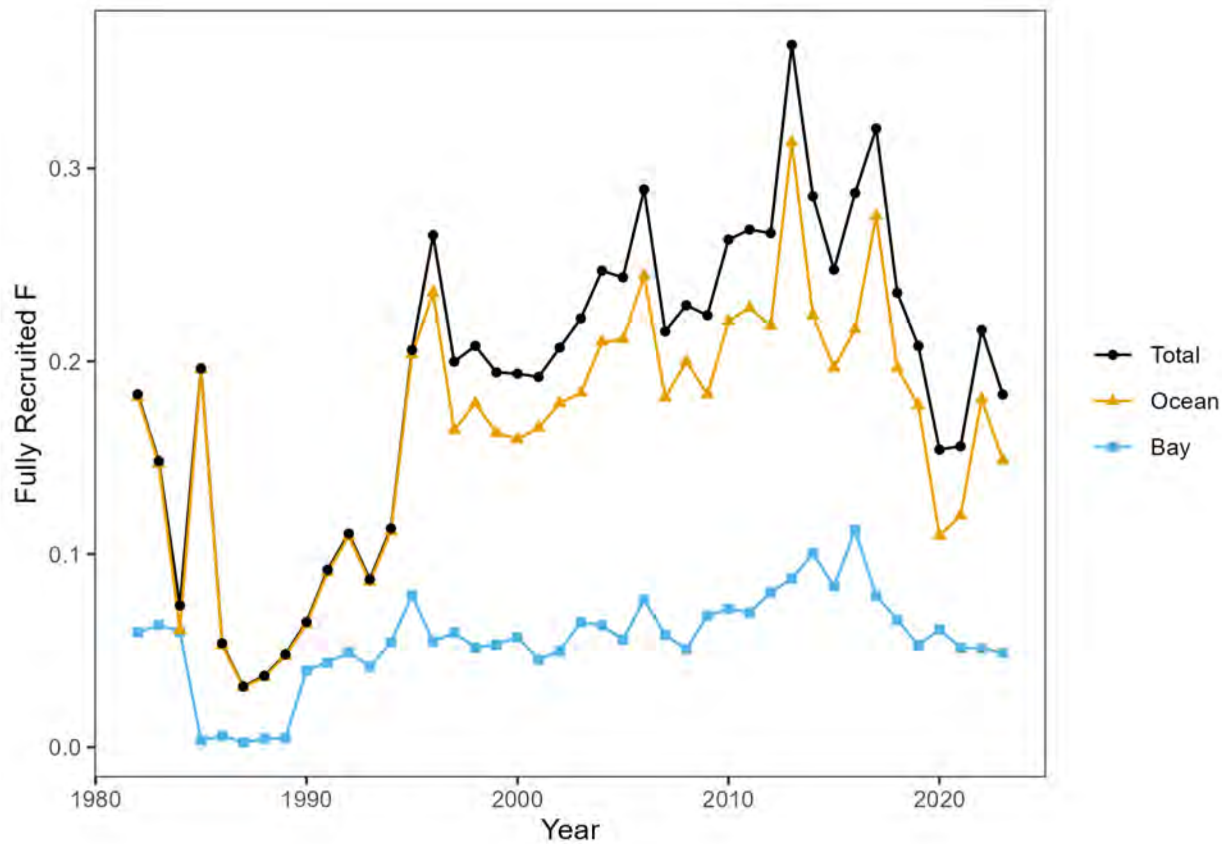


Figure 7. Fully recruited fishing mortality for the Bay and Ocean fleets plotted with the total fully recruited *F*.

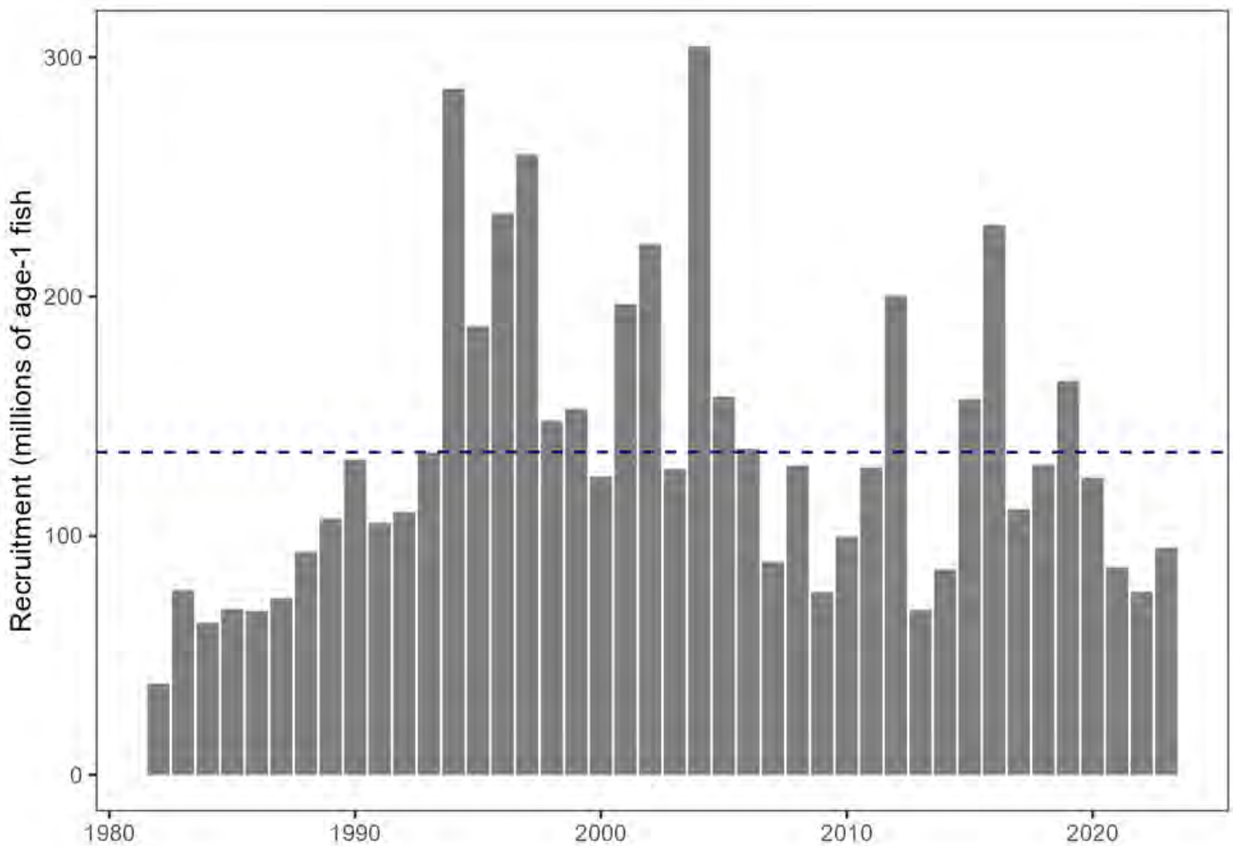


Figure 8. Estimates of striped bass recruitment plotted with the time series mean.

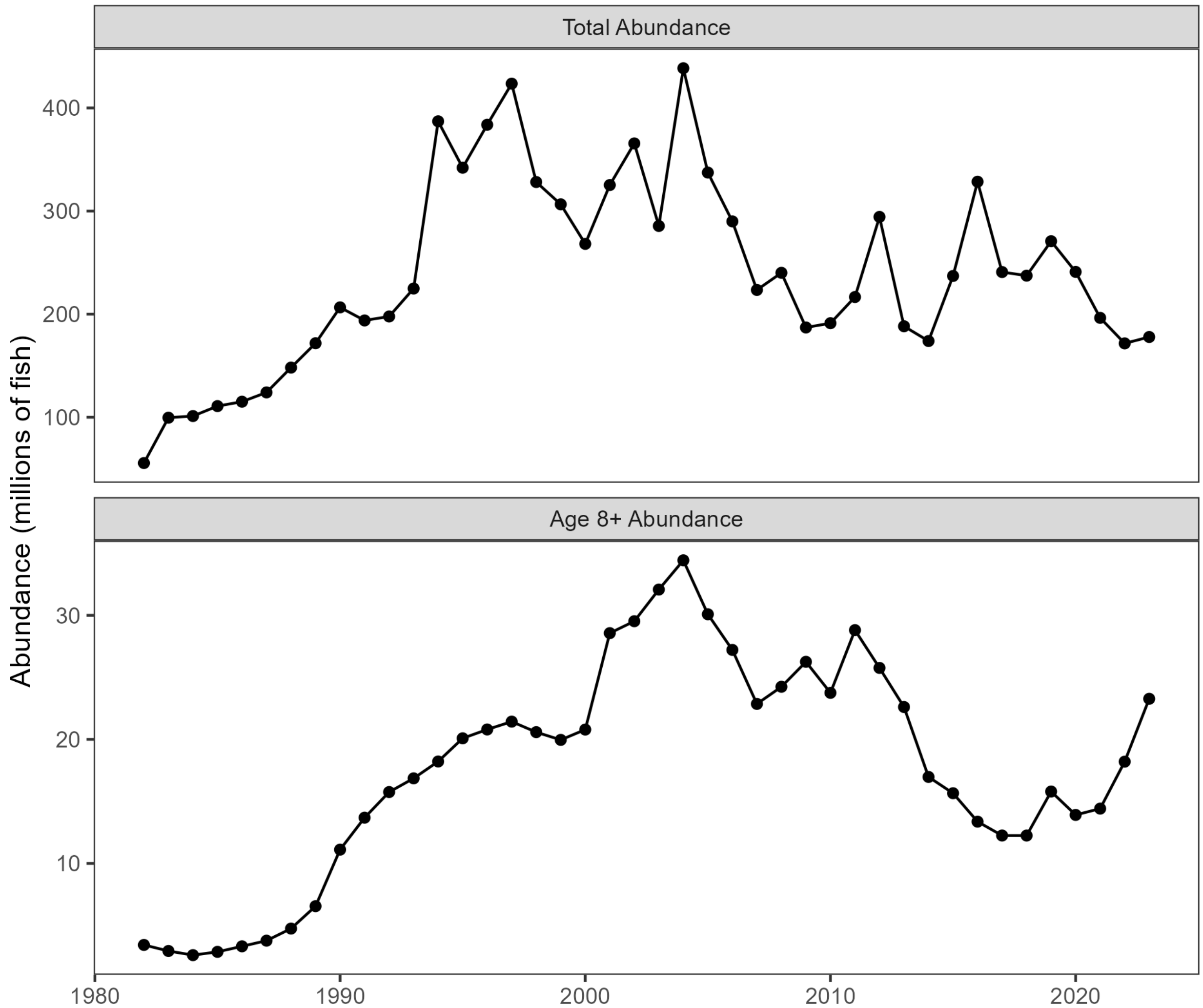


Figure 9. Total abundance (top) and age-8+ abundance (bottom) of striped bass over time.

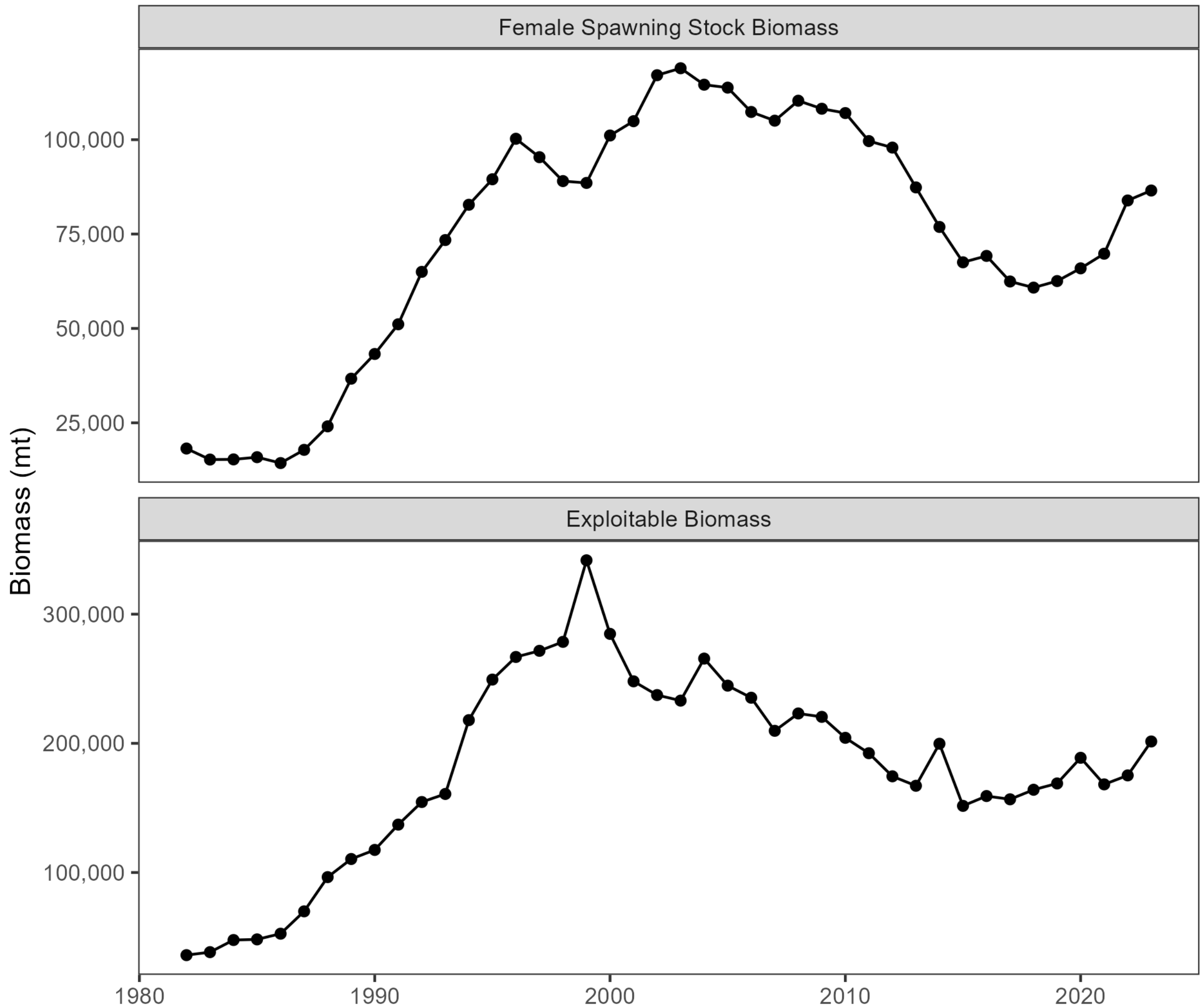


Figure 10. Female spawning stock biomass (top) and exploitable biomass (bottom) of striped bass over time.

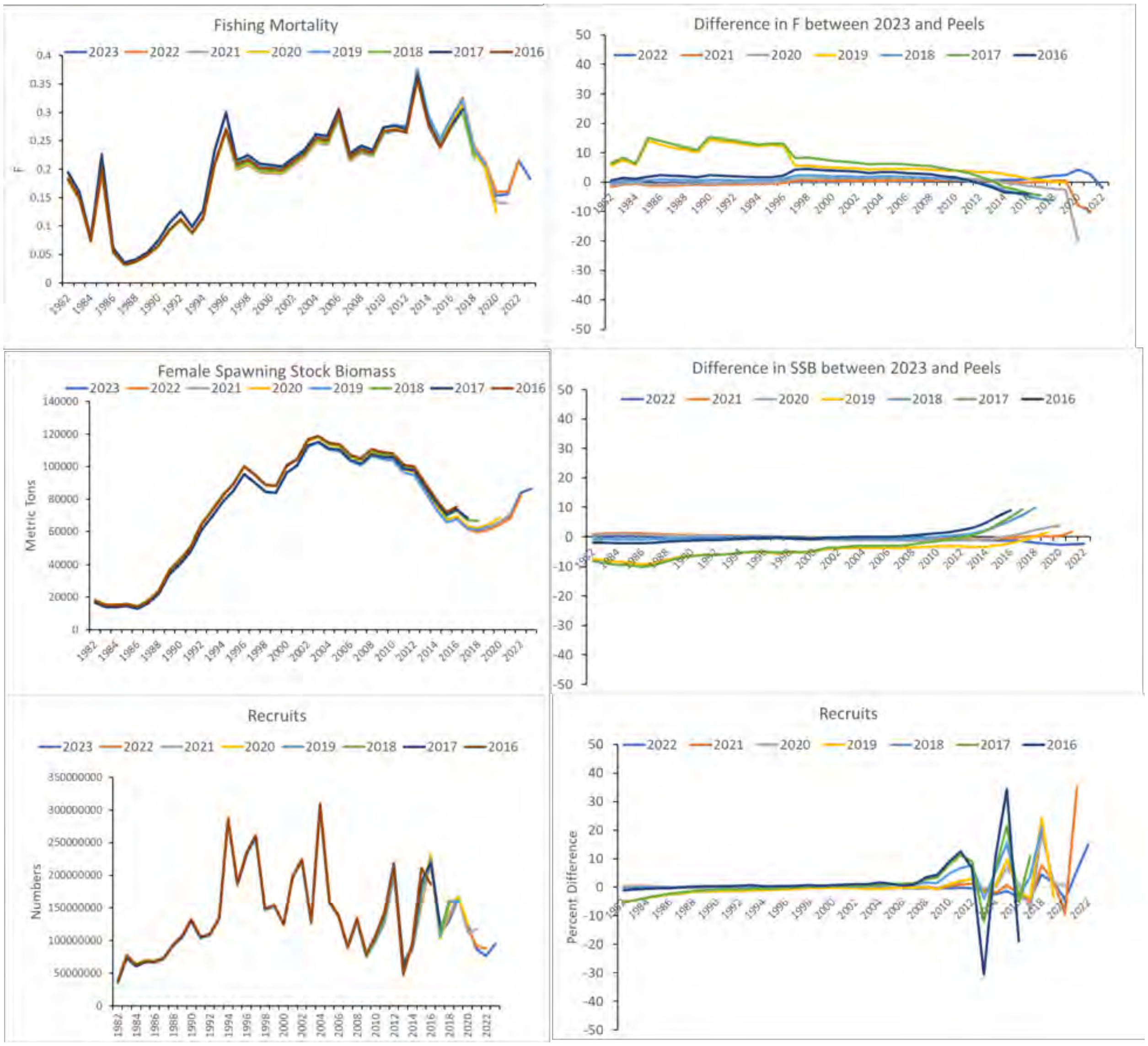


Figure 11. Retrospective plots of five-year peels for fishing mortality (top), female spawning stock biomass (middle), and recruitment (bottom).

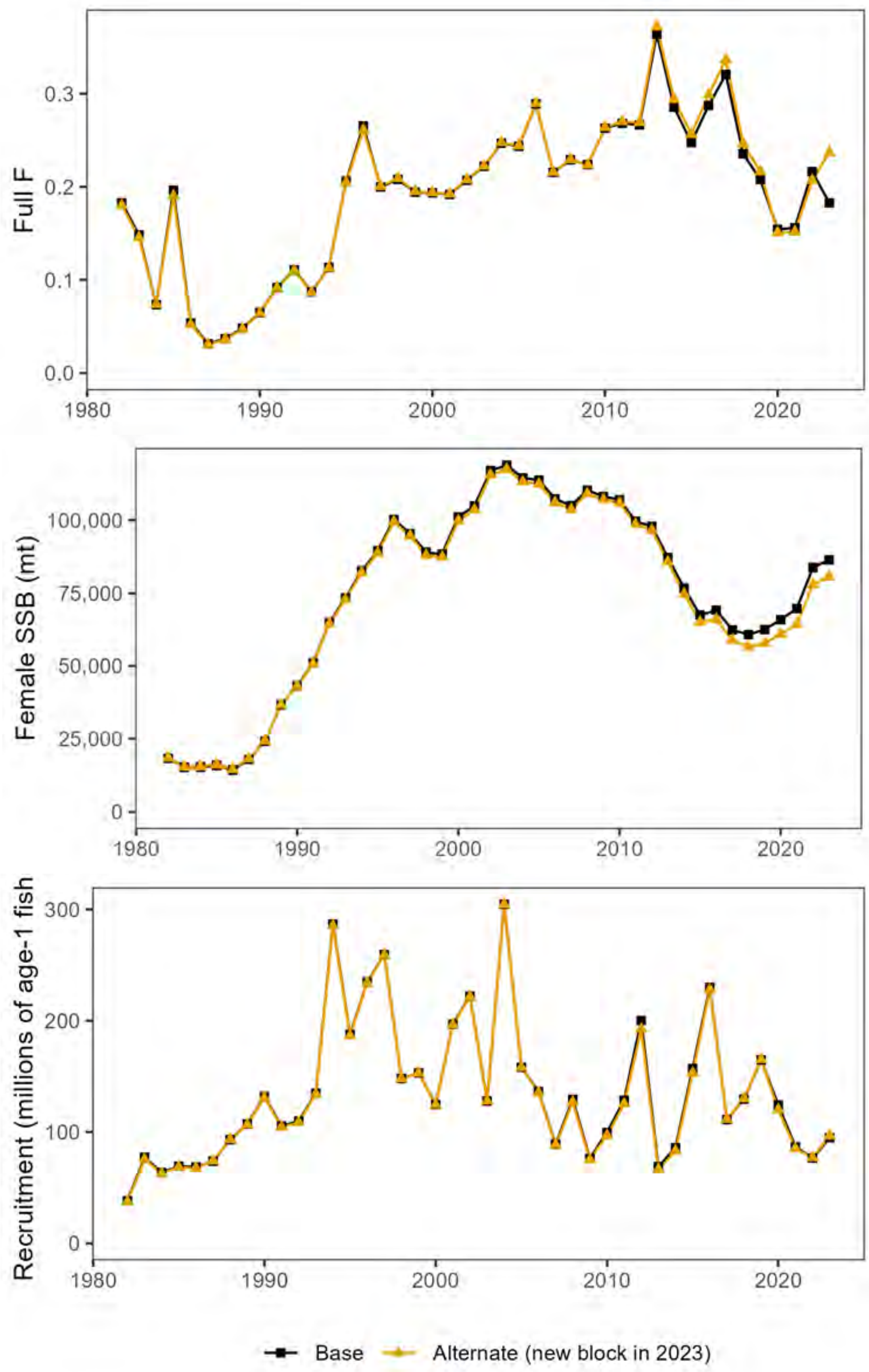


Figure 12. Comparison of fully-recruited fishing mortality (top), female SSB (middle) and recruitment (bottom) from the update assessment base model and sensitivity run with a new 2023 selectivity block for both fleets.

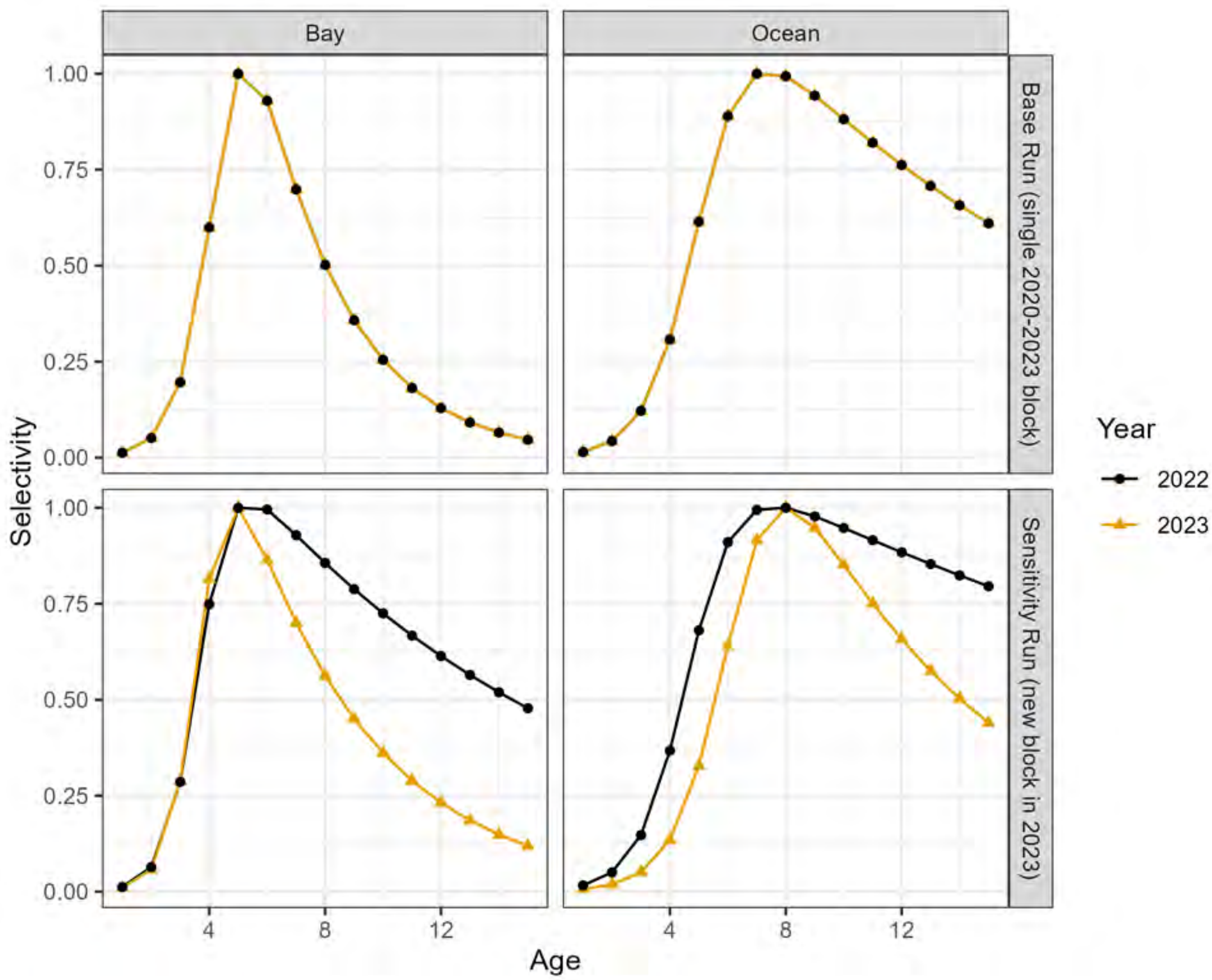


Figure 13. Selectivity curves for 2022 and 2023 for the Bay and Ocean fleets from the base run with a single 2020-2023 block (top row) and the sensitivity run with a new block in 2023 (bottom row).

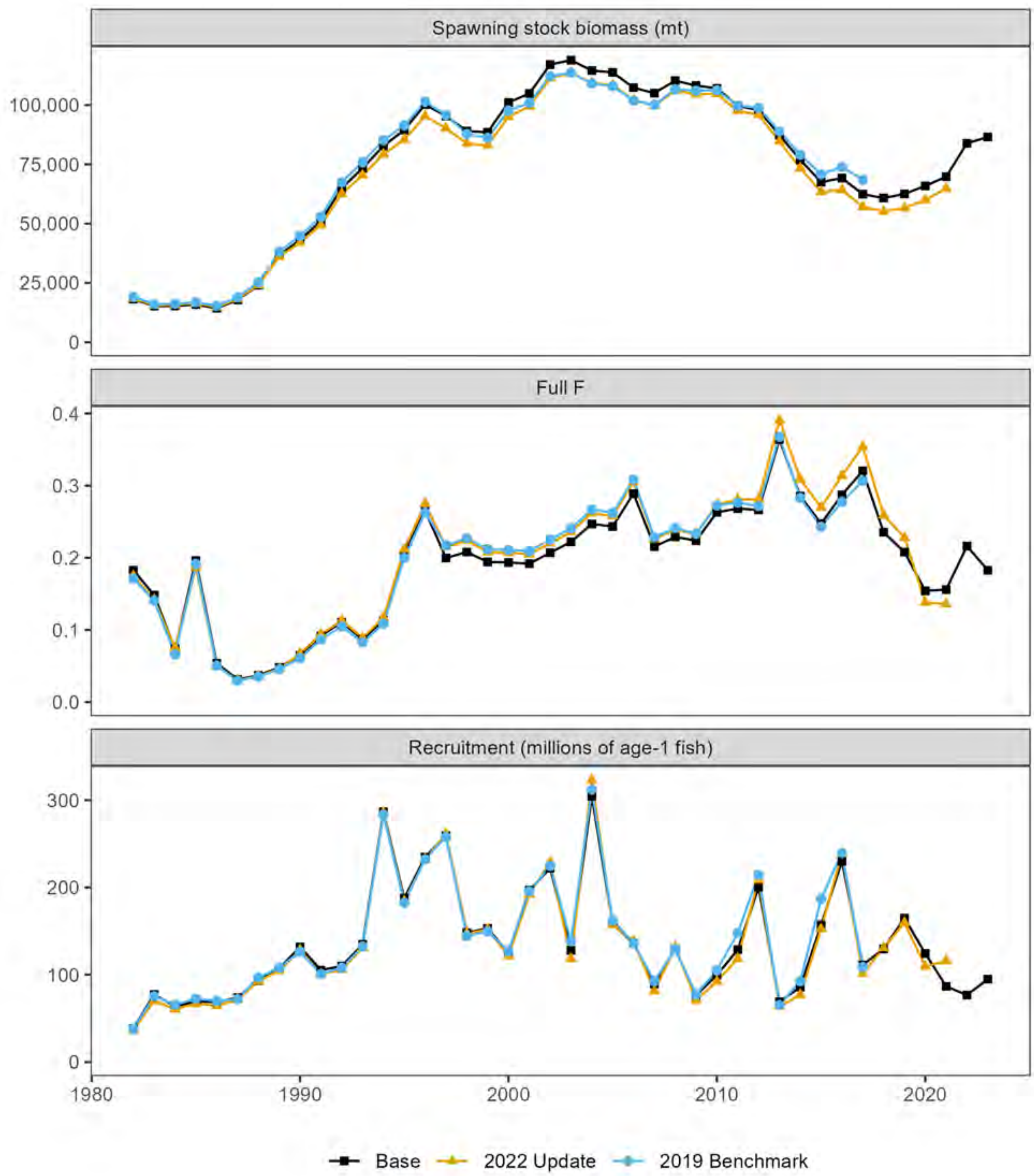


Figure 14. Comparison of estimates of female spawning stock biomass (top), total fishing mortality (middle), and recruitment (bottom) from the 2019 benchmark assessment, the 2022 assessment update, and the current assessment update.

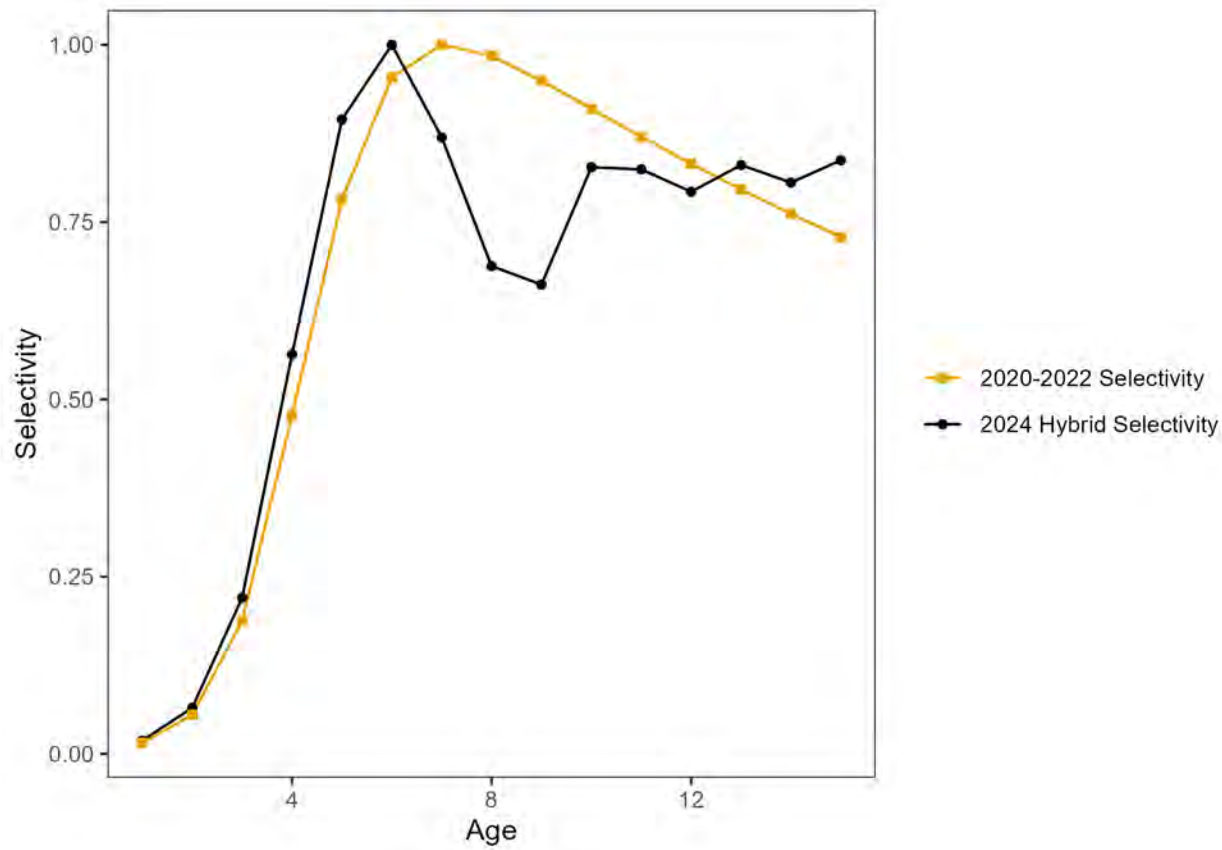


Figure 15. Hybrid selectivity pattern based on 2024 regulations used in the reference point calculations and rebuilding projections plotted with the 2020-2022 selectivity curve.

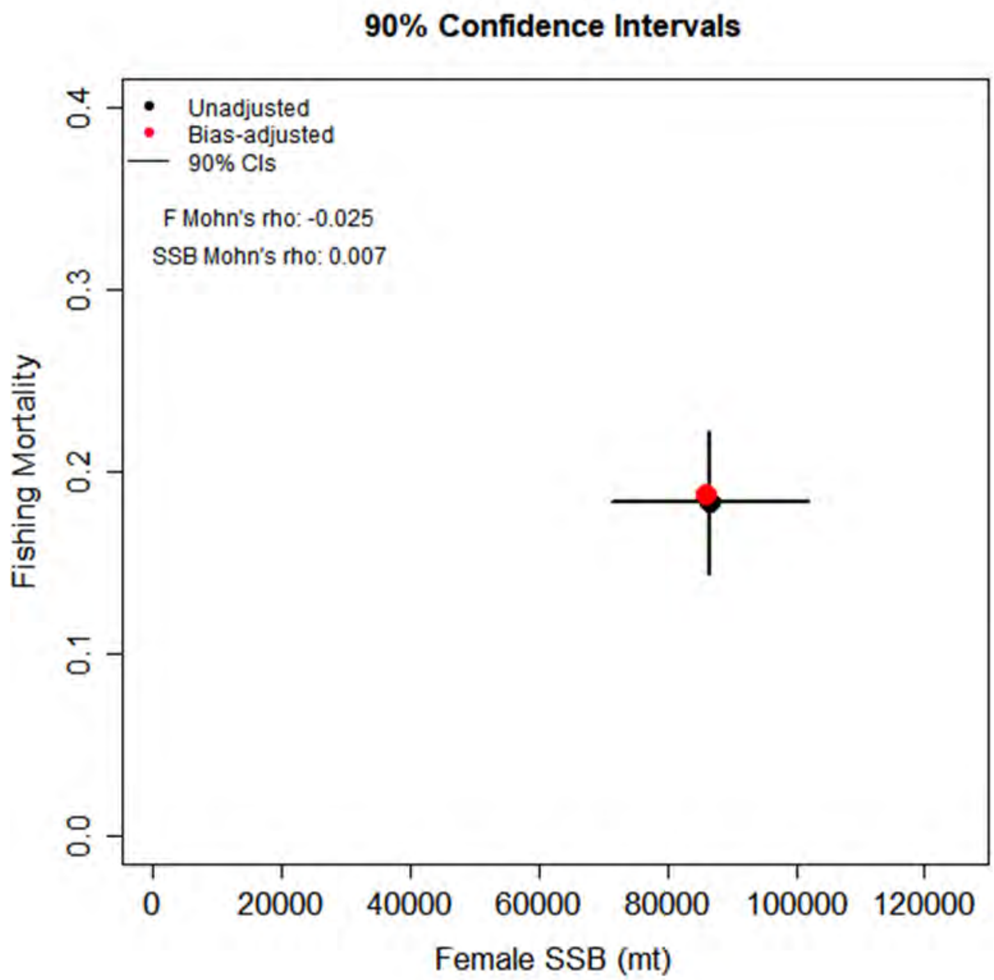


Figure 16. Plot comparing the 2023 retrospective-adjusted *F* and female SSB values with the unadjusted *F* and SSB estimates and their associated 90% confidence intervals.

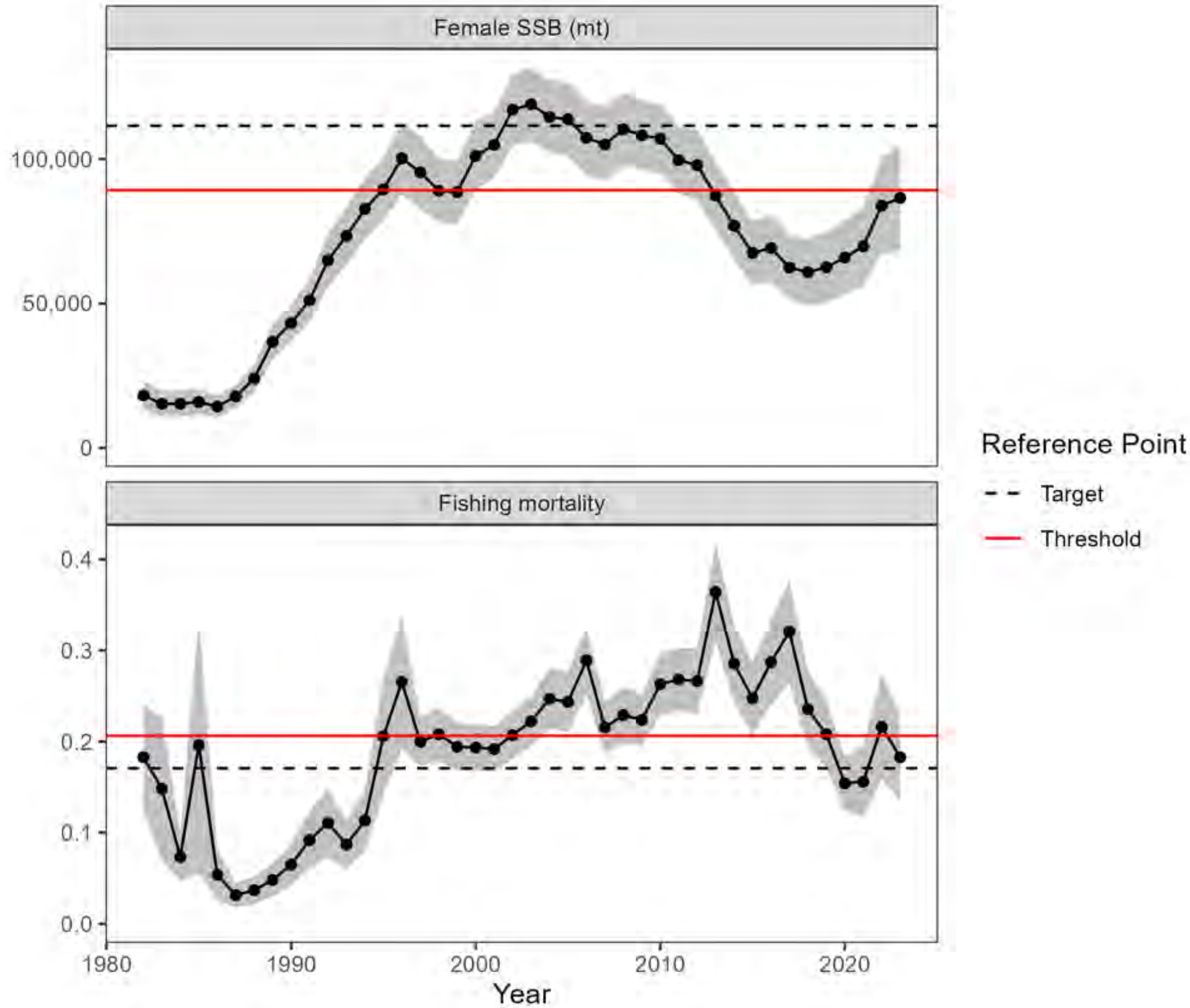


Figure 17. Female SSB (top) and total F estimates (bottom) plotted with their respective targets and thresholds. Shaded area indicates 95% confidence intervals of the estimates.

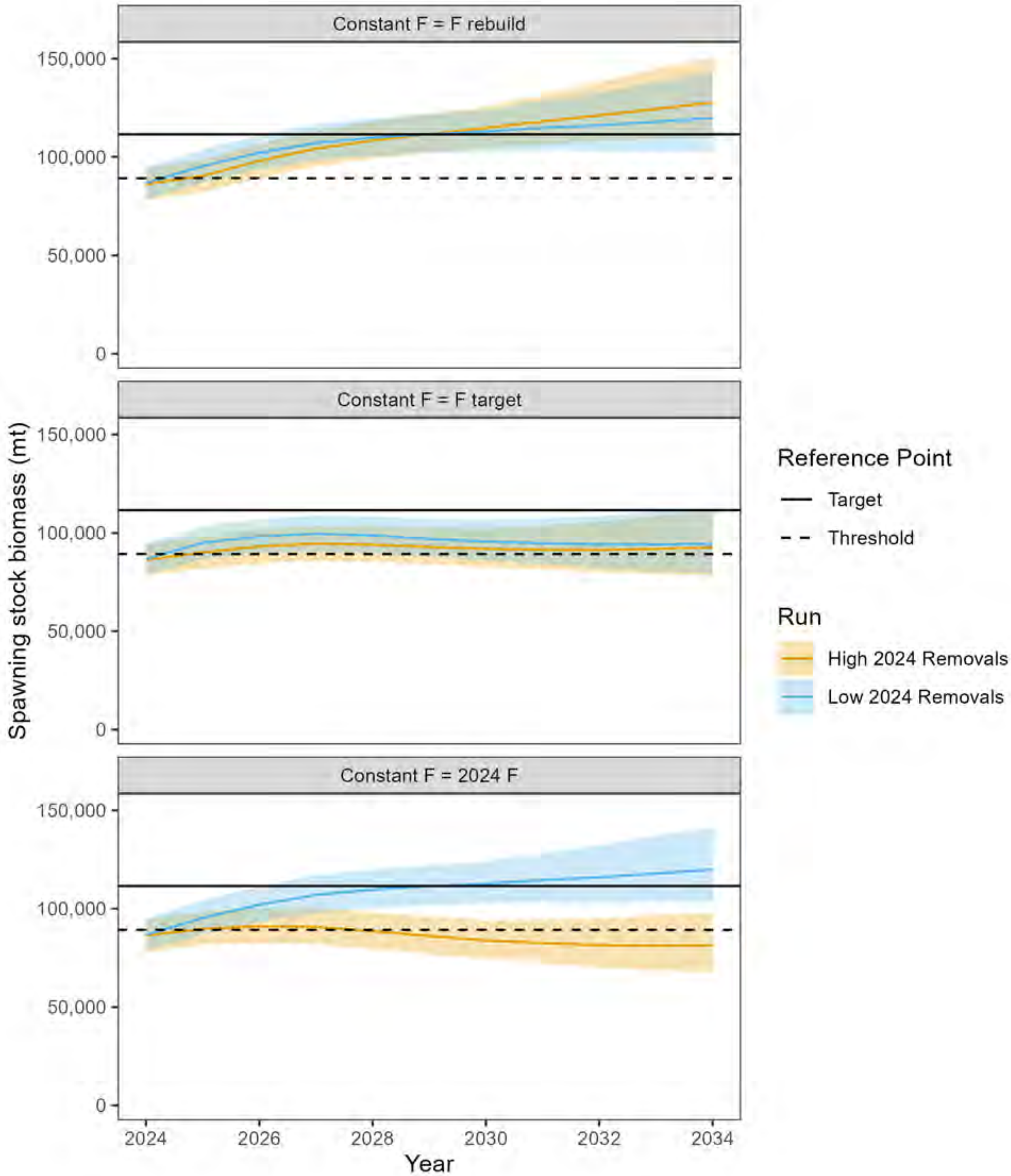


Figure 18. Projections of female spawning stock biomass through 2034 under constant $F_{rebuild}$ (top), F_{target} (middle), and estimated 2024 *F* (bottom) under different 2024 removal scenarios.

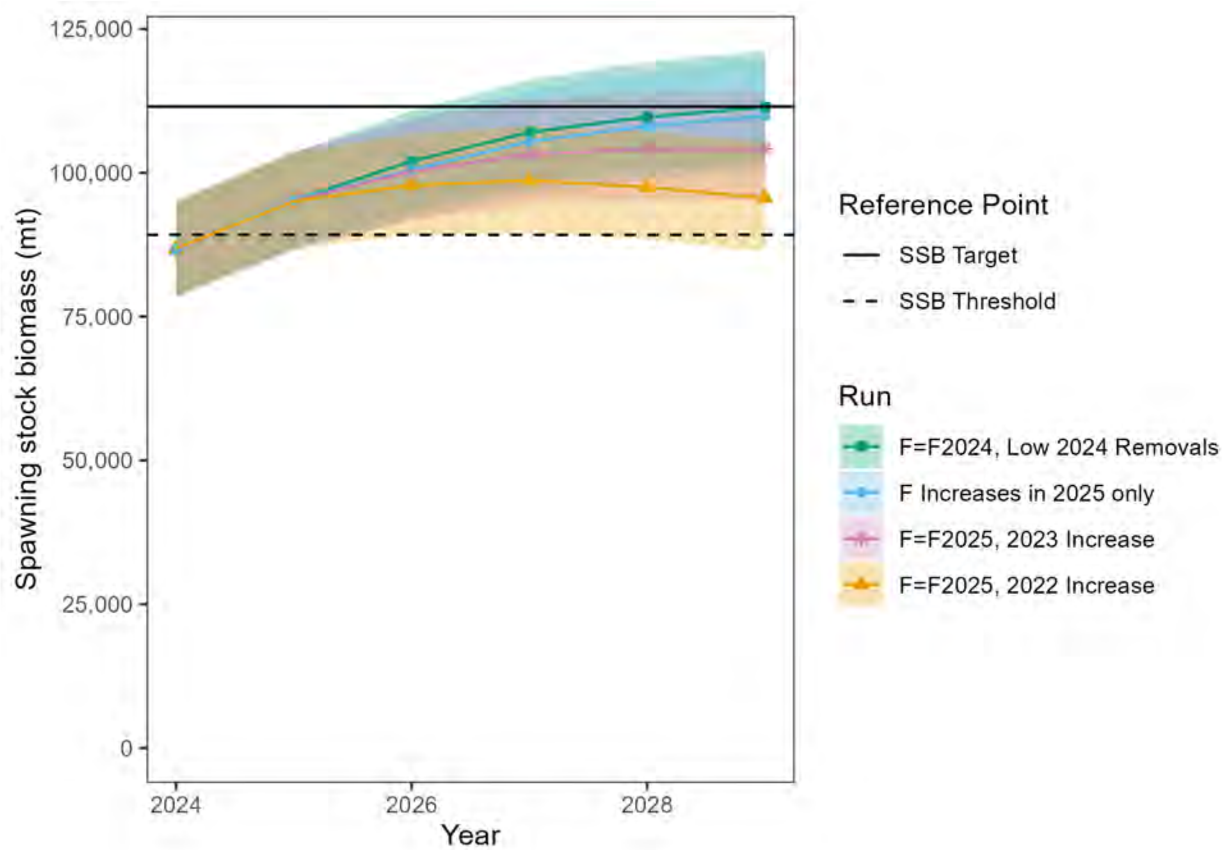


Figure 19. Projections of female spawning stock biomass through 2029 under different future *F* scenarios: assuming *F* stays the same as in 2024 under the low removals scenario (*F=F 2024)*, increases at a rate comparable to what was observed in 2022 (*F=F 2025, 2022 Increase)* or 2023 (*F=F2025, 2023 Increase)*, or increases in 2025 only and then returns to 2024 levels.

Appendix 1
Model Structure

General Definitions	Symbol	Description/Definition
Year Index	y	$y = \{1982,..,2021\}$ for catch. $y = \{1970,..,2021\}$ for indices.
Age Index	a	$a = \{1,..,15+\}$
Fleet Index	f	$f = \{1$: Chesapeake Bay, 2: Coast $\}$
Indices Index:	t	$t = \{1,..,14\}$
Input Data	**Symbol**	**Description/Definition**
Observed Fleet Catch	$C_{f,y}$	Reported number of striped bass killed each year (y) by fleet (f)
Coefficient of Variation for Fleets	$CV_{f,y}$	Calculated from MRIP harvest and releases estimates with associated proportional standard errors (commercial harvest from census – no error)
Observed Fleet Age Compositions	$P_{f,y,a}$	Proportion-at-age (a) for each year (y) and fleet (f)
Observed Total Indices of Relative Abundance	$I_{t,y}$	Reported by various states. YOY and Age 1 Indices: 6 Indices with Age Composition: 8 (one fisheries-dependent, 7 fishery-independent)
Coefficient of Variation for Indices	$CV_{t,y}$	Calculated from indices and associated standard errors
Observed Age Compositions of Indices of Relative Abundance	$P_{t,y,a}$	Proportion-at-age (a) for each year (y) and index (t)
Effective Sample Size	$\hat{n}$	Starting Values from 2018 Benchmark Fleets: Bay – 68.4, Ocean – 71 Indices: NYOHS – 21.4, NJ Trawl – 5.2, MDSSN – 16.8, DESSN – 19.7, MRIP – 35.6, CTLIST – 12.4, DE30FT – 7.3, ChesMap – 10.7 The multiplier from equation 1.8 method of Francis (2011) is used to adjust the starting values.

Population Model	Symbol	Equation
Age-1 numbers	$\hat{N}_{y,1}$	$\hat{N}_{y,1} = \bar{N}_1 e^{\hat{\varepsilon}_y - 0.5\sigma_R^2}$ $\hat{\sigma}_R = \sqrt{\frac{\Sigma_y(\hat{\varepsilon}_y - \hat{\bar{\varepsilon}})^2}{n-1}}$ where ε_y are independent and identically distributed normal random variables with zero mean and constant variance and are constrained to sum to zero over all years
Abundance-at-Age	$\hat{N}_{y,a}$	First year (ages 2-A in 1970): $\hat{N}_{y,a} = \hat{N}_{y,a-1} \exp^{-\hat{F}_{1982,a-1} - M_{1982,a-1}}$ Rest of years (ages 2-15): $\hat{N}_{y,a} = \hat{N}_{y-1,a-1} \exp^{-\hat{F}_{y-1,a-1} - M_{y-1,a-1}}$
Plus-group abundance-at-age	$\hat{N}_{y,A}$	$\hat{N}_{y,A} = \hat{N}_{y-1,A-1} \exp^{-\hat{F}_{y-1,A-1} - M_{y-1,A-1}} + \hat{N}_{y-1,A} \exp^{-\hat{F}_{y-1,A} - M_{y-1,A}}$
Fishing Mortality	$\hat{F}_{f,y,a}$	$\hat{F}_{f,y,a} = \hat{F}_{f,y} \cdot \hat{s}_{f,a}$ where $F_{f,y}$ and $s_{f,a}$ are estimated parameters
Total Mortality	$\hat{Z}_{y,a}$	$Z_{y,a} = F_{y,a} + M_{y,a}$
Fleet Selectivity Time Blocks and Selectivity Equations	$\hat{s}_{f,a}$	Fleet 1 (Chespeake Bay): 1982-1984, 1985-1989, 1990-1995, 1996-2019, 2020-2021 $\hat{s}_a = \frac{1}{1-\hat{\gamma}} \cdot \left(\frac{1-\hat{\gamma}}{\hat{\gamma}}\right)^{\hat{\gamma}} \frac{\exp^{\hat{\alpha}\hat{\gamma}(\hat{\beta}-a)}}{1+\exp^{\hat{\alpha}(\hat{\beta}-a)}}$ Fleet 2 (Ocean): 1982-1984, 1985-1989,1990-1996,1997-2019, 2020-2021 $\hat{s}_a = \exp^{(-\exp^{-\hat{\beta}(a-\hat{\alpha})})}$
Predicted Catch-At-Age	$\hat{C}_{f,y,a}$	$\hat{C}_{f,y,a} = \frac{\hat{F}_{f,y,a}}{\hat{F}_{f,y,a} + M_{y,a}} \cdot (1 - \exp^{-\hat{F}_{y,a} - M_{y,a}}) \cdot \hat{N}_{y,a}$

Population Model	Symbol	Equation
Predicted Total Catch	$\hat{C}_{f,y}$	$\hat{C}_{f,y} = \sum_a \hat{C}_{f,y,a}$
Predicted Proportions of Catch-At-Age	$\hat{P}_{f,y,a}$	$\hat{P}_{f,y,a} = \frac{\hat{C}_{f,y,a}}{\sum_a \hat{C}_{f,y,a}}$
Predicted Aggregated Indices of Relative Abundance	$\hat{I}_{t,y,\sum a}$	$\hat{I}_{t,y,\Sigma a} = \hat{q}_t \cdot \sum_a \hat{N}_{y,a} \cdot \exp^{-p_t \cdot Z_{y,a}}$ where q_t is the estimated catchability coefficient of index t and p_t is the fraction of the year when the survey takes place.
Predicted Age-Specific Indices of Relative Abundance	$\hat{I}_{t,y,a}$	$\hat{I}_{t,y,a} = \hat{q}_t \cdot \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot exp^{-p_t \cdot \hat{Z}_{y,a}}$ where $\hat{s}_{t,a}$ is the selectivity-at-age a for index t
Predicted Total Indices of Relative Abundance with Age Composition Data	$\hat{I}_{t,y}$	$\hat{I}_{t,y} = \hat{q}_t \sum_a \hat{s}_{t,a} \cdot \hat{N}_{y,a} \cdot \exp^{-p_t \cdot \hat{Z}_{y,a}}$
Predicted Age Composition of Survey	$\hat{U}_{t,y,a}$	$\hat{U}_{t,y,a} = \frac{\hat{I}_{t,y,a}}{\sum_a \hat{I}_{t,y,a}}$
Female Spawning Stock Biomass (metric tons)	SSB_y	$SSB_y = \sum_{a=1}^{A} N_{y,a} \cdot sr_a \cdot m_a \cdot w_{y,a}/1000$ where sr_a is the female sex ratio at age a and m_a is female maturity at age a.

Likelihood	Symbol	Equation
Concentrated Lognormal Likelihood for Fleet Catch (F) and Indices of Relative Abundance (T)	$-L_F$; $-L_T$	$$-L_F = 0.5 * \sum_f n_f * ln\left(\frac{\sum_f RSS_f}{\sum_f n_f}\right)$$ $$-L_T = 0.5 * \sum_t n_t * ln\left(\frac{\sum_t RSS_t}{\sum_t n_t}\right)$$ where $$RSS_f = \lambda_f \sum_y \left(\frac{ln(C_{f,y} + 0.00001) - ln(\hat{C}_{f,y} + 0.00001)}{\delta_f \cdot CV_{f,y}}\right)^2$$ $$RSS_t = \lambda_t \sum_y \left(\frac{ln(I_{t,y} + 0.00001) - ln(\hat{I}_{t,y} + 0.00001)}{\delta_t \cdot CV_{t,y}}\right)^2$$ *ln* is the natural log. $CV_{f,y}$ and $CV_{t,y}$ are the annual coefficient of variation for the observed total catch (f) and index (t) in year *y*, δ_f and δ_t is the CV weights for total catch *f* and index *t*, and λ_t and λ_f are relative weights.
Multinomial fleet catch (FC) and index (TC) age compositions	$-L_{FC}$; $-L_{TC}$	$$-L_{FC} = \lambda_f \sum_y -n_{f,y} \sum_a P_{f,y,a} \cdot ln(\hat{P}_{f,y,a} + 0.0000001)$$ $$-L_{TC} = \lambda_t \sum_y -n_{t,y} \sum_a U_{t,y,a} \cdot ln(\hat{U}_{t,y,a} + 0.0000001)$$ where λ_f and λ_t are a user-defined weighting factors and n_y are the effective sample sizes.
Constraints Added To Total Likelihood	P_{n1}, P_{rdev}, P_{fadd}	$P_{n1} = \lambda_{n1}(\hat{N}_{y,1} - N^e_{y,1})^2$ - forces $N_{1,1}$ to follow S-R curve $P_{rdev} = \lambda_R \sum_y log_e(\hat{\sigma}_R) + \frac{\hat{\varepsilon}_y^2}{2\hat{\sigma}_R^2}$ - for bias correction to constrain deviations $$P_{f_{add}} = \begin{cases} \text{phase} < 3, & 10 \cdot \sum_y (F_{f,y} - 0.15)^2 \\ \text{phase} \geq 3, & 0.000001 \cdot \sum_y (F_{f,y} - 0.15)^2 \end{cases}$$ - avoid small F values at start

Diagnostics	Symbol	Equation
Standardized residuals (lognormal – catch and surveys)	$r_{f,y,a}$ or $r_{t,y,a}$	$r_{t,y} = \frac{\ln I_{t,y} - \widehat{\ln I}_{t,y}}{\sqrt{\ln((\delta_t CV_{t,y})^2 + 1)}}$ $r_{f,y} = \frac{\ln C_{f,y} - \widehat{\ln C}_{f,y}}{\sqrt{\ln(CV_{f,y}^2 + 1)}}$
Standardized residuals (age compositions – catch and surveys)	$ra_{f,y,a}$ or $ra_{t,y,a}$	$ra_{f,y,a} = \frac{P_{f,y,a} - \hat{P}_{f,y,a}}{\sqrt{\frac{\hat{P}_{f,y,a}(1-\hat{P}_{f,y,a})}{\hat{\bar{n}}_f}}}$ $ra_{t,y,a} = \frac{P_{t,y,a} - \hat{P}_{t,y,a}}{\sqrt{\frac{\hat{P}_{t,y,a}(1-\hat{P}_{t,y,a})}{\hat{\bar{n}}_t}}}$
Root mean square error	$RMSE$	Total catch $RMSE_f = \sqrt{\frac{\sum_y r_{f,y}^2}{n_f}}$ Index $RMSE_t = \sqrt{\frac{\sum_y r_{t,y}^2}{n_t}}$

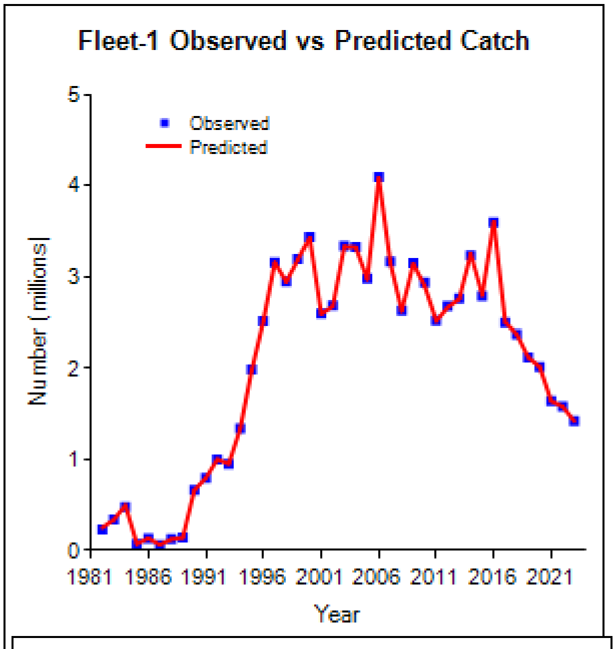
Appendix 2
Diagnostic plots, detailed results, and projections for the base model and sensitivity run

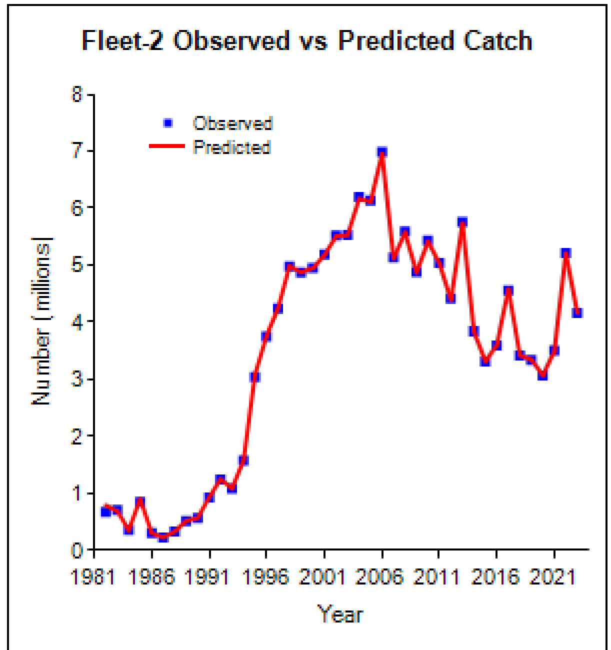
Base Run

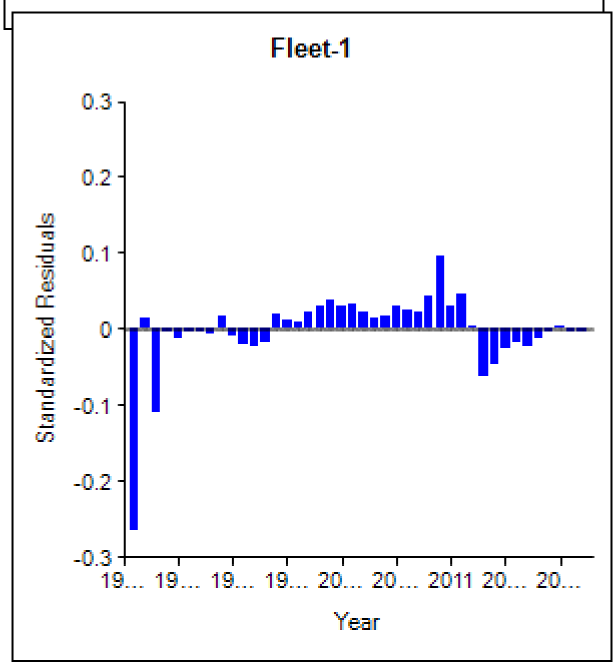
Run configuration:

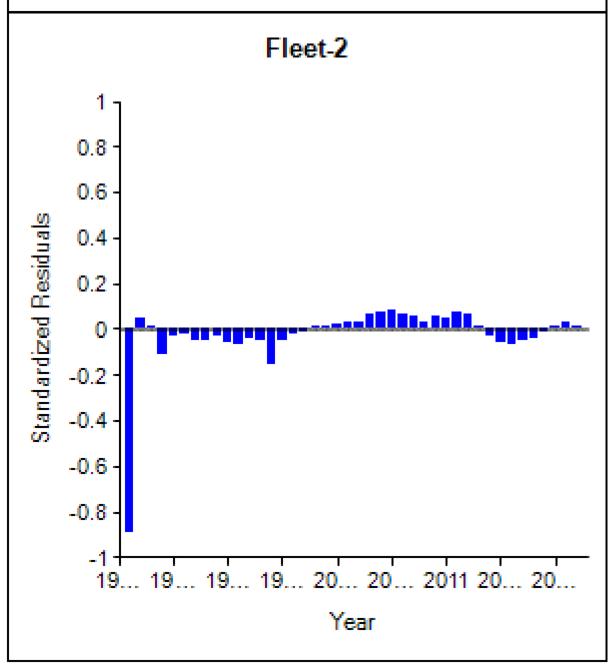
Bay and Ocean fleets: 2020-2023 selectivity block (no separate 2023 block)

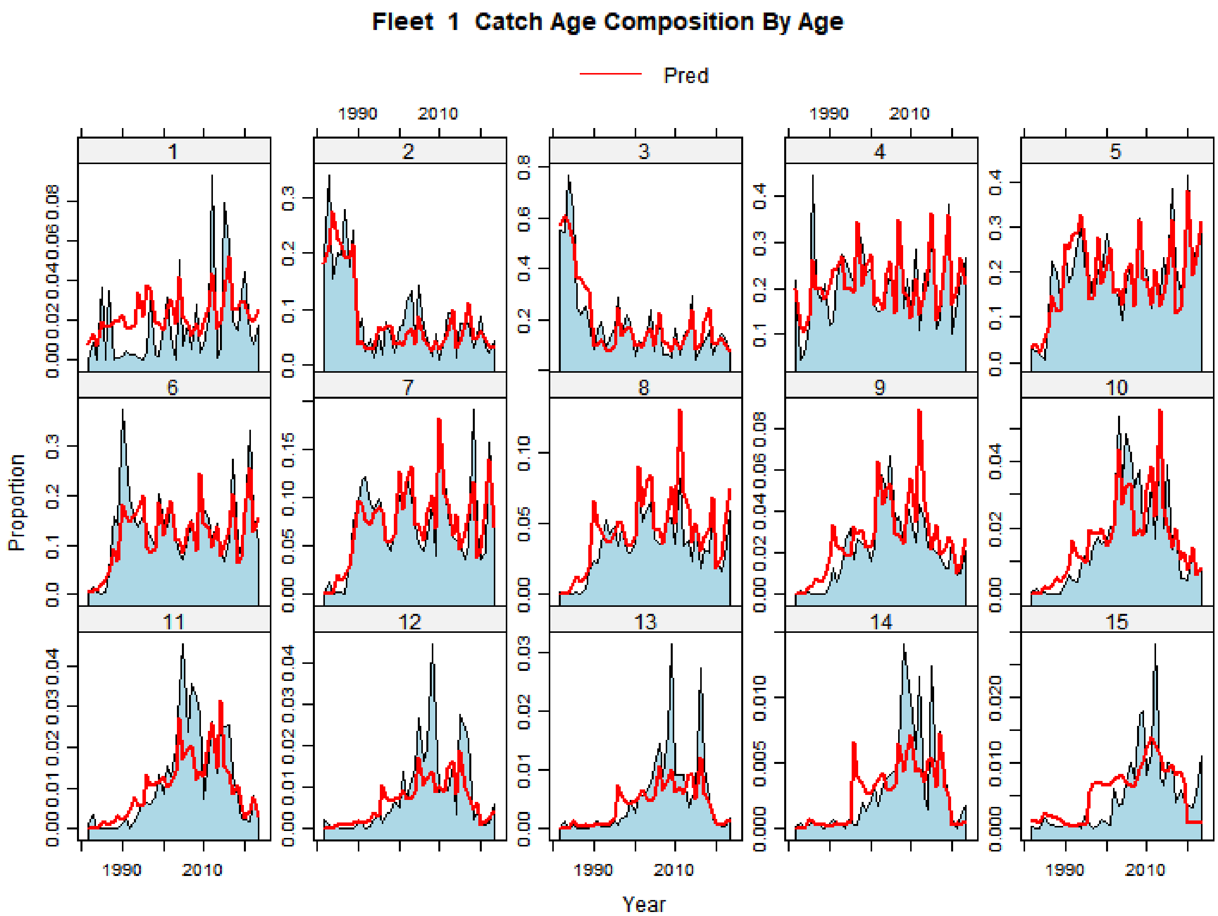
Diagnostic Plots

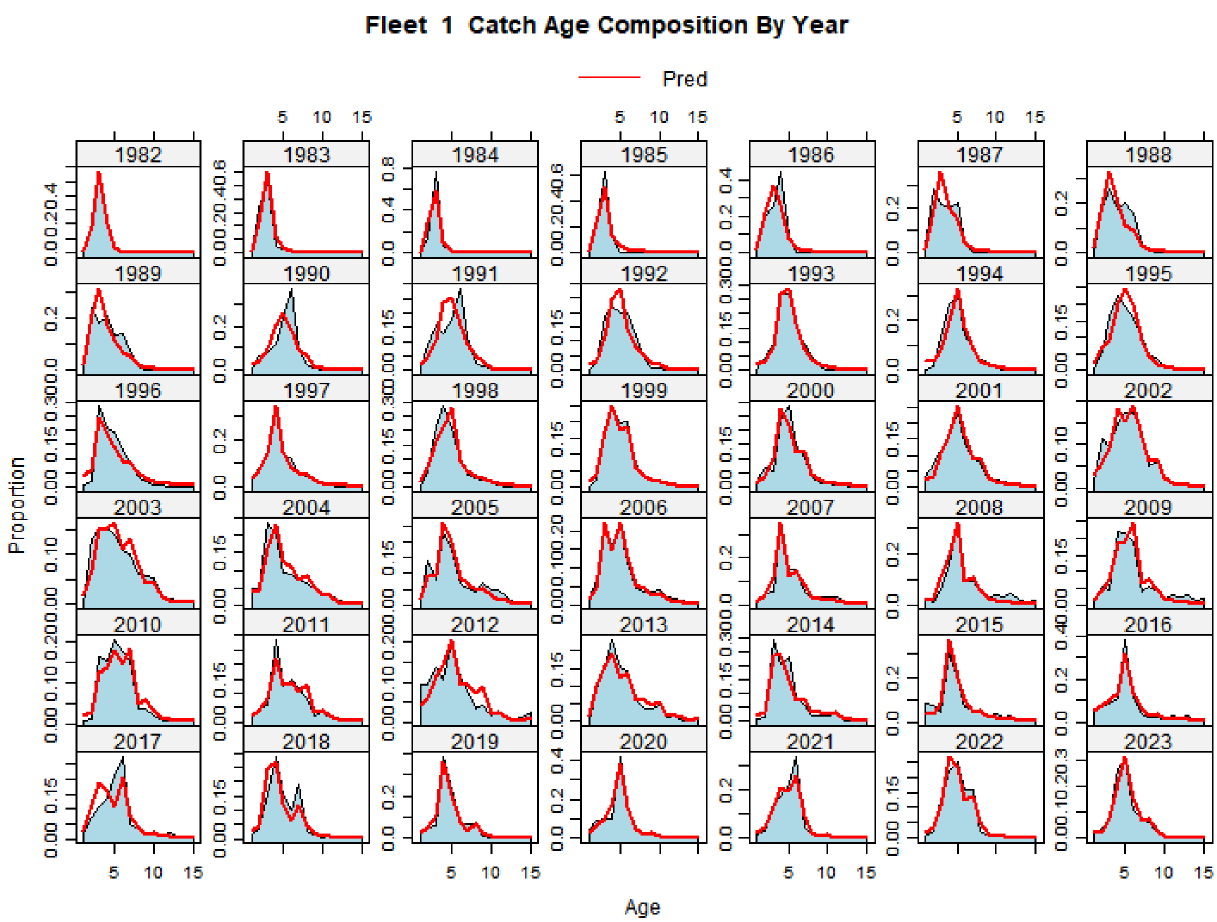


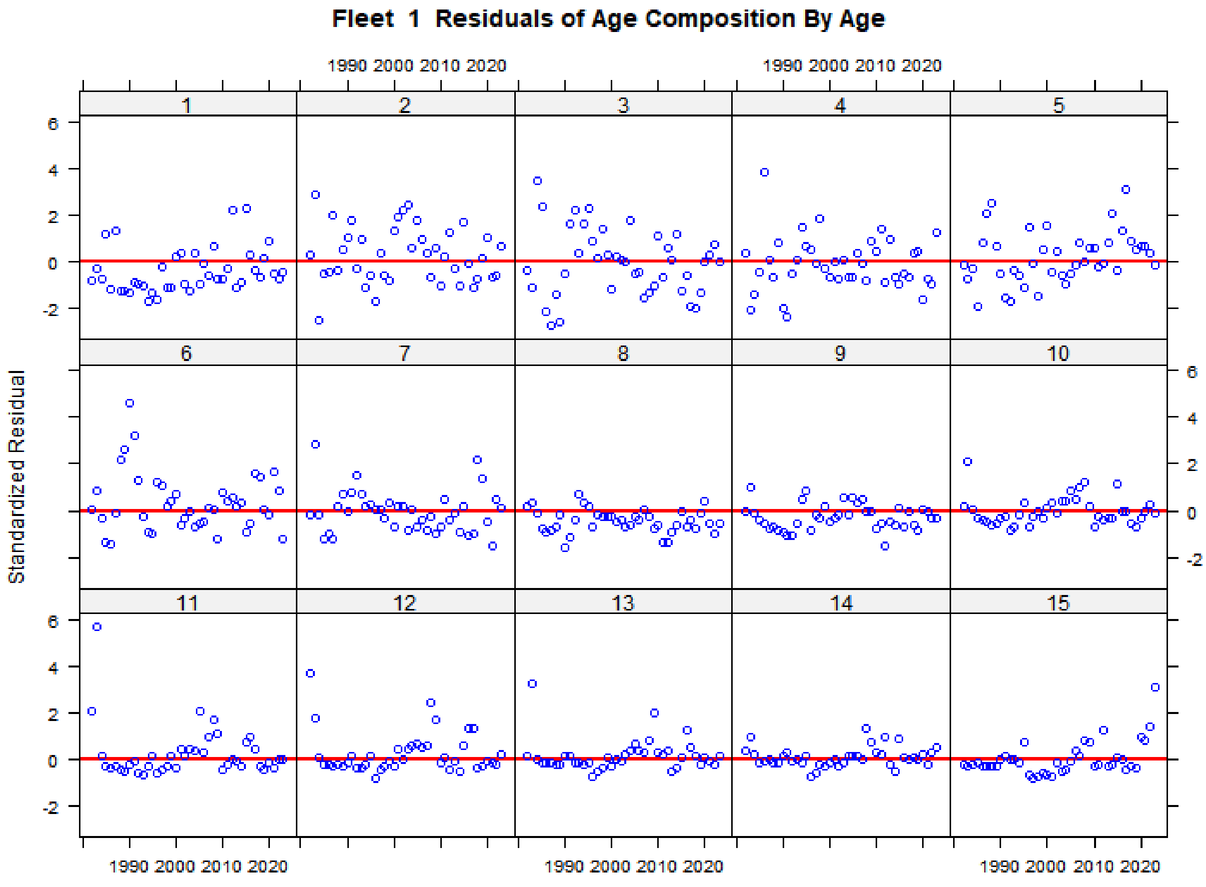


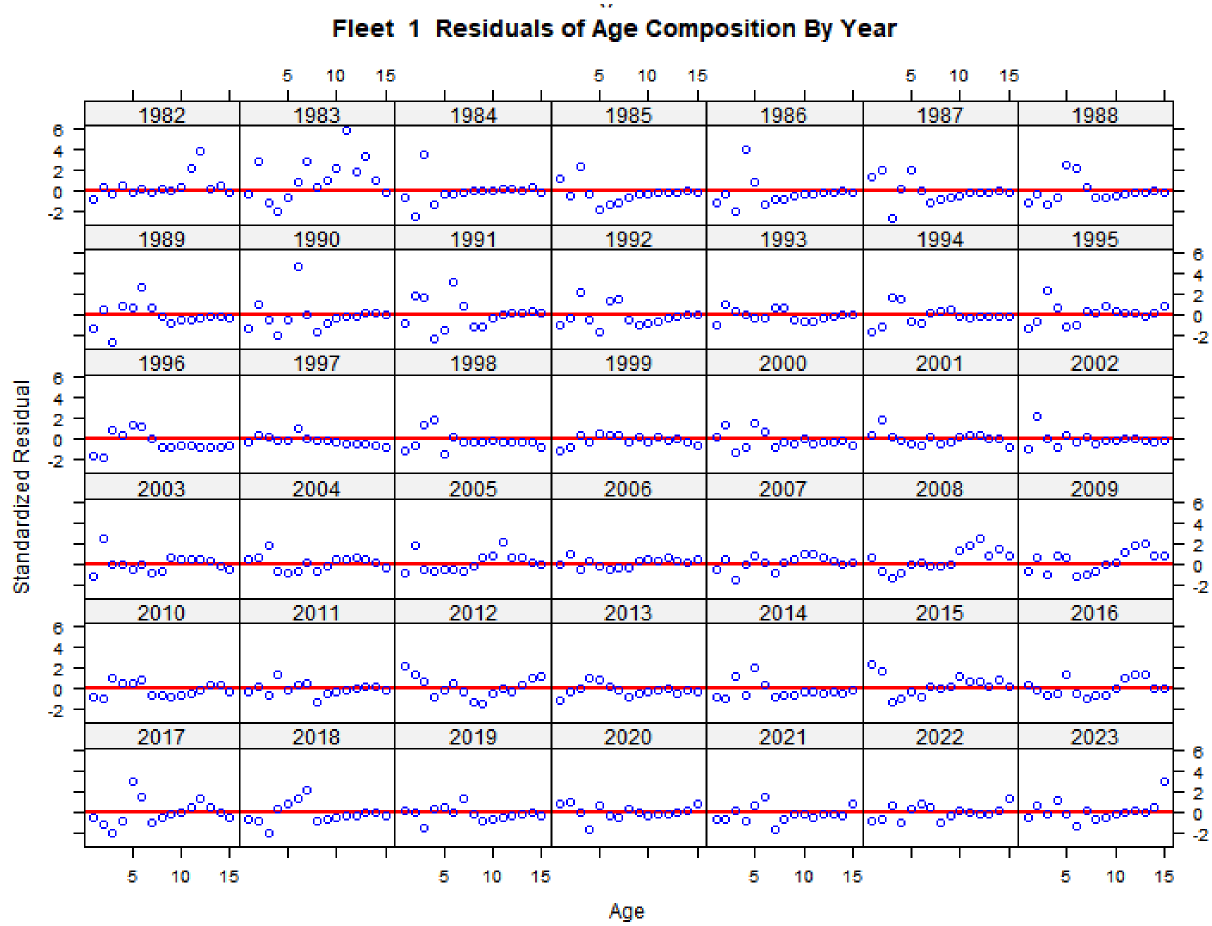


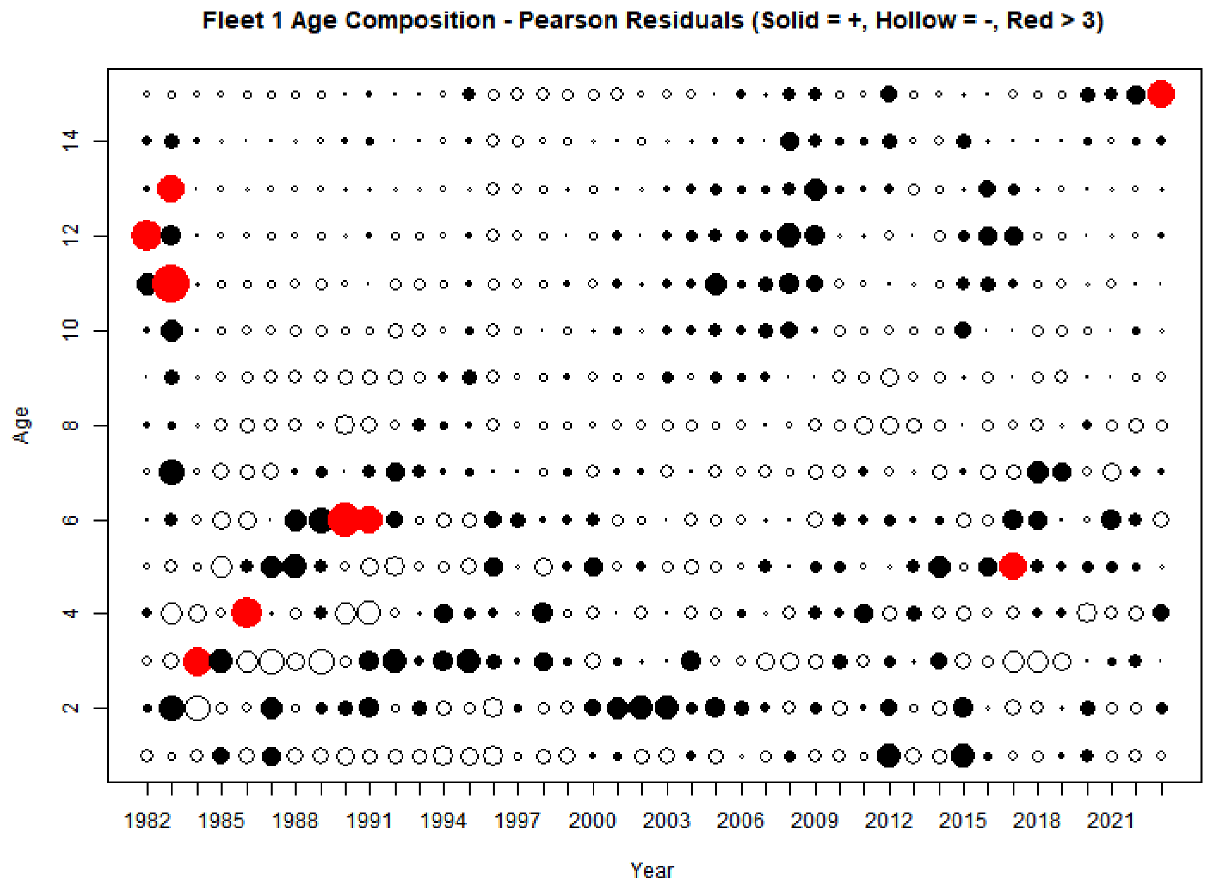



Fleet 1 Catch Age Composition By Age
Pred
Proportion
Year

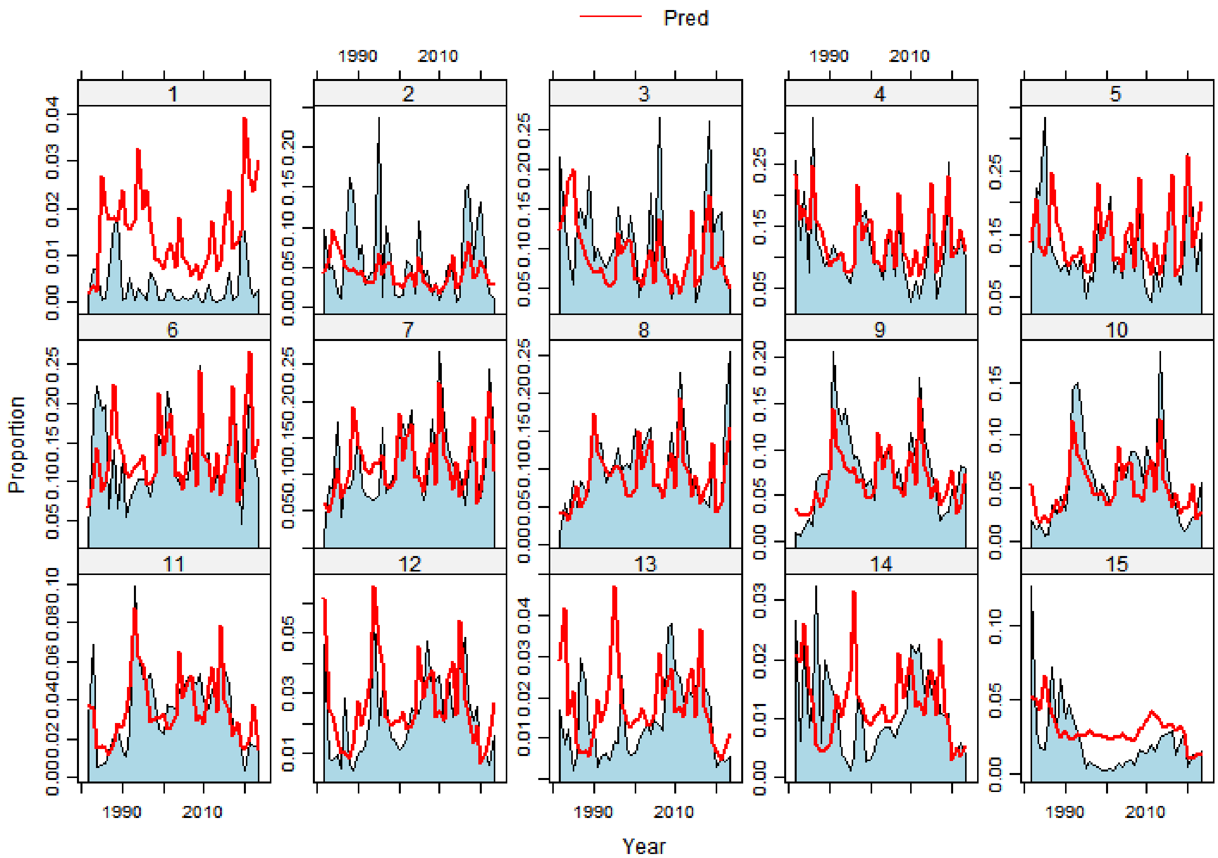

Fleet 1 Catch Age Composition By Year
Pred
Proportion
Age


Fleet 1 Residuals of Age Composition By Age
Standardized Residual
1990 2000 2010 2020
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

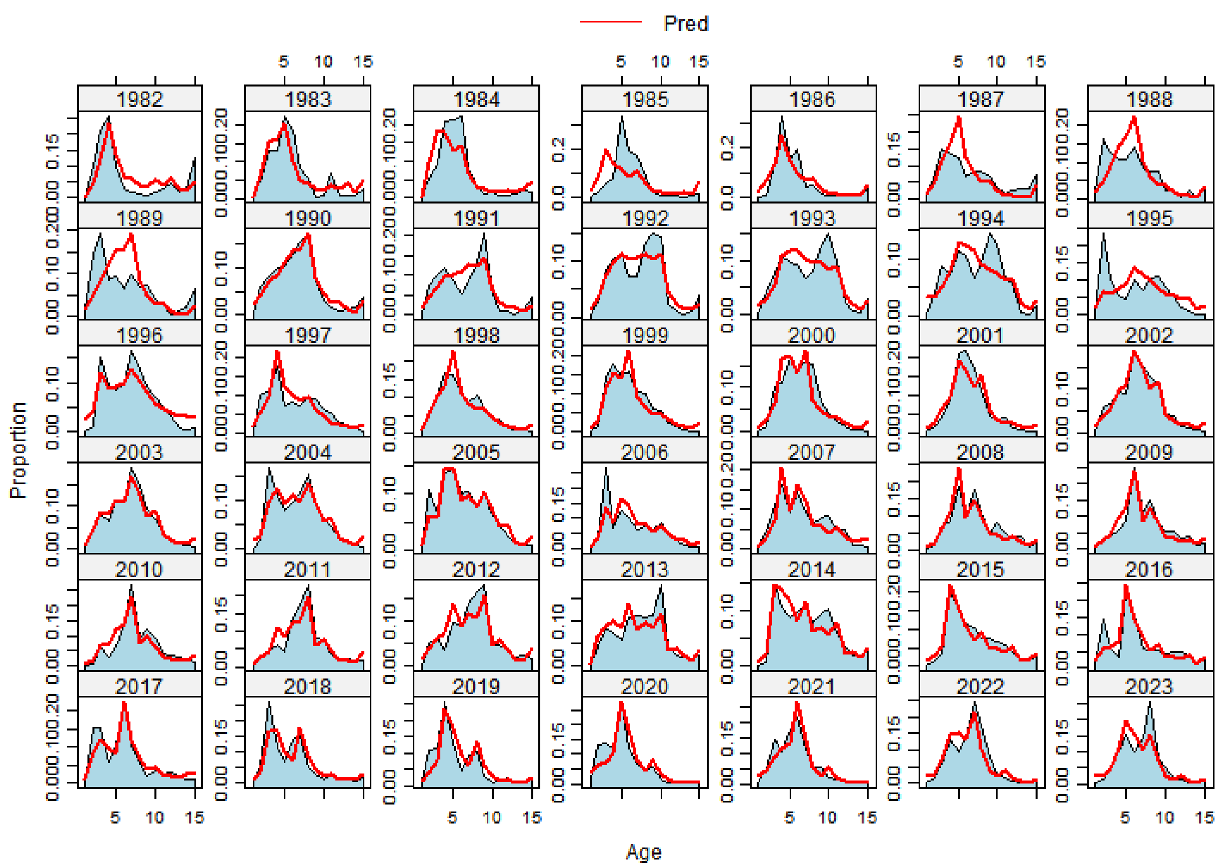

Fleet 1 Residuals of Age Composition By Year
Standardized Residual
Age
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


Fleet 1 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

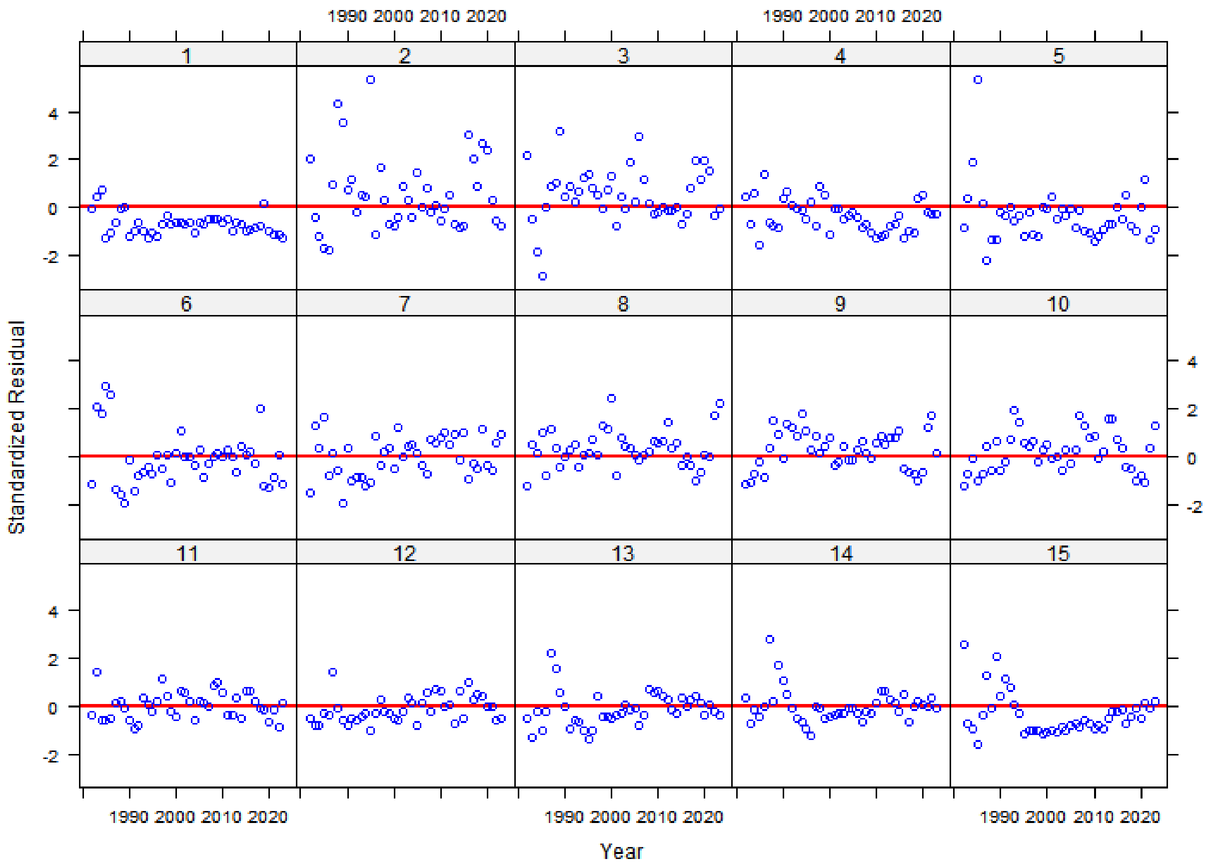
Fleet 2 Catch Age Composition By Age



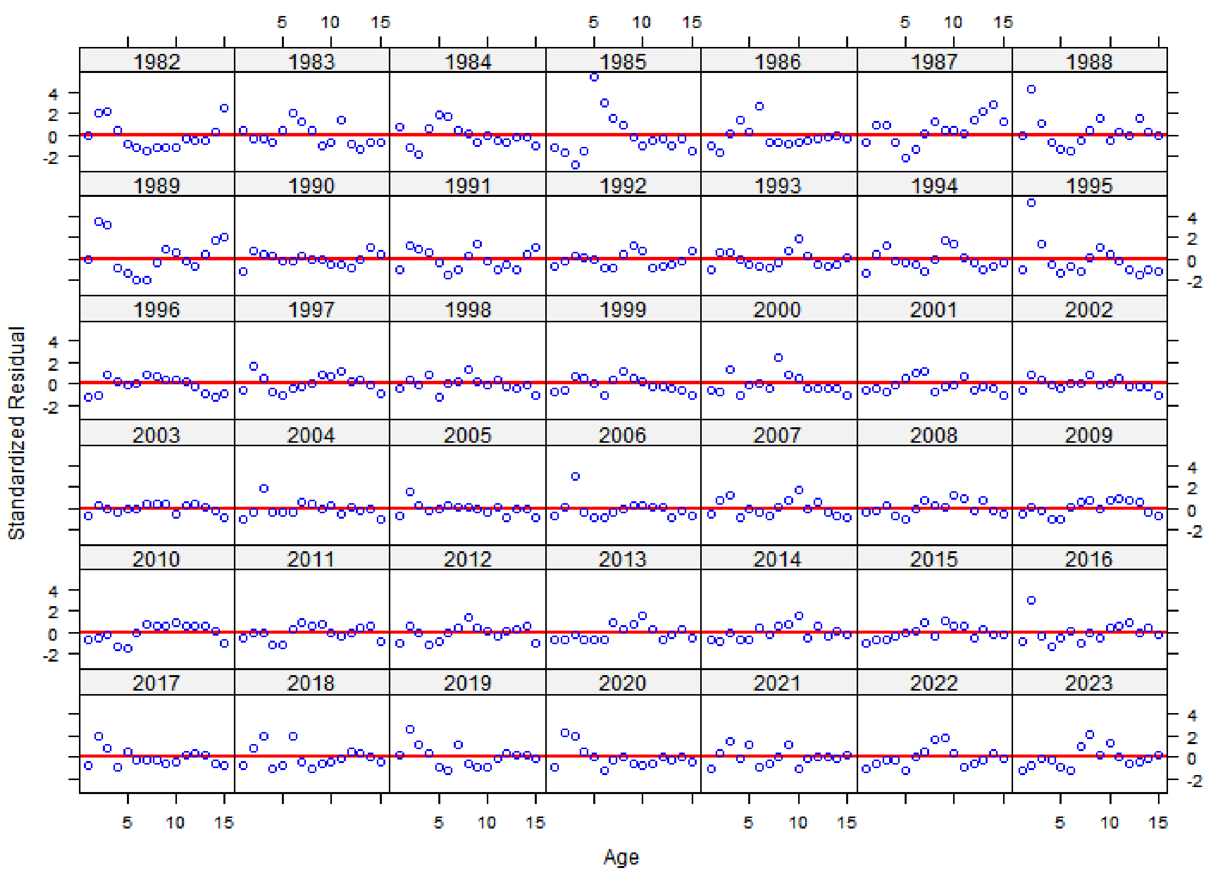
Fleet 2 Catch Age Composition By Year

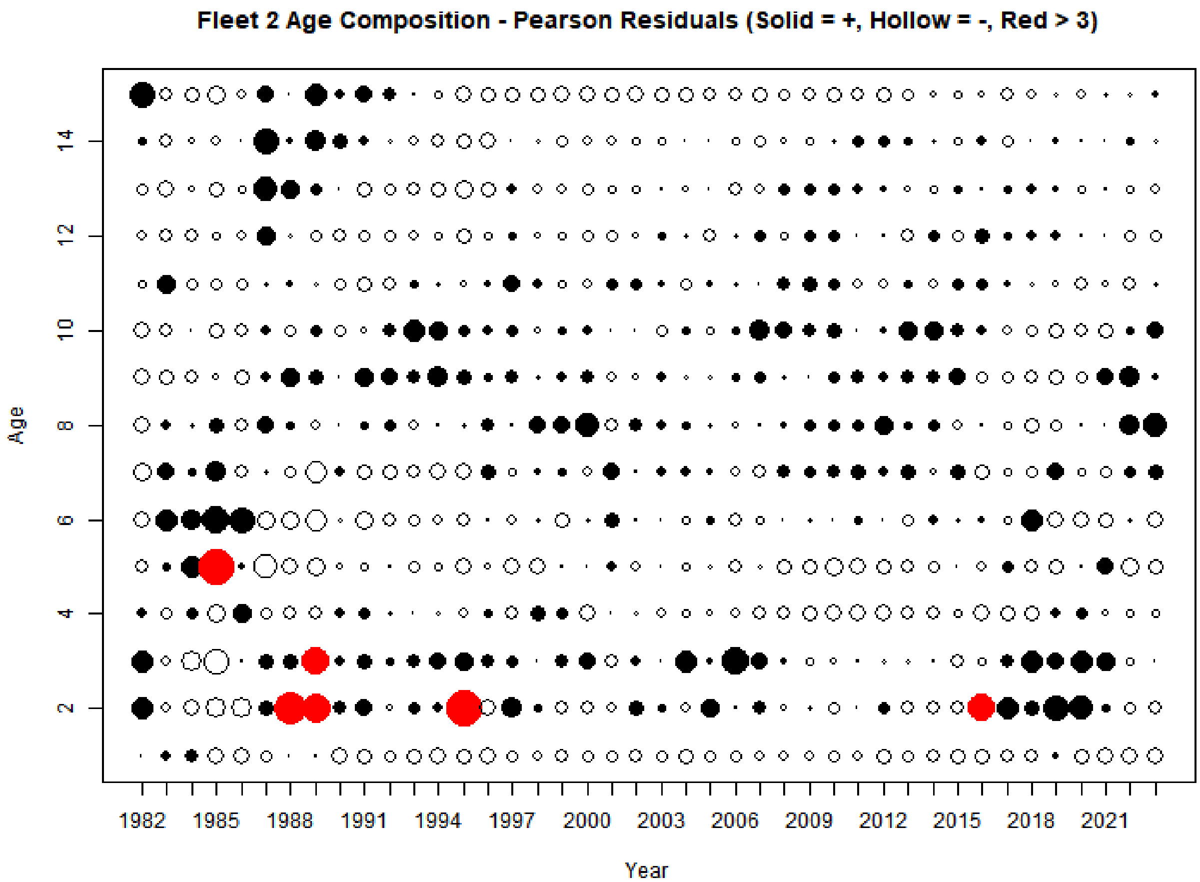


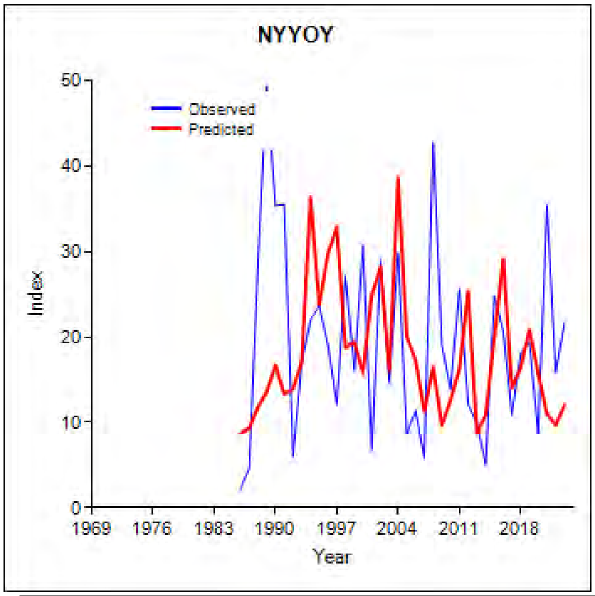
Fleet 2 Residuals of Age Composition By Age

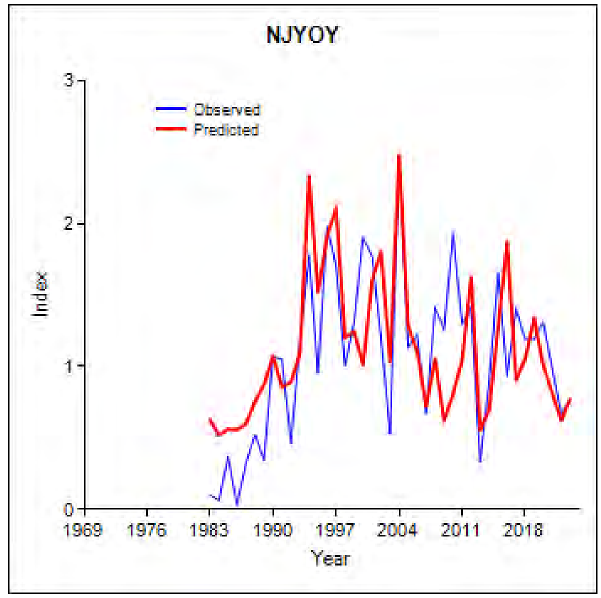


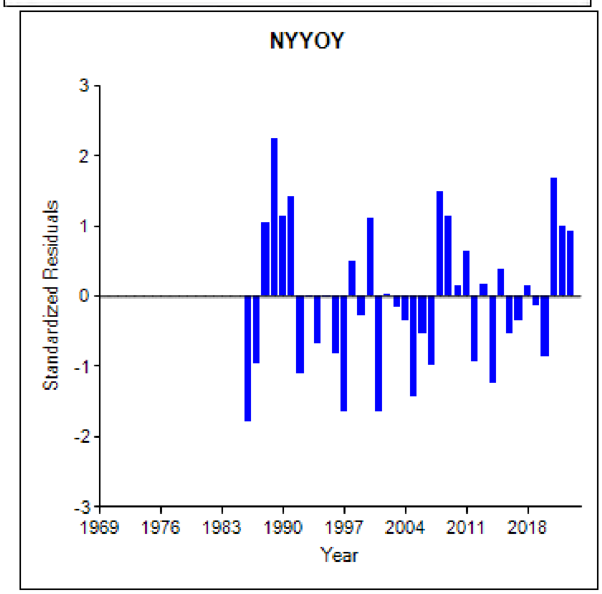
Fleet 2 Residuals of Age Composition By Year

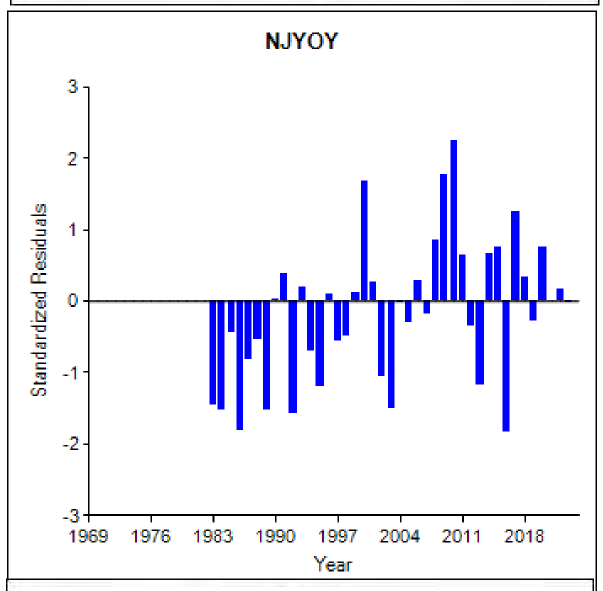


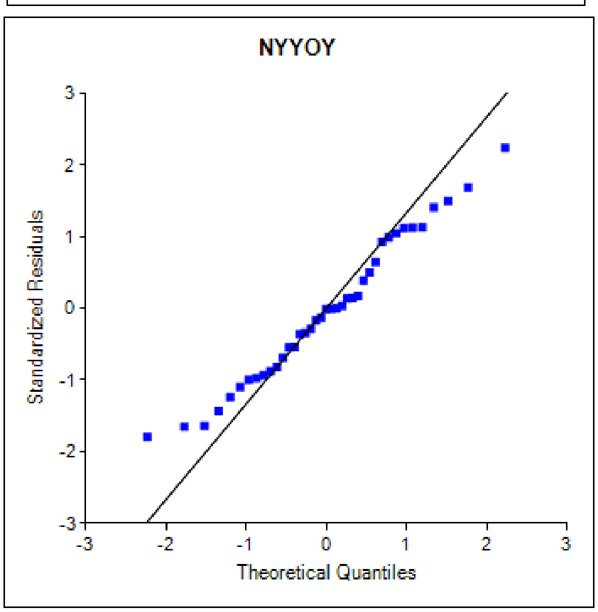

Fleet 2 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

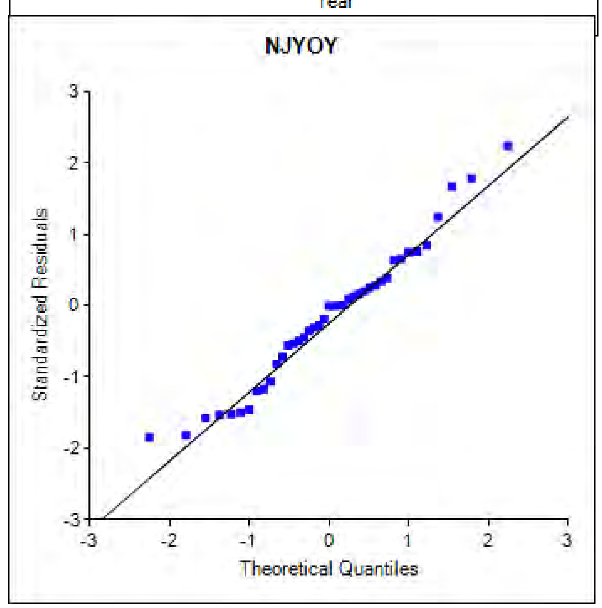

NYYOY
Observed
Predicted
Index
Year

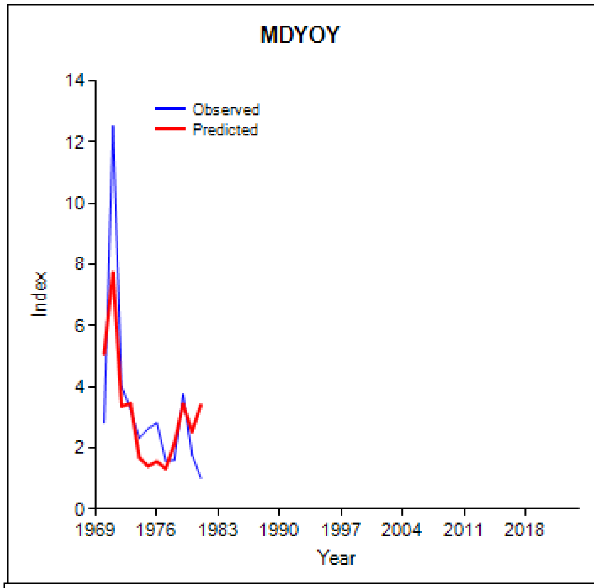

NJYOY
Observed
Predicted
Index
Year

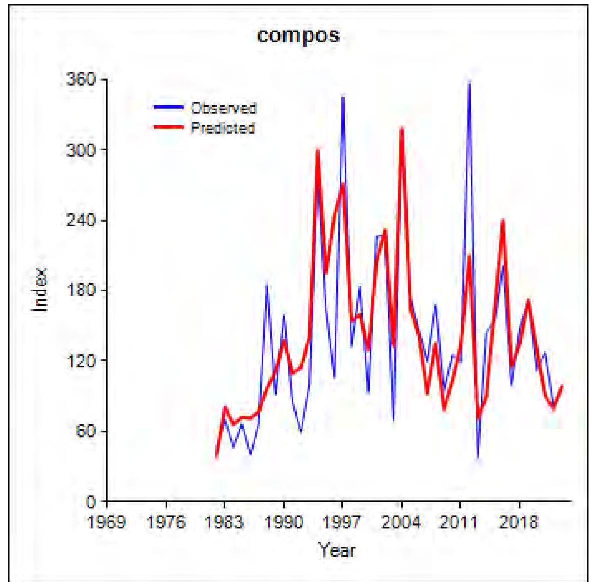

NYYOY
Standardized Residuals
Year

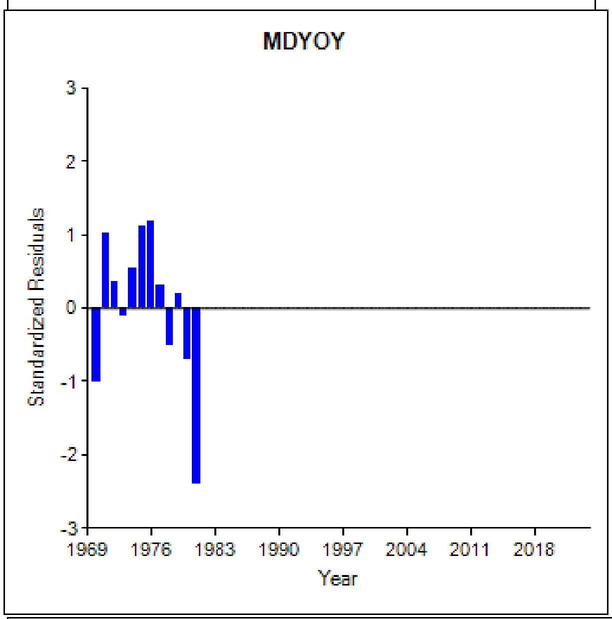

NJYOY
Standardized Residuals
Year

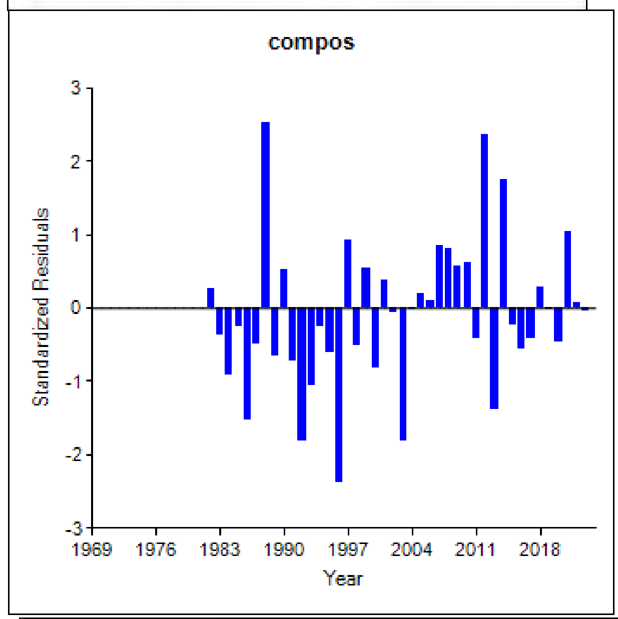

NYYOY
Standardized Residuals
Theoretical Quantiles

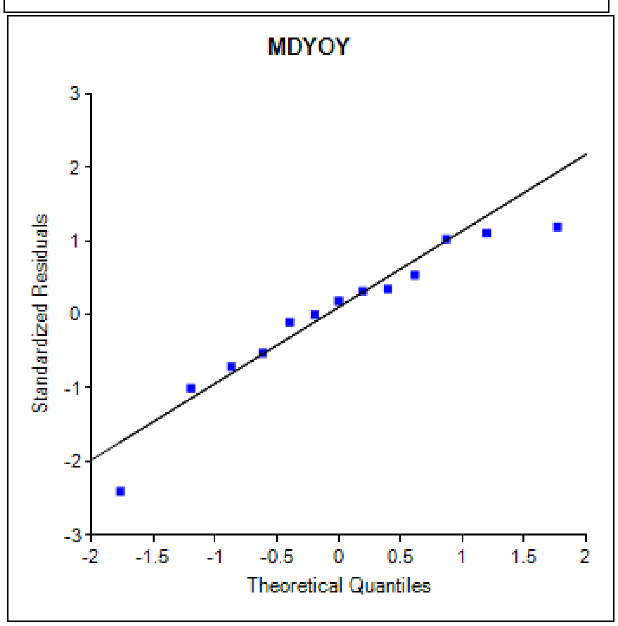

NJYOY
Standardized Residuals
Theoretical Quantiles

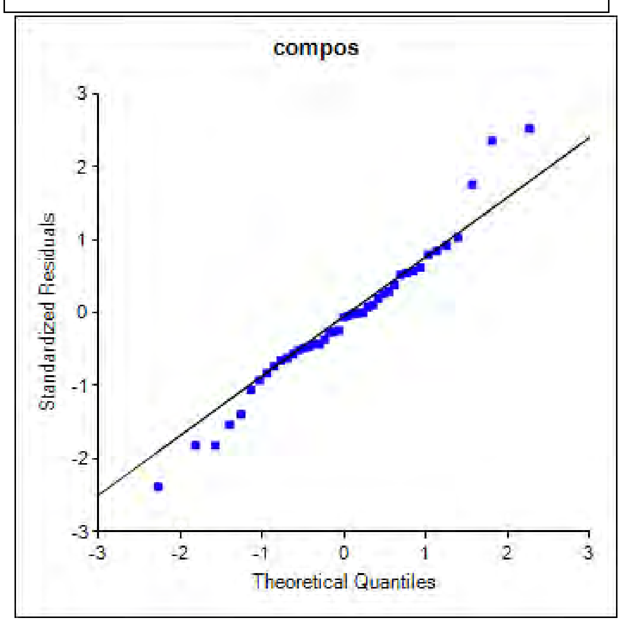

MDYOY
Observed
Predicted
Index
Year

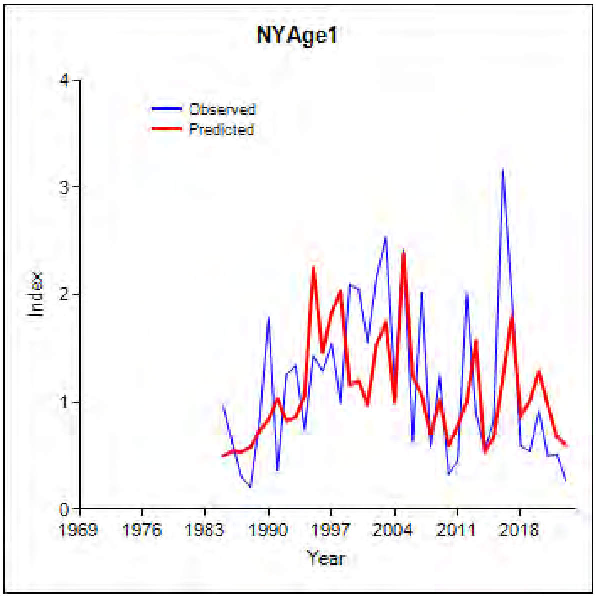

compos
Observed
Predicted
Index
Year

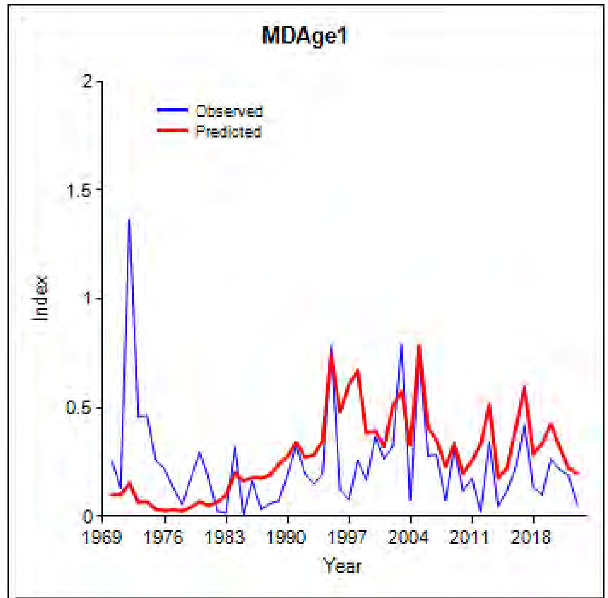

MDYOY
Standardized Residuals
Year

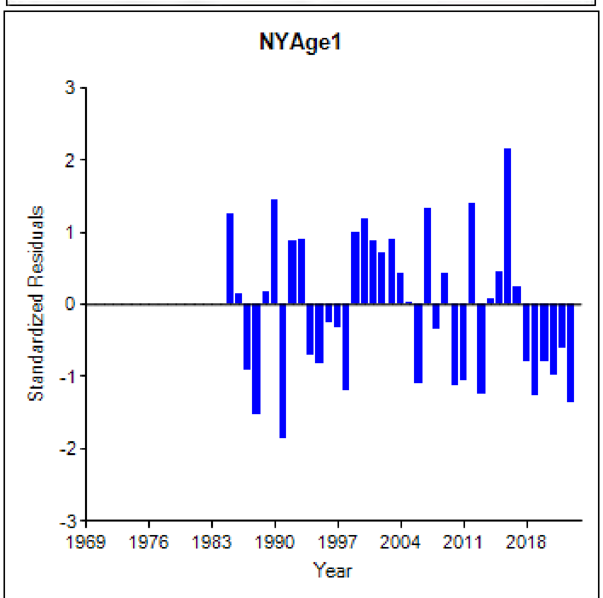

compos
Standardized Residuals
Year

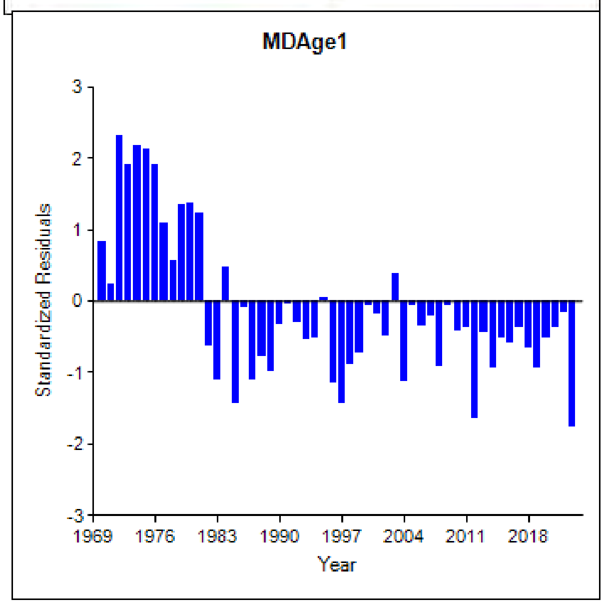

MDYOY
Standardized Residuals
Theoretical Quantiles

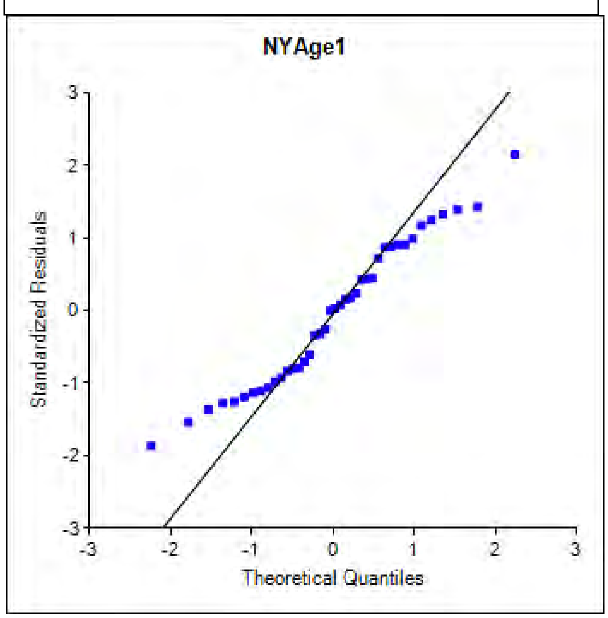

compos
Standardized Residuals
Theoretical Quantiles

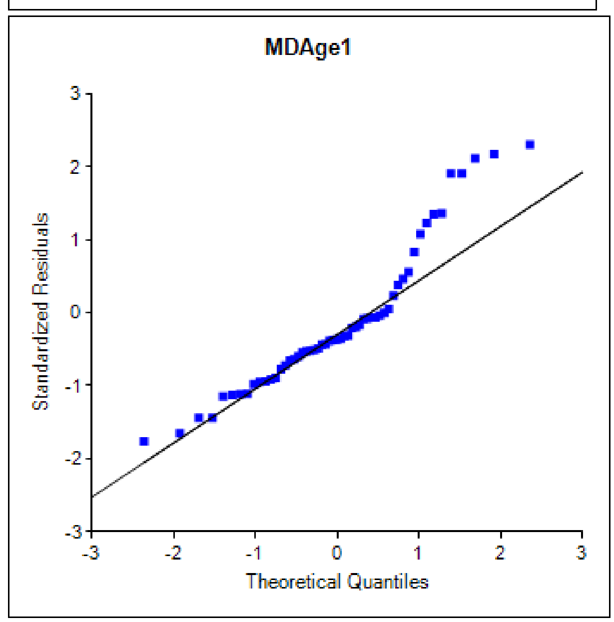

NYAge1
Observed
Predicted
Index
Year
0
1
2
3
4
1969
1976
1983
1990
1997
2004
2011
2018

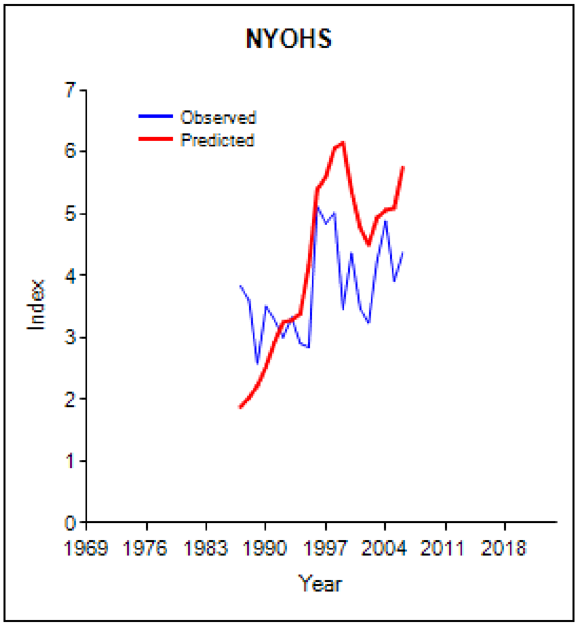

MDAge1
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969
1976
1983
1990
1997
2004
2011
2018

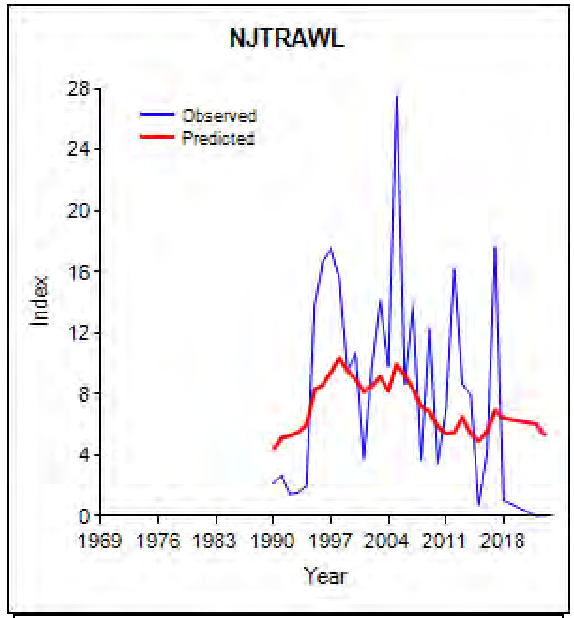

NYAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

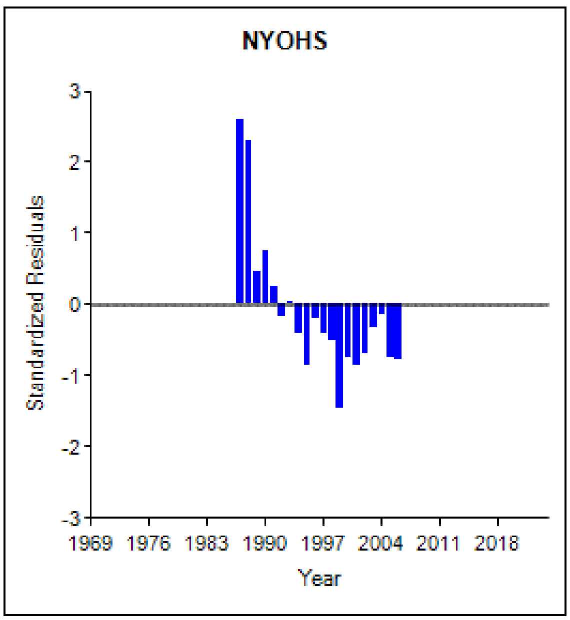

MDAge1
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969
1976
1983
1990
1997
2004
2011
2018

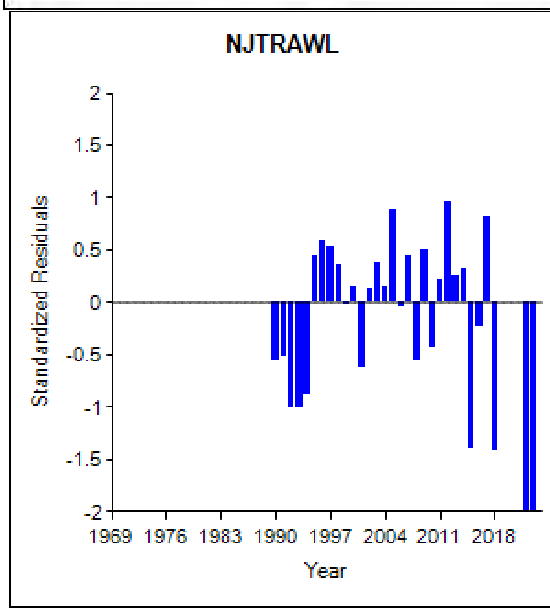

NYAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3


MDAge1
Standardized Residuals
Theoretical Quantiles
-3
-2
-1
0
1
2
3


NYOHS
Observed
Predicted
Index
Year
7
6
5
4
3
2
1
0
1969 1976 1983 1990 1997 2004 2011 2018


NJTRAWL
Observed
Predicted
Index
Year
28
24
20
16
12
8
4
0
1969 1976 1983 1990 1997 2004 2011 2018


NYOHS
Standardized Residuals
Year
3
2
1
0
-1
-2
-3
1969 1976 1983 1990 1997 2004 2011 2018


NJTRAWL
Standardized Residuals
Year
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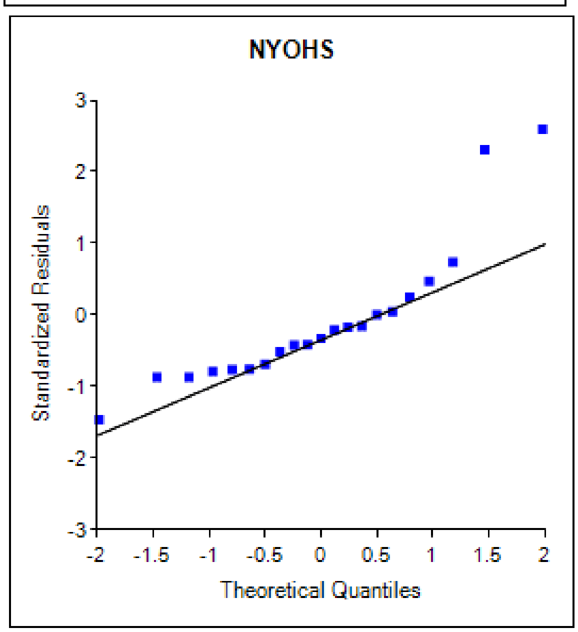
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1969 1976 1983 1990 1997 2004 2011 2018


NYOHS
Standardized Residuals
Theoretical Quantiles
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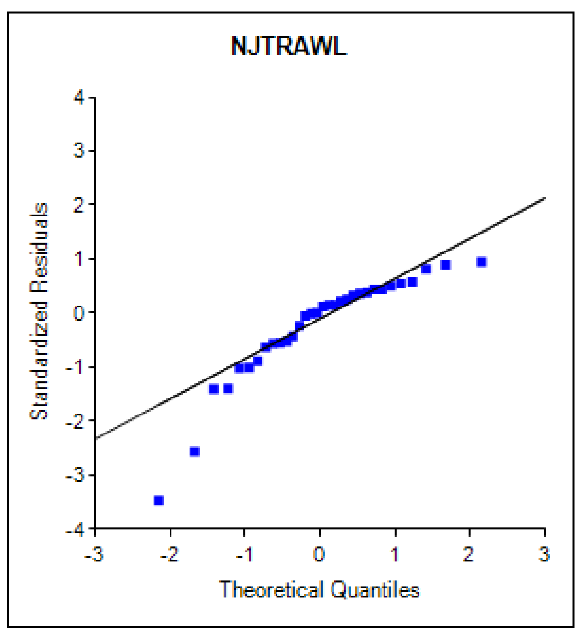
2
1
0
-1
-2
-3
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2


NJTRAWL
Standardized Residuals
Theoretical Quantiles
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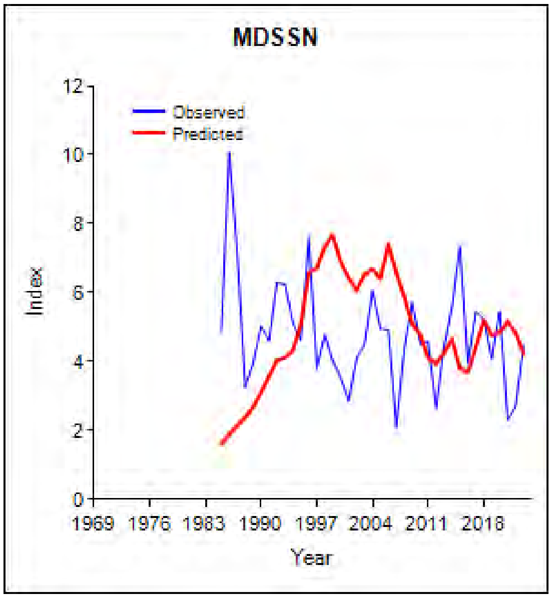
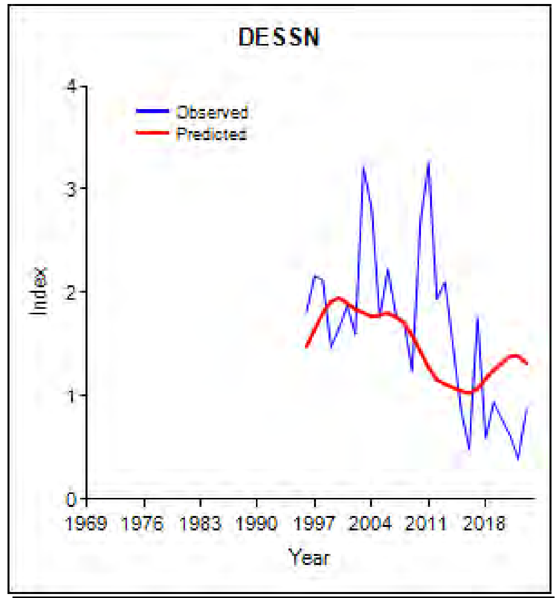
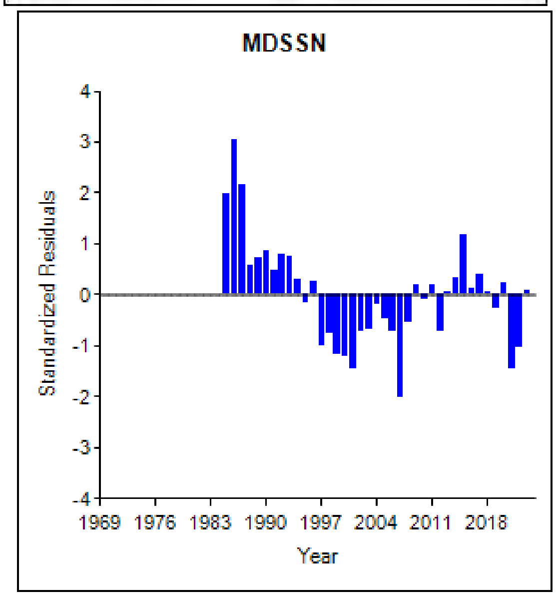
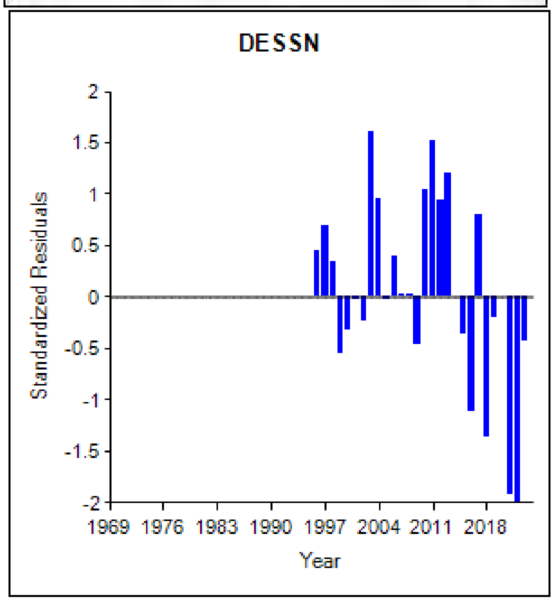
3
2
1
0
-1
-2
-3
-4
-3 -2 -1 0 1 2 3


MDSSN
Observed
Predicted
Index
Year
1969 1976 1983 1990 1997 2004 2011 2018


DESSN
Observed
Predicted
Index
Year
1969 1976 1983 1990 1997 2004 2011 2018


MDSSN
Standardized Residuals
Year
1969 1976 1983 1990 1997 2004 2011 2018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Standardized Residuals
Year
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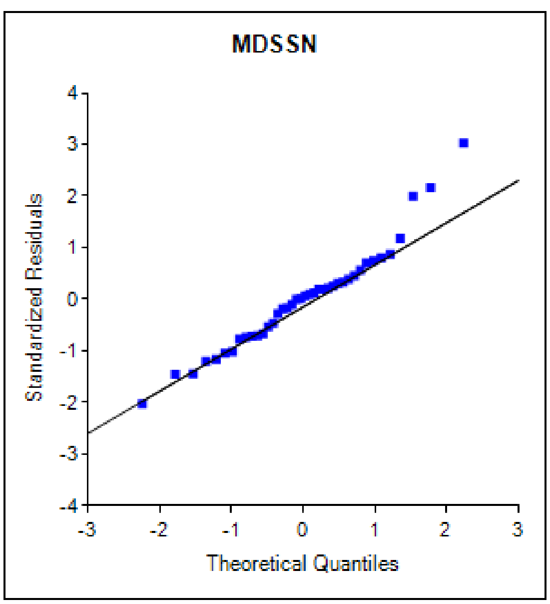
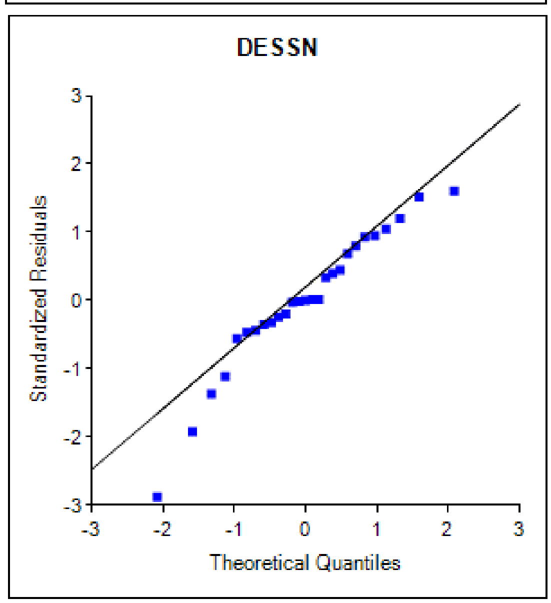
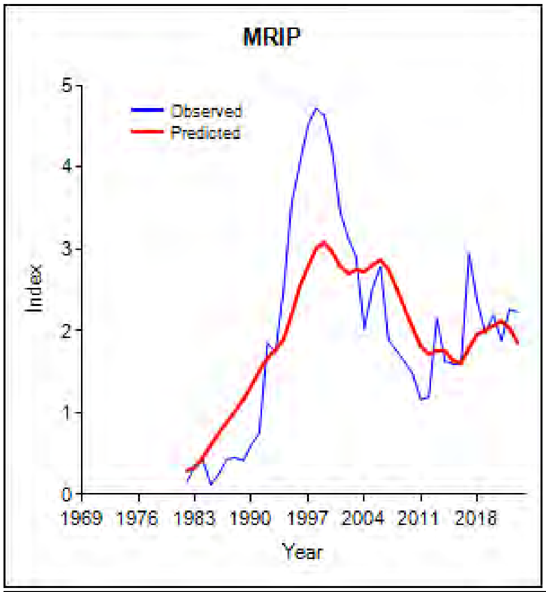
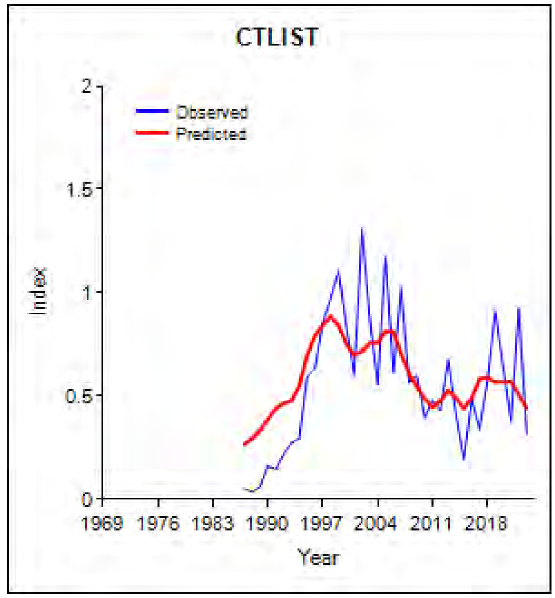
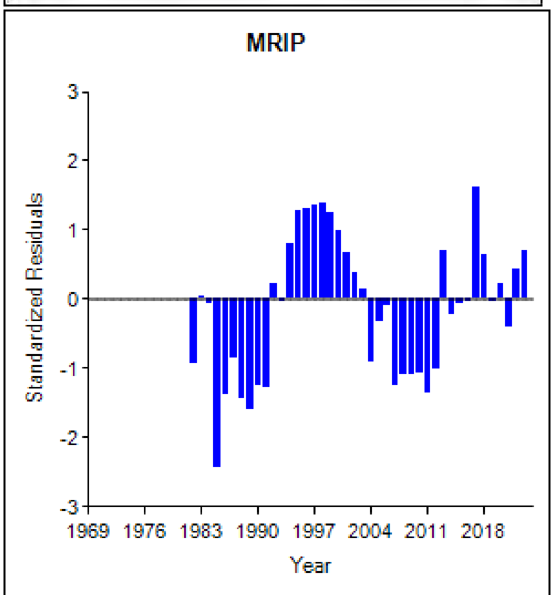
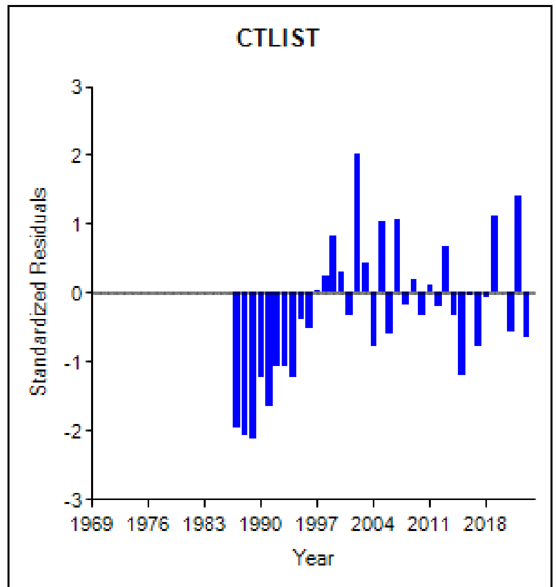

MDSSN
Standardized Residuals
Theoretical Quantiles

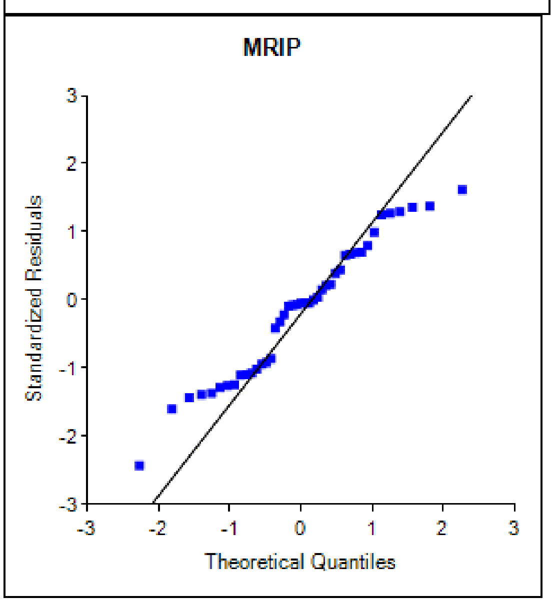

DESSN
Standardized Residuals
Theoretical Quantiles

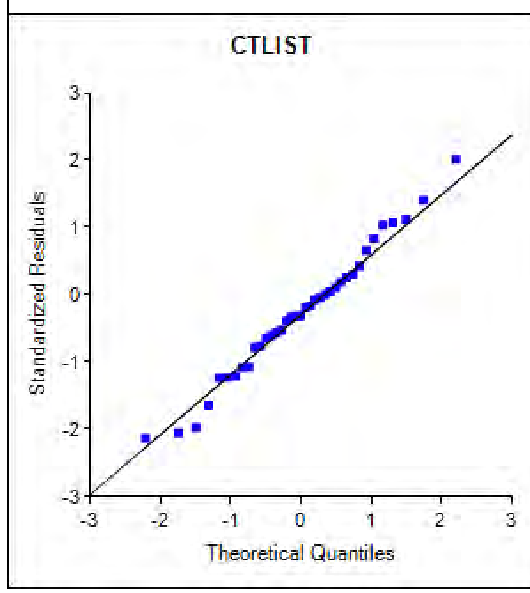

MRIP
Observed
Predicted
Index
Year
0
1
2
3
4
5
1969 1976 1983 1990 1997 2004 2011 2018

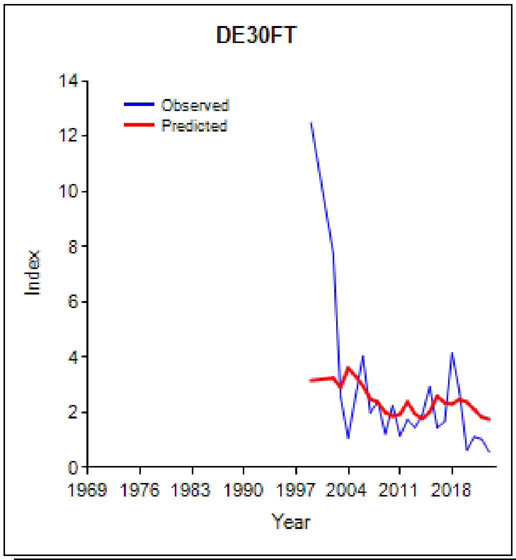

CTLIST
Observed
Predicted
Index
Year
0
0.5
1
1.5
2
1969 1976 1983 1990 1997 2004 2011 2018

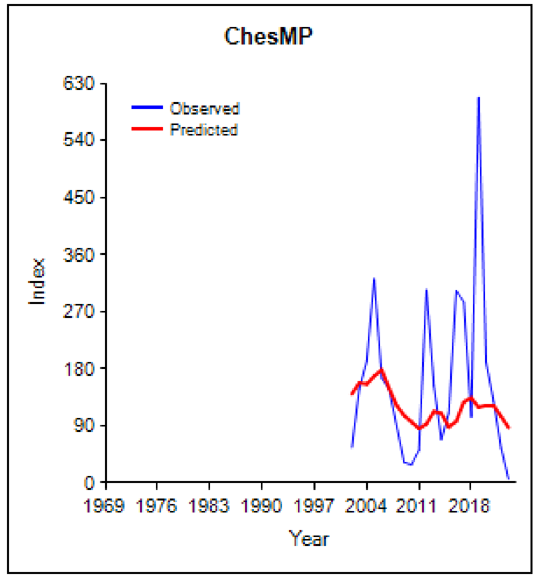

MRIP
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

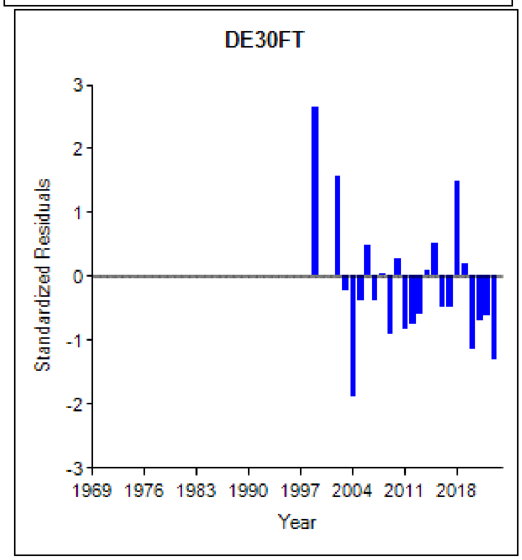

CTLIST
Standardized Residuals
Year
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018

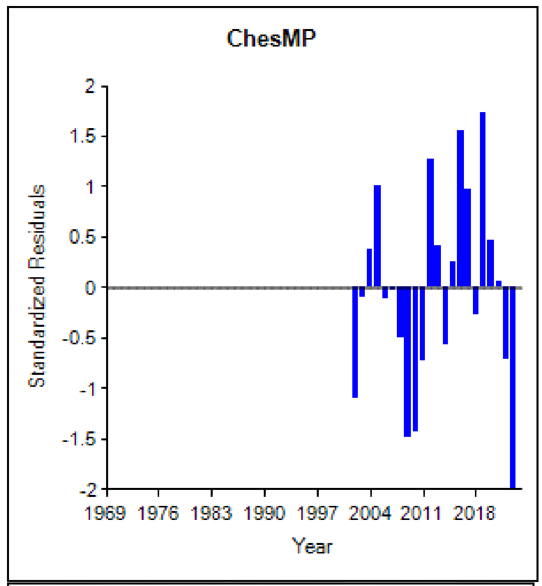

MRIP
Standardized Residuals
Theoretical Quantiles
-3 -2 -1 0 1 2 3

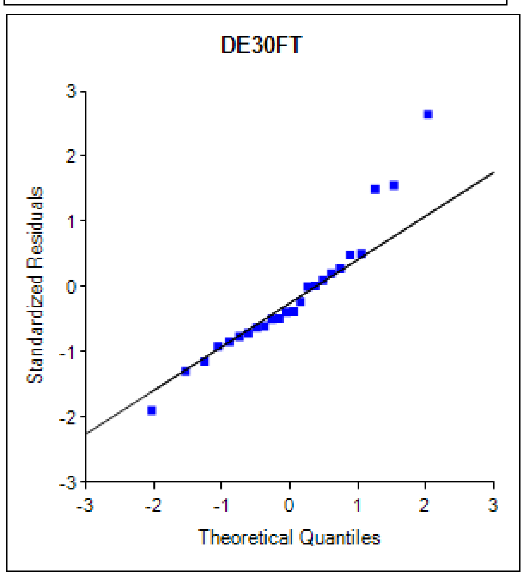

CTLIST
Standardized Residuals
Theoretical Quantiles
-3 -2 -1 0 1 2 3

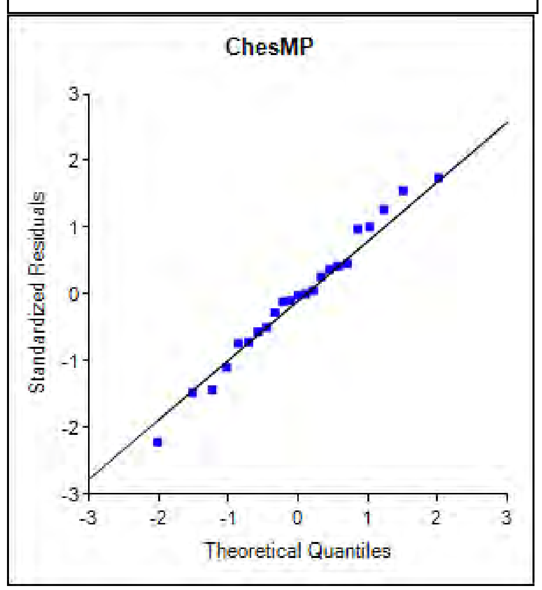

DE30FT
Observed
Predicted
Index
Year


ChesMP
Observed
Predicted
Index
Year

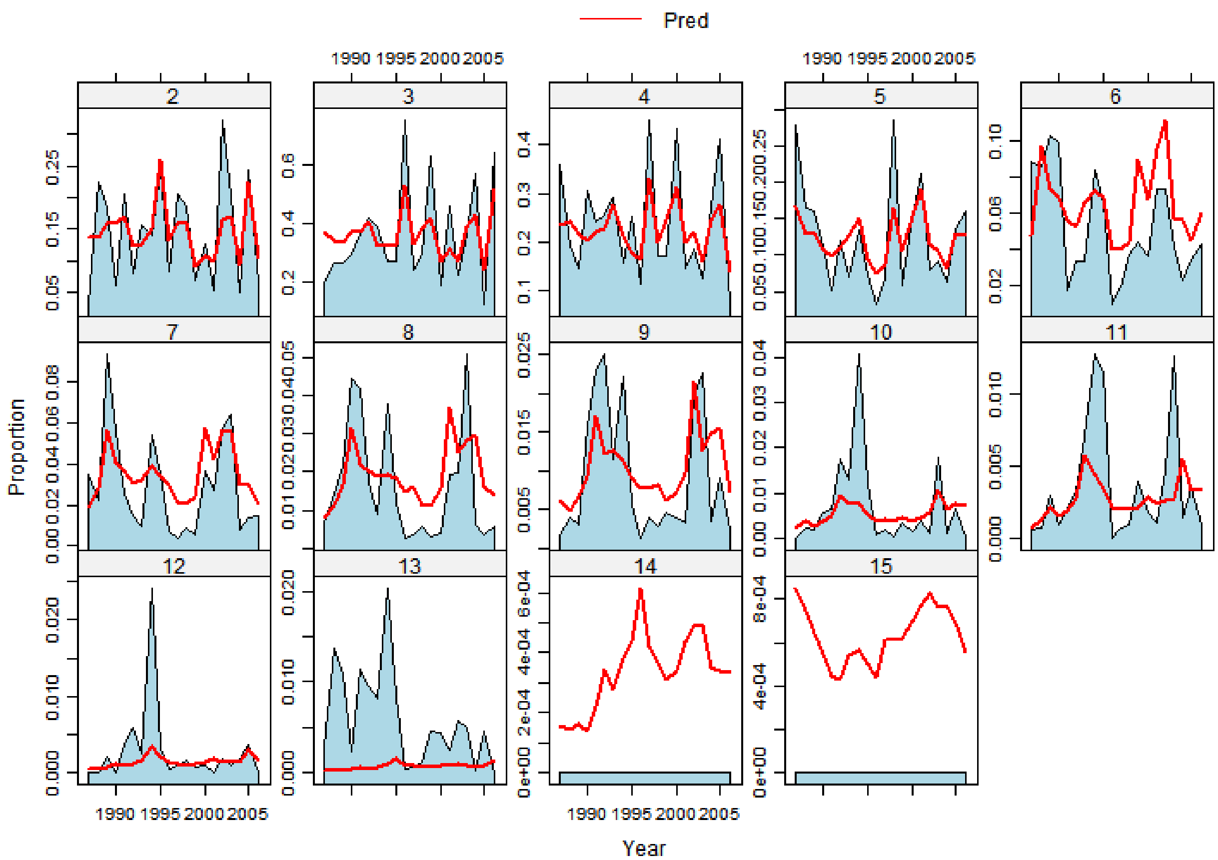

DE30FT
Standardized Residuals
Year


ChesMP
Standardized Residuals
Year

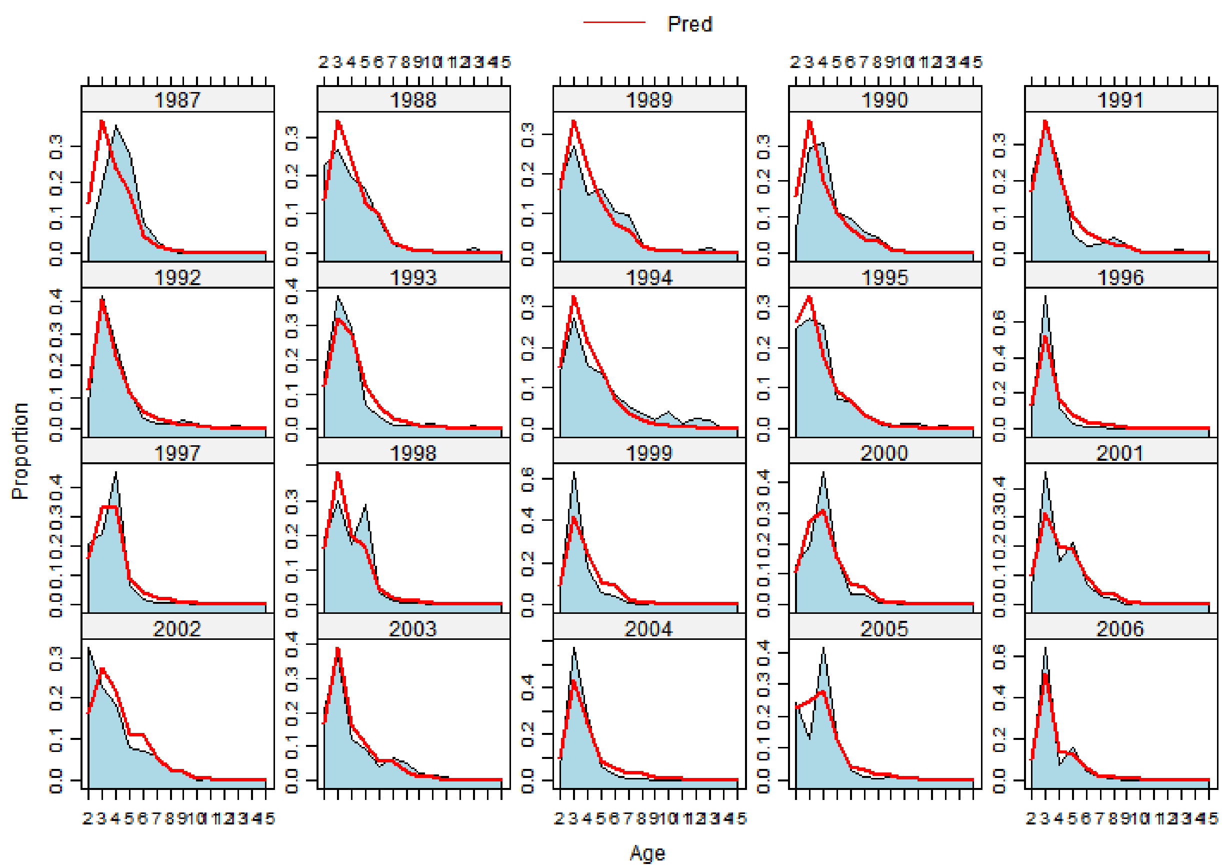

DE30FT
Standardized Residuals
Theoretical Quantiles


ChesMP
Standardized Residuals
Theoretical Quantiles

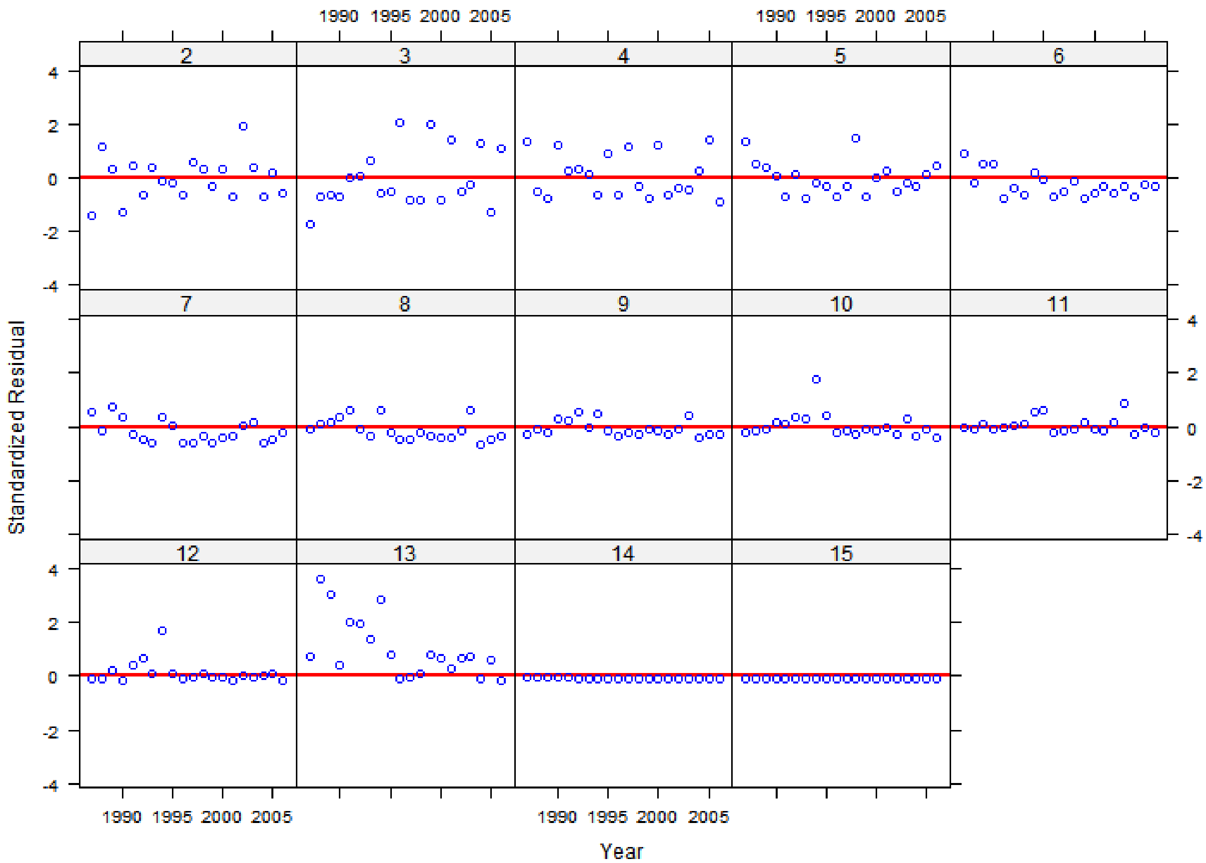
NYOHS Age Composition By Age



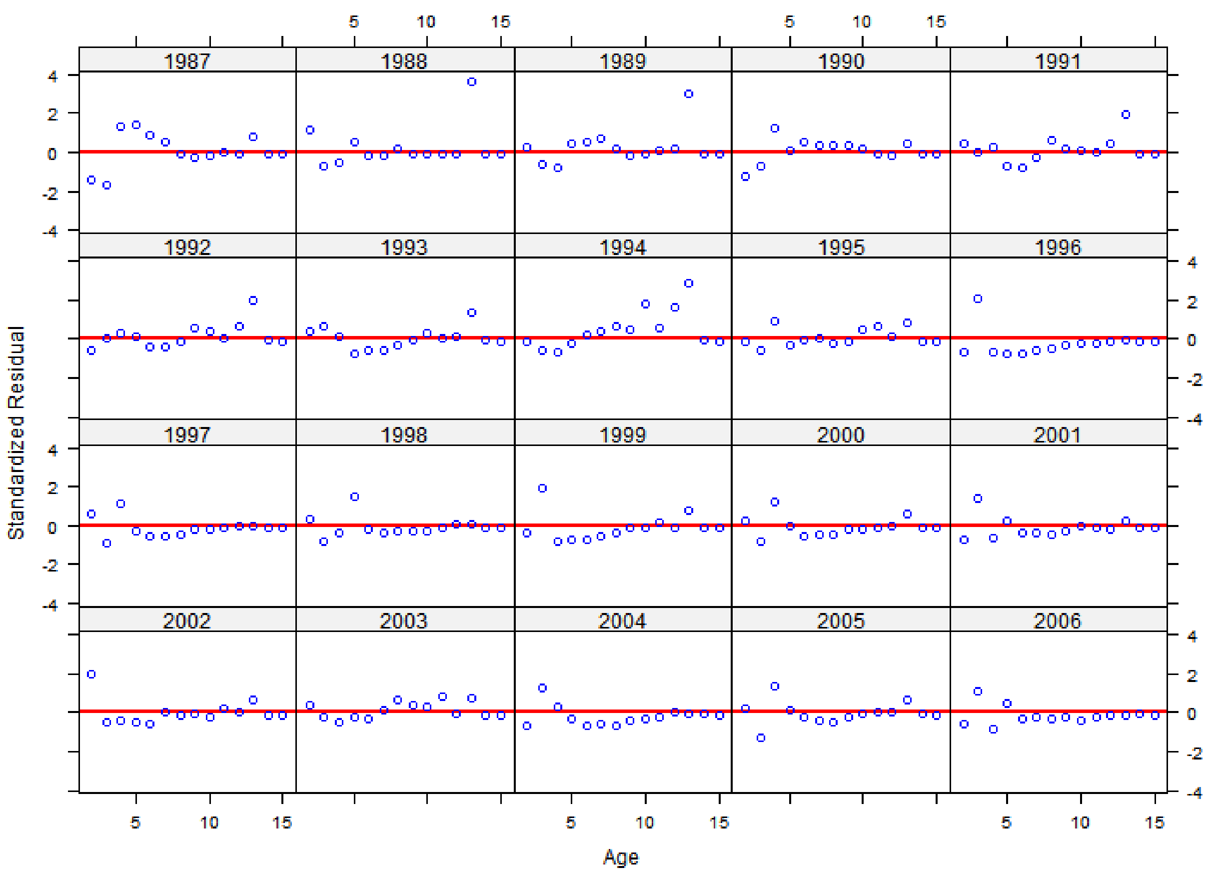
NYOHS Age Composition By Year

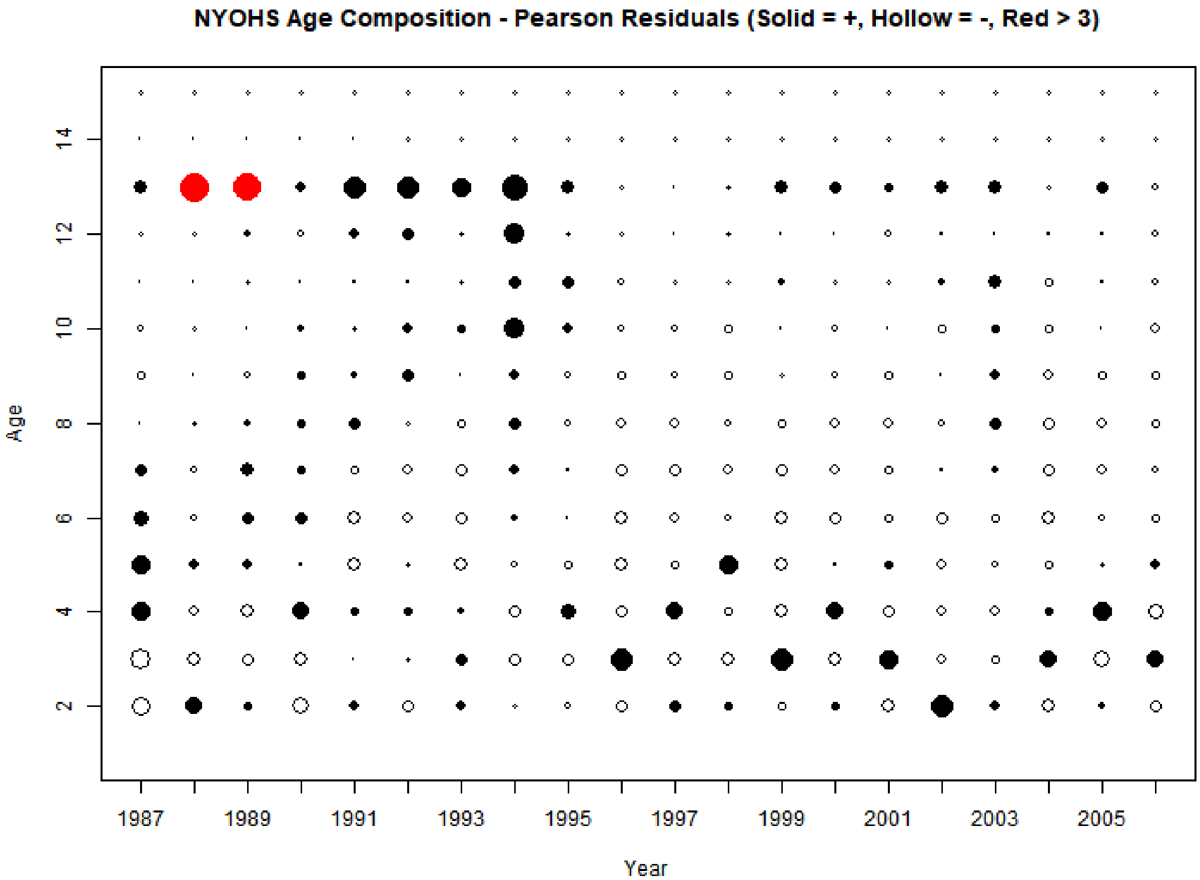


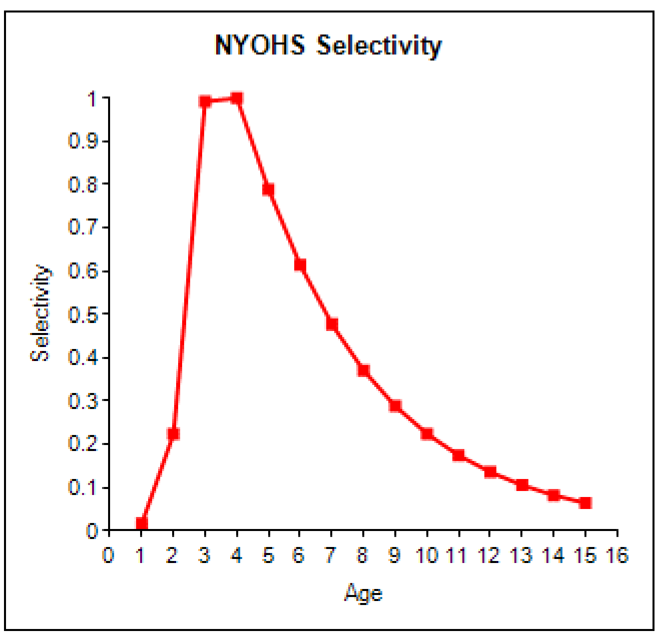
NYOHS Age Residuals By Age

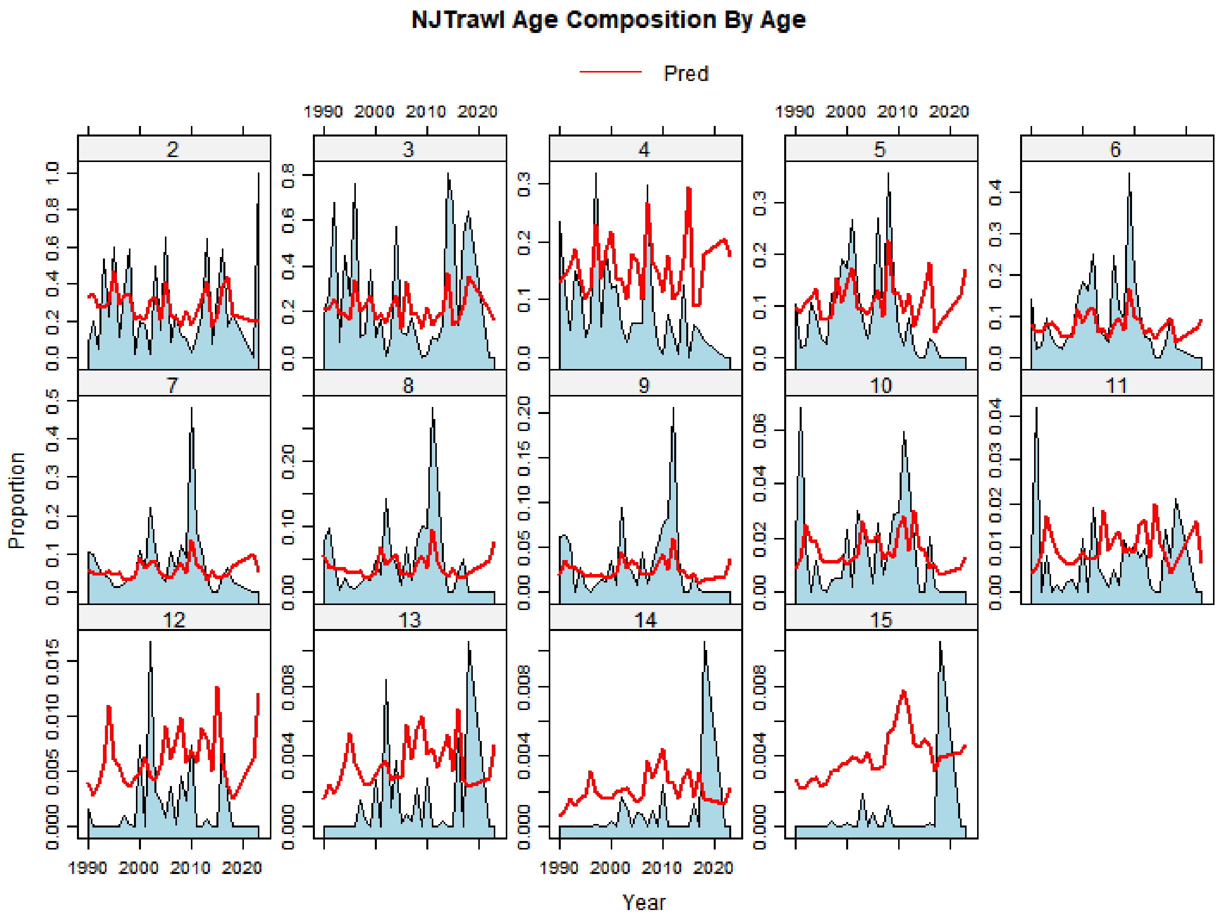


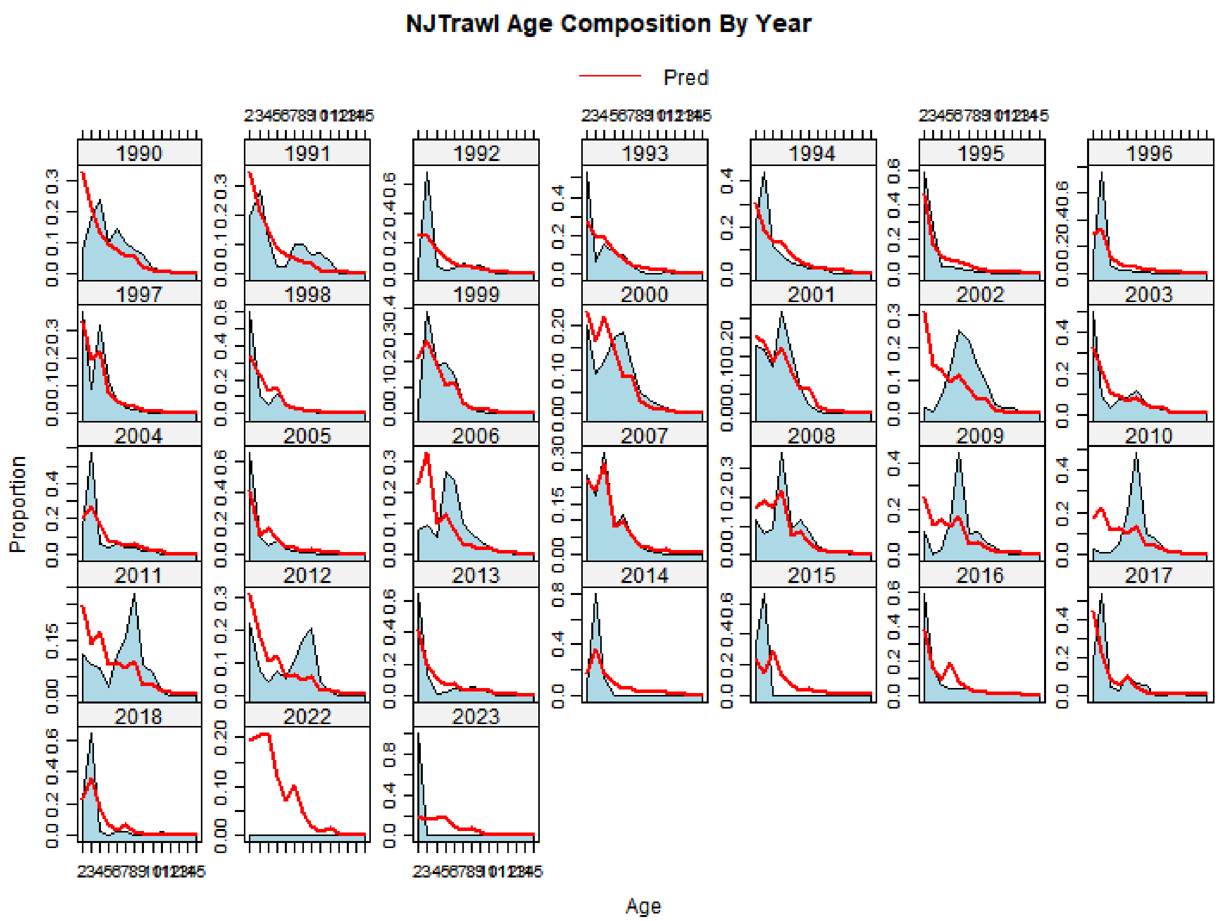
NYOHS Age Residuals By Year

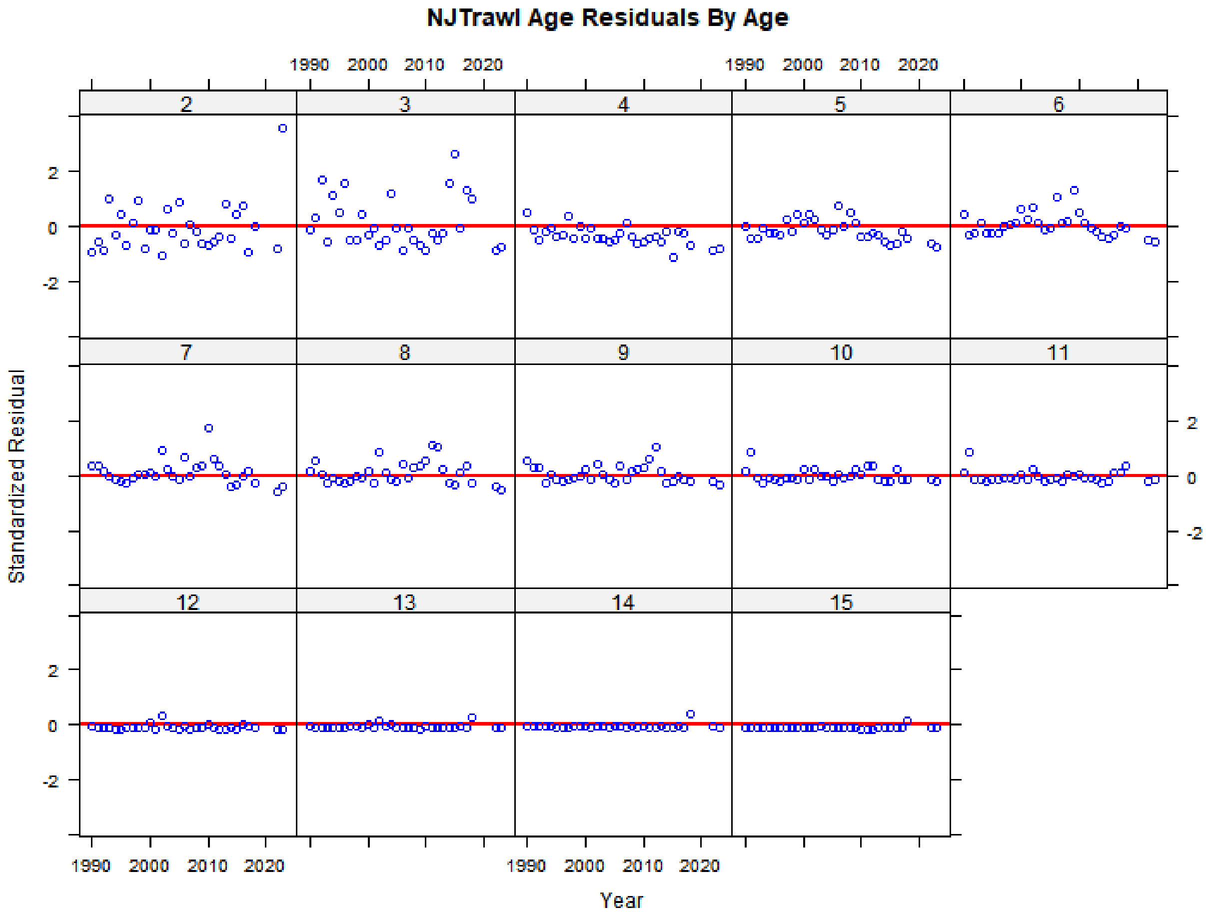


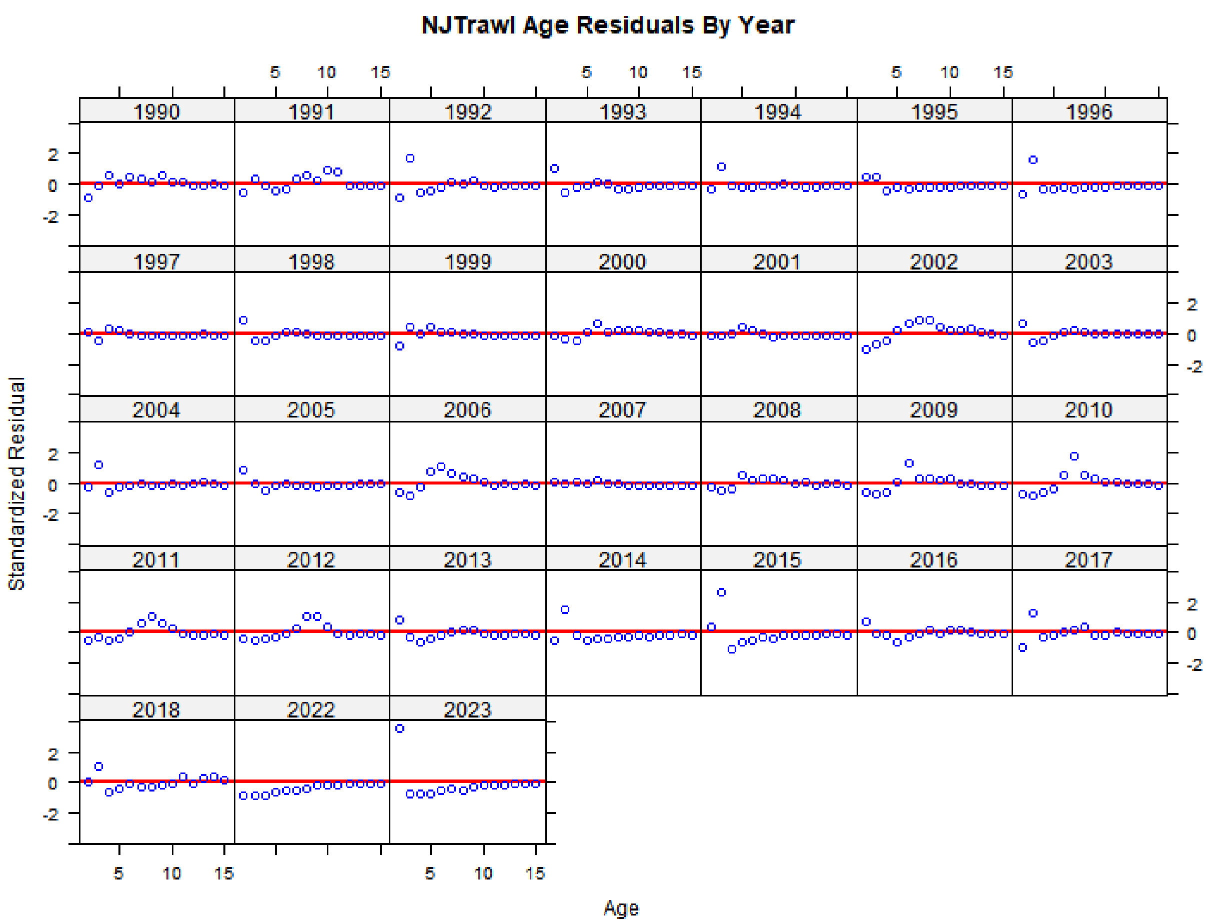

NYOHS Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
Year

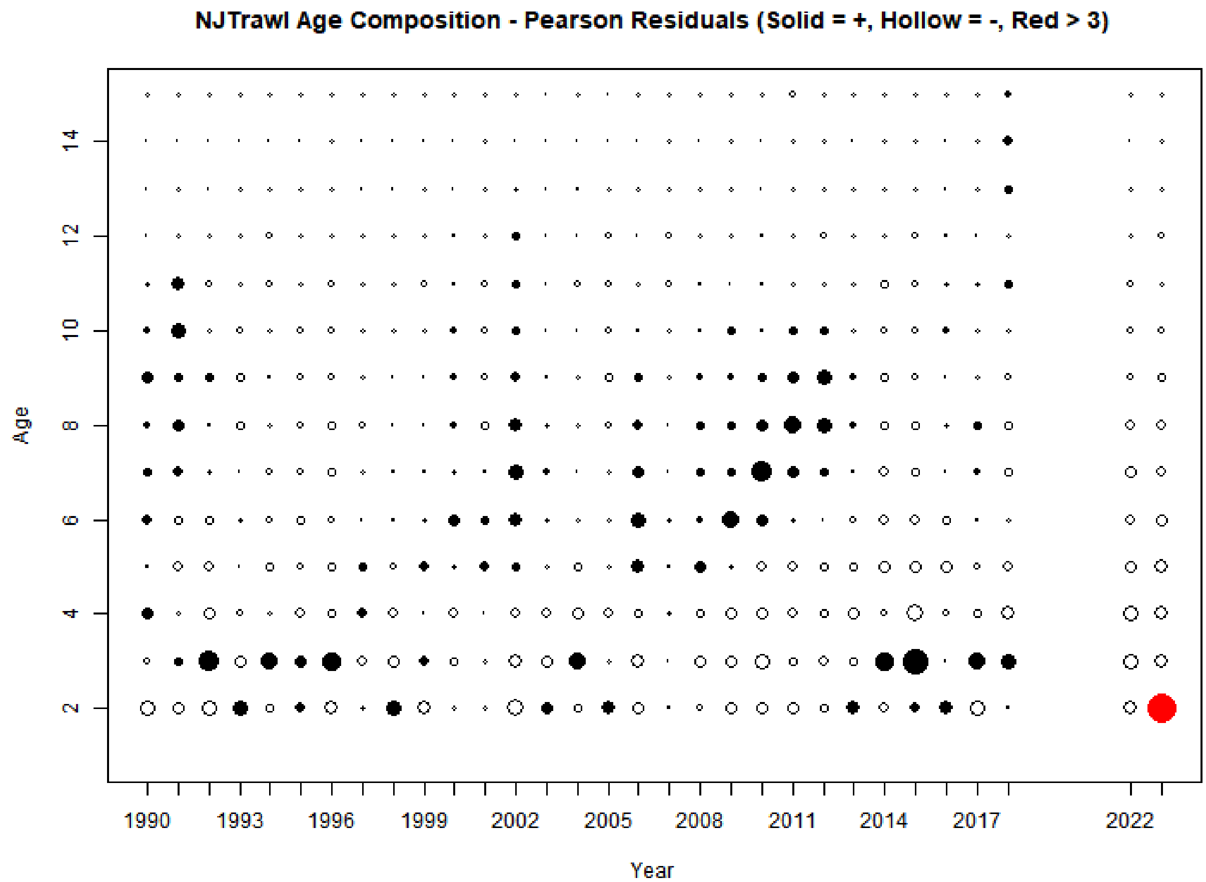

NYOHS Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

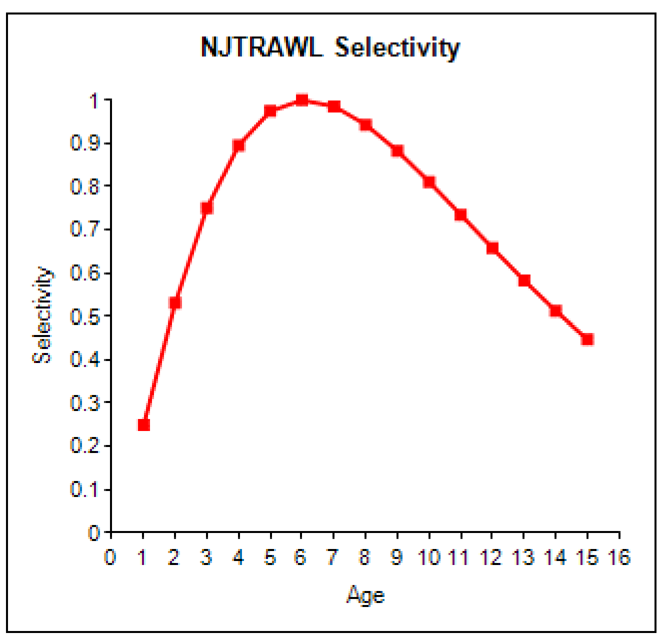

NJTrawl Age Composition By Age
Pred
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990 2000 2010 2020
Proportion
Year

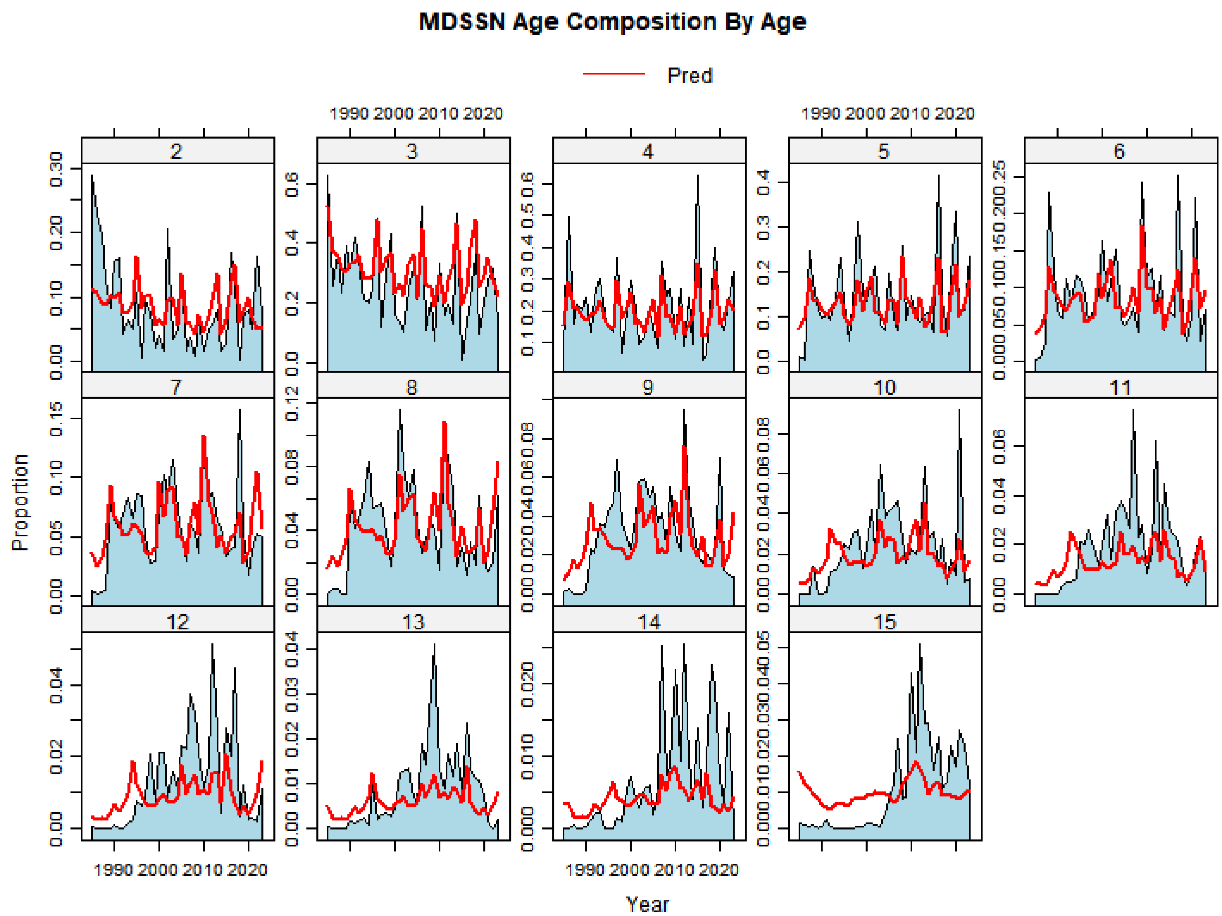

NJTrawl Age Composition By Year
Pred
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2022
2023
Proportion
Age

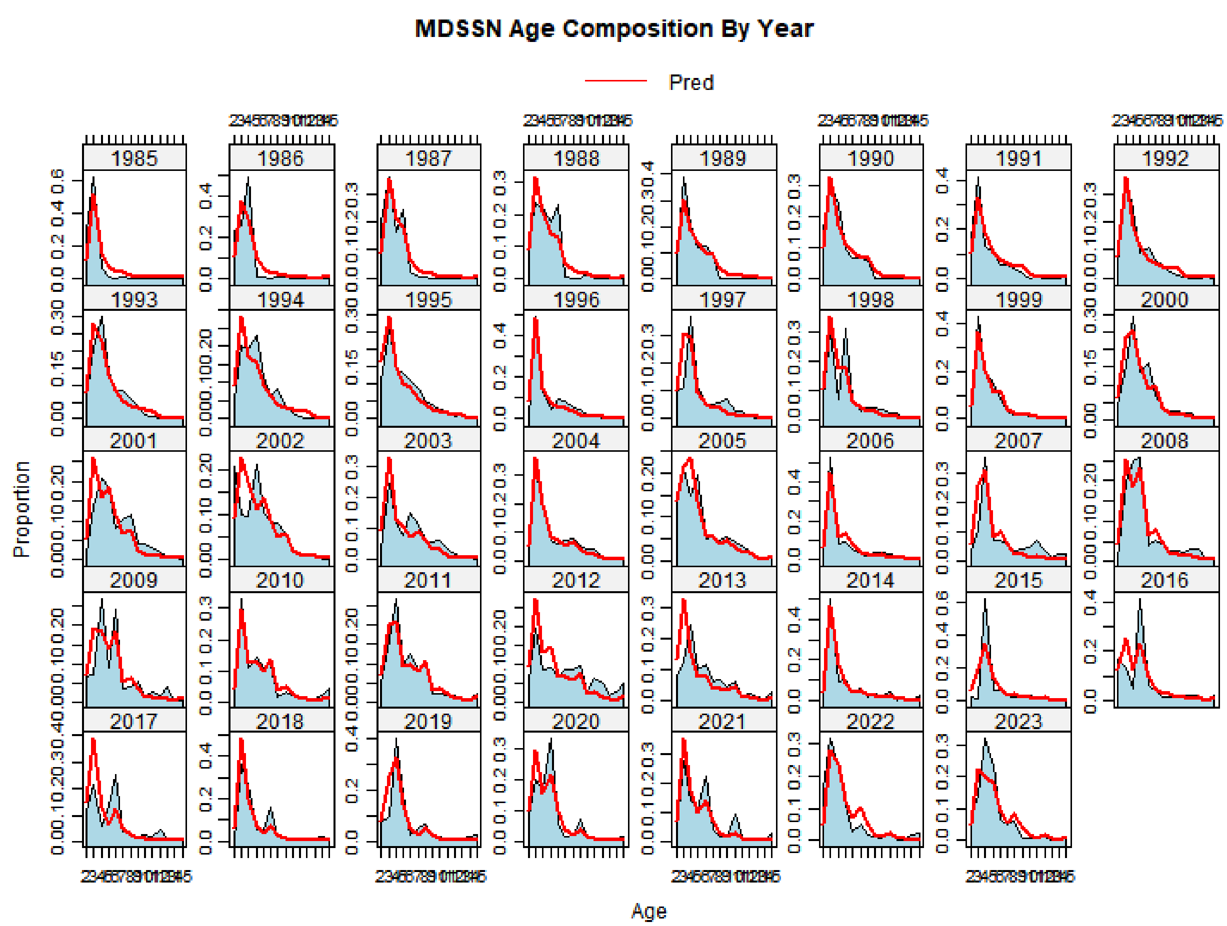

NJTrawl Age Residuals By Age
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990
2000
2010
2020
2
0
-2
Standardized Residual
Year


NJTrawl Age Residuals By Year
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2022
2023
5
10
15
2
0
-2
Standardized Residual
Age

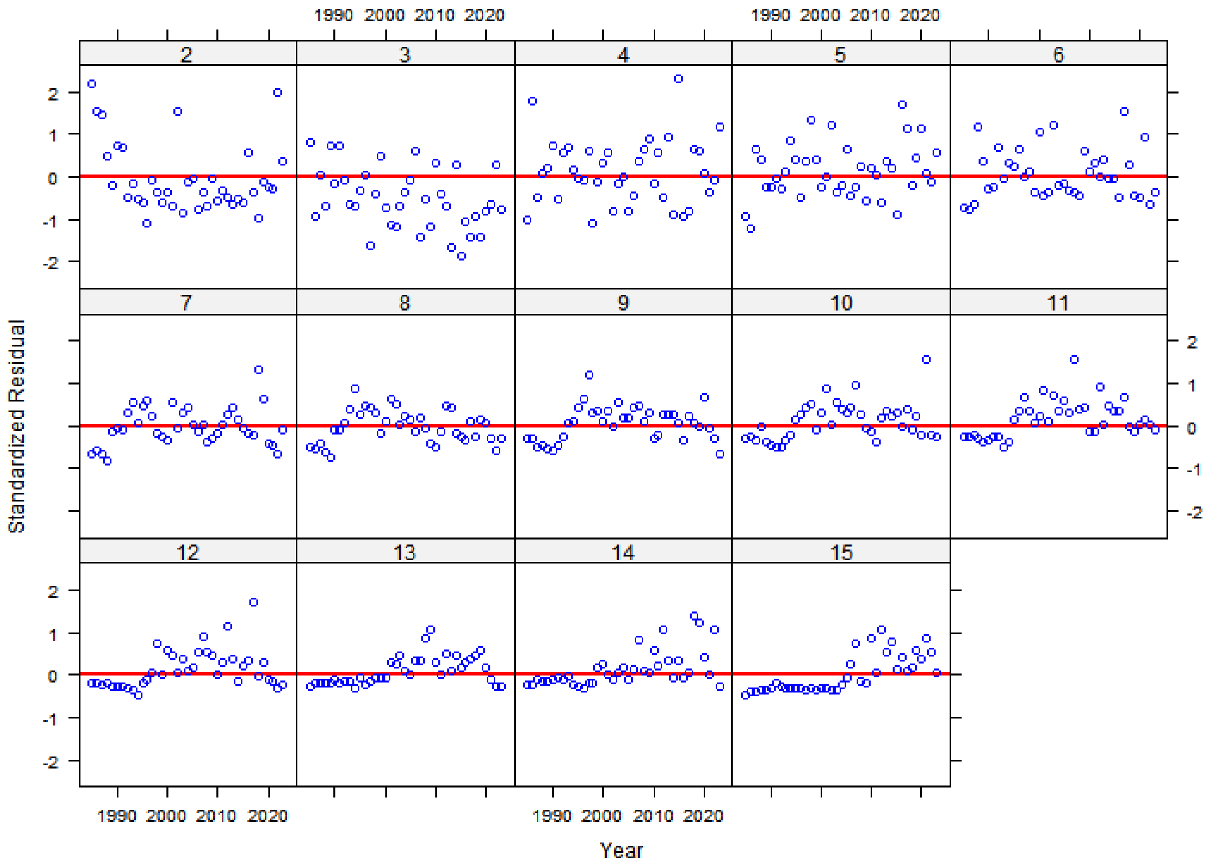

NJTrawl Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2022


NJTRAWL Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Age
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

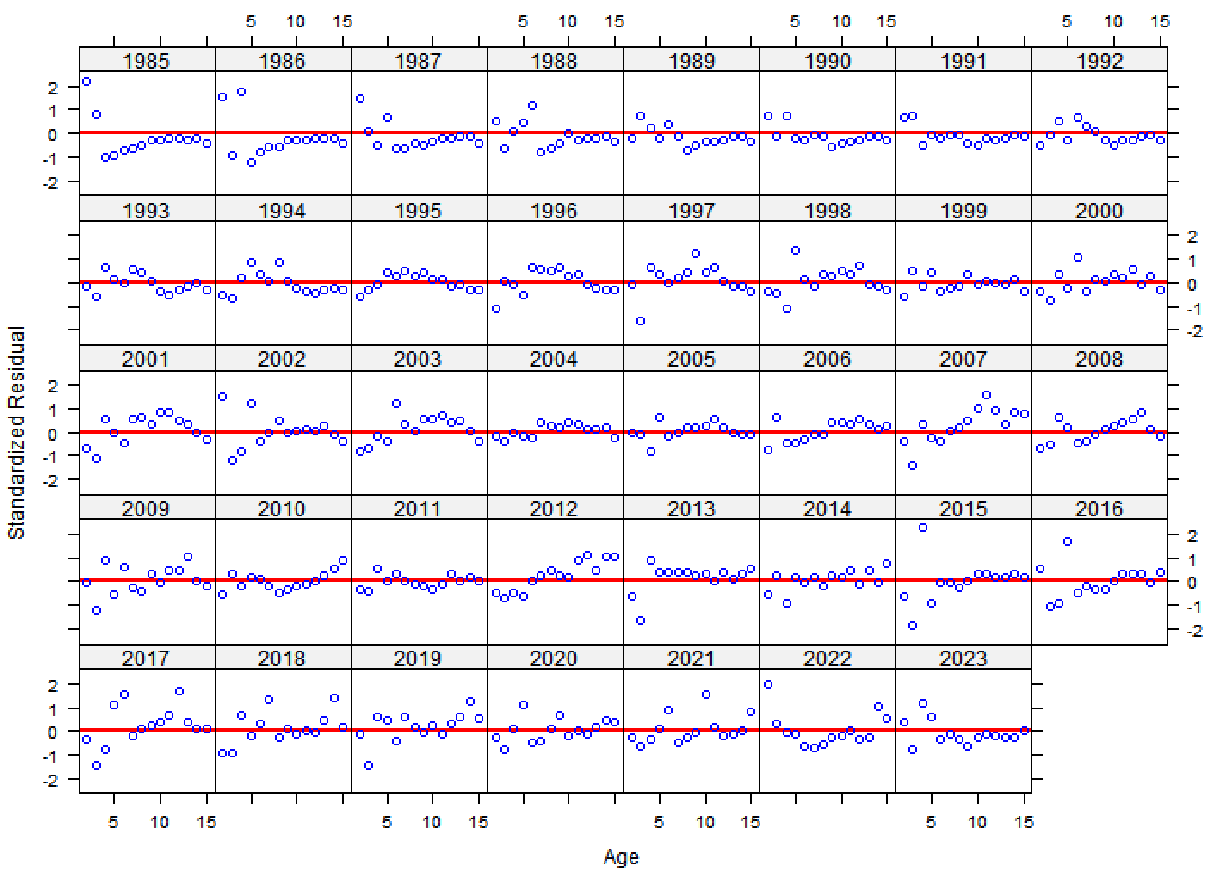

MDSSN Age Composition By Age
Pred
Proportion
Year
1990 2000 2010 2020

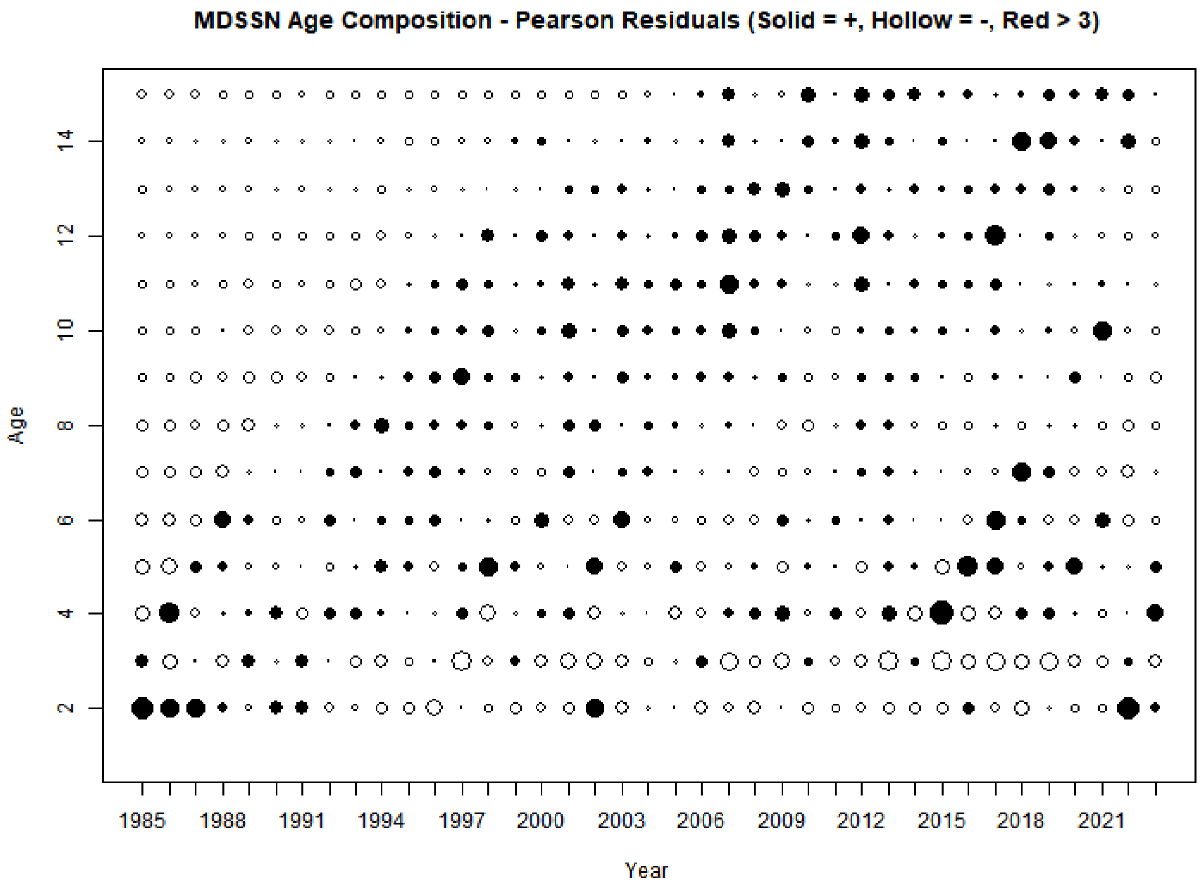

MDSSN Age Composition By Year
Pred
Proportion
Age

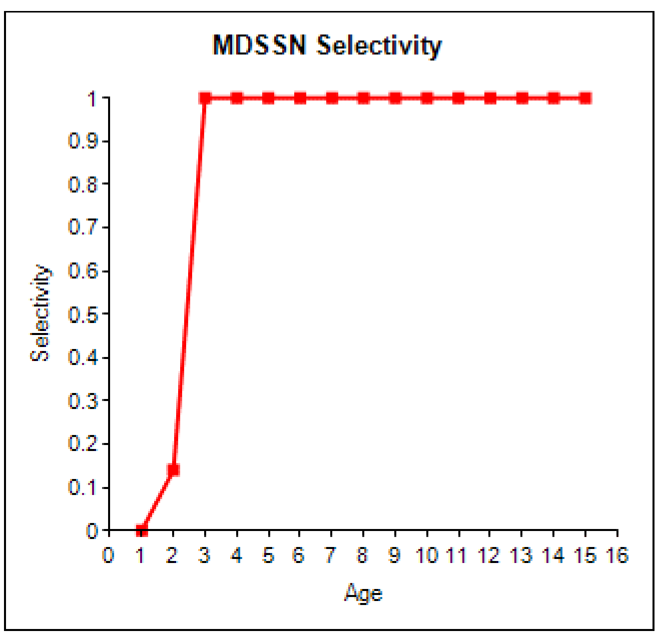
MDSSN Age Residuals By Age

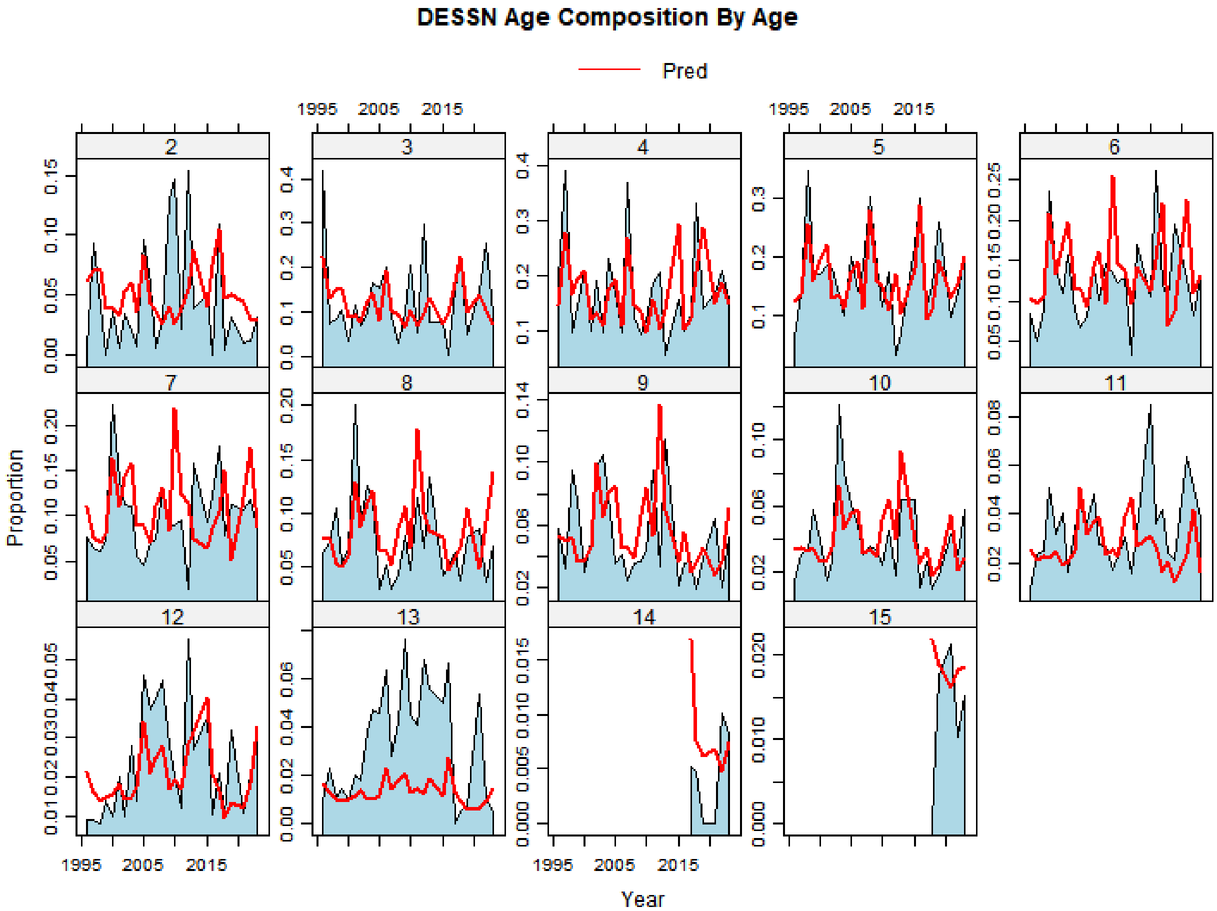


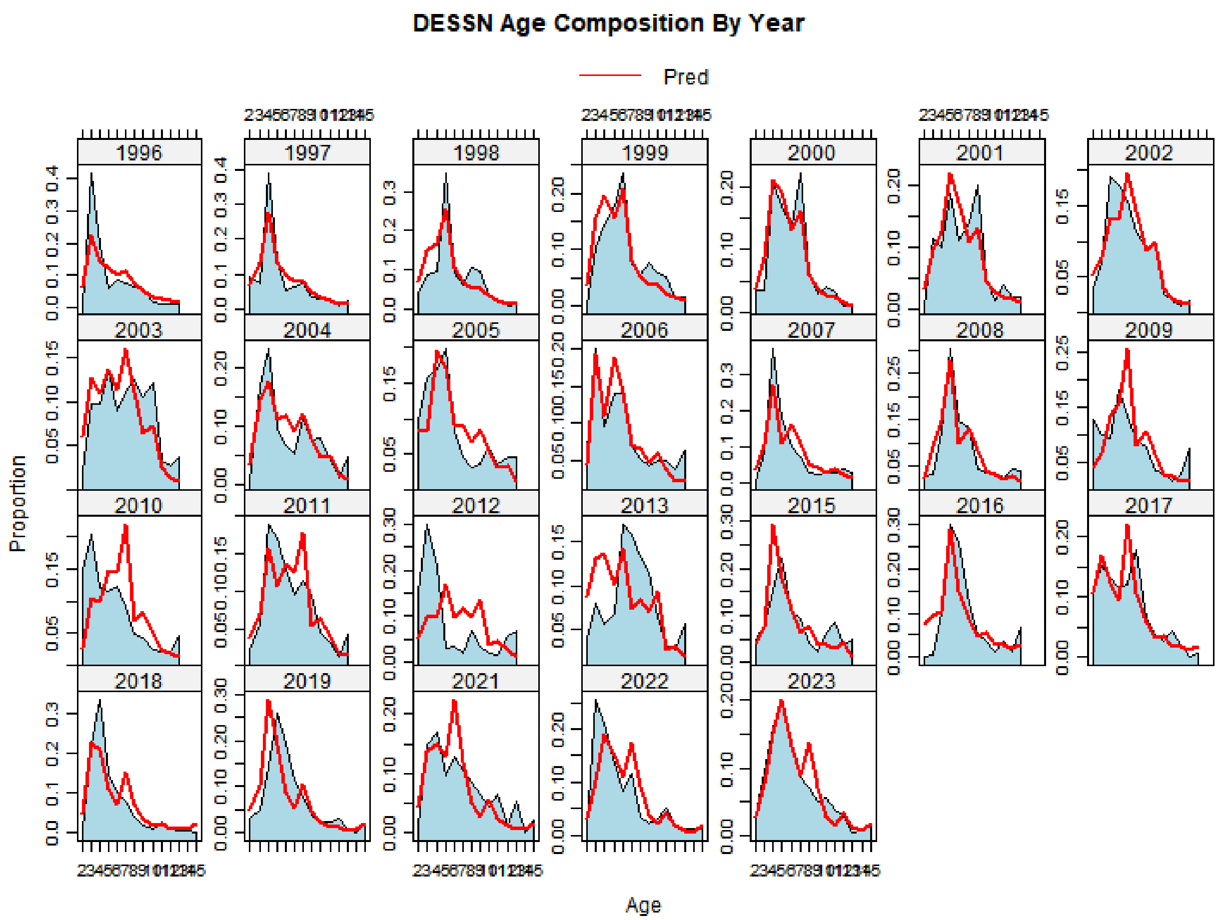
MDSSN Age Residuals By Year



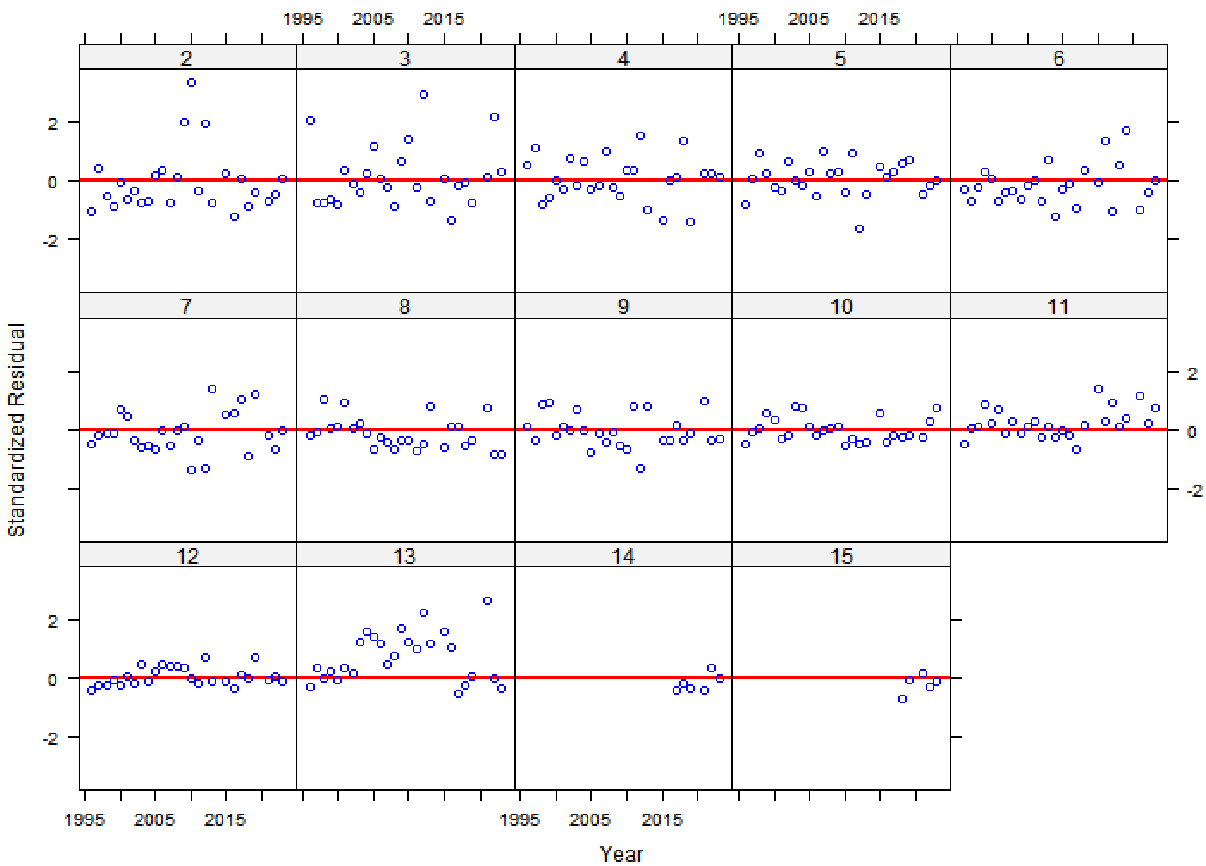

MDSSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021


MDSSN Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

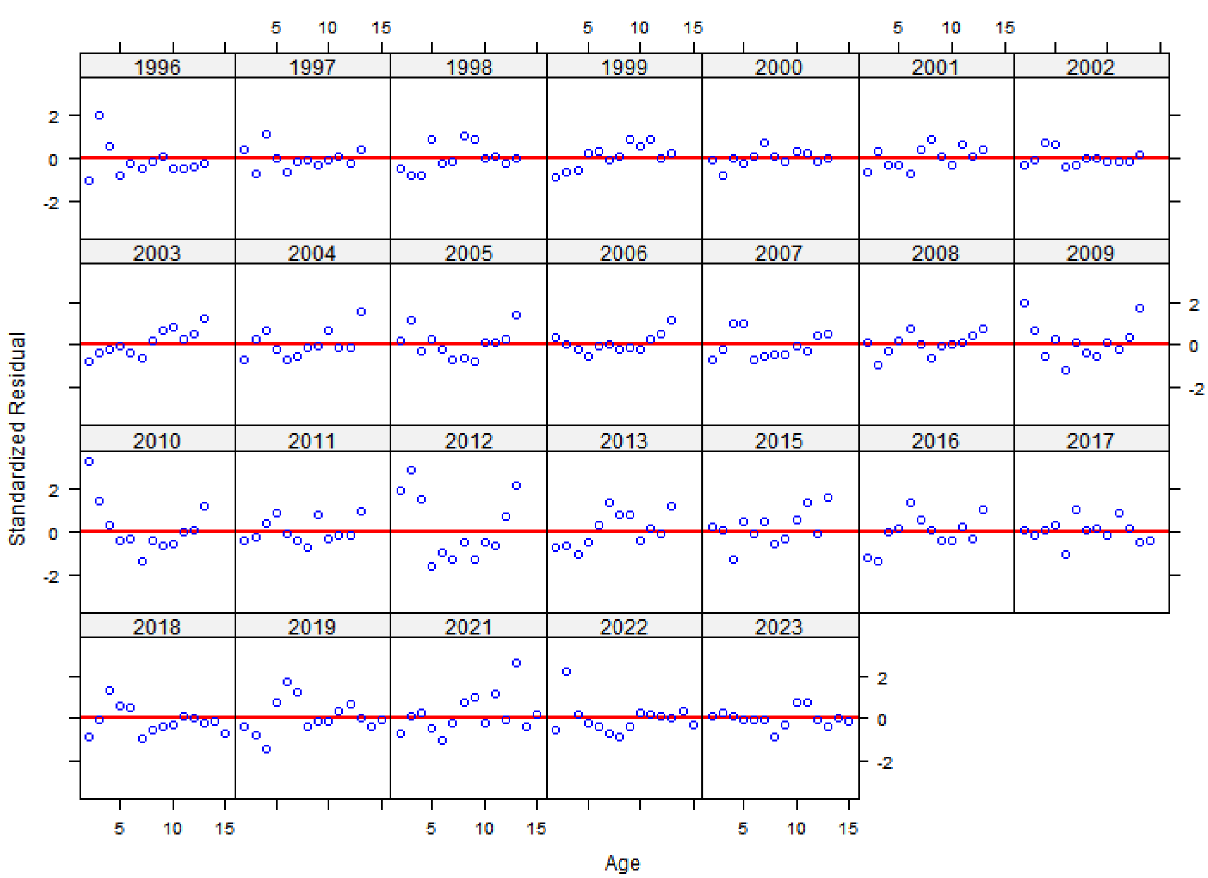

DESSN Age Composition By Age
Pred
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Proportion
Year
1995
2005
2015

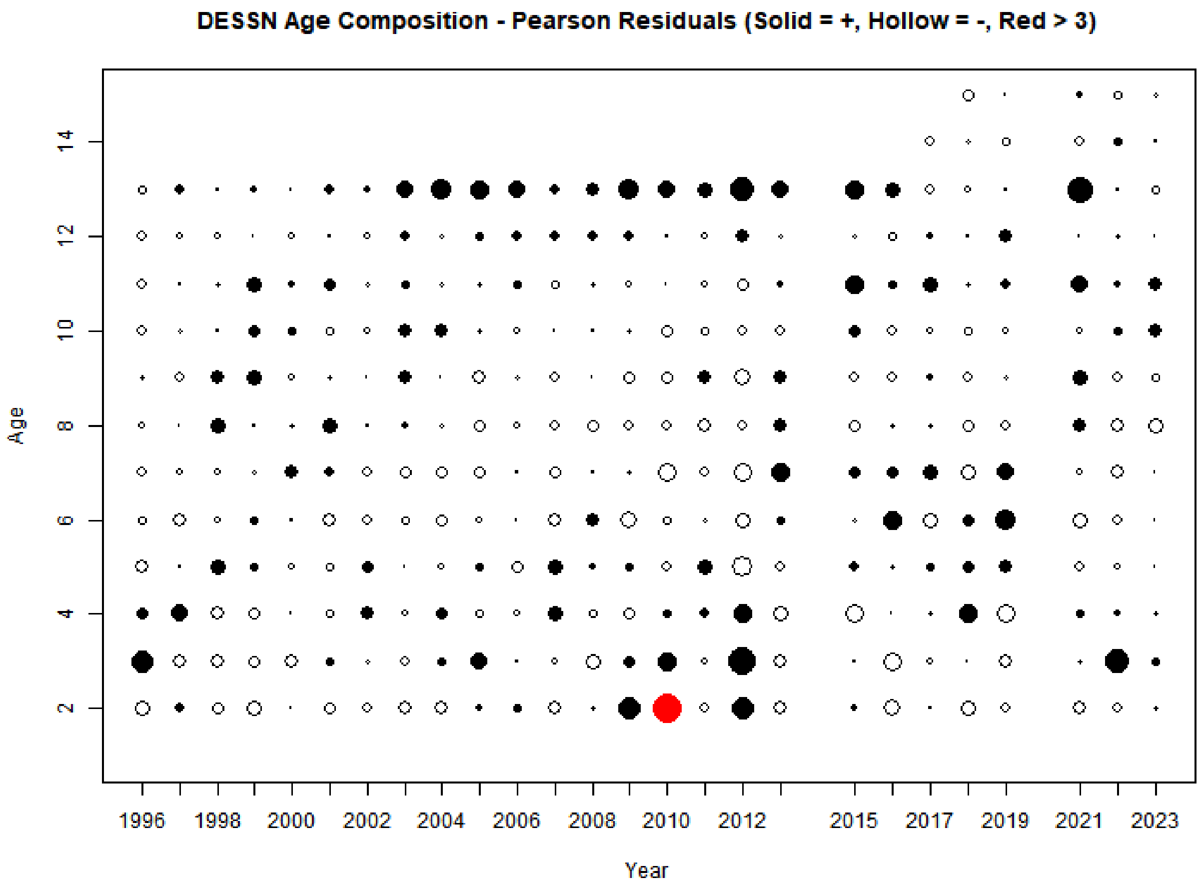

DESSN Age Composition By Year
Pred
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2018
2019
2021
2022
2023
Proportion
Age

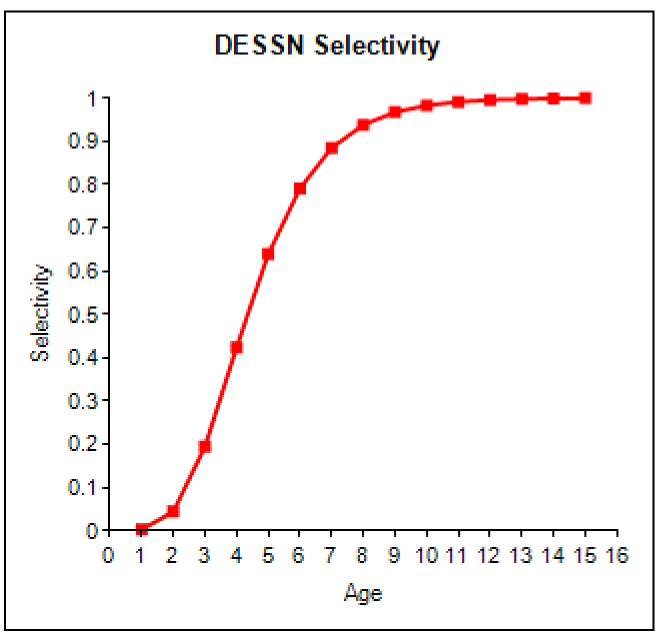
DESSN Age Residuals By Age



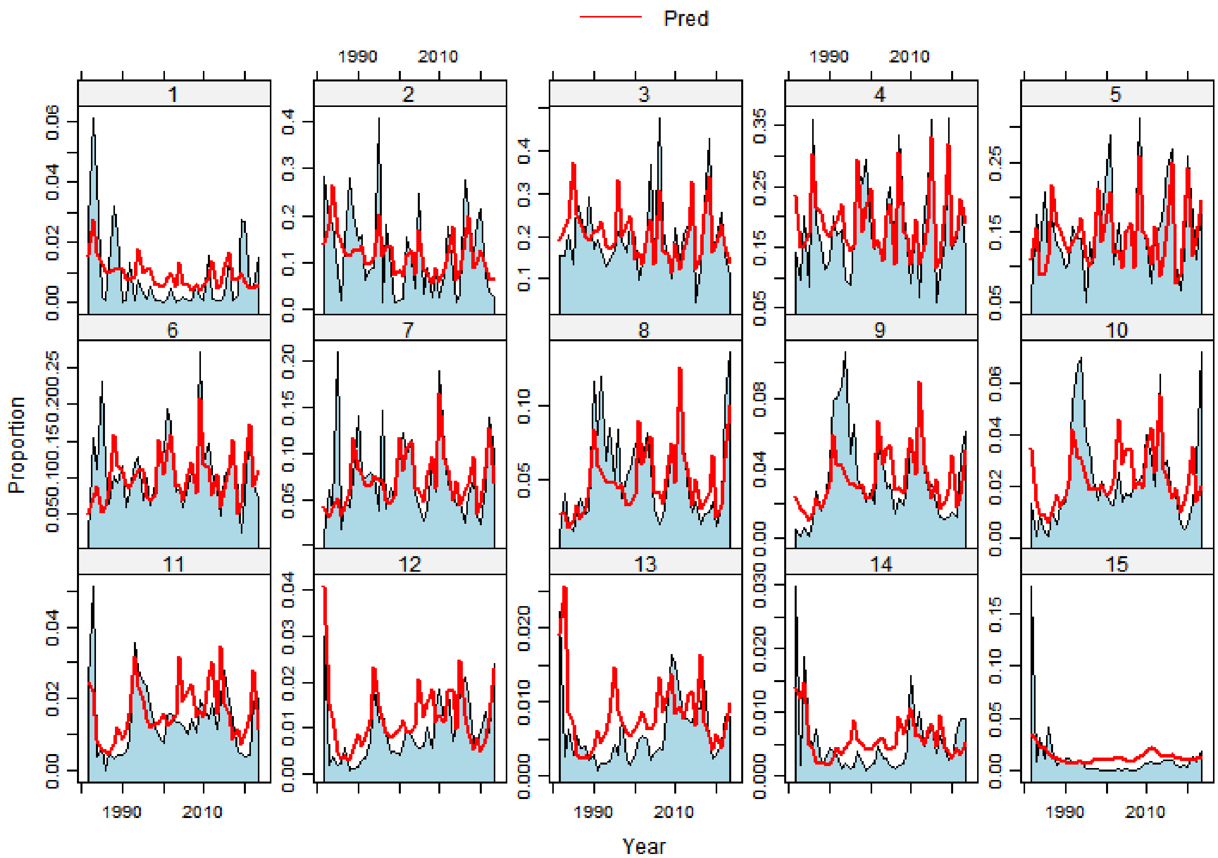
DESSN Age Residuals By Year



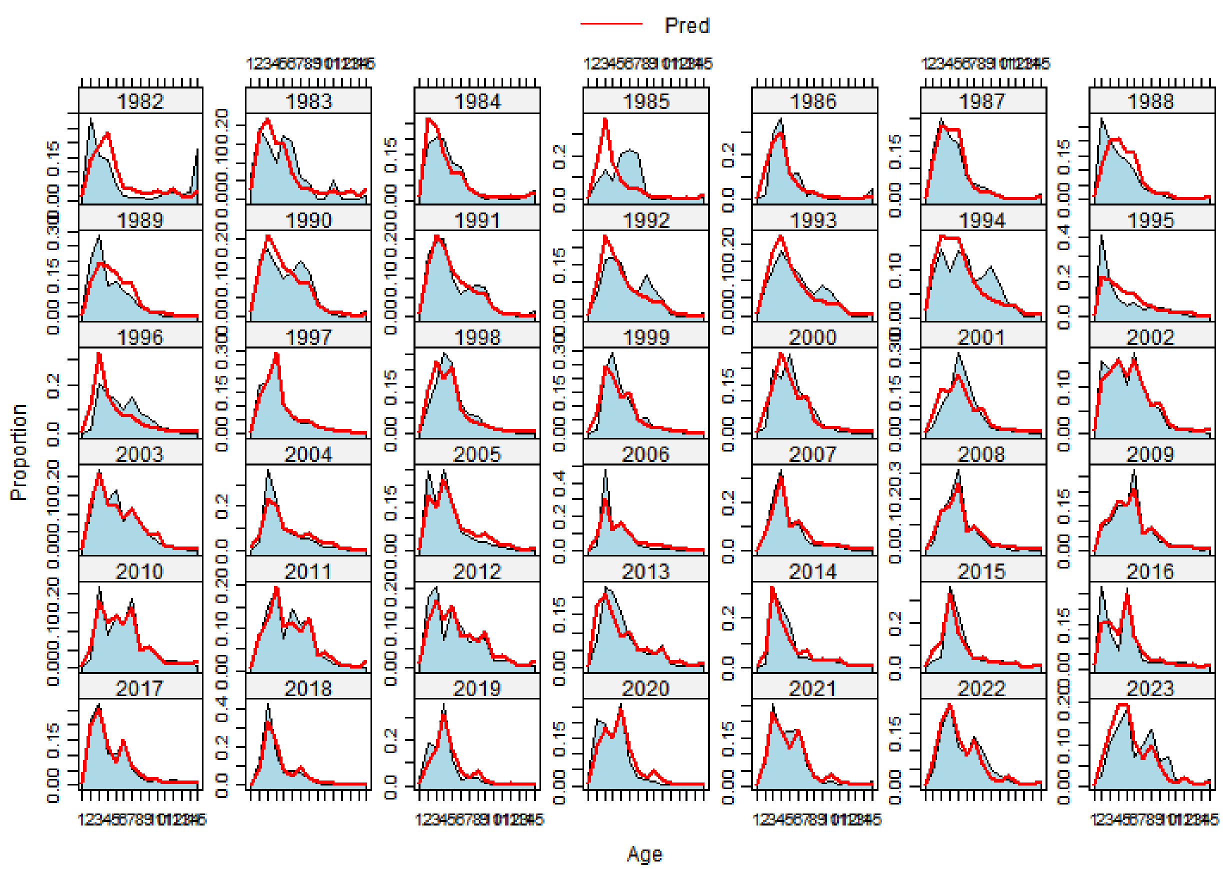

DESSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1996
1998
2000
2002
2004
2006
2008
2010
2012
2015
2017
2019
2021
2023
Year

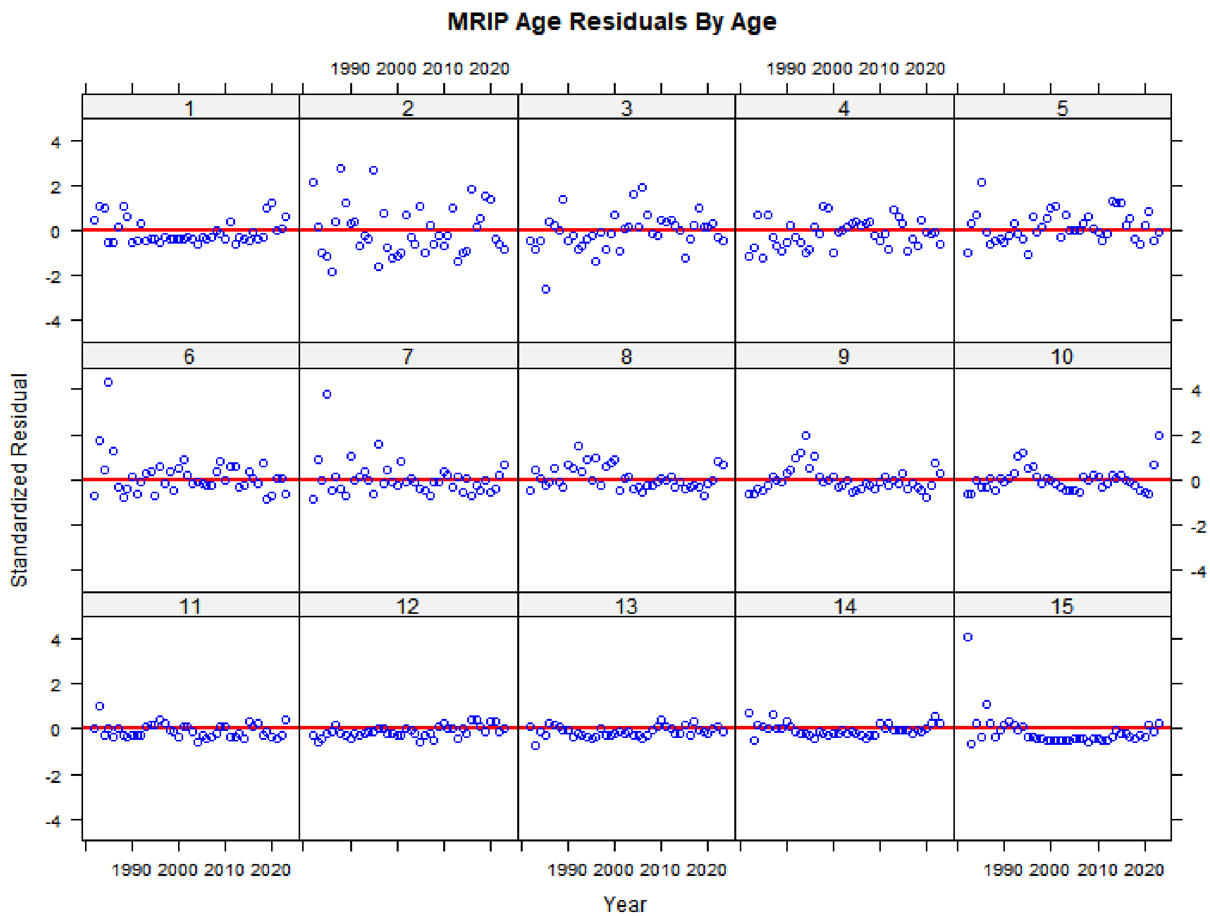

DESSN Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

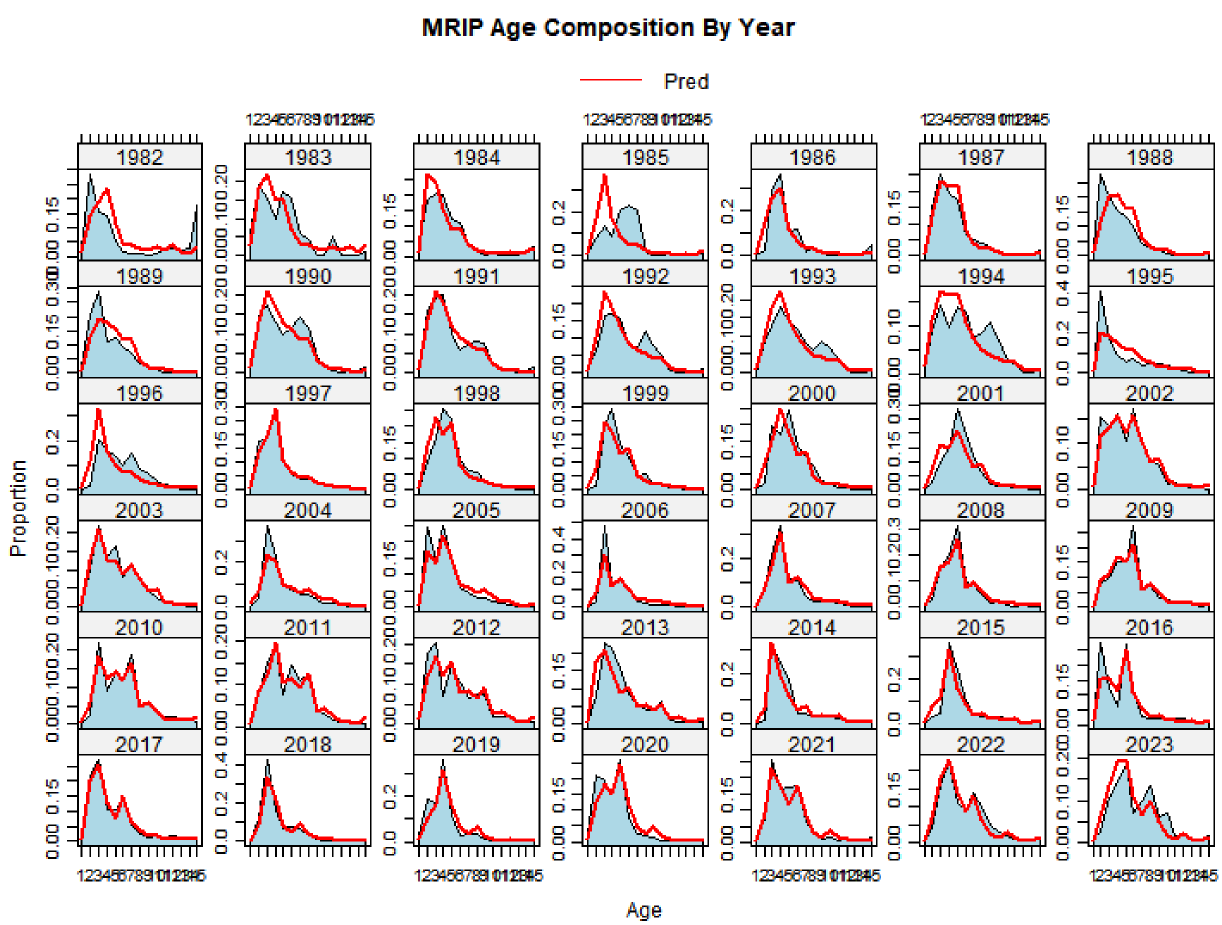
MRIP Age Composition By Age

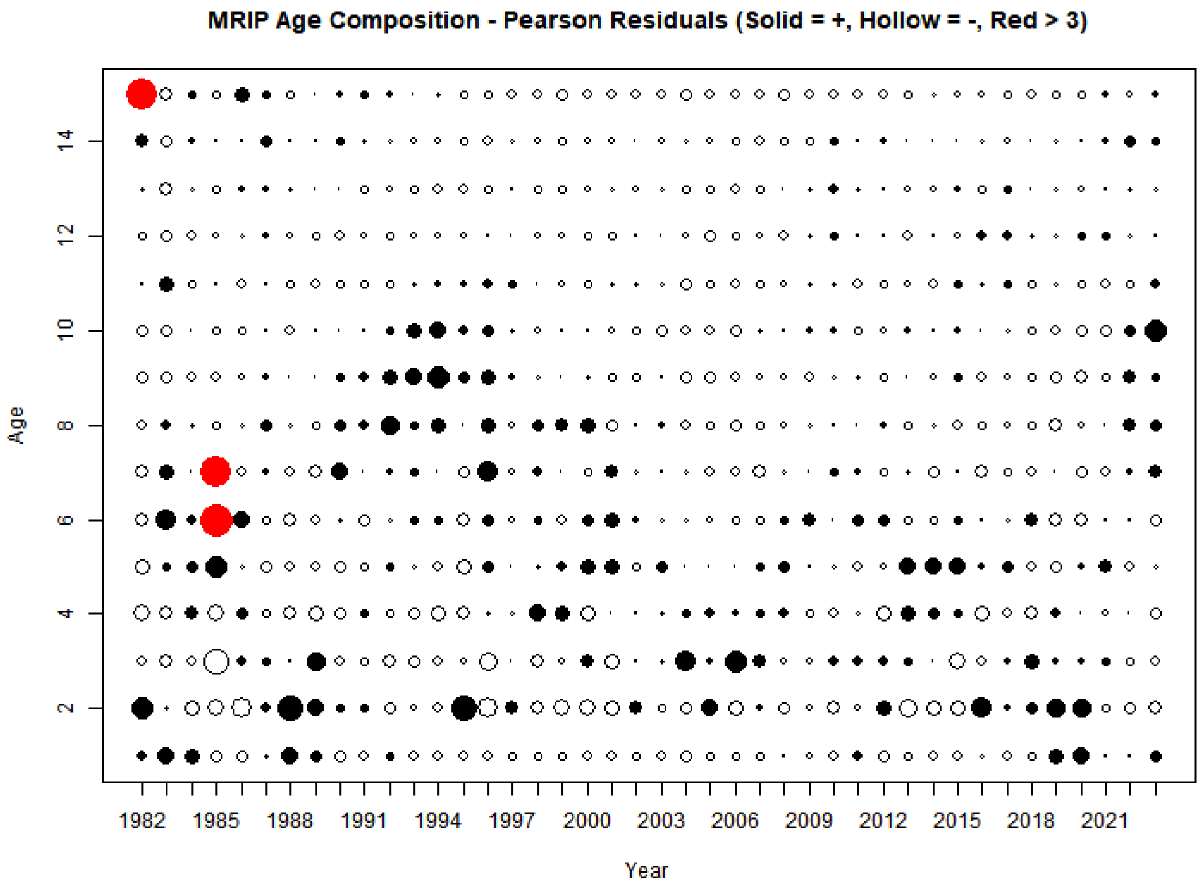


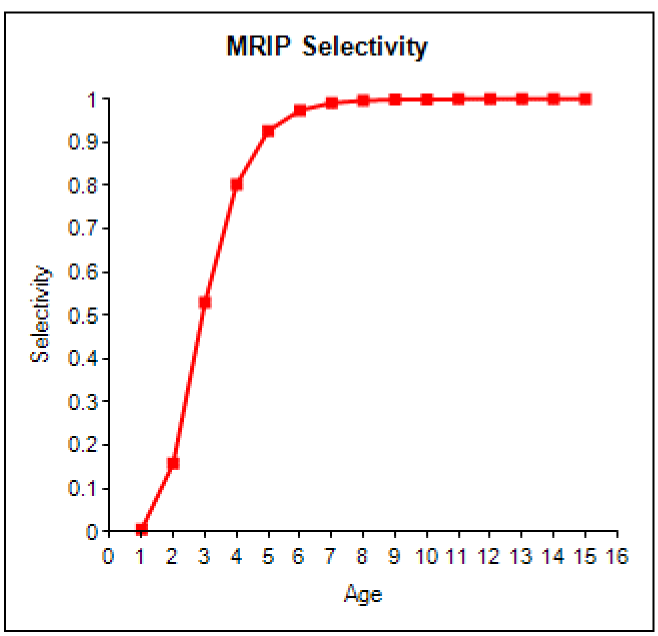
MRIP Age Composition By Year

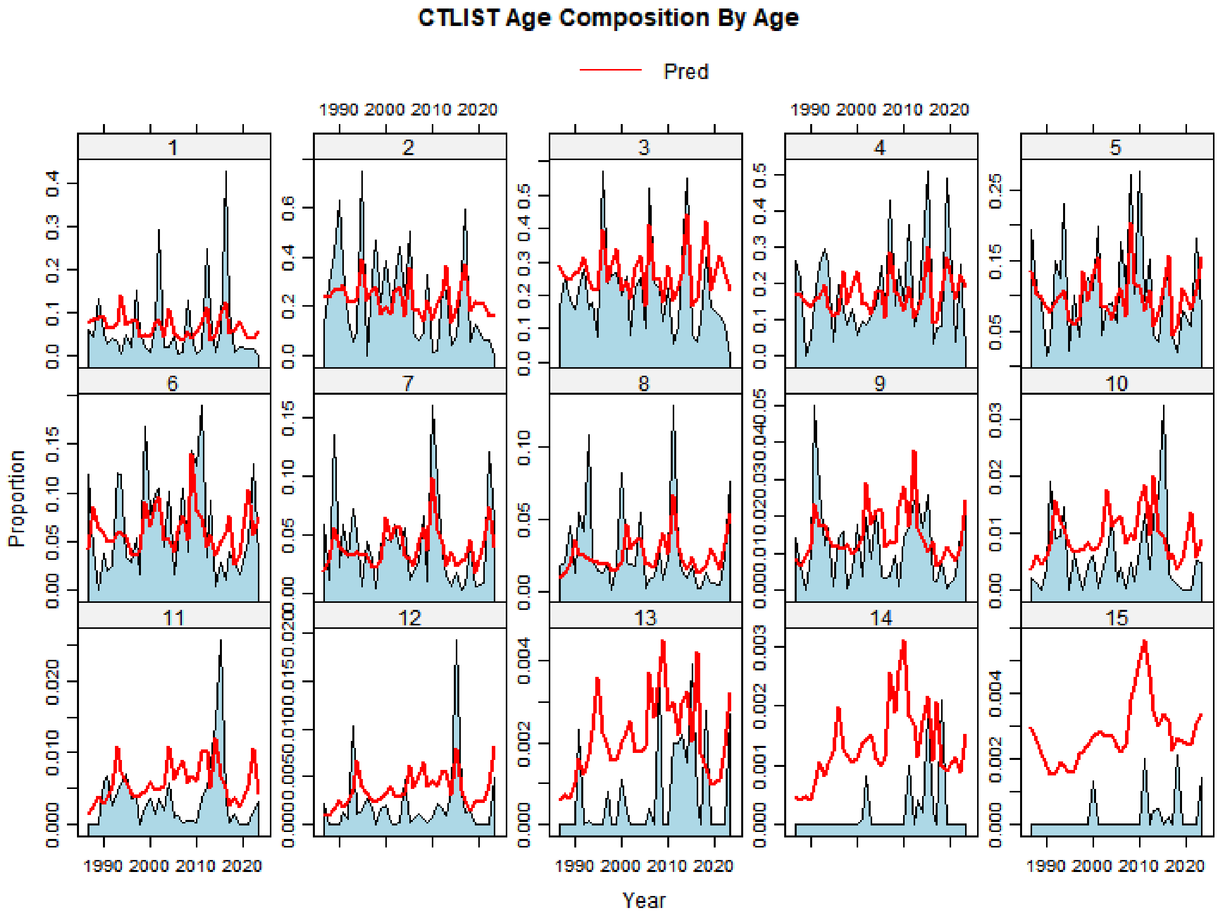


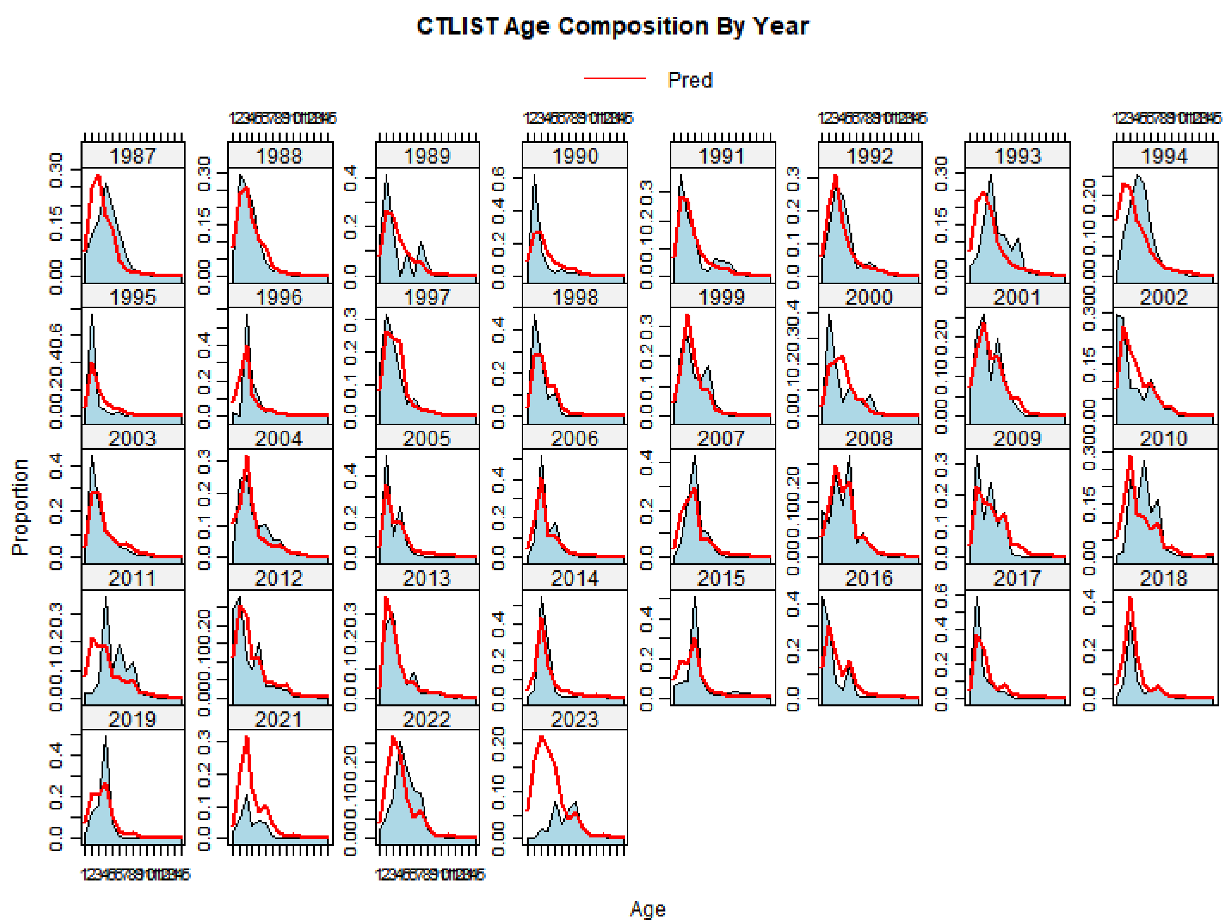

MRIP Age Residuals By Age
Standardized Residual
Year

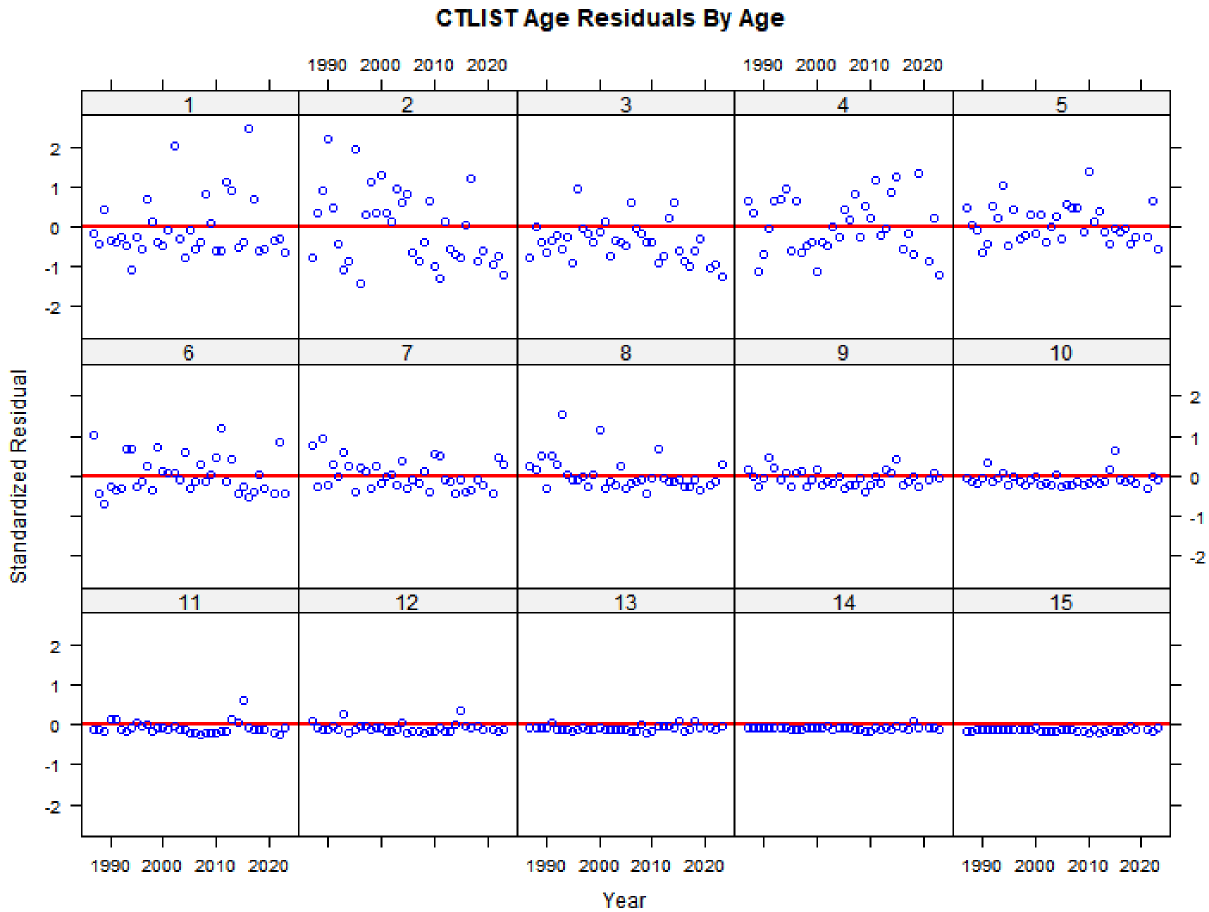

MRIP Age Composition By Year
Pred
Proportion
Age

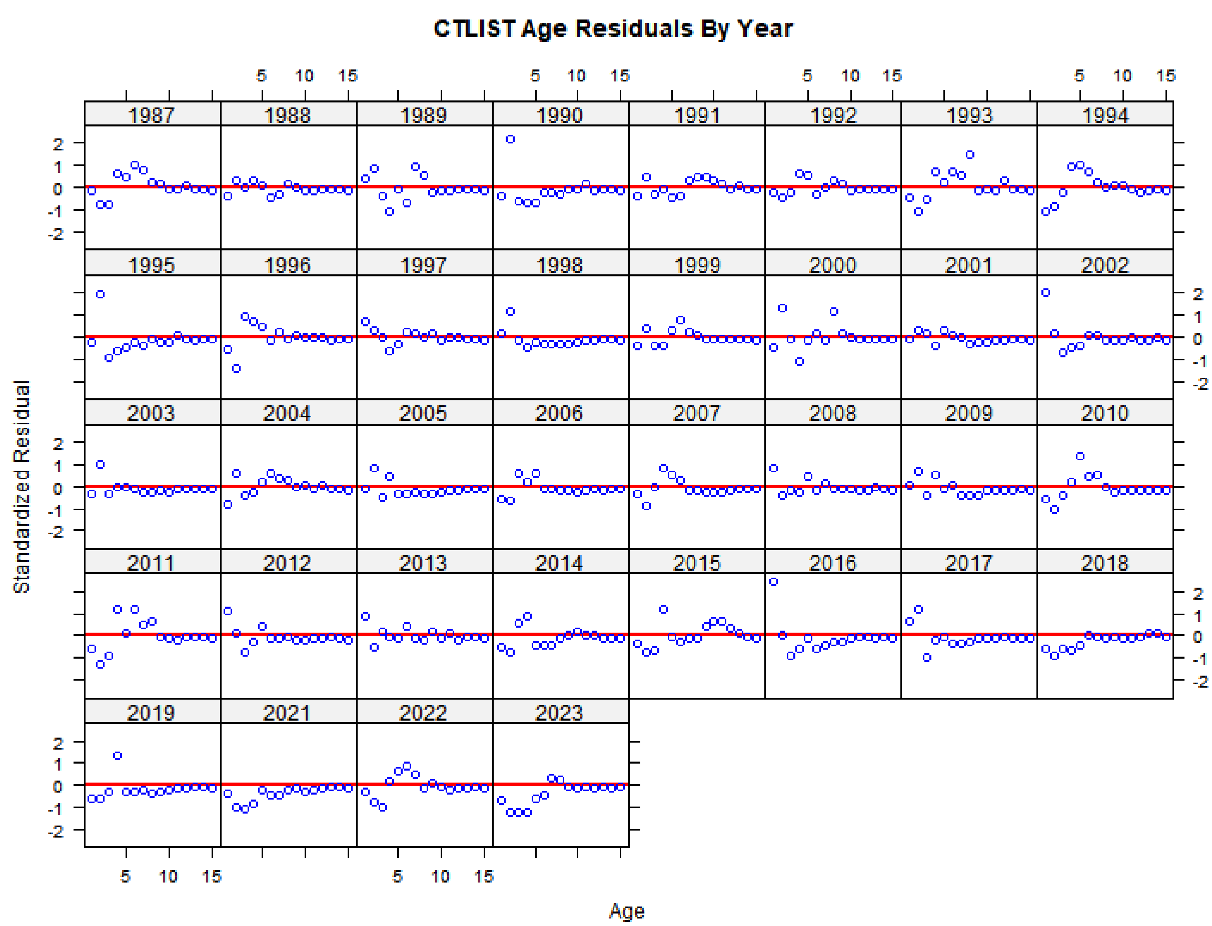

MRIP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

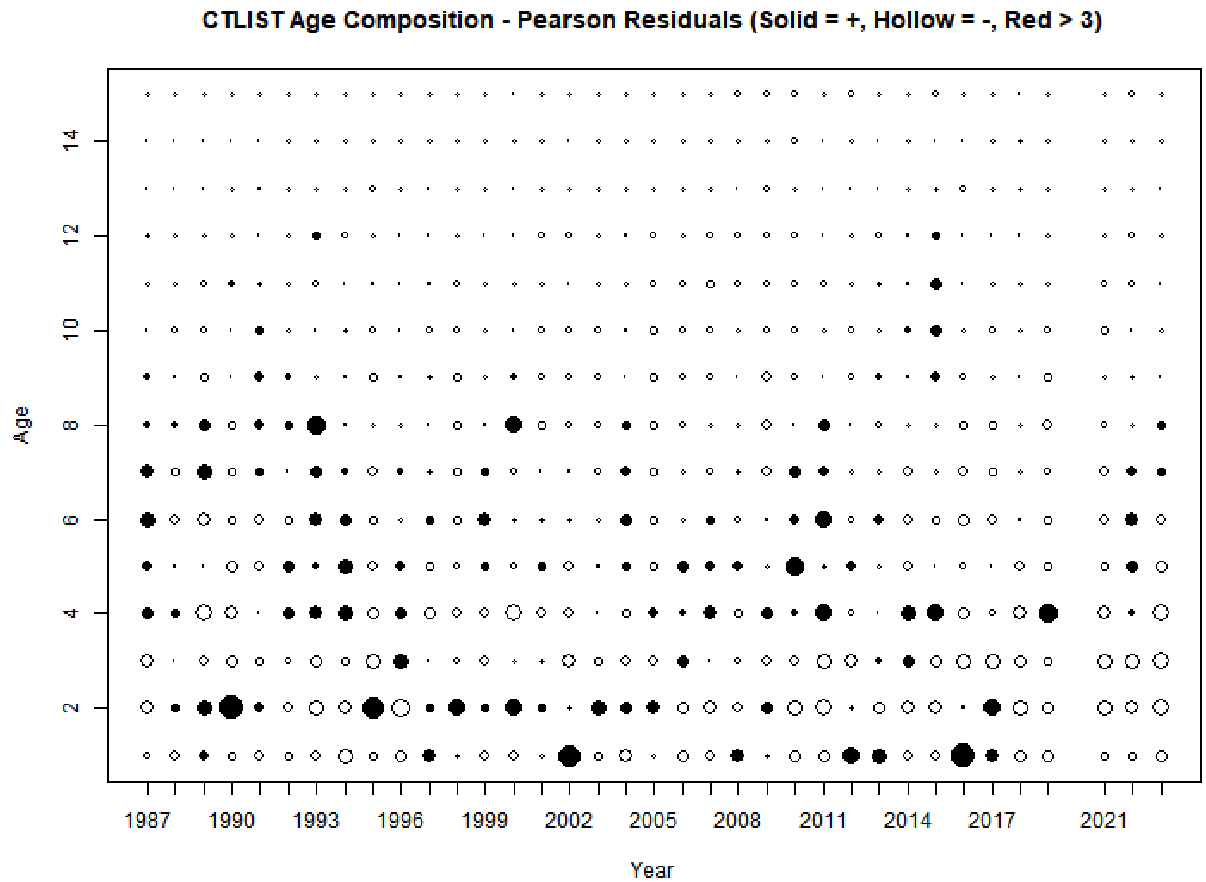

MRIP Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


CTLIST Age Composition By Age
Pred
Proportion
Year

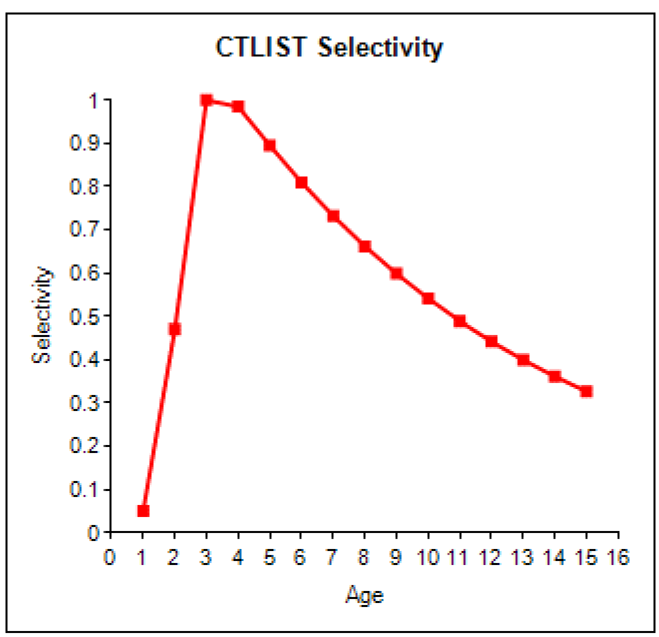

CTLIST Age Composition By Year
Pred
Proportion
Age


CTLIST Age Residuals By Age
Standardized Residual
Year
1990
2000
2010
2020
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
2
1
0
-1
-2

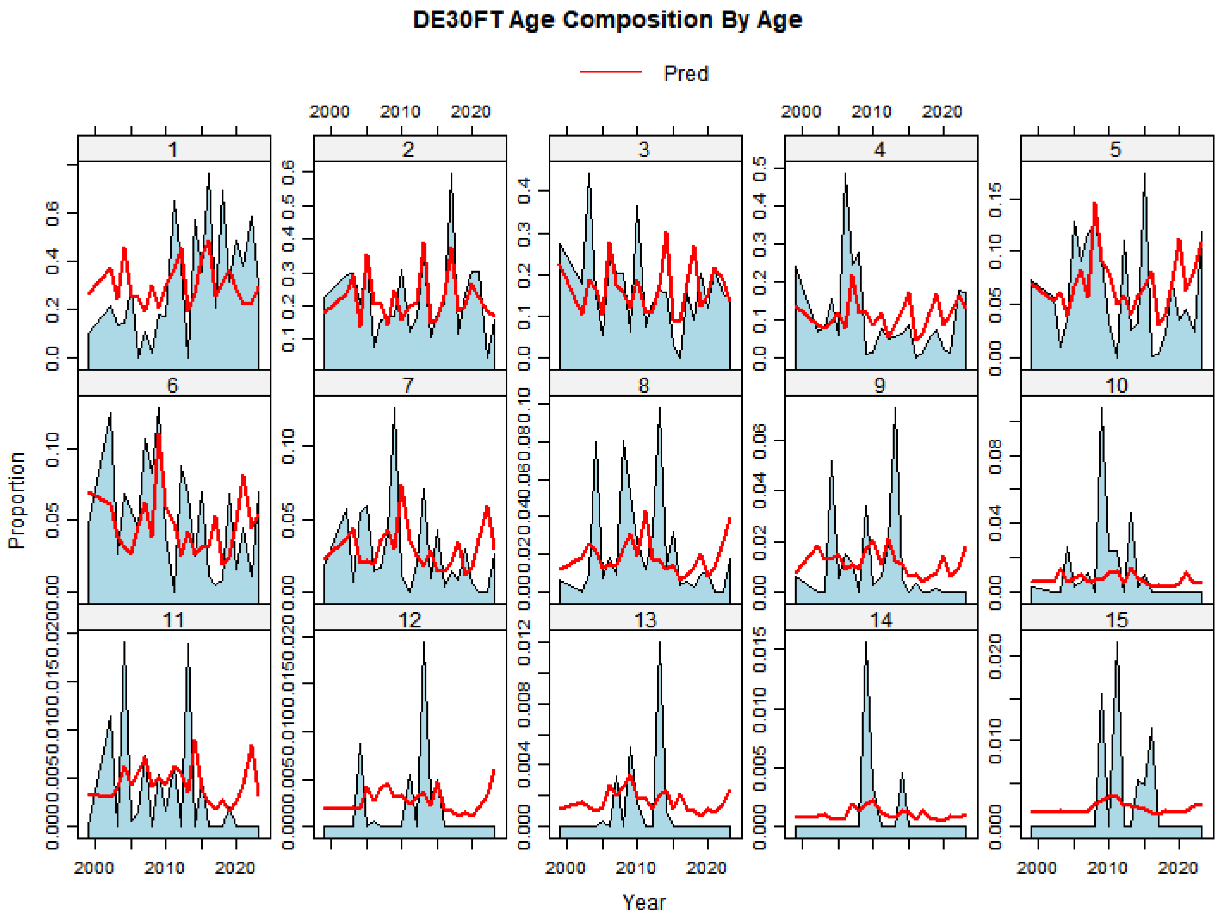

CTLIST Age Residuals By Year
Standardized Residual
Age
5
10
15
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
2023
2
1
0
-1
-2

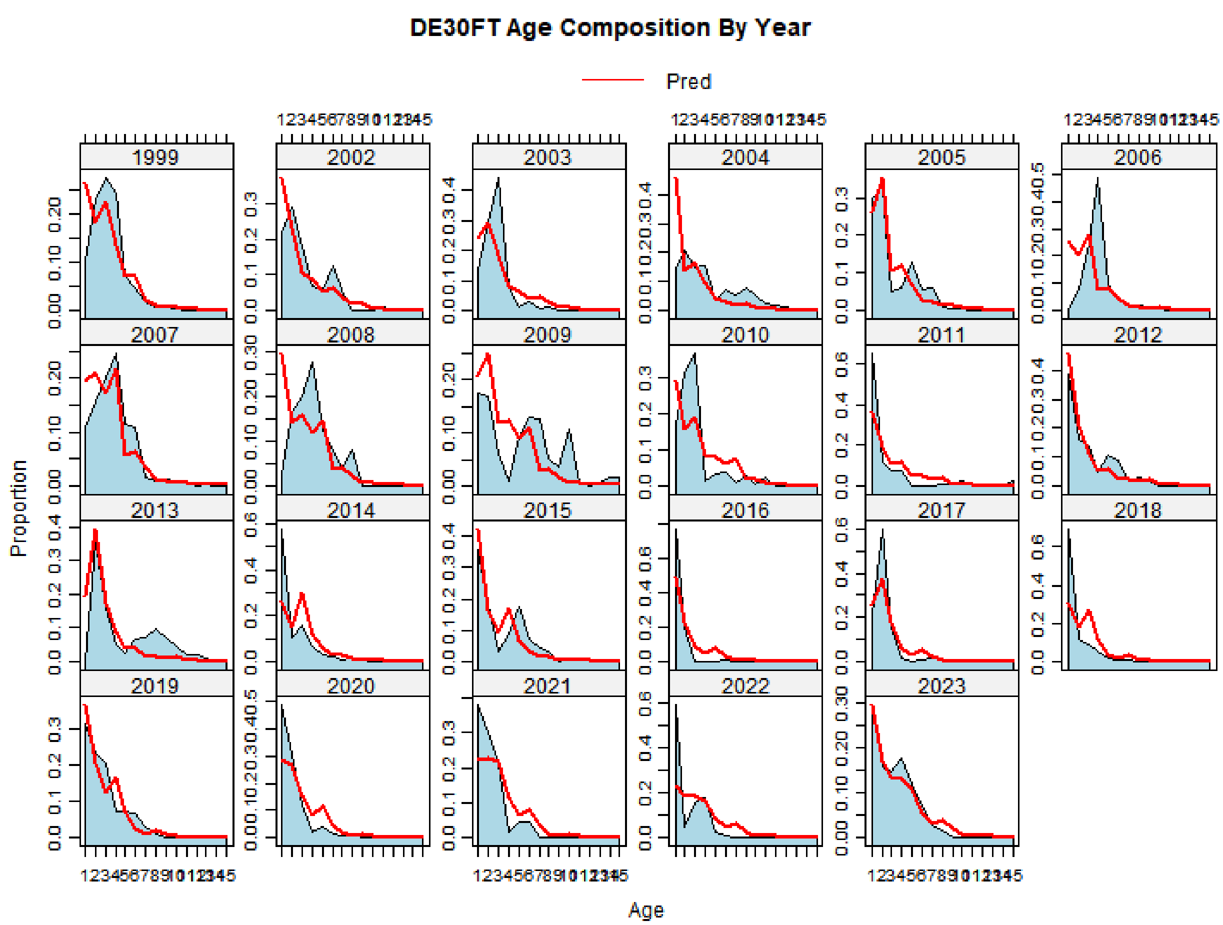


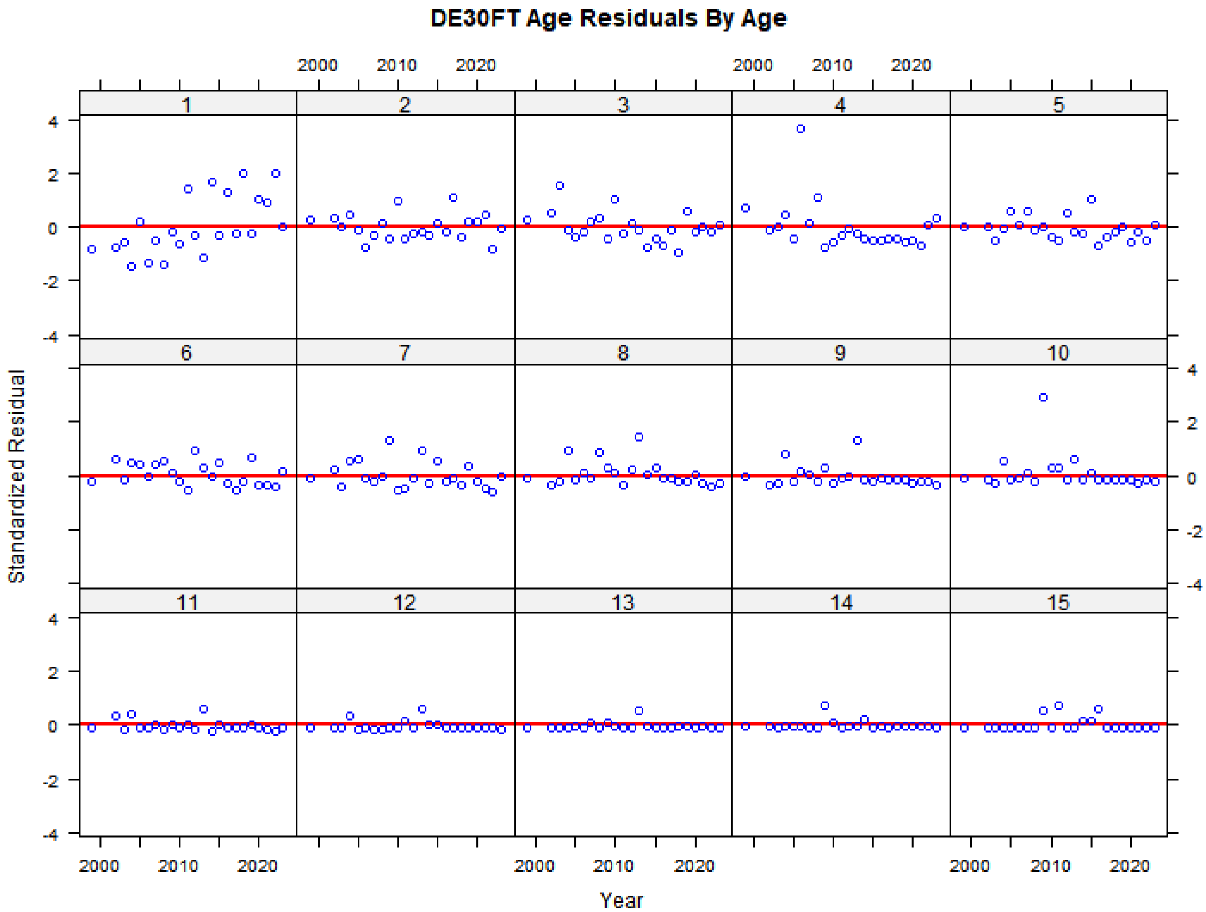
CTLIST Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2021
Year

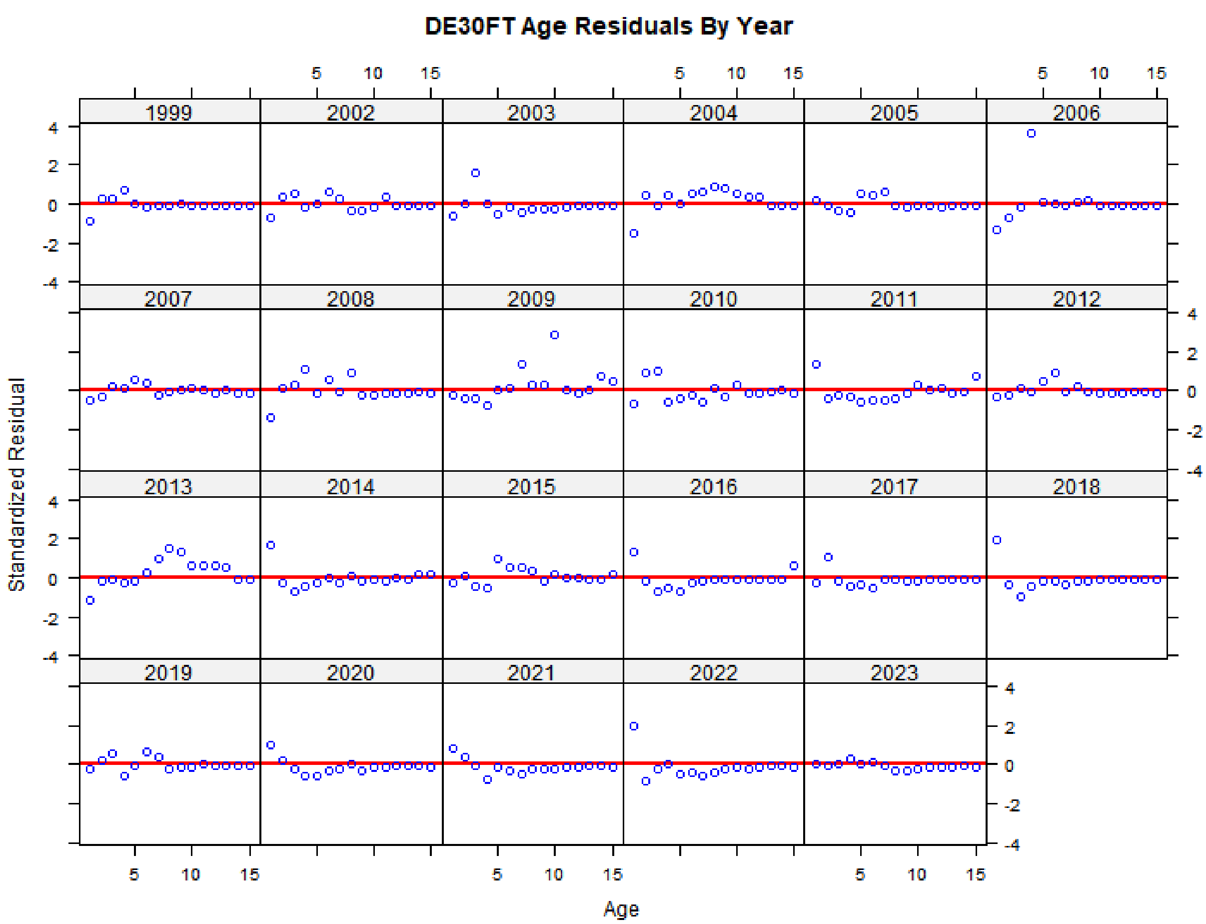


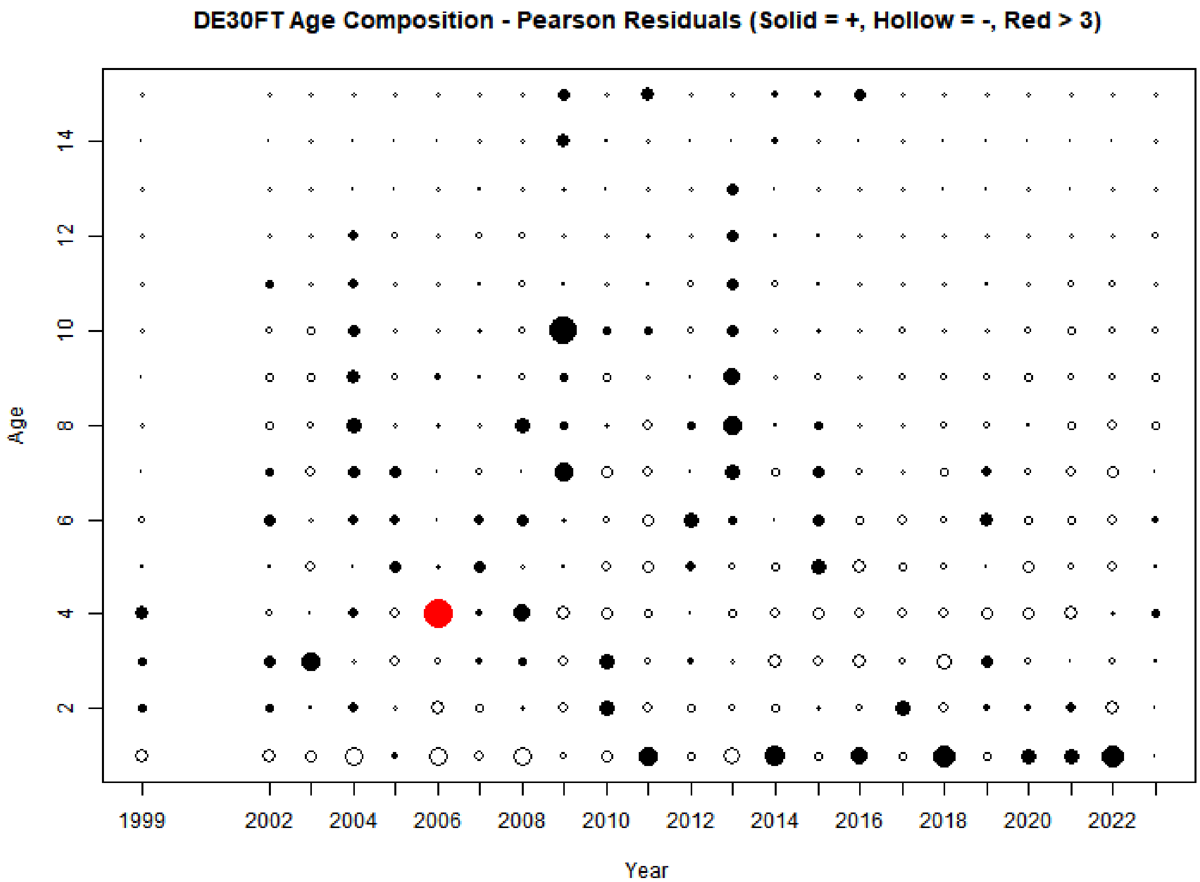
CTLIST Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

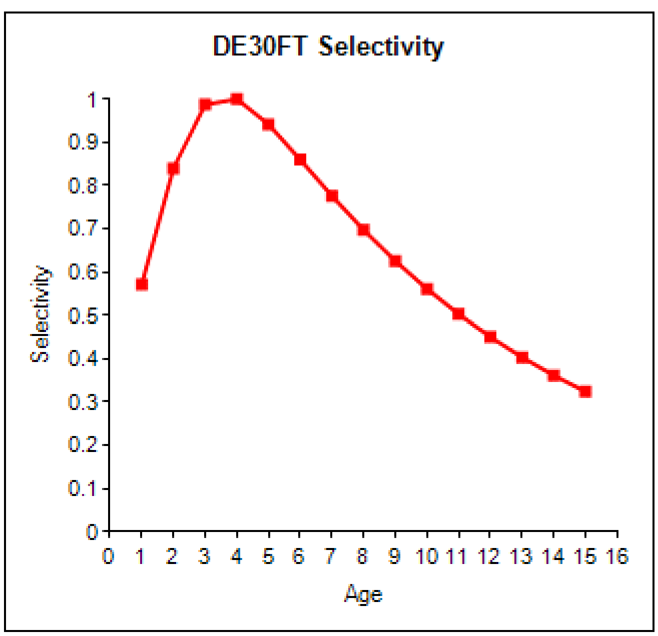

DE30FT Age Composition By Age
Pred
Proportion
Year

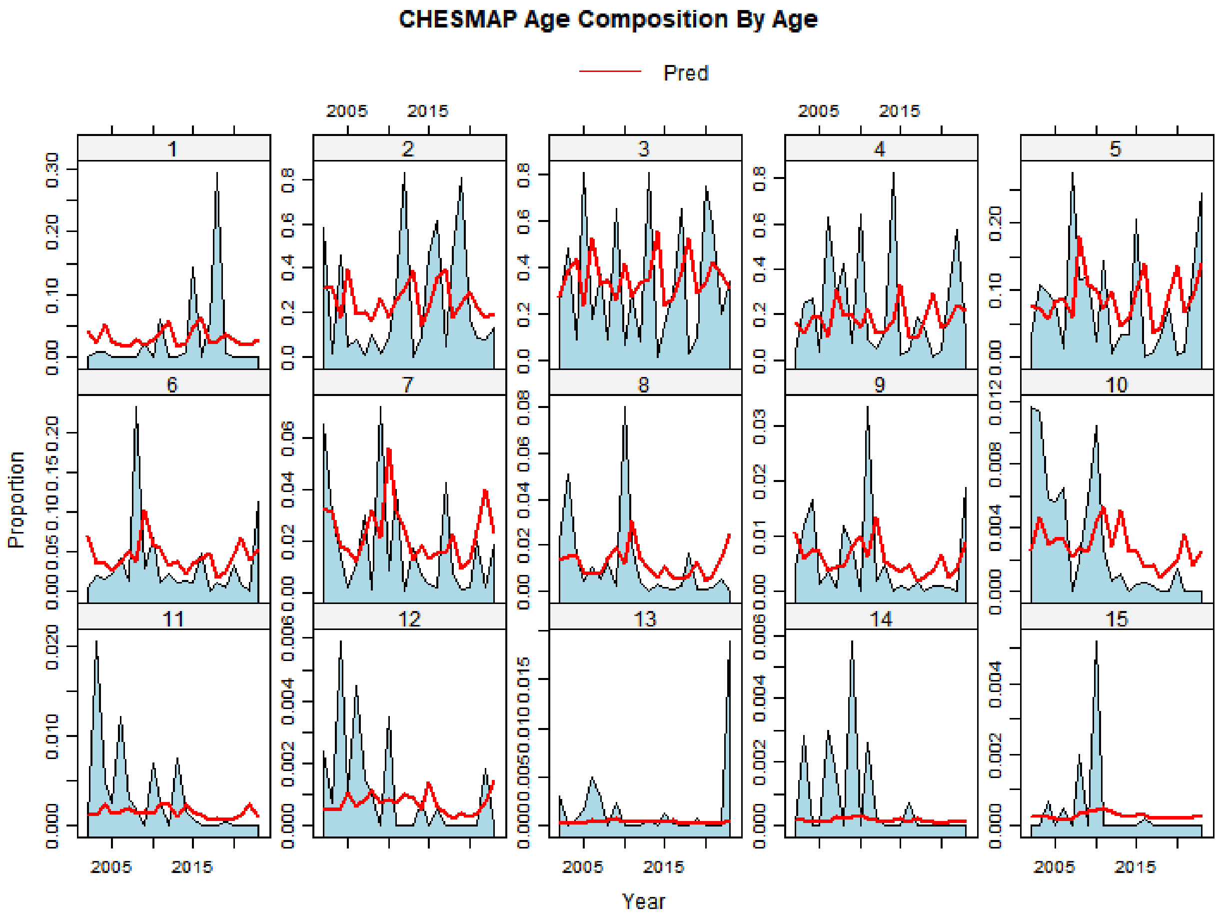

DE30FT Age Composition By Year
Pred
Proportion
Age


DE30FT Age Residuals By Age
Standardized Residual
Year

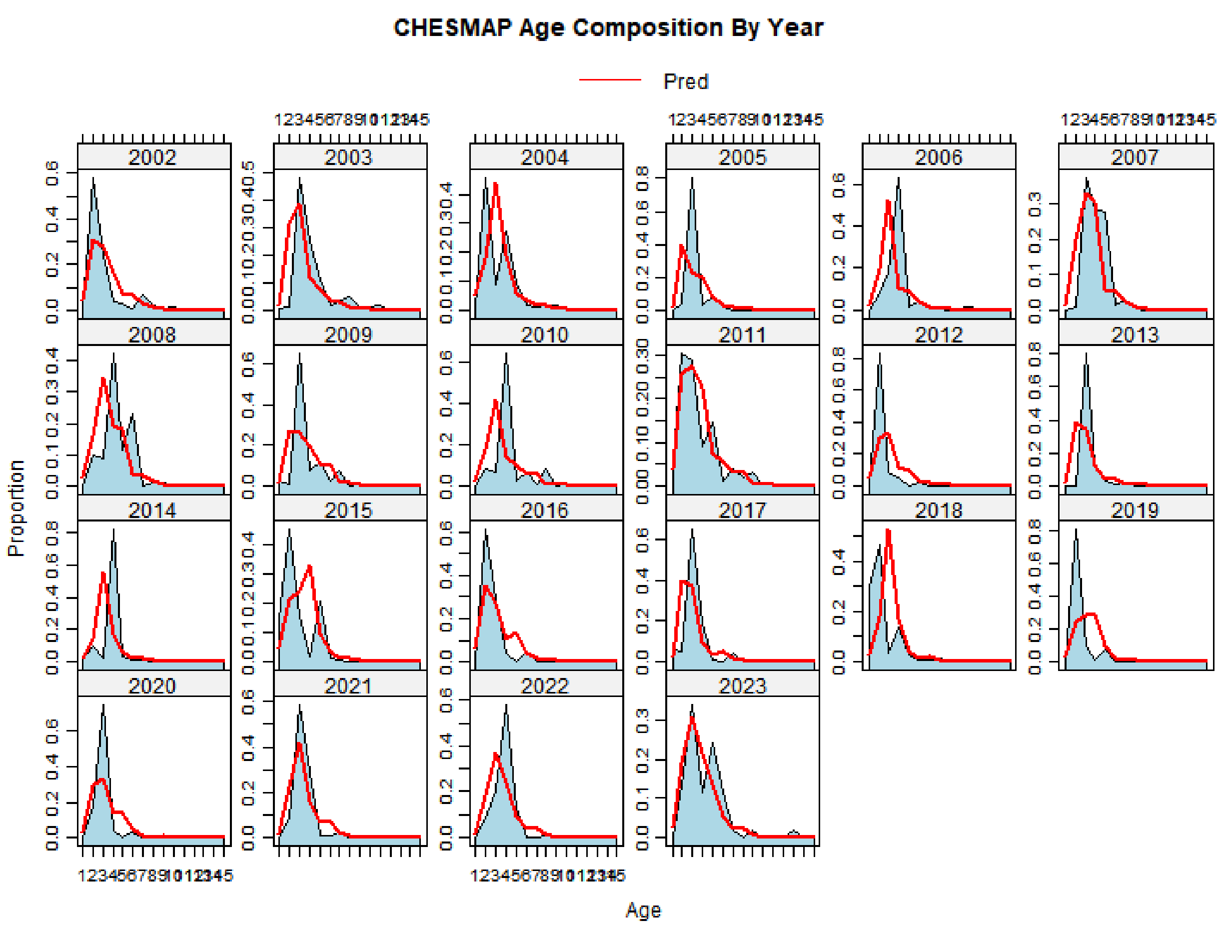

DE30FT Age Residuals By Year
Standardized Residual
Age


DE30FT Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1999
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Year

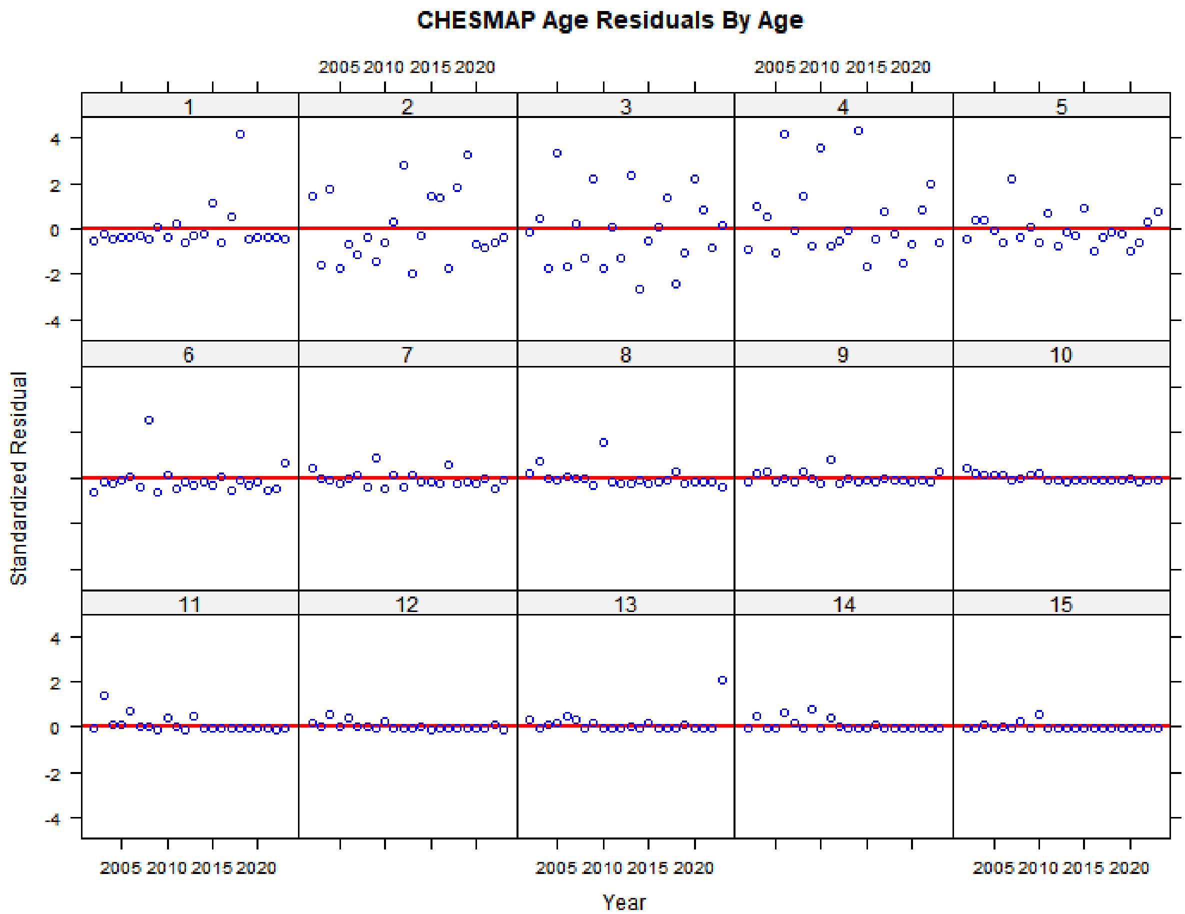

DE30FT Selectivity
Selectivity
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

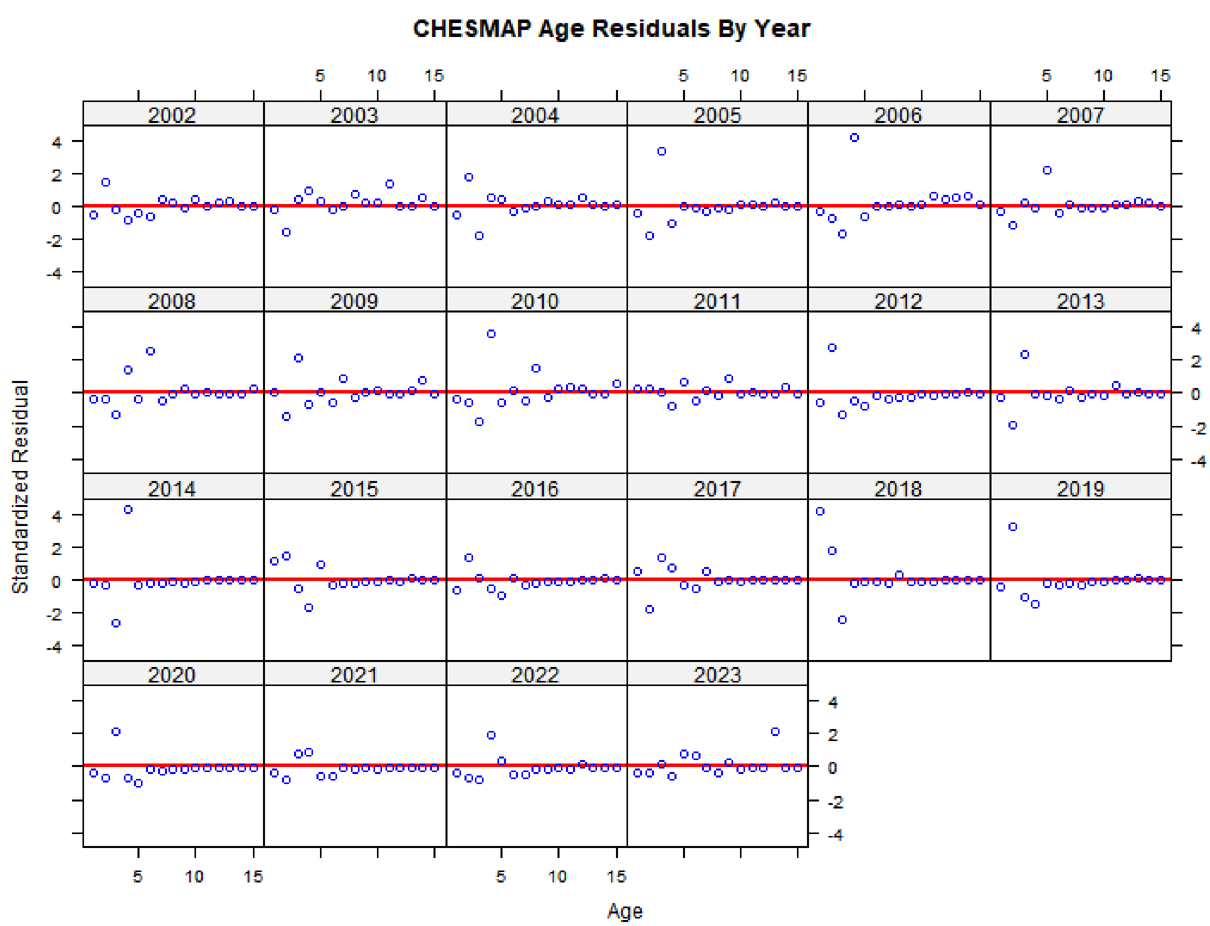


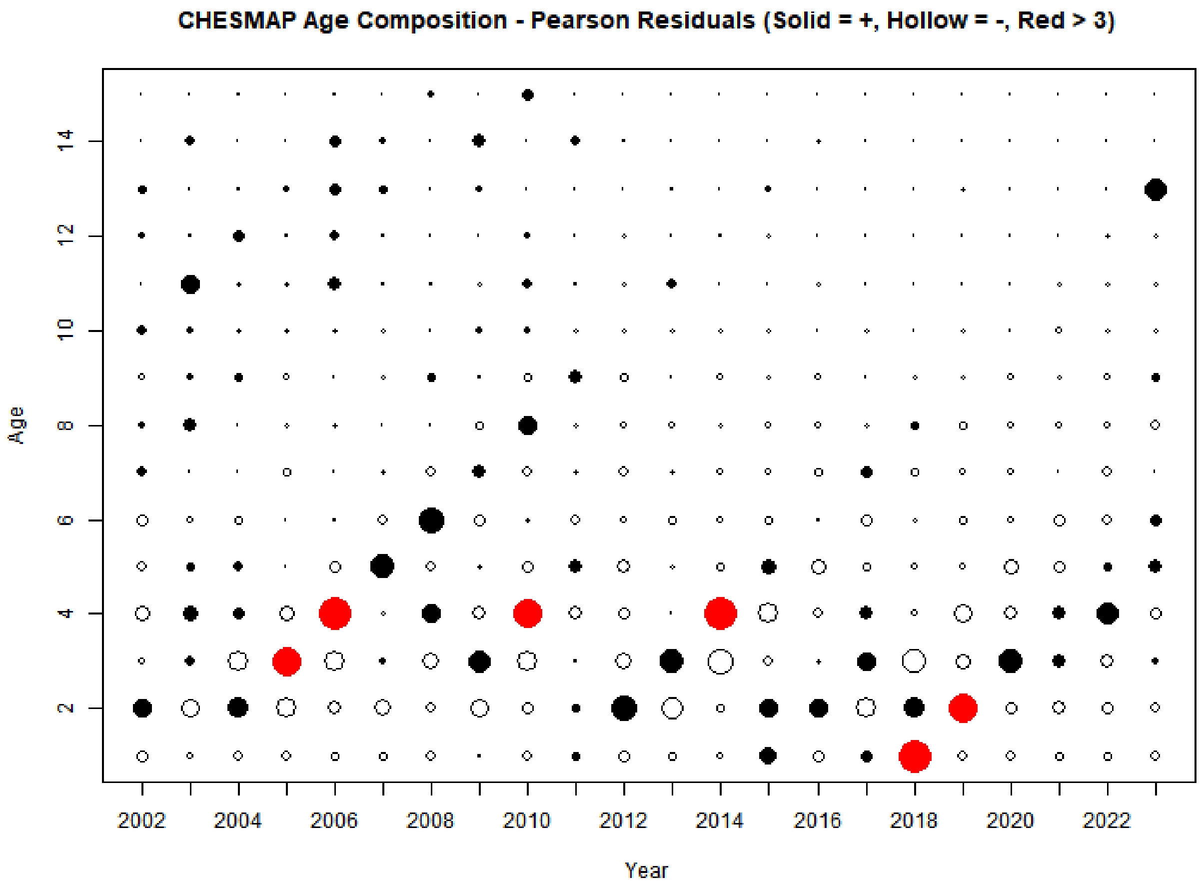
CHESMAP Age Composition By Age
Pred
Proportion
Year

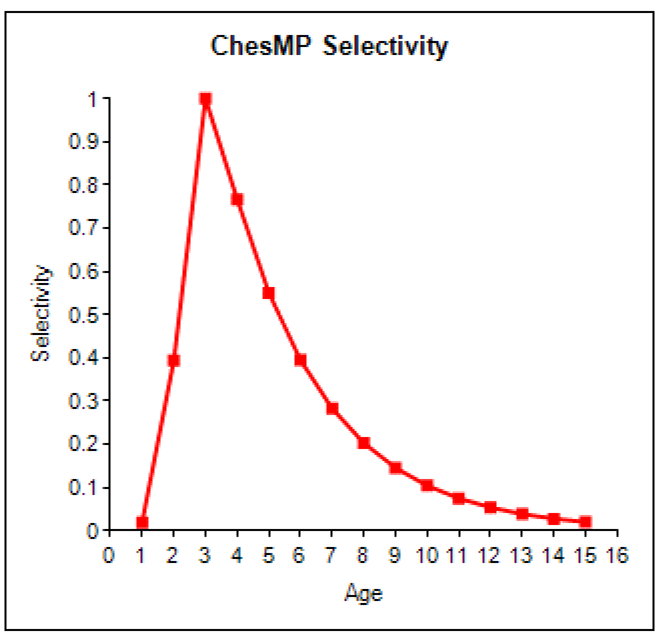


CHESMAP Age Composition By Year
Pred
Proportion
Age


CHESMAP Age Residuals By Age
Standardized Residual
Year


CHESMAP Age Residuals By Year
Standardized Residual
Age


CHESMAP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2
4
6
8
10
12
14


ChesMP Selectivity
Selectivity
Age
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Results and Projections

Table X2. Comparison of RMSE, CV weights and effective sample sizes from the 2024 Base and 2024 Alternate Assessment.

2024 Base Update Assessment

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.00932	2.97	
NJYOY	40	1.01128	1.63	
MDYOY	12	1.0054	1.96	
compos	42	1.01242	1.00	
NYAge1	39	1.00882	1.19	
MDAge1	54	1.00057	3.25	
NYOHS	20	0.996985	2.55	21.34
NJTRAWL	31	0.999935	5.85	2.98
MDSSN	39	1.00736	2.40	15.57
DESSN	26	1.00552	1.42	19.45
MRIP	42	0.994992	2.27	27.47
CTLIST	36	1.00365	3.05	7.22
DE30FT	23	0.998003	0.85	5.62
ChesMP	22	0.995453	3.40	6.10

2024 Alternate Run

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.01062	2.97	
NJYOY	40	1.00465	1.63	
MDYOY	12	0.99246	1.92	
compos	42	1.002	1	
NYAge1	39	1.00667	1.19	
MDAge1	54	0.998896	3.25	
NYOHS	20	0.989164	2.55	21.31
NJTRAWL	31	1.00093	5.85	2.99
MDSSN	39	1.00337	2.4	15.61
DESSN	26	1.0164	1.42	19.39
MRIP	42	0.995036	2.25	27.82
CTLIST	36	1.00515	3.05	7.21
DE30FT	23	1.00116	0.85	5.44
ChesMP	22	0.992707	3.4	6.04

Table X3. Summary of likelihood component values.

	Likelihood Weight	RSS
Fleet 1 Total Catch:	2	0.216277
Fleet 2 Total Catch:	2	1.80129
Aggregate Abundance Indices		
NYYOY	1	30.7946
NJYOY	1	32.1672
MDYOY	1	10.3112
Composite	1	40.0734
NYAge1	1	34.3205
MDAge1	1	26.5649
Age Comp Abundance Indices		
NYOHS	1	18.6032
NJTrawl	1	6.56288
MDSSN	1	33.5359
DESSN	1	23.7251
MRIP	1	36.8262
CTLIST	1	29.1962
DE30FT	1	18.6787
CHESMAP	1	13.862
Total RSS		357.24
No. of Obs		548
Conc. Likel.		-117.236
Age Composition Data		
Fleet 1 Age Comp	1	7028.36
Fleet 2 Age Comp	1	6137.48
NYOHS	1	710.515
NJTrawl	1	169.297
MDSSN	1	1243.94
DESSN	1	1155.37
MRIP	1	2516.32
CTLIST	1	463.009
DE30FT	1	234.301
CHESMAP	1	233.231
Recr Devs	1	41.6345
Total Likelihood		19743.3
AIC		39882.5

Table X4. Estimates of Bay and Ocean fully-recruited fishing mortality and total fully-recruited fishing mortality with associated standard errors.

	Bay			Ocean			Total		
	Fully-recruited			Fully-recruited			Fully-recruited		
Year	F	SD	CV	F	SD	CV	F	SD	CV
1982	0.059	0.014	0.240	0.182	0.003	0.019	0.183	0.030	0.161
1983	0.063	0.029	0.461	0.147	0.012	0.084	0.148	0.040	0.269
1984	0.060	0.008	0.132	0.061	0.004	0.060	0.073	0.014	0.189
1985	0.004	0.040	11.075	0.196	0.016	0.082	0.196	0.071	0.364
1986	0.006	0.013	2.259	0.053	0.004	0.072	0.054	0.014	0.262
1987	0.002	0.012	4.844	0.031	0.015	0.494	0.031	0.007	0.216
1988	0.004	0.001	0.132	0.036	0.005	0.125	0.037	0.008	0.213
1989	0.005	0.071	15.619	0.047	0.018	0.371	0.048	0.009	0.191
1990	0.040	0.002	0.048	0.064	0.004	0.059	0.065	0.012	0.180
1991	0.044	0.014	0.319	0.091	0.013	0.148	0.092	0.016	0.175
1992	0.049	0.001	0.013	0.109	0.003	0.027	0.111	0.019	0.171
1993	0.042	0.007	0.161	0.086	0.015	0.173	0.087	0.014	0.159
1994	0.054	0.001	0.017	0.112	0.004	0.036	0.113	0.017	0.151
1995	0.079	0.008	0.099	0.204	0.013	0.064	0.206	0.033	0.159
1996	0.055	0.001	0.018	0.236	0.007	0.028	0.265	0.038	0.142
1997	0.059	0.009	0.154	0.164	0.016	0.097	0.200	0.014	0.068
1998	0.052	0.005	0.103	0.178	0.005	0.026	0.208	0.015	0.072
1999	0.053	0.012	0.217	0.163	0.016	0.100	0.194	0.013	0.069
2000	0.057	0.007	0.122	0.160	0.006	0.040	0.194	0.013	0.067
2001	0.045	0.016	0.350	0.166	0.017	0.100	0.192	0.013	0.066
2002	0.050	0.005	0.102	0.178	0.006	0.031	0.207	0.013	0.065
2003	0.065	0.019	0.290	0.184	0.025	0.134	0.222	0.014	0.061
2004	0.063	0.004	0.062	0.210	0.008	0.039	0.247	0.017	0.069
2005	0.056	0.014	0.246	0.211	0.020	0.094	0.244	0.017	0.068
2006	0.077	0.005	0.060	0.244	0.006	0.024	0.289	0.019	0.065
2007	0.058	0.017	0.291	0.181	0.018	0.098	0.216	0.014	0.067
2008	0.051	0.006	0.124	0.200	0.009	0.044	0.229	0.016	0.069
2009	0.068	0.033	0.478	0.183	0.020	0.111	0.224	0.014	0.064
2010	0.072	0.004	0.049	0.221	0.006	0.029	0.263	0.017	0.066
2011	0.070	0.036	0.522	0.228	0.026	0.114	0.268	0.018	0.065
2012	0.080	0.003	0.040	0.218	0.005	0.023	0.266	0.019	0.070
2013	0.087	0.012	0.140	0.314	0.019	0.062	0.364	0.027	0.074
2014	0.100	0.003	0.027	0.224	0.004	0.017	0.286	0.022	0.077
2015	0.084	0.014	0.163	0.197	0.018	0.090	0.248	0.020	0.082
2016	0.112	0.003	0.024	0.217	0.005	0.025	0.287	0.024	0.082
2017	0.079	0.012	0.158	0.275	0.018	0.065	0.321	0.029	0.090
2018	0.066	0.003	0.049	0.196	0.005	0.024	0.235	0.021	0.090
2019	0.053	0.012	0.223	0.177	0.018	0.103	0.208	0.019	0.092
2020	0.061	0.002	0.039	0.110	0.005	0.047	0.154	0.015	0.098
2021	0.051	0.012	0.224	0.120	0.027	0.228	0.156	0.020	0.131
2022	0.051	0.003	0.055	0.180	0.005	0.027	0.216	0.029	0.136
2023	0.049	0.012	0.246	0.149	0.022	0.151	0.183	0.024	0.133

Table X4 cont.

Year	Recruitment	SD	CV
1982	38296700	3654460	0.095
1983	77301100	6167490	0.080
1984	63603600	5047760	0.079
1985	69323200	5215200	0.075
1986	68551600	5141120	0.075
1987	73855100	5382970	0.073
1988	93137700	6438600	0.069
1989	107221000	7324070	0.068
1990	131811000	8541010	0.065
1991	105317000	7693570	0.073
1992	109903000	8167730	0.074
1993	134808000	9302590	0.069
1994	286886000	14658400	0.051
1995	187595000	11521500	0.061
1996	234759000	13265600	0.057
1997	259536000	13803100	0.053
1998	148101000	9952600	0.067
1999	153117000	9938990	0.065
2000	124771000	8982140	0.072
2001	196937000	11333500	0.058
2002	222073000	11997600	0.054
2003	127874000	8798540	0.069
2004	304610000	13910500	0.046
2005	158237000	9633660	0.061
2006	136369000	8712020	0.064
2007	89174400	6734280	0.076
2008	129419000	8190850	0.063
2009	76363900	6033890	0.079
2010	99619400	7126830	0.072
2011	128567000	8405000	0.065
2012	200280000	11453200	0.057
2013	68928800	6110650	0.089
2014	85838800	6954950	0.081
2015	157070000	11041100	0.070
2016	229985000	15528700	0.068
2017	111203000	9427490	0.085
2018	129634000	11108600	0.086
2019	164809000	14493500	0.088
2020	124284000	12813500	0.103
2021	86716700	11651300	0.134
2022	76653000	10730500	0.140
2023	94898600	15356800	0.162

Catch Selectivity Parameters

Bay				Ocean			
	Estimate	SD	CV		Estimate	SD	CV
1982-1984				1982-1984			
α	-5.449	0.188	0.03	α	3.481	0.205	0.06
β	2.554	0.041	0.02	β	0.836	0.094	0.11
ϒ	0.831	0.020	0.02	1985-1989			
1985-1989				α	4.951	0.448	0.09
α	-3.934	0.473	0.12	β	0.446	0.052	0.12
β	2.286	0.085	0.04				
ϒ	0.959	0.013	0.01	1990-1996			
1990-1995				α	6.257	0.570	0.09
α	-2.062	0.096	0.05	β	0.340	0.037	0.11
β	4.470	0.180	0.04				
ϒ	0.815	0.032	0.04	1997-2019			
1996-2019				α	4.807	0.175	0.04
α	-1.815	0.063	0.03	β	0.464	0.025	0.05
β	3.623	0.084	0.02				
ϒ	0.962	0.009	0.01	2020-2023			
2020-2023				α	-1.167	0.136	0.12
α	-1.745	0.109	0.06	β	5.069	0.717	0.14
β	4.471	0.220	0.05	ϒ	0.936	0.070	0.07
ϒ	0.805	0.039	0.05				

Survey Selectivity Parameters

NYOHS	Estimate	SD	CV
α	-3.027	0.511	0.17
β	2.620	0.154	0.06
ϒ	0.917	0.026	0.03
NJ Trawl			
α	1.434	0.739	0.51
β	0.236	0.156	0.66
MDSSN			
s_2	0.140	0.021	0.15
DE SSN			
α	3.763	0.237	0.06
β	0.647	0.087	0.13
MRIP			
α	2.576	0.076	0.03
β	1.064	0.064	0.06
CTLIST			
α	-2.805	0.393	0.14
β	2.163	0.160	0.07
ϒ	0.964	0.017	0.02
DE30FT			
α	-0.993	0.736	0.74
β	1.495	1.239	0.83
ϒ	0.890	0.162	0.18
ChesMap			
α	-3.659	0.598	0.16
β	2.282	0.139	0.06
ϒ	0.909	0.027	0.03

Catchability Coefficients

Survey	Estimate	SD	CV
NYYOY	1.27E-07	1.24E-08	0.10
NJYOY	8.13E-09	4.94E-10	0.06
MDYOY	1.32E-07	2.02E-08	0.15
compos	1.04E-06	4.62E-08	0.04
NYAge1	2.42E-08	1.77E-09	0.07
MDAge1	8.00E-09	1.31E-09	0.16
NYOHS	8.78E-08	8.11E-09	0.09
NJTRAWL	9.26E-08	2.70E-08	0.29
MDSSN	7.60E-08	6.35E-09	0.08
DESSN	4.14E-08	5.39E-09	0.13
MRIP	4.32E-08	2.92E-09	0.07
CTLIST	7.90E-09	7.35E-10	0.09
DE30FT	2.63E-08	4.53E-09	0.17
ChesMP	2.43E-06	4.34E-07	0.18

Table X5. Region-specific and total fishing mortality-at-age, 1982-2021

Bay Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0076	0.0595	0.0257	0.0102	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1983	0.0001	0.0081	0.0634	0.0274	0.0109	0.0043	0.0017	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0014
1984	0.0001	0.0076	0.0598	0.0259	0.0103	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1985	0.0000	0.0011	0.0036	0.0032	0.0028	0.0023	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009	0.0008	0.0006	0.0005
1986	0.0001	0.0018	0.0059	0.0053	0.0045	0.0038	0.0033	0.0028	0.0024	0.0020	0.0017	0.0015	0.0012	0.0010	0.0009
1987	0.0000	0.0008	0.0024	0.0022	0.0019	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004
1988	0.0000	0.0014	0.0045	0.0040	0.0034	0.0029	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1989	0.0000	0.0014	0.0046	0.0041	0.0035	0.0030	0.0025	0.0022	0.0018	0.0016	0.0013	0.0011	0.0010	0.0008	0.0007
1990	0.0002	0.0010	0.0053	0.0215	0.0399	0.0349	0.0247	0.0169	0.0116	0.0079	0.0054	0.0037	0.0025	0.0017	0.0012
1991	0.0002	0.0011	0.0058	0.0236	0.0439	0.0384	0.0272	0.0186	0.0127	0.0087	0.0059	0.0040	0.0028	0.0019	0.0013
1992	0.0002	0.0013	0.0065	0.0265	0.0492	0.0430	0.0305	0.0209	0.0143	0.0097	0.0067	0.0045	0.0031	0.0021	0.0014
1993	0.0002	0.0011	0.0055	0.0225	0.0417	0.0365	0.0258	0.0177	0.0121	0.0083	0.0056	0.0039	0.0026	0.0018	0.0012
1994	0.0003	0.0014	0.0072	0.0292	0.0543	0.0475	0.0336	0.0230	0.0157	0.0107	0.0073	0.0050	0.0034	0.0023	0.0016
1995	0.0004	0.0020	0.0104	0.0423	0.0787	0.0688	0.0487	0.0334	0.0228	0.0156	0.0106	0.0073	0.0050	0.0034	0.0023
1996	0.0007	0.0036	0.0166	0.0421	0.0547	0.0545	0.0515	0.0482	0.0450	0.0420	0.0393	0.0367	0.0342	0.0320	0.0299
1997	0.0007	0.0039	0.0180	0.0456	0.0593	0.0591	0.0558	0.0522	0.0488	0.0455	0.0425	0.0397	0.0371	0.0346	0.0324
1998	0.0006	0.0034	0.0156	0.0397	0.0515	0.0514	0.0485	0.0454	0.0424	0.0396	0.0370	0.0345	0.0323	0.0301	0.0281
1999	0.0006	0.0035	0.0161	0.0409	0.0531	0.0530	0.0500	0.0468	0.0437	0.0408	0.0381	0.0356	0.0333	0.0311	0.0290
2000	0.0007	0.0038	0.0172	0.0439	0.0569	0.0568	0.0536	0.0502	0.0469	0.0438	0.0409	0.0382	0.0356	0.0333	0.0311
2001	0.0006	0.0030	0.0138	0.0350	0.0454	0.0453	0.0428	0.0400	0.0374	0.0349	0.0326	0.0305	0.0285	0.0266	0.0248
2002	0.0006	0.0033	0.0151	0.0384	0.0498	0.0497	0.0469	0.0439	0.0410	0.0383	0.0358	0.0334	0.0312	0.0291	0.0272
2003	0.0008	0.0043	0.0196	0.0499	0.0647	0.0645	0.0609	0.0570	0.0533	0.0497	0.0465	0.0434	0.0405	0.0378	0.0353
2004	0.0008	0.0042	0.0191	0.0486	0.0631	0.0629	0.0594	0.0556	0.0519	0.0485	0.0453	0.0423	0.0395	0.0369	0.0344
2005	0.0007	0.0037	0.0169	0.0430	0.0558	0.0557	0.0526	0.0492	0.0459	0.0429	0.0401	0.0374	0.0349	0.0326	0.0305
2006	0.0009	0.0051	0.0232	0.0590	0.0765	0.0763	0.0721	0.0674	0.0630	0.0588	0.0549	0.0513	0.0479	0.0447	0.0418
2007	0.0007	0.0039	0.0176	0.0448	0.0581	0.0579	0.0547	0.0512	0.0478	0.0447	0.0417	0.0390	0.0364	0.0340	0.0317
2008	0.0006	0.0034	0.0154	0.0391	0.0507	0.0506	0.0478	0.0447	0.0418	0.0390	0.0364	0.0340	0.0318	0.0297	0.0277
2009	0.0008	0.0045	0.0206	0.0525	0.0681	0.0679	0.0641	0.0600	0.0561	0.0524	0.0489	0.0457	0.0426	0.0398	0.0372
2010	0.0009	0.0048	0.0217	0.0552	0.0717	0.0715	0.0675	0.0632	0.0590	0.0551	0.0515	0.0481	0.0449	0.0419	0.0391
2011	0.0008	0.0046	0.0211	0.0536	0.0696	0.0695	0.0656	0.0614	0.0573	0.0535	0.0500	0.0467	0.0436	0.0407	0.0380
2012	0.0010	0.0053	0.0243	0.0618	0.0802	0.0800	0.0755	0.0706	0.0660	0.0616	0.0576	0.0538	0.0502	0.0469	0.0438
2013	0.0011	0.0058	0.0265	0.0673	0.0874	0.0871	0.0823	0.0770	0.0719	0.0672	0.0627	0.0586	0.0547	0.0511	0.0477
2014	0.0012	0.0067	0.0304	0.0774	0.1005	0.1002	0.0946	0.0885	0.0827	0.0772	0.0721	0.0673	0.0629	0.0587	0.0548
2015	0.0010	0.0055	0.0253	0.0643	0.0835	0.0833	0.0787	0.0736	0.0687	0.0642	0.0600	0.0560	0.0523	0.0488	0.0456
2016	0.0014	0.0075	0.0341	0.0866	0.1124	0.1121	0.1059	0.0991	0.0925	0.0864	0.0807	0.0754	0.0704	0.0657	0.0614
2017	0.0010	0.0052	0.0238	0.0605	0.0786	0.0783	0.0740	0.0692	0.0646	0.0604	0.0564	0.0527	0.0492	0.0459	0.0429
2018	0.0008	0.0044	0.0200	0.0508	0.0660	0.0658	0.0621	0.0581	0.0543	0.0507	0.0474	0.0442	0.0413	0.0386	0.0360
2019	0.0006	0.0035	0.0160	0.0407	0.0528	0.0527	0.0497	0.0465	0.0435	0.0406	0.0379	0.0354	0.0331	0.0309	0.0288
2020	0.0008	0.0031	0.0120	0.0366	0.0610	0.0567	0.0426	0.0306	0.0218	0.0155	0.0111	0.0079	0.0056	0.0040	0.0028
2021	0.0007	0.0026	0.0101	0.0309	0.0515	0.0478	0.0360	0.0259	0.0184	0.0131	0.0093	0.0066	0.0047	0.0034	0.0024
2022	0.0007	0.0026	0.0101	0.0307	0.0513	0.0476	0.0358	0.0257	0.0184	0.0131	0.0093	0.0066	0.0047	0.0034	0.0024
2023	0.0006	0.0025	0.0096	0.0293	0.0488	0.0454	0.0341	0.0245	0.0175	0.0124	0.0089	0.0063	0.0045	0.0032	0.0023

Table X5 cont.

Ocean Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0058	0.0407	0.0950	0.1371	0.1608	0.1722	0.1775	0.1798	0.1808	0.1812	0.1814	0.1815	0.1815	0.1816
1983	0.0001	0.0047	0.0329	0.0768	0.1109	0.1300	0.1393	0.1436	0.1454	0.1462	0.1466	0.1468	0.1468	0.1468	0.1469
1984	0.0000	0.0019	0.0136	0.0318	0.0459	0.0538	0.0576	0.0594	0.0601	0.0605	0.0606	0.0607	0.0607	0.0607	0.0607
1985	0.0006	0.0047	0.0182	0.0429	0.0745	0.1059	0.1327	0.1533	0.1681	0.1783	0.1852	0.1897	0.1927	0.1946	0.1958
1986	0.0002	0.0013	0.0049	0.0116	0.0201	0.0286	0.0359	0.0414	0.0454	0.0482	0.0500	0.0513	0.0521	0.0526	0.0529
1987	0.0001	0.0008	0.0029	0.0068	0.0118	0.0168	0.0211	0.0243	0.0267	0.0283	0.0294	0.0301	0.0306	0.0309	0.0311
1988	0.0001	0.0009	0.0034	0.0080	0.0138	0.0196	0.0246	0.0284	0.0312	0.0330	0.0343	0.0352	0.0357	0.0361	0.0363
1989	0.0001	0.0012	0.0044	0.0104	0.0180	0.0256	0.0321	0.0371	0.0407	0.0432	0.0448	0.0459	0.0466	0.0471	0.0474
1990	0.0002	0.0010	0.0033	0.0078	0.0145	0.0225	0.0308	0.0386	0.0452	0.0506	0.0549	0.0582	0.0606	0.0624	0.0637
1991	0.0002	0.0014	0.0046	0.0111	0.0206	0.0320	0.0439	0.0549	0.0644	0.0721	0.0782	0.0828	0.0863	0.0888	0.0907
1992	0.0003	0.0016	0.0056	0.0134	0.0248	0.0386	0.0529	0.0661	0.0776	0.0869	0.0942	0.0998	0.1039	0.1070	0.1092
1993	0.0002	0.0013	0.0044	0.0105	0.0195	0.0303	0.0415	0.0519	0.0609	0.0682	0.0740	0.0783	0.0816	0.0840	0.0858
1994	0.0003	0.0017	0.0057	0.0137	0.0254	0.0395	0.0541	0.0677	0.0794	0.0889	0.0964	0.1021	0.1064	0.1095	0.1118
1995	0.0006	0.0031	0.0104	0.0249	0.0463	0.0720	0.0986	0.1233	0.1446	0.1619	0.1755	0.1859	0.1937	0.1994	0.2036
1996	0.0006	0.0035	0.0121	0.0288	0.0535	0.0832	0.1140	0.1426	0.1672	0.1873	0.2031	0.2151	0.2241	0.2307	0.2355
1997	0.0005	0.0042	0.0164	0.0387	0.0665	0.0934	0.1156	0.1322	0.1438	0.1516	0.1568	0.1601	0.1622	0.1636	0.1644
1998	0.0005	0.0045	0.0178	0.0420	0.0720	0.1012	0.1252	0.1432	0.1558	0.1643	0.1699	0.1735	0.1758	0.1772	0.1781
1999	0.0005	0.0041	0.0162	0.0384	0.0659	0.0925	0.1146	0.1310	0.1425	0.1503	0.1554	0.1587	0.1608	0.1621	0.1630
2000	0.0005	0.0041	0.0159	0.0376	0.0645	0.0906	0.1122	0.1283	0.1396	0.1472	0.1522	0.1554	0.1575	0.1588	0.1596
2001	0.0005	0.0042	0.0165	0.0390	0.0670	0.0941	0.1165	0.1332	0.1449	0.1528	0.1580	0.1613	0.1635	0.1648	0.1657
2002	0.0005	0.0045	0.0178	0.0420	0.0721	0.1013	0.1253	0.1433	0.1560	0.1644	0.1700	0.1736	0.1759	0.1774	0.1783
2003	0.0005	0.0047	0.0183	0.0432	0.0742	0.1043	0.1291	0.1476	0.1606	0.1693	0.1751	0.1788	0.1812	0.1827	0.1836
2004	0.0006	0.0053	0.0210	0.0495	0.0850	0.1194	0.1478	0.1690	0.1838	0.1938	0.2004	0.2046	0.2074	0.2091	0.2102
2005	0.0006	0.0054	0.0211	0.0498	0.0855	0.1201	0.1486	0.1700	0.1849	0.1950	0.2016	0.2058	0.2086	0.2103	0.2114
2006	0.0007	0.0062	0.0243	0.0575	0.0987	0.1387	0.1717	0.1963	0.2136	0.2252	0.2328	0.2378	0.2409	0.2429	0.2442
2007	0.0005	0.0046	0.0181	0.0427	0.0733	0.1030	0.1275	0.1458	0.1586	0.1673	0.1729	0.1766	0.1789	0.1804	0.1813
2008	0.0006	0.0051	0.0199	0.0471	0.0808	0.1135	0.1405	0.1607	0.1749	0.1844	0.1906	0.1947	0.1972	0.1989	0.1999
2009	0.0005	0.0046	0.0182	0.0431	0.0740	0.1039	0.1286	0.1471	0.1600	0.1687	0.1745	0.1781	0.1805	0.1820	0.1829
2010	0.0006	0.0056	0.0220	0.0520	0.0893	0.1254	0.1553	0.1775	0.1932	0.2037	0.2106	0.2150	0.2179	0.2197	0.2208
2011	0.0007	0.0058	0.0227	0.0536	0.0920	0.1292	0.1600	0.1829	0.1990	0.2099	0.2170	0.2216	0.2245	0.2264	0.2276
2012	0.0006	0.0055	0.0218	0.0515	0.0883	0.1241	0.1536	0.1756	0.1911	0.2015	0.2083	0.2127	0.2155	0.2173	0.2184
2013	0.0009	0.0080	0.0313	0.0738	0.1268	0.1781	0.2204	0.2521	0.2743	0.2892	0.2990	0.3053	0.3093	0.3119	0.3135
2014	0.0006	0.0057	0.0223	0.0527	0.0905	0.1271	0.1573	0.1799	0.1958	0.2064	0.2134	0.2179	0.2208	0.2226	0.2238
2015	0.0006	0.0050	0.0196	0.0463	0.0795	0.1117	0.1383	0.1582	0.1721	0.1814	0.1876	0.1915	0.1941	0.1957	0.1967
2016	0.0006	0.0055	0.0216	0.0510	0.0876	0.1230	0.1523	0.1742	0.1895	0.1998	0.2066	0.2109	0.2137	0.2155	0.2166
2017	0.0008	0.0070	0.0274	0.0648	0.1113	0.1563	0.1935	0.2213	0.2407	0.2538	0.2624	0.2680	0.2715	0.2738	0.2752
2018	0.0006	0.0050	0.0196	0.0463	0.0794	0.1115	0.1381	0.1579	0.1718	0.1812	0.1873	0.1913	0.1938	0.1954	0.1964
2019	0.0005	0.0045	0.0177	0.0417	0.0717	0.1006	0.1246	0.1425	0.1550	0.1635	0.1690	0.1726	0.1749	0.1763	0.1772
2020	0.0016	0.0047	0.0134	0.0337	0.0674	0.0975	0.1096	0.1089	0.1033	0.0966	0.0899	0.0835	0.0776	0.0720	0.0669
2021	0.0018	0.0052	0.0146	0.0369	0.0738	0.1068	0.1200	0.1192	0.1132	0.1058	0.0985	0.0915	0.0850	0.0789	0.0732
2022	0.0027	0.0078	0.0220	0.0556	0.1110	0.1606	0.1805	0.1793	0.1702	0.1591	0.1481	0.1376	0.1278	0.1186	0.1101
2023	0.0022	0.0064	0.0181	0.0458	0.0914	0.1323	0.1487	0.1477	0.1402	0.1311	0.1220	0.1133	0.1053	0.0977	0.0907

Table X5 cont.

Total Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0002	0.0133	0.1002	0.1207	0.1473	0.1648	0.1739	0.1781	0.1800	0.1809	0.1813	0.1814	0.1815	0.1816	0.1829
1983	0.0001	0.0127	0.0963	0.1042	0.1218	0.1344	0.1410	0.1442	0.1457	0.1463	0.1466	0.1468	0.1468	0.1469	0.1483
1984	0.0001	0.0095	0.0734	0.0576	0.0561	0.0579	0.0592	0.0600	0.0604	0.0606	0.0607	0.0607	0.0607	0.0607	0.0621
1985	0.0006	0.0058	0.0218	0.0462	0.0772	0.1082	0.1347	0.1550	0.1695	0.1795	0.1862	0.1906	0.1934	0.1952	0.1964
1986	0.0002	0.0031	0.0108	0.0169	0.0246	0.0324	0.0391	0.0442	0.0478	0.0502	0.0517	0.0527	0.0533	0.0536	0.0538
1987	0.0001	0.0015	0.0053	0.0090	0.0137	0.0184	0.0224	0.0255	0.0277	0.0291	0.0301	0.0307	0.0311	0.0313	0.0315
1988	0.0002	0.0023	0.0079	0.0120	0.0172	0.0225	0.0271	0.0305	0.0329	0.0346	0.0356	0.0363	0.0366	0.0369	0.0370
1989	0.0002	0.0025	0.0090	0.0145	0.0215	0.0286	0.0347	0.0393	0.0425	0.0447	0.0461	0.0470	0.0476	0.0479	0.0481
1990	0.0004	0.0020	0.0085	0.0293	0.0544	0.0574	0.0555	0.0555	0.0568	0.0585	0.0603	0.0618	0.0631	0.0641	0.0648
1991	0.0005	0.0025	0.0104	0.0347	0.0645	0.0704	0.0710	0.0735	0.0771	0.0808	0.0841	0.0868	0.0890	0.0907	0.0920
1992	0.0005	0.0029	0.0121	0.0399	0.0741	0.0817	0.0833	0.0870	0.0918	0.0966	0.1008	0.1043	0.1070	0.1091	0.1107
1993	0.0004	0.0024	0.0099	0.0329	0.0612	0.0668	0.0673	0.0696	0.0730	0.0765	0.0796	0.0822	0.0842	0.0858	0.0870
1994	0.0006	0.0031	0.0129	0.0429	0.0797	0.0870	0.0877	0.0907	0.0951	0.0997	0.1037	0.1071	0.1098	0.1118	0.1134
1995	0.0009	0.0051	0.0208	0.0672	0.1250	0.1407	0.1472	0.1567	0.1674	0.1775	0.1862	0.1932	0.1987	0.2028	0.2059
1996	0.0013	0.0072	0.0286	0.0709	0.1082	0.1378	0.1655	0.1908	0.2122	0.2293	0.2423	0.2517	0.2583	0.2626	0.2654
1997	0.0012	0.0081	0.0343	0.0844	0.1257	0.1525	0.1714	0.1844	0.1926	0.1972	0.1993	0.1998	0.1993	0.1982	0.1968
1998	0.0011	0.0079	0.0334	0.0817	0.1236	0.1526	0.1738	0.1886	0.1982	0.2039	0.2069	0.2080	0.2080	0.2073	0.2063
1999	0.0011	0.0077	0.0323	0.0793	0.1190	0.1455	0.1646	0.1778	0.1863	0.1911	0.1935	0.1943	0.1940	0.1932	0.1920
2000	0.0012	0.0078	0.0332	0.0814	0.1215	0.1474	0.1658	0.1785	0.1865	0.1910	0.1930	0.1936	0.1931	0.1920	0.1907
2001	0.0010	0.0072	0.0303	0.0740	0.1124	0.1394	0.1593	0.1732	0.1823	0.1877	0.1906	0.1918	0.1919	0.1914	0.1905
2002	0.0011	0.0078	0.0329	0.0804	0.1219	0.1509	0.1722	0.1872	0.1969	0.2027	0.2058	0.2070	0.2071	0.2065	0.2055
2003	0.0013	0.0090	0.0379	0.0931	0.1390	0.1688	0.1900	0.2046	0.2139	0.2191	0.2215	0.2222	0.2217	0.2205	0.2189
2004	0.0014	0.0095	0.0401	0.0981	0.1481	0.1823	0.2072	0.2245	0.2358	0.2423	0.2457	0.2469	0.2468	0.2460	0.2446
2005	0.0013	0.0091	0.0380	0.0928	0.1413	0.1757	0.2012	0.2191	0.2308	0.2379	0.2416	0.2433	0.2435	0.2429	0.2419
2006	0.0016	0.0113	0.0475	0.1165	0.1753	0.2150	0.2437	0.2637	0.2766	0.2840	0.2878	0.2891	0.2888	0.2877	0.2860
2007	0.0012	0.0085	0.0357	0.0875	0.1314	0.1609	0.1822	0.1970	0.2064	0.2119	0.2146	0.2155	0.2153	0.2144	0.2131
2008	0.0012	0.0084	0.0353	0.0862	0.1316	0.1641	0.1883	0.2054	0.2166	0.2234	0.2270	0.2287	0.2290	0.2285	0.2276
2009	0.0014	0.0092	0.0389	0.0956	0.1421	0.1718	0.1928	0.2071	0.2161	0.2211	0.2233	0.2238	0.2231	0.2218	0.2201
2010	0.0015	0.0104	0.0437	0.1072	0.1610	0.1969	0.2228	0.2407	0.2522	0.2588	0.2620	0.2631	0.2628	0.2616	0.2600
2011	0.0015	0.0104	0.0438	0.1072	0.1616	0.1987	0.2256	0.2443	0.2564	0.2634	0.2670	0.2683	0.2681	0.2671	0.2656
2012	0.0016	0.0109	0.0461	0.1132	0.1685	0.2040	0.2291	0.2463	0.2571	0.2631	0.2659	0.2665	0.2657	0.2642	0.2622
2013	0.0020	0.0138	0.0577	0.1412	0.2142	0.2652	0.3027	0.3291	0.3462	0.3563	0.3617	0.3639	0.3640	0.3630	0.3612
2014	0.0019	0.0123	0.0527	0.1301	0.1909	0.2273	0.2519	0.2684	0.2784	0.2836	0.2855	0.2853	0.2837	0.2814	0.2786
2015	0.0016	0.0105	0.0449	0.1107	0.1631	0.1950	0.2169	0.2317	0.2408	0.2456	0.2475	0.2475	0.2464	0.2445	0.2423
2016	0.0020	0.0130	0.0556	0.1376	0.2000	0.2351	0.2582	0.2732	0.2820	0.2862	0.2873	0.2863	0.2841	0.2812	0.2780
2017	0.0017	0.0122	0.0512	0.1253	0.1898	0.2346	0.2674	0.2905	0.3054	0.3142	0.3188	0.3206	0.3207	0.3197	0.3181
2018	0.0014	0.0094	0.0396	0.0971	0.1454	0.1773	0.2002	0.2160	0.2261	0.2319	0.2346	0.2355	0.2351	0.2340	0.2324
2019	0.0012	0.0080	0.0337	0.0824	0.1245	0.1533	0.1743	0.1890	0.1985	0.2041	0.2069	0.2080	0.2079	0.2072	0.2061
2020	0.0024	0.0079	0.0254	0.0703	0.1284	0.1542	0.1522	0.1395	0.1252	0.1122	0.1010	0.0914	0.0832	0.0760	0.0697
2021	0.0024	0.0078	0.0247	0.0678	0.1252	0.1546	0.1560	0.1451	0.1316	0.1189	0.1078	0.0981	0.0897	0.0822	0.0756
2022	0.0033	0.0104	0.0321	0.0863	0.1622	0.2082	0.2163	0.2050	0.1885	0.1722	0.1574	0.1442	0.1325	0.1220	0.1125
2023	0.0028	0.0089	0.0277	0.0750	0.1402	0.1777	0.1828	0.1722	0.1577	0.1435	0.1308	0.1196	0.1097	0.1009	0.0930

Table X6. Estimates of age-specific population abundance, 1982-2023

	Age																
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	8+
1982	38,296,700	8,340,660	3,115,980	2,426,610	963,810	401,321	330,477	216,139	186,669	274,688	192,524	317,028	149,222	107,118	271,568	55,590,514	1,714,956
1983	77,301,100	12,369,200	4,169,560	1,797,470	1,546,240	647,793	281,447	239,054	155,683	134,197	197,304	138,235	227,592	107,118	271,568	99,583,561	1,470,751
1984	63,603,600	24,967,300	6,187,210	2,414,570	1,164,360	1,066,130	468,347	210,378	178,120	115,831	99,780	146,659	102,739	169,141	281,139	101,175,304	1,303,787
1985	69,323,200	20,543,900	12,528,700	3,665,860	1,638,700	857,300	832,081	379,925	170,528	144,325	93,837	80,826	118,796	83,219	364,422	110,825,618	1,435,877
1986	68,551,600	22,380,000	10,347,300	7,816,770	2,516,570	1,181,390	636,221	625,945	280,064	123,888	103,808	67,044	57,496	84,268	316,665	115,089,028	1,659,177
1987	73,855,100	22,139,800	11,303,200	6,526,960	5,525,510	1,912,230	945,774	526,600	515,473	229,810	101,413	84,844	54,743	46,919	327,025	124,095,401	1,886,827
1988	93,137,700	23,854,900	11,199,600	7,168,980	4,650,280	4,244,760	1,552,510	795,995	441,849	431,571	192,121	84,700	70,817	45,675	311,899	148,183,357	2,374,627
1989	107,221,000	30,082,100	12,058,200	7,085,350	5,092,510	3,559,770	3,431,990	1,300,570	664,531	367,979	358,835	159,575	70,306	58,760	296,602	171,808,078	3,277,158
1990	131,811,000	34,629,800	15,201,400	7,619,980	5,020,450	3,881,590	2,860,740	2,853,350	1,076,320	548,160	302,872	294,925	131,036	57,700	291,511	206,580,834	5,555,874
1991	105,317,000	42,563,900	17,509,300	9,610,570	5,320,270	3,703,030	3,030,900	2,329,310	2,323,360	875,273	444,983	245,433	238,626	105,888	281,733	193,899,576	6,844,606
1992	109,903,000	34,005,600	21,510,000	11,048,600	6,673,720	3,884,710	2,854,100	2,429,860	1,862,780	1,851,380	694,893	352,112	193,677	187,896	304,426	197,756,754	7,877,024
1993	134,808,000	35,483,600	17,177,800	13,550,600	7,632,850	4,826,460	2,960,610	2,260,120	1,917,080	1,462,640	1,446,750	540,734	273,050	149,781	379,574	224,869,649	8,429,729
1994	286,886,000	43,528,800	17,934,200	10,845,200	9,426,270	5,591,480	3,733,410	2,382,280	1,814,440	1,533,890	1,166,220	1,149,960	428,695	216,031	417,795	387,054,671	9,109,311
1995	187,595,000	92,621,500	21,984,800	11,289,000	7,469,600	6,778,730	4,238,710	2,943,530	1,872,610	1,420,010	1,195,010	904,883	889,256	330,622	487,318	342,020,579	10,043,239
1996	234,759,000	60,543,300	46,685,800	13,729,600	7,588,290	5,134,020	4,869,770	3,148,820	2,166,160	1,363,390	1,023,450	853,845	642,024	627,496	573,716	383,708,681	10,398,901
1997	259,536,000	75,736,800	30,453,100	28,928,700	9,194,840	5,303,680	3,699,220	3,552,200	2,239,550	1,507,950	933,003	691,345	571,367	426,812	794,049	423,568,616	10,716,276
1998	148,101,000	83,739,100	38,059,900	18,762,400	19,115,000	6,314,940	3,765,770	2,682,500	2,542,610	1,589,960	1,065,640	657,939	487,280	402,920	862,693	328,149,652	10,291,542
1999	153,117,000	47,787,400	42,088,100	23,471,800	12,431,100	13,156,400	4,483,340	2,724,240	1,911,960	1,794,920	1,116,050	745,814	459,946	340,639	885,983	306,514,692	9,979,552
2000	124,771,000	49,407,000	24,025,200	25,982,800	15,587,900	8,595,090	9,406,450	3,273,240	1,962,810	1,365,980	1,276,130	791,583	528,578	326,059	871,073	268,170,893	10,395,453
2001	196,937,000	40,258,900	24,835,300	14,819,600	17,218,600	10,751,400	6,133,630	6,859,180	2,356,830	1,402,040	971,340	905,555	561,425	375,065	851,196	325,237,061	14,282,631
2002	222,073,000	63,551,900	20,249,200	15,363,400	9,894,030	11,983,900	7,734,110	4,502,030	4,964,740	1,690,470	1,000,200	690,961	643,403	398,847	872,159	365,612,350	14,762,810
2003	127,874,000	71,657,000	31,945,400	12,494,100	10,192,300	6,821,200	8,521,970	5,603,520	3,213,330	3,509,300	1,188,020	700,782	483,519	450,197	890,486	285,545,124	16,039,154
2004	304,610,000	41,253,500	35,979,100	19,611,800	8,183,900	6,908,030	4,764,720	6,065,590	3,930,510	2,233,230	2,426,230	819,350	483,009	333,429	926,560	438,528,958	17,217,908
2005	158,237,000	98,264,700	20,701,700	22,040,600	12,782,000	5,496,480	4,760,860	3,333,710	4,170,720	2,672,520	1,508,510	1,633,380	550,916	324,795	848,863	337,326,754	15,043,414
2006	136,369,000	51,050,300	49,333,200	12,708,200	14,441,600	8,643,100	3,812,990	3,351,020	2,304,740	2,849,820	1,813,320	1,019,680	1,102,310	371,699	792,924	289,963,903	13,605,513
2007	89,174,400	43,980,000	25,573,000	29,996,600	8,131,870	9,439,080	5,764,880	2,572,010	2,215,620	1,504,410	1,846,370	1,170,450	657,328	710,764	752,687	223,489,469	11,429,639
2008	129,419,000	28,771,100	22,093,400	15,734,700	19,759,200	5,553,150	6,645,480	4,135,400	1,817,940	1,551,300	1,047,590	1,282,230	812,096	456,184	1,017,250	240,096,020	12,119,990
2009	76,363,900	41,756,900	14,453,400	13,598,900	10,378,100	13,491,400	3,897,170	4,738,050	2,898,430	1,259,980	1,067,930	718,532	878,045	555,924	1,009,760	187,066,421	13,126,651
2010	99,619,400	24,634,800	20,961,800	8,864,620	8,885,580	7,011,960	9,395,570	2,766,250	3,315,250	2,009,910	869,367	735,198	494,433	604,596	1,080,680	191,249,414	11,875,684
2011	128,567,000	32,132,100	12,351,800	12,794,000	5,724,910	5,891,090	4,762,210	6,471,910	1,871,580	2,217,460	1,335,500	575,780	486,408	327,226	1,117,810	216,626,784	14,403,674
2012	200,280,000	41,469,200	16,110,300	7,538,550	8,262,610	3,793,100	3,993,930	3,271,220	4,363,080	1,246,620	1,466,630	880,152	378,977	320,202	953,348	294,327,919	12,880,229
2013	68,928,800	64,593,800	20,782,000	9,810,020	4,839,520	5,437,030	2,557,870	2,733,820	2,200,970	2,904,070	824,754	967,648	580,355	250,074	842,900	188,253,631	11,304,591
2014	85,838,800	22,222,800	32,277,300	12,508,100	6,124,220	3,042,450	3,448,870	1,626,560	1,693,240	1,340,080	1,750,270	494,423	578,823	347,095	655,249	173,948,280	8,485,740
2015	157,070,000	27,677,400	11,120,300	19,523,800	7,895,460	3,940,520	2,004,520	2,307,400	1,070,410	1,103,200	868,587	1,132,320	319,941	375,144	652,306	237,061,308	7,829,308
2016	229,985,000	50,659,100	13,874,900	6,779,290	12,565,700	5,223,860	2,681,360	1,388,840	1,575,220	724,153	742,744	583,678	760,896	215,246	693,483	328,453,470	6,684,260
2017	111,203,000	74,145,700	25,334,400	8,368,210	4,247,160	8,012,180	3,414,780	1,782,770	909,619	1,022,650	468,159	479,672	377,310	492,949	591,874	240,850,433	6,125,003
2018	129,634,000	35,859,800	37,108,200	15,347,400	5,307,490	2,735,810	5,240,150	2,249,410	1,147,640	576,892	642,876	292,950	299,608	235,655	678,816	237,356,697	6,123,847
2019	164,809,000	41,819,100	17,997,900	22,743,500	10,012,800	3,574,150	1,894,770	3,691,900	1,559,920	787,898	393,781	437,601	199,243	203,851	623,609	270,749,023	7,897,803
2020	124,284,000	53,177,800	21,017,400	11,096,100	15,057,100	6,885,270	2,535,560	1,369,940	2,630,370	1,100,920	552,977	275,583	305,924	139,297	579,418	241,007,659	6,954,429
2021	86,716,700	40,051,700	26,729,600	13,065,800	7,435,710	10,313,700	4,880,090	1,874,220	1,025,570	1,997,590	847,029	430,241	216,477	242,295	576,241	196,402,963	7,209,663
2022	76,653,000	27,944,400	20,132,600	16,627,000	8,777,720	5,109,230	7,307,150	3,593,770	1,395,330	773,887	1,526,580	654,555	335,705	170,342	651,928	171,653,197	9,102,097
2023	94,898,600	24,679,400	14,010,100	12,431,900	10,965,600	5,812,440	3,430,900	5,066,100	2,519,770	994,613	560,736	1,122,630	487,738	253,097	631,181	177,864,805	11,635,865

Table X7. Estimates of female spawning stock biomass, 1982-2023.

								Age								
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	0	0	0	139	357	406	892	836	890	2,001	1,864	3,141	1,838	1,474	4,345	18,183.4
1983	0	0	0	97	546	535	610	844	765	877	1,642	1,319	2,572	1,398	4,054	15,259.6
1984	0	0	0	142	439	903	1,236	733	946	734	747	1,588	1,190	2,252	4,393	15,302.9
1985	0	0	0	255	555	777	2,144	1,376	909	902	722	737	1,346	1,038	5,128	15,889.3
1986	0	0	0	642	934	924	1,426	2,144	1,271	675	717	561	544	890	3,606	14,335.3
1987	0	0	0	509	2,293	1,460	1,917	1,632	2,324	1,246	668	721	523	498	4,043	17,832.9
1988	0	0	0	547	2,206	4,154	3,573	2,396	1,885	2,107	1,385	753	695	495	3,865	24,060.2
1989	0	0	0	555	2,342	4,024	9,970	5,070	3,144	2,454	2,571	1,384	731	659	3,781	36,685.0
1990	0	0	0	574	1,945	3,839	7,989	11,305	5,224	2,857	2,105	2,447	1,192	584	3,173	43,233.3
1991	0	0	0	743	2,188	2,971	7,980	8,643	12,225	4,637	3,364	1,814	2,217	1,073	3,249	51,103.9
1992	0	0	0	806	2,931	3,571	7,259	9,135	10,208	12,346	5,432	3,737	2,179	2,444	4,937	64,984.7
1993	0	0	0	1,016	3,225	4,438	7,703	8,904	10,674	9,828	11,892	5,200	3,163	1,929	5,443	73,415.9
1994	0	0	0	879	4,092	5,027	9,844	9,420	9,965	9,842	9,672	10,910	4,689	2,646	5,775	82,759.6
1995	0	0	0	963	3,244	6,300	11,777	11,589	10,775	10,129	8,017	7,972	9,037	3,712	5,997	89,513.4
1996	0	0	0	1,159	3,691	5,563	15,528	14,055	13,072	10,120	8,305	7,223	6,729	7,259	7,534	100,240.4
1997	0	0	0	2,604	4,085	5,070	9,576	12,853	12,553	11,404	8,062	6,255	6,237	5,294	11,374	95,367.1
1998	0	0	0	1,169	7,296	4,979	9,508	9,658	13,221	9,485	7,636	5,882	4,847	4,562	10,785	89,027.4
1999	0	0	0	1,345	3,782	8,700	8,371	9,075	9,937	11,685	8,157	6,223	4,805	4,023	12,441	88,543.2
2000	0	0	0	1,467	4,693	5,905	18,824	10,121	10,521	8,400	10,412	7,280	5,860	4,194	13,428	101,106.2
2001	0	0	0	962	5,688	8,342	13,167	21,784	11,659	9,173	7,161	7,071	5,498	4,164	10,229	104,898.3
2002	0	0	0	896	3,387	9,394	17,445	15,469	23,482	10,502	7,748	5,912	6,368	4,587	11,888	117,078.5
2003	0	0	0	678	3,381	5,357	18,761	18,557	15,644	20,705	8,672	5,898	4,784	5,082	11,409	118,926.8
2004	0	0	0	1,049	2,867	5,315	10,573	19,852	18,775	13,074	16,958	6,564	4,597	3,596	11,341	114,561.9
2005	0	0	0	1,272	4,188	4,463	10,571	11,682	20,661	15,781	10,836	13,995	5,467	3,667	11,206	113,787.1
2006	0	0	0	682	4,468	6,140	7,986	11,263	12,050	17,312	13,086	8,385	11,163	4,267	10,538	107,340.6
2007	0	0	0	1,441	2,535	7,003	12,783	8,484	11,756	9,721	14,460	10,269	6,981	8,699	10,897	105,029.4
2008	0	0	0	843	6,188	4,593	16,971	14,403	9,413	10,485	8,178	11,235	8,561	5,500	13,949	110,318.3
2009	0	0	0	739	3,065	10,765	9,392	17,701	15,444	8,045	8,186	6,097	8,945	6,471	13,349	108,198.2
2010	0	0	0	480	2,681	5,493	21,452	9,300	16,605	12,771	6,617	5,992	4,886	6,836	13,939	107,052.7
2011	0	0	0	758	1,734	4,381	10,584	21,232	9,299	13,616	9,474	5,028	4,844	3,755	14,918	99,622.6
2012	0	0	0	464	2,844	2,939	9,231	11,766	21,995	8,280	11,164	7,759	4,055	3,876	13,531	97,903.2
2013	0	0	0	521	1,673	4,465	5,644	9,203	11,534	17,893	6,482	8,677	6,214	3,063	11,985	87,352.8
2014	0	0	0	614	1,946	2,326	7,919	5,413	8,996	9,075	13,434	4,961	6,779	4,693	10,728	76,881.8
2015	0	0	0	1,115	2,754	3,464	4,728	8,197	5,696	7,077	6,755	10,380	3,549	4,698	9,107	67,520.2
2016	0	0	0	325	4,153	4,413	6,828	5,227	8,579	5,167	6,124	5,556	8,892	2,867	11,079	69,211.1
2017	0	0	0	462	1,467	6,360	8,086	6,136	4,652	7,084	3,918	4,550	4,373	6,579	8,769	62,435.9
2018	0	0	0	824	1,721	2,414	11,216	7,612	6,465	4,062	5,707	3,185	3,505	3,013	11,084	60,808.2
2019	0	0	0	1,199	3,163	2,746	4,354	13,766	8,865	5,681	3,464	4,563	2,617	2,720	9,407	62,544.0
2020	0	0	0	680	4,704	4,878	5,894	5,326	14,420	8,035	5,001	2,943	3,744	1,824	8,471	65,920.7
2021	0	0	0	751	2,624	6,967	10,210	6,357	4,888	13,744	5,178	4,279	2,727	3,188	8,877	69,791.5
2022	0	0	0	1,091	3,169	4,691	16,560	11,572	7,346	4,766	12,719	5,946	4,005	2,161	9,865	83,892.4
2023	0	0	0	844	4,153	5,059	8,491	16,700	12,354	5,919	4,780	10,799	5,570	3,289	8,576	86,535.7

Table x8. Estimate of total female spawning stock biomass with associated standard errors and coefficients of variation.

Year	Total	SE	CV
1982	18,183	2,616	0.144
1983	15,260	2,314	0.152
1984	15,303	2,308	0.151
1985	15,889	2,234	0.141
1986	14,335	1,905	0.133
1987	17,833	2,097	0.118
1988	24,060	2,377	0.099
1989	36,685	3,104	0.085
1990	43,233	3,296	0.076
1991	51,104	3,701	0.072
1992	64,985	4,700	0.072
1993	73,416	5,099	0.069
1994	82,760	5,430	0.066
1995	89,513	5,595	0.062
1996	100,240	6,380	0.064
1997	95,367	6,515	0.068
1998	89,027	5,639	0.063
1999	88,543	5,610	0.063
2000	101,106	6,067	0.060
2001	104,898	5,742	0.055
2002	117,078	6,351	0.054
2003	118,927	6,451	0.054
2004	114,562	6,391	0.056
2005	113,787	6,596	0.058
2006	107,340	6,452	0.060
2007	105,029	6,530	0.062
2008	110,318	6,475	0.059
2009	108,198	6,214	0.057
2010	107,053	6,046	0.056
2011	99,623	5,914	0.059
2012	97,903	6,148	0.063
2013	87,353	5,977	0.068
2014	76,882	6,046	0.079
2015	67,520	5,519	0.082
2016	69,211	5,925	0.086
2017	62,436	5,676	0.091
2018	60,808	5,963	0.098
2019	62,544	6,198	0.099
2020	65,921	6,516	0.099
2021	69,792	6,982	0.100
2022	83,892	8,420	0.100
2023	86,536	9,309	0.108

Table x9 . Estimates of exploitable biomass, 1982-2023.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	2,420	4,405	3,030	3,012	2,000	1,501	1,515	1,228	1,013	2,271	2,120	3,381	1,940	1,527	4,649	36,012
1983	8,926	3,307	3,234	2,197	2,954	1,828	1,058	1,216	918	951	1,798	1,464	2,677	1,471	4,323	38,323
1984	9,575	8,649	5,965	2,980	2,227	3,022	1,913	971	1,072	791	824	1,614	1,191	2,279	4,644	47,716
1985	1,349	7,861	10,039	6,140	3,087	2,654	3,395	1,999	1,055	1,024	784	766	1,462	1,100	5,495	48,210
1986	4,092	4,139	9,107	12,526	5,065	3,088	2,396	3,117	1,526	795	789	609	588	963	3,809	52,610
1987	6,925	7,269	10,133	10,685	13,535	5,095	3,174	2,279	2,722	1,366	698	739	534	502	4,261	69,914
1988	17,645	10,177	10,307	11,978	11,932	13,457	5,543	3,279	2,202	2,404	1,434	761	719	506	4,077	96,420
1989	7,274	15,259	12,705	11,097	12,535	13,383	15,946	6,794	3,541	2,482	2,544	1,459	758	670	3,992	110,437
1990	3,110	13,068	14,787	12,051	11,493	13,288	13,492	16,142	6,414	3,292	2,434	2,657	1,266	626	3,355	117,474
1991	12,201	11,547	18,761	15,116	12,330	10,107	13,009	12,258	14,416	5,220	3,344	1,929	2,287	1,095	3,446	137,067
1992	3,987	12,945	23,614	17,433	16,480	12,046	11,249	12,823	11,671	13,434	5,426	3,820	2,049	2,340	5,245	154,561
1993	2,437	9,782	16,332	21,879	17,648	15,308	12,426	12,367	12,231	10,921	12,750	5,544	3,367	2,036	5,770	160,797
1994	40,316	11,801	20,325	18,453	22,449	17,410	15,700	12,996	11,696	11,160	10,296	11,607	4,855	2,753	6,137	217,954
1995	27,125	37,964	26,175	21,668	18,481	21,863	18,393	16,238	12,572	11,022	9,022	8,805	9,625	3,967	6,433	249,353
1996	15,618	32,828	47,358	24,298	20,136	18,166	23,518	19,475	15,025	11,150	9,295	7,466	6,903	7,499	8,130	266,864
1997	13,863	22,314	33,897	55,012	23,477	18,186	16,702	20,219	15,492	12,761	8,922	6,750	6,366	5,465	12,189	271,614
1998	38,022	26,494	32,829	25,941	44,971	18,182	15,559	13,553	14,951	10,936	8,989	6,517	5,129	4,913	11,569	278,555
1999	100,793	28,312	38,911	30,855	21,867	31,266	14,115	13,232	11,650	13,133	8,723	6,491	4,936	4,091	13,325	341,699
2000	45,554	28,851	23,905	32,963	26,188	19,841	29,393	13,537	11,738	9,498	11,136	7,633	5,880	4,250	14,381	284,748
2001	22,637	15,096	19,492	20,561	30,823	27,135	20,796	30,311	13,410	10,434	7,756	8,120	5,928	4,557	10,955	248,011
2002	11,918	14,154	12,851	19,980	19,325	31,719	28,540	21,392	27,315	11,722	8,417	6,345	6,290	4,651	12,751	237,371
2003	7,039	19,228	17,786	15,220	18,577	18,016	30,723	26,156	18,579	23,123	9,523	6,478	4,994	5,368	12,253	233,063
2004	47,517	7,494	25,543	23,205	15,095	18,070	17,343	27,926	22,082	14,718	18,620	7,178	4,810	3,796	12,212	265,608
2005	12,032	33,323	12,697	25,869	22,534	15,399	17,165	16,109	23,953	17,680	11,742	14,773	5,565	3,765	12,062	244,670
2006	15,355	11,347	31,396	15,765	25,892	21,549	13,429	15,847	14,168	19,595	14,262	9,120	11,713	4,472	11,394	235,302
2007	4,204	12,655	15,284	30,781	13,692	23,154	20,027	11,625	13,452	10,903	15,401	10,907	7,028	8,878	11,697	209,688
2008	15,817	6,103	15,281	18,243	32,957	14,990	26,166	20,153	10,846	11,703	8,892	12,313	8,863	5,788	14,994	223,109
2009	12,100	15,067	9,840	16,468	17,196	35,798	15,383	25,510	17,833	9,061	9,110	6,703	9,270	6,813	14,339	220,490
2010	8,841	10,510	17,390	10,683	14,884	17,757	35,216	13,379	19,889	14,571	7,239	6,601	5,067	7,199	15,032	204,257
2011	16,598	9,268	10,539	16,782	9,614	14,585	17,623	30,290	10,816	15,247	10,577	5,448	4,955	3,906	16,097	192,343
2012	6,474	12,849	11,675	9,935	15,601	9,671	14,770	16,062	25,330	9,098	12,115	8,132	4,168	3,990	14,596	174,464
2013	7,698	12,789	14,107	11,624	9,423	15,160	9,383	13,262	13,804	20,453	7,235	9,406	6,519	3,232	13,057	167,149
2014	54,674	7,184	21,315	13,811	10,587	8,032	13,118	7,619	10,306	10,064	14,563	5,192	6,872	4,765	11,591	199,693
2015	13,915	10,433	7,910	23,225	14,069	11,189	7,500	11,387	6,506	8,088	7,545	11,132	3,818	5,061	9,804	151,582
2016	23,268	12,866	6,599	7,270	23,341	15,230	11,317	7,295	9,984	5,710	6,523	5,852	9,049	2,913	11,970	159,185
2017	13,932	21,180	17,104	9,319	7,493	21,376	13,298	8,953	5,651	7,955	4,373	4,995	4,569	6,959	9,511	156,668
2018	20,188	12,622	25,451	18,562	9,698	8,168	18,766	10,885	7,242	4,362	6,127	3,294	3,584	3,185	11,920	164,056
2019	19,877	15,467	14,761	26,449	17,126	9,178	7,312	18,207	9,847	6,375	3,779	4,907	2,728	2,843	10,090	168,946
2020	32,140	17,637	15,947	14,986	25,571	16,805	9,425	7,069	17,069	8,962	5,322	3,084	3,851	1,960	8,964	188,790
2021	5,098	15,860	19,423	16,242	14,388	24,272	16,300	8,999	6,123	15,055	6,282	4,642	2,804	3,330	9,398	168,215
2022	7,116	6,845	15,373	22,218	17,029	15,375	25,345	16,171	8,360	5,094	13,779	5,605	4,061	2,314	10,483	175,169
2023	29,297	7,682	11,252	18,245	23,408	17,128	14,286	24,161	14,238	6,843	5,002	11,518	5,836	3,453	9,095	201,445

Table X10. Reference points and probability of female spawning stock biomass being greater or equal to the SSB target and SSBthreshold over a six-year projection under the current fully-recruited 2023 F, Ftarget and Fthreshold.

	Reference Points	
	SSB	F
Target	111,891.8	0.1707
Threshold	89,513.4	0.2064
Current	86,535.7	0.1828

	Current F		Ftarget		Fthreshold	
Year	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget
2023	0.333	0.001	0.334	0.000	0.328	0.000
2024	0.756	0.016	0.771	0.018	0.756	0.016
2025	0.880	0.459	0.910	0.062	0.820	0.031
2026	0.913	0.073	0.952	0.111	0.802	0.029
2027	0.915	0.077	0.960	0.141	0.745	0.021
2028	0.894	0.066	0.958	0.138	0.632	0.011
2029	0.854	0.051	0.951	0.131	0.533	0.007

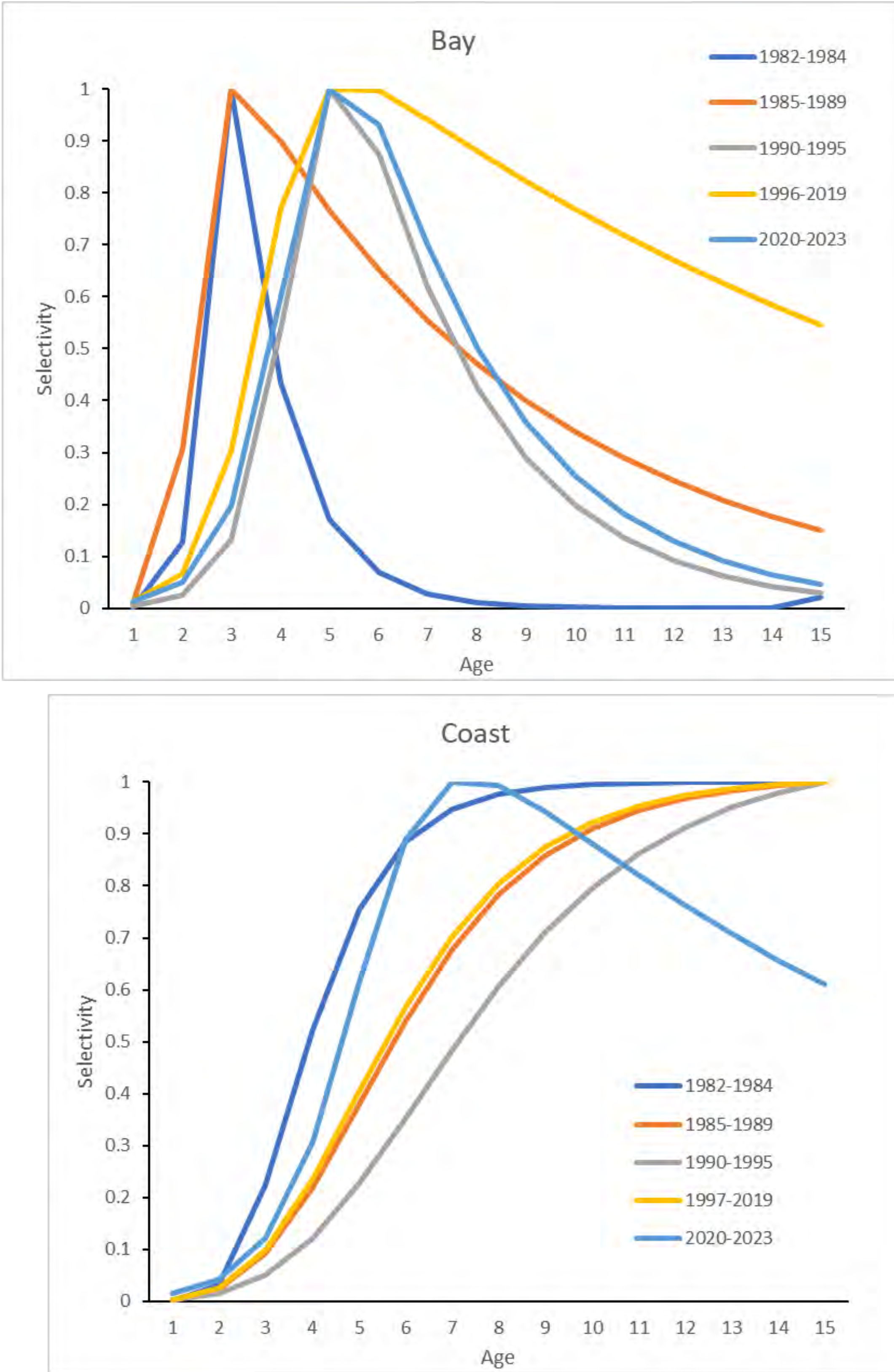


Figure 1. Estimates of selectivity patterns for the five Bay and Ocean time blocks.

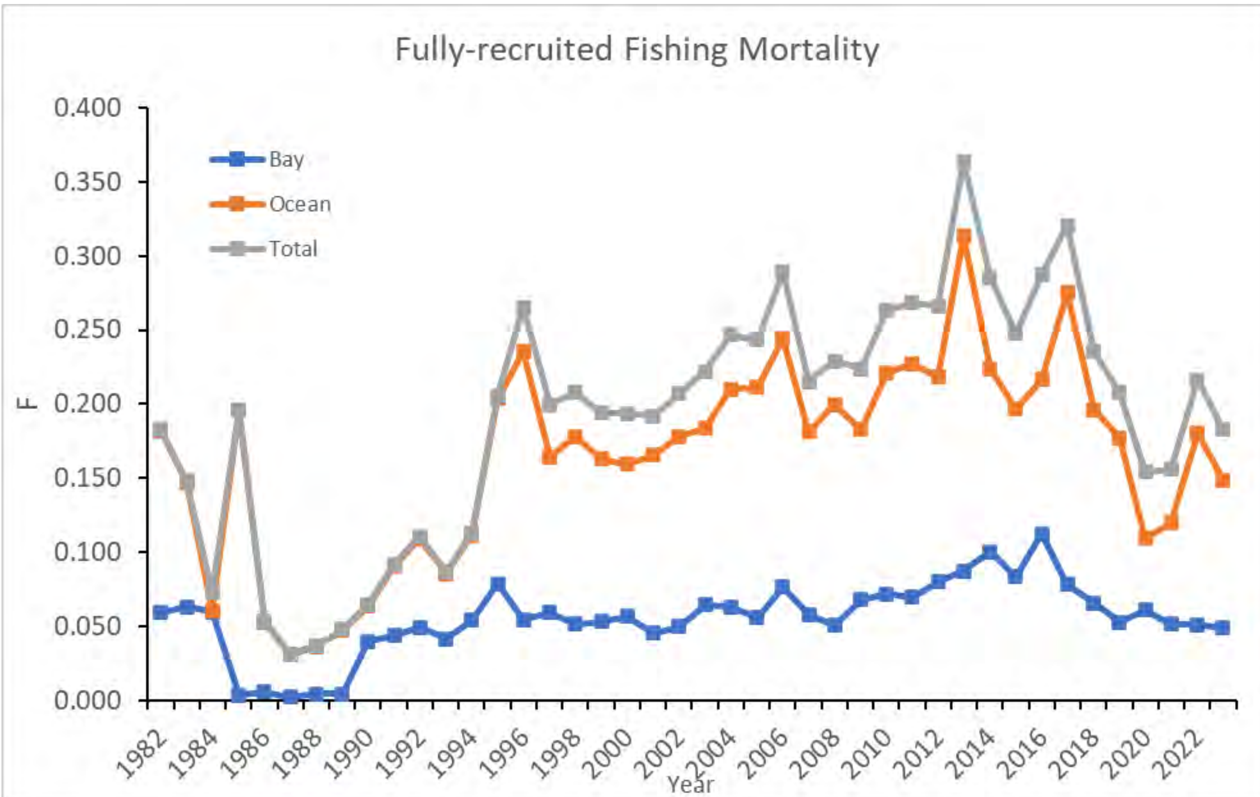


Figure 2. Estimates of region-specific and total fully-recruited fishing mortality in the Bay and Ocean, 1982-2023.

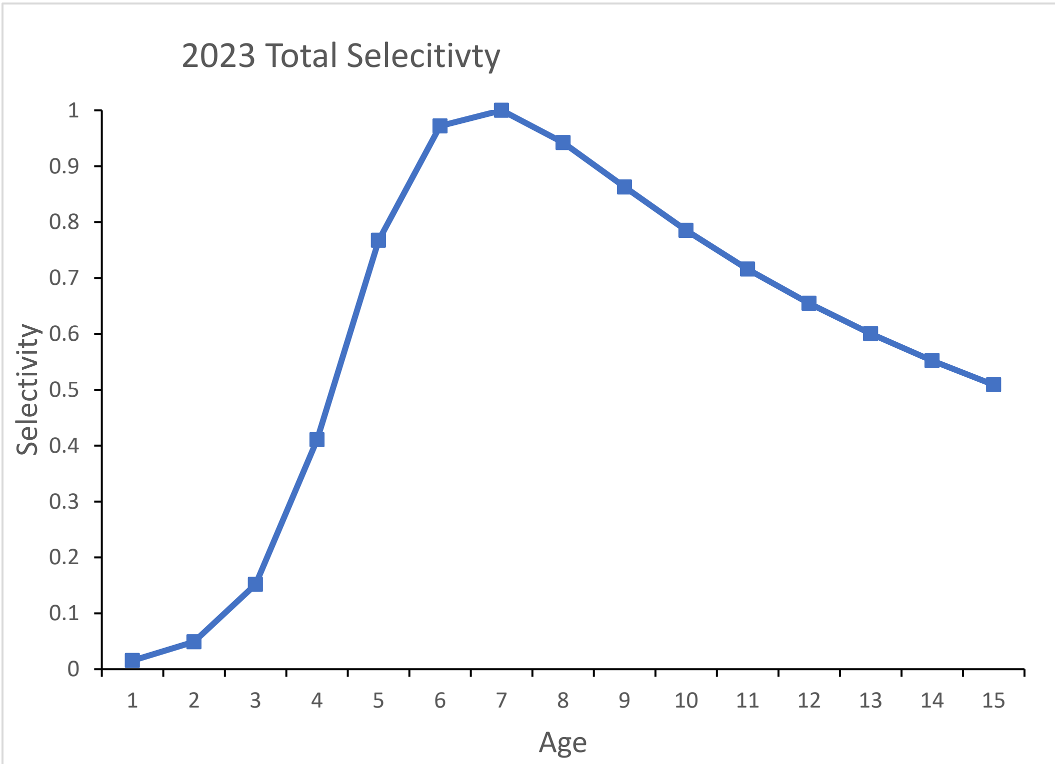


Figure 3. Total selectivity pattern for 2023 (Bay and Ocean combined) derived from total fishing mortality-at-age.

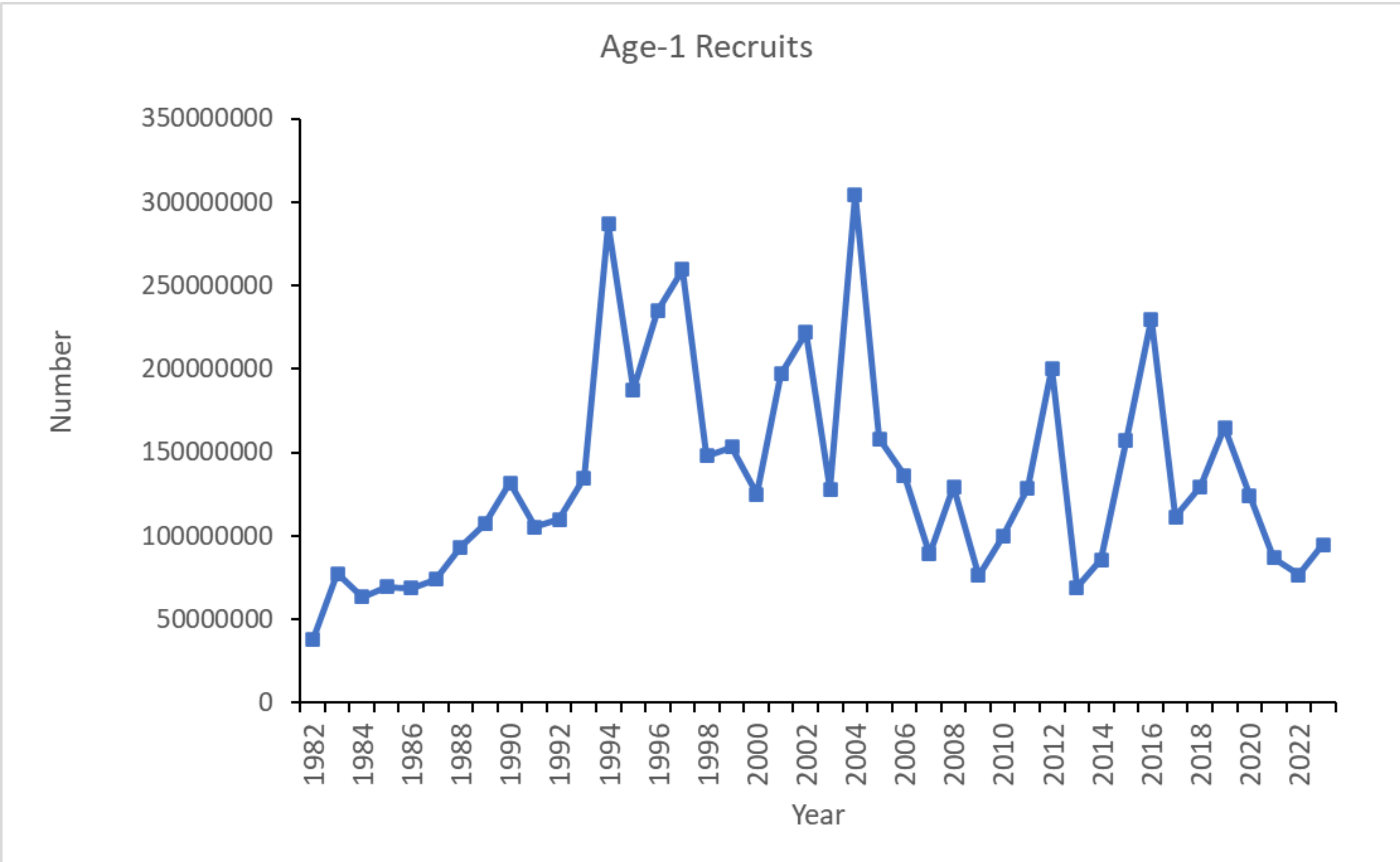


Figure 4. Estimates of recruit (age-1) abundance, 1982-2023.

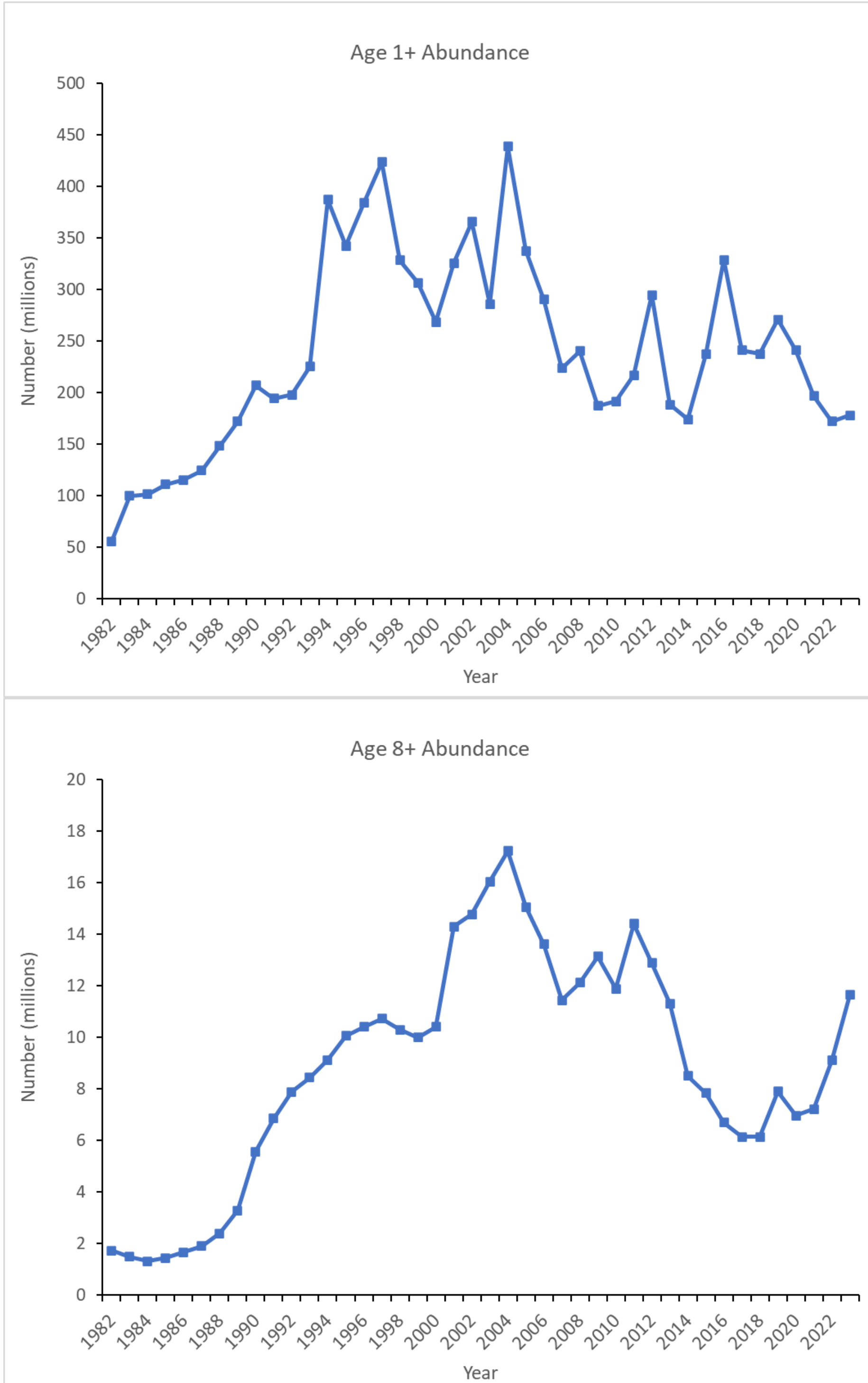


Figure 5. Estimates of total (top) and age-8 + (bottom) abundance from the updated stock assessment, 1982-2023.

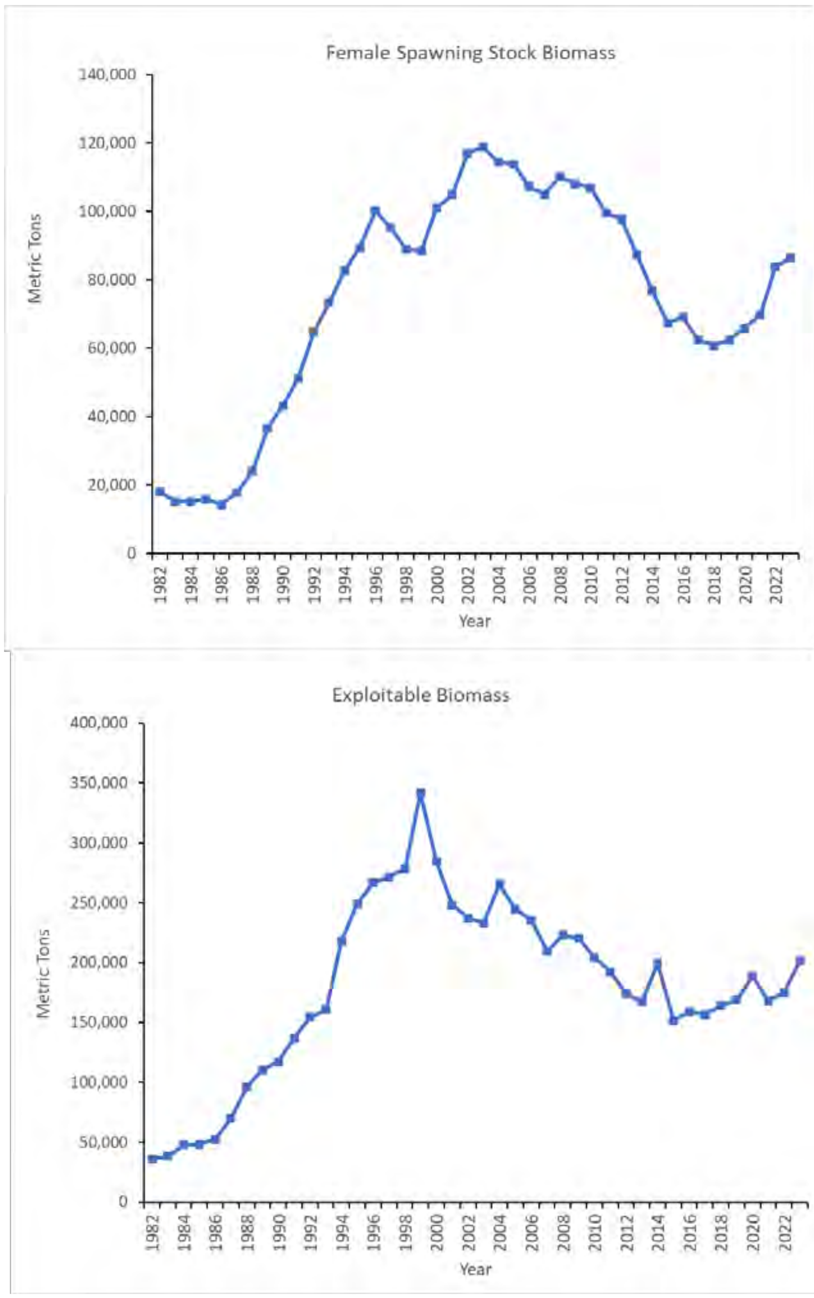


Figure 6. Estimates of female spawning stock biomass (top) and exploitable biomass (bottom), 1982-2023

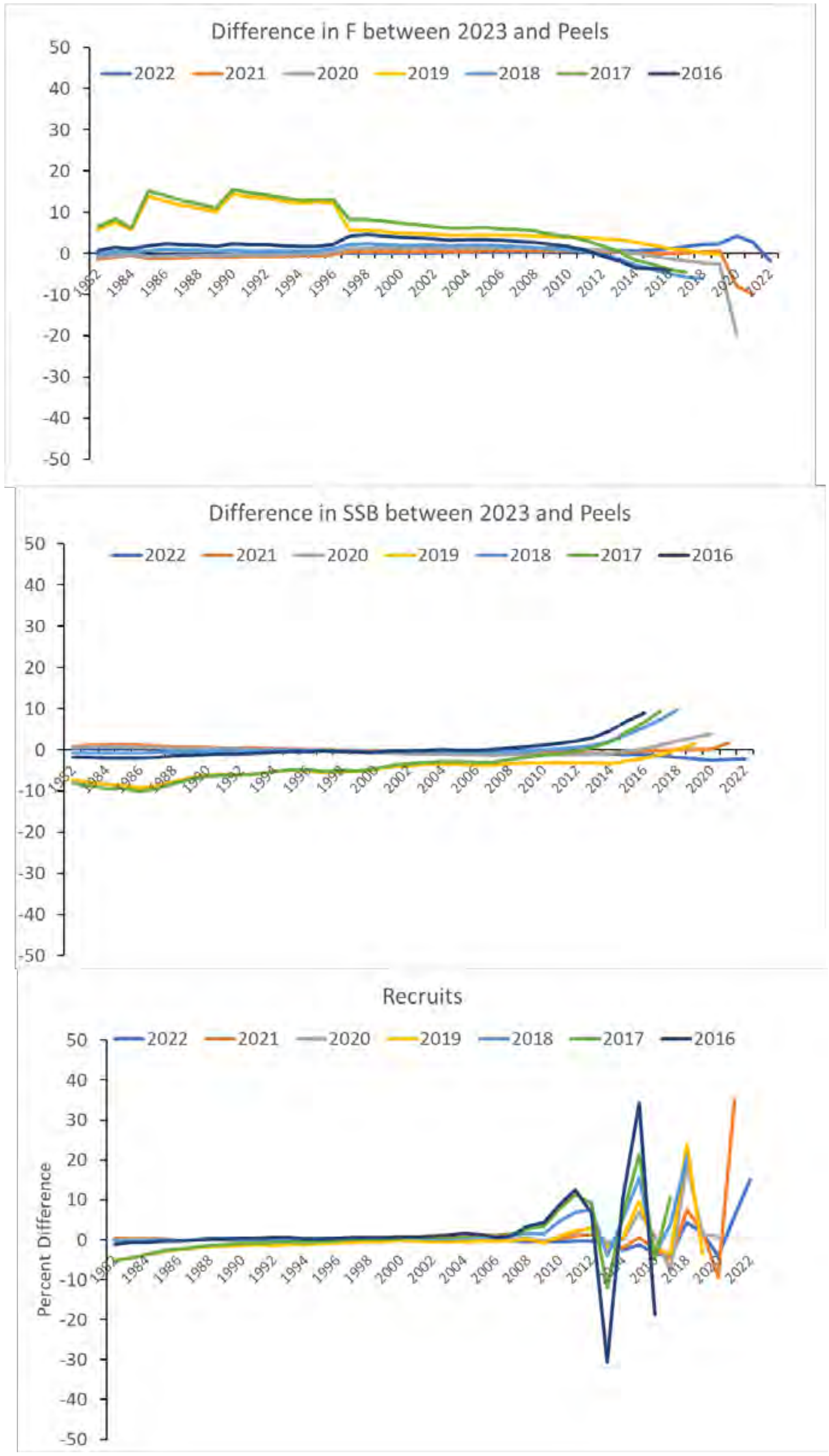


Figure 7. Retrospective plots of seven-year peels for fishing mortality, female spawning stock biomass and recruitment.

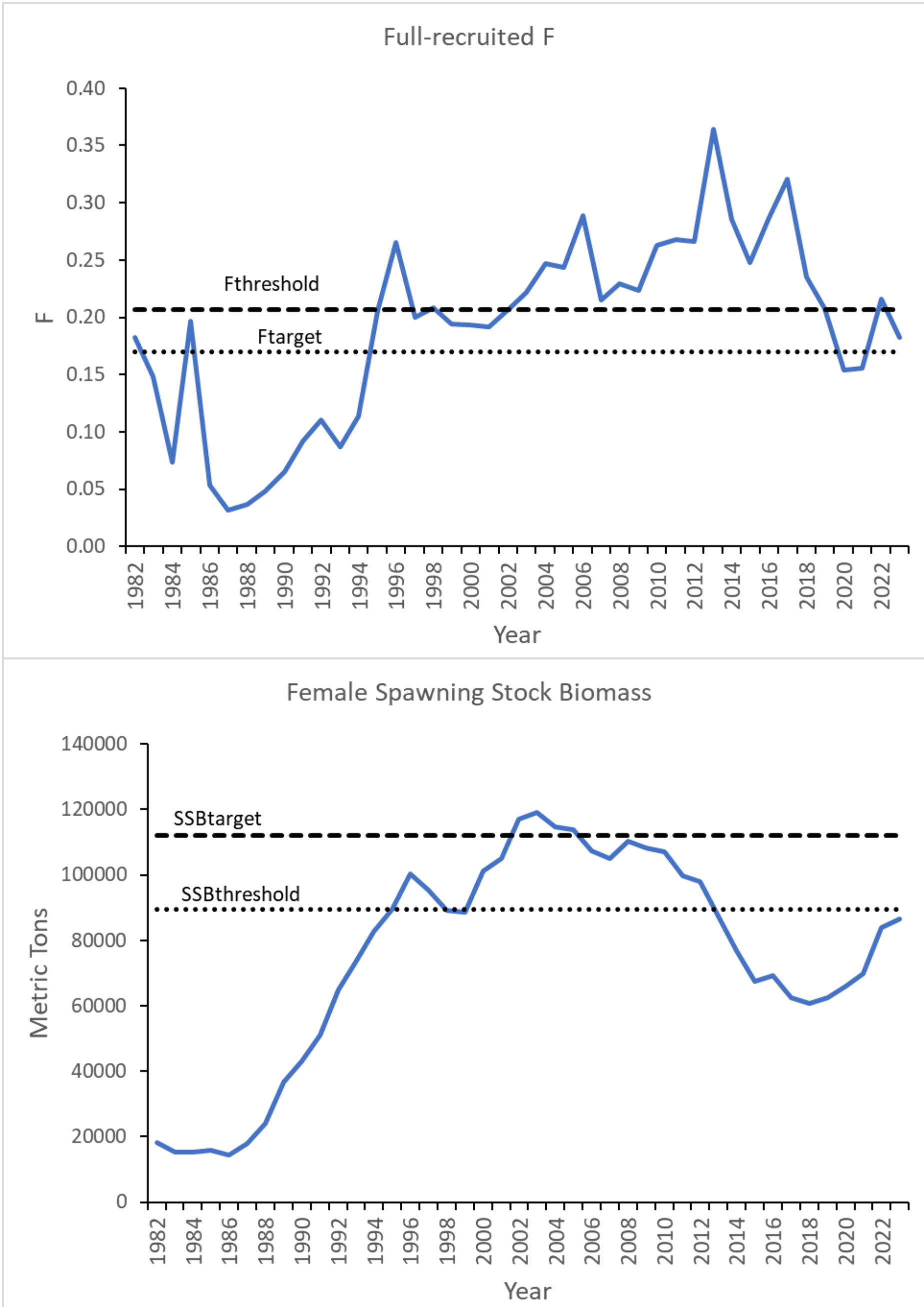


Figure 13. Comparison of SSB and F estimates to SSB and F reference points.

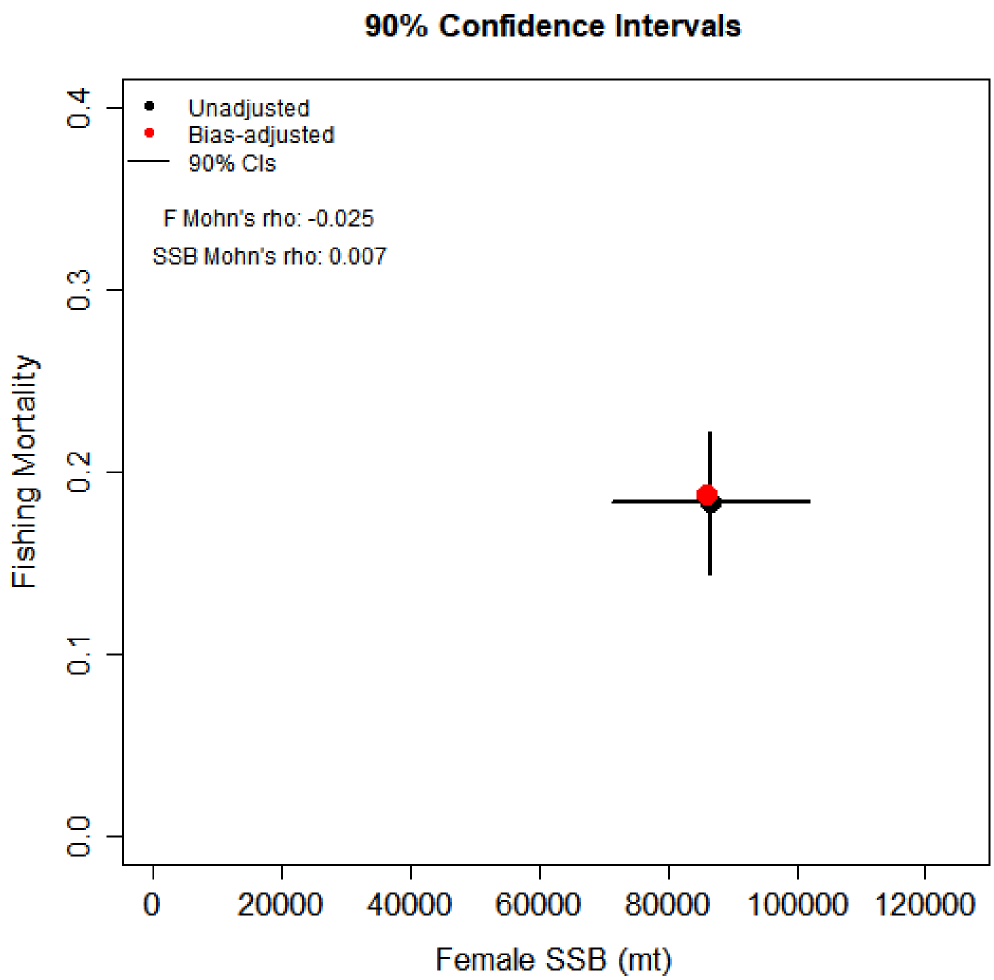


Figure 14. Plot comparing the 2023 bias-corrected F and female SSB values the uncorrected F and SSB estimates and their associated 90% confidence intervals. Because the retrospective adjusted values fall within the 90% confidence intervals, bias-correction is not needed.

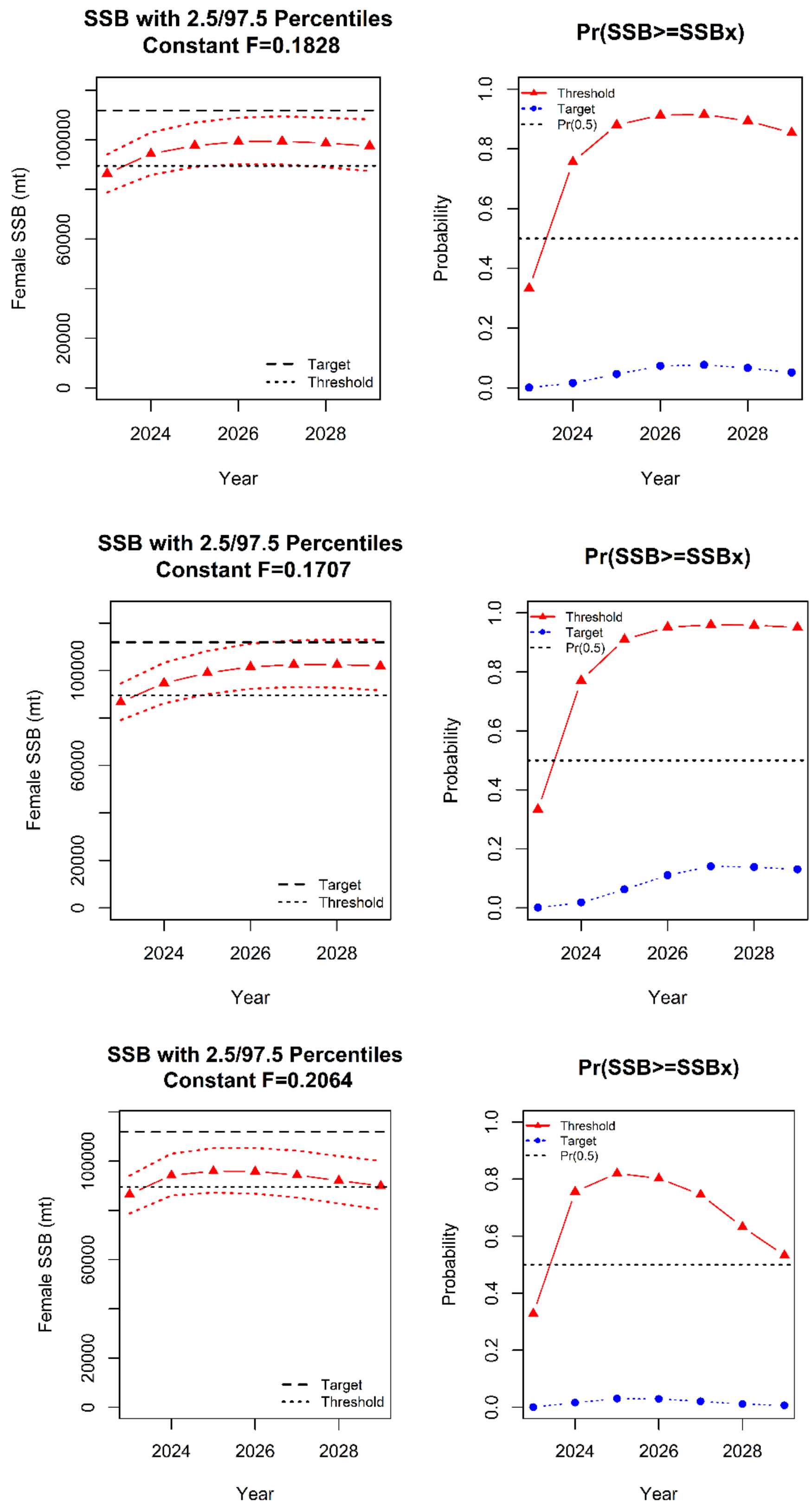


Figure 15. Projections of female spawning stock biomass through 2029 under current, target and threshold fishing mortality (left) and the probability of female SSB being above the target and threshold values of 111,891 and 89513 metric tons, respectively, over time (right).

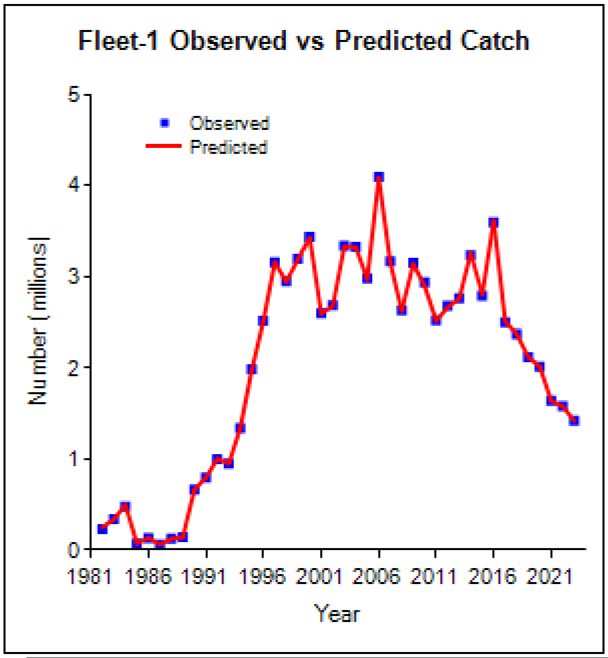
Sensitivity Run

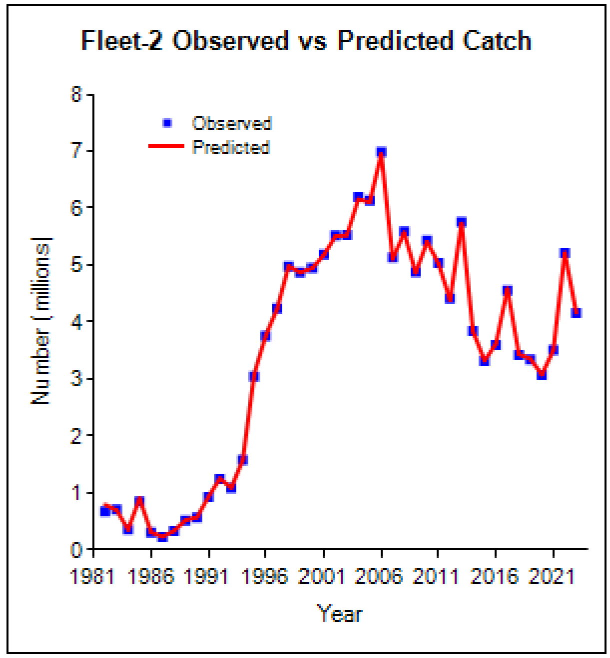
Model configuration:

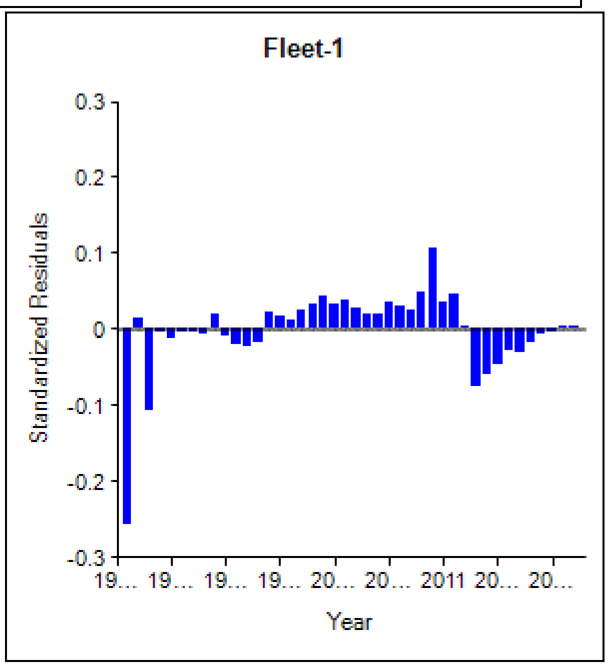
Ocean recent selectivity blocks: 2020-2022, 2023 (new blocks in 2020 and 2023)

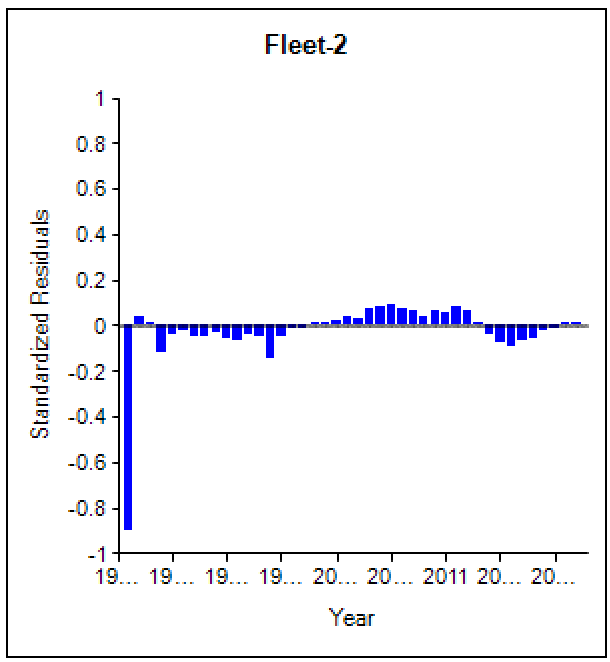
Bay recent selectivity blocks: 1996-2022, 2023 (new block in 2023 only)

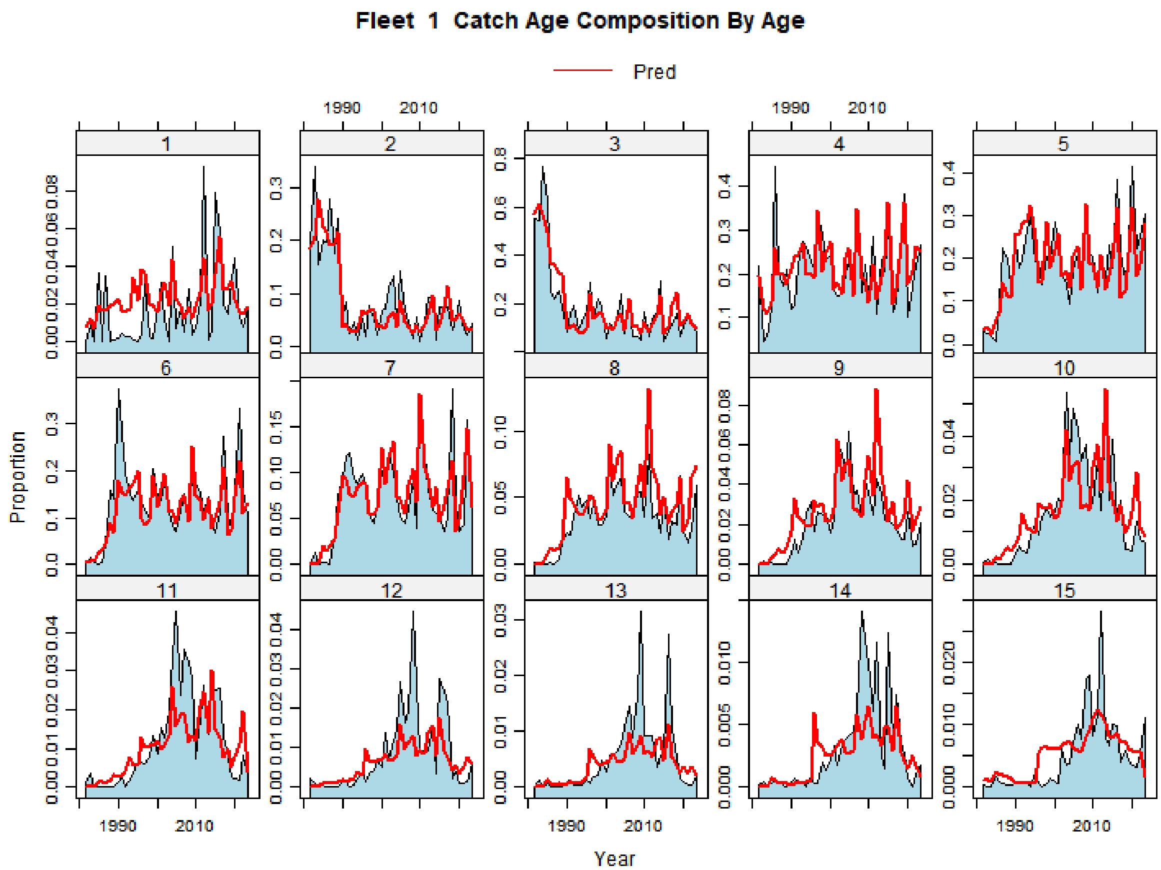
Diagnostics

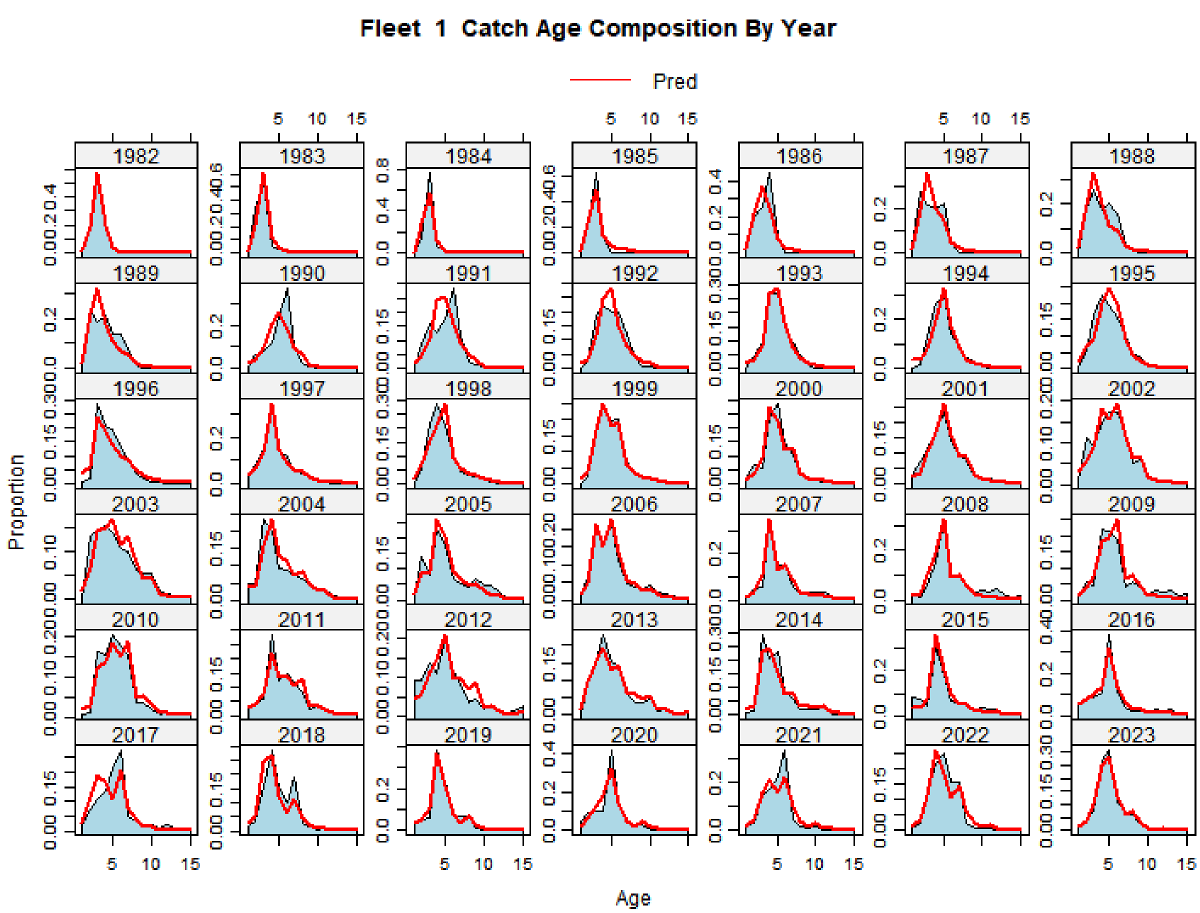


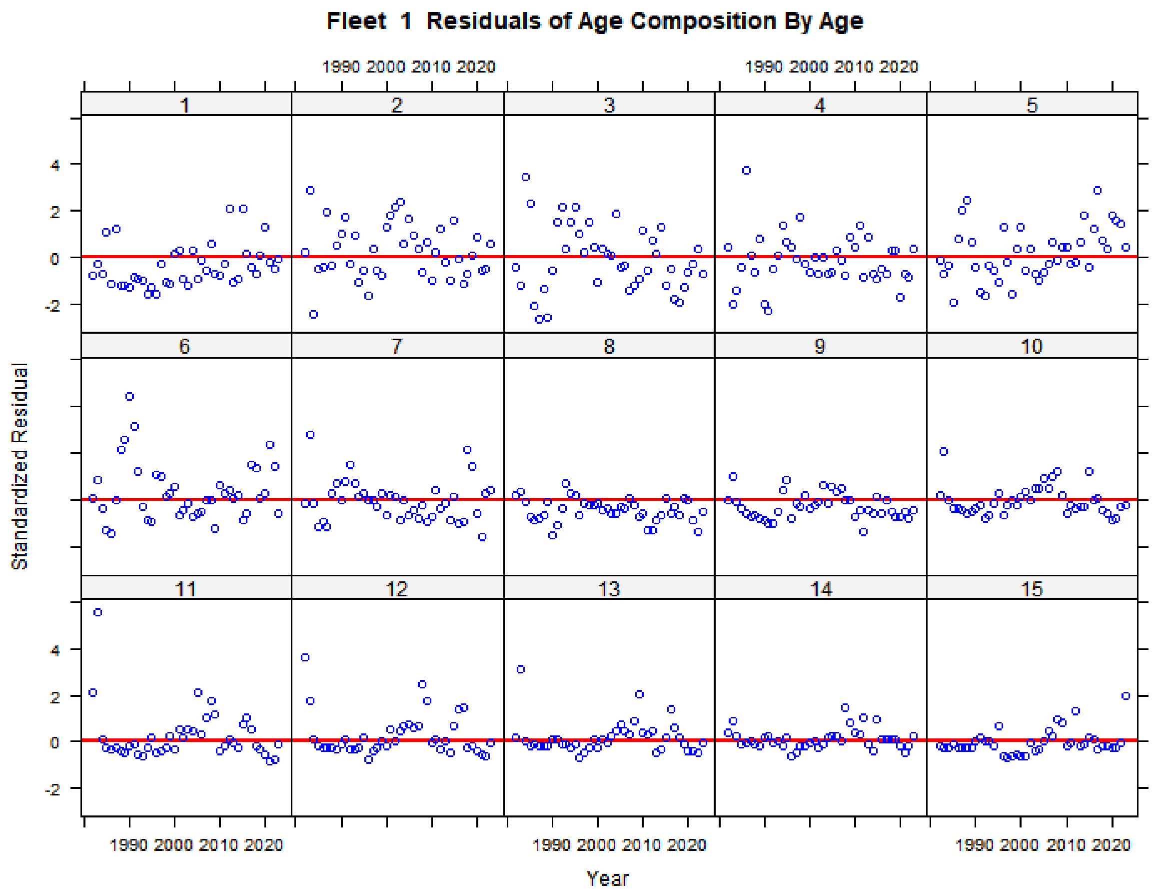


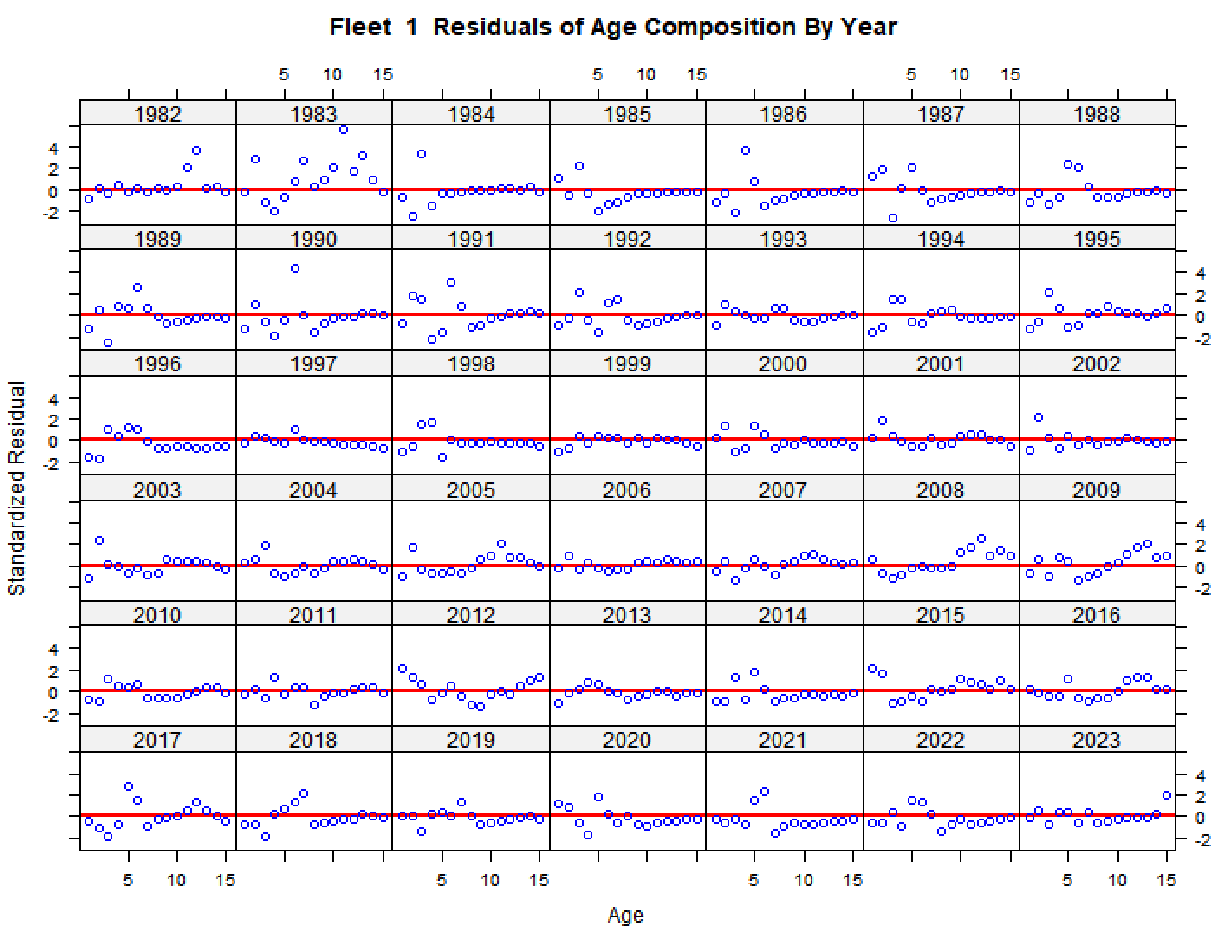





Fleet 1 Catch Age Composition By Age
Pred
Proportion
Year


Fleet 1 Catch Age Composition By Year
Pred
Proportion
Age


Fleet 1 Residuals of Age Composition By Age
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1990 2000 2010 2020
Standardized Residual
Year


Fleet 1 Residuals of Age Composition By Year
1982 1983 1984 1985 1986 1987 1988
1989 1990 1991 1992 1993 1994 1995
1996 1997 1998 1999 2000 2001 2002
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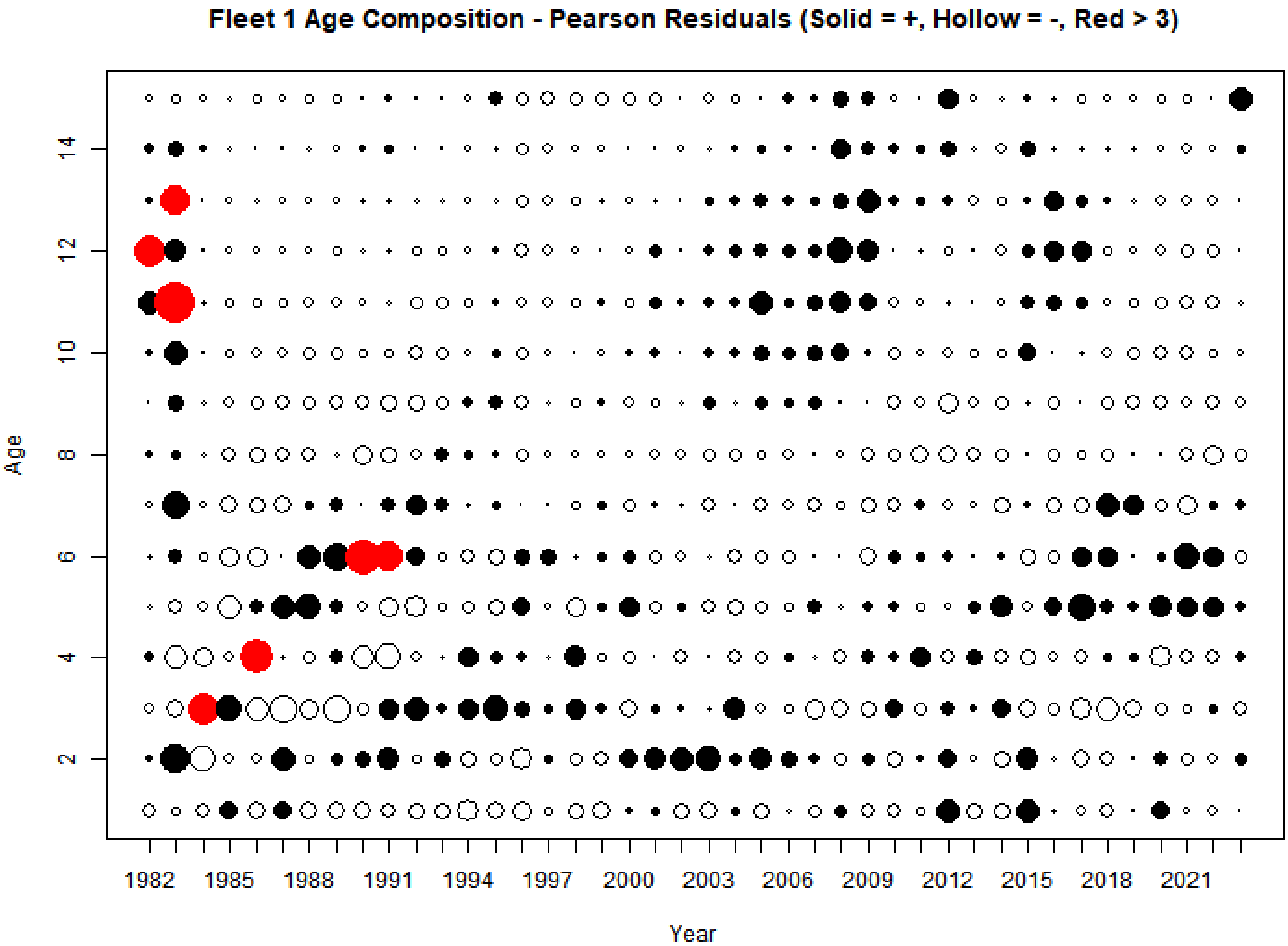
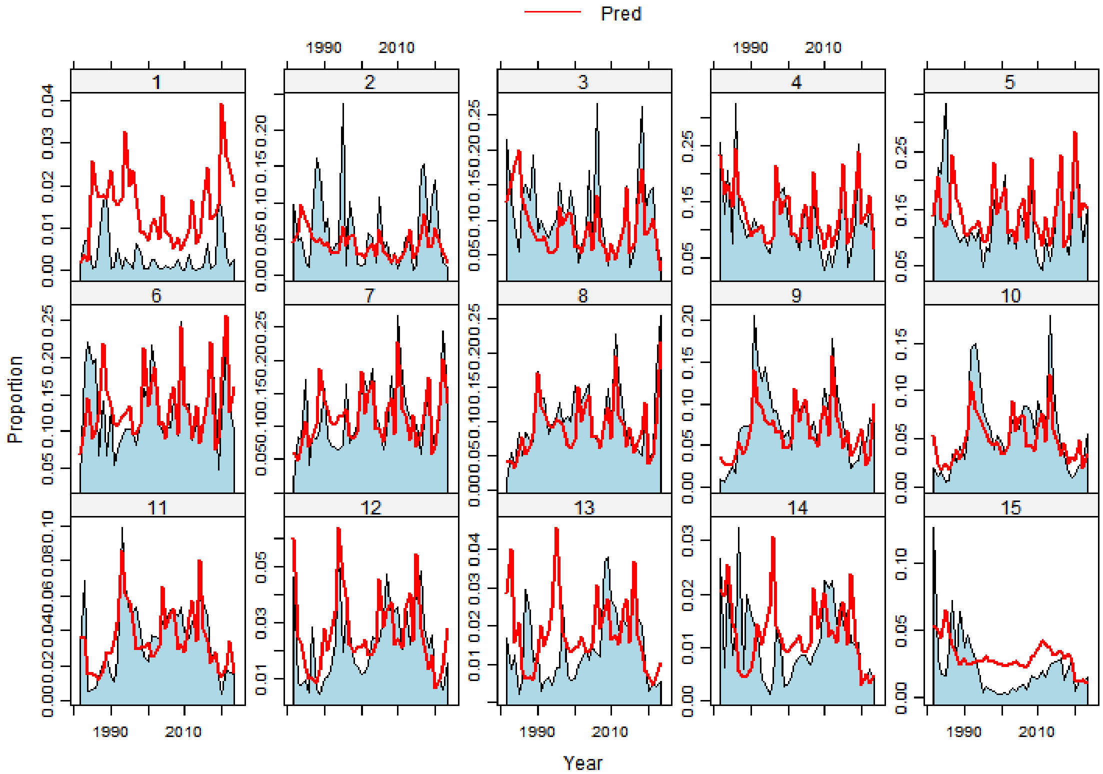
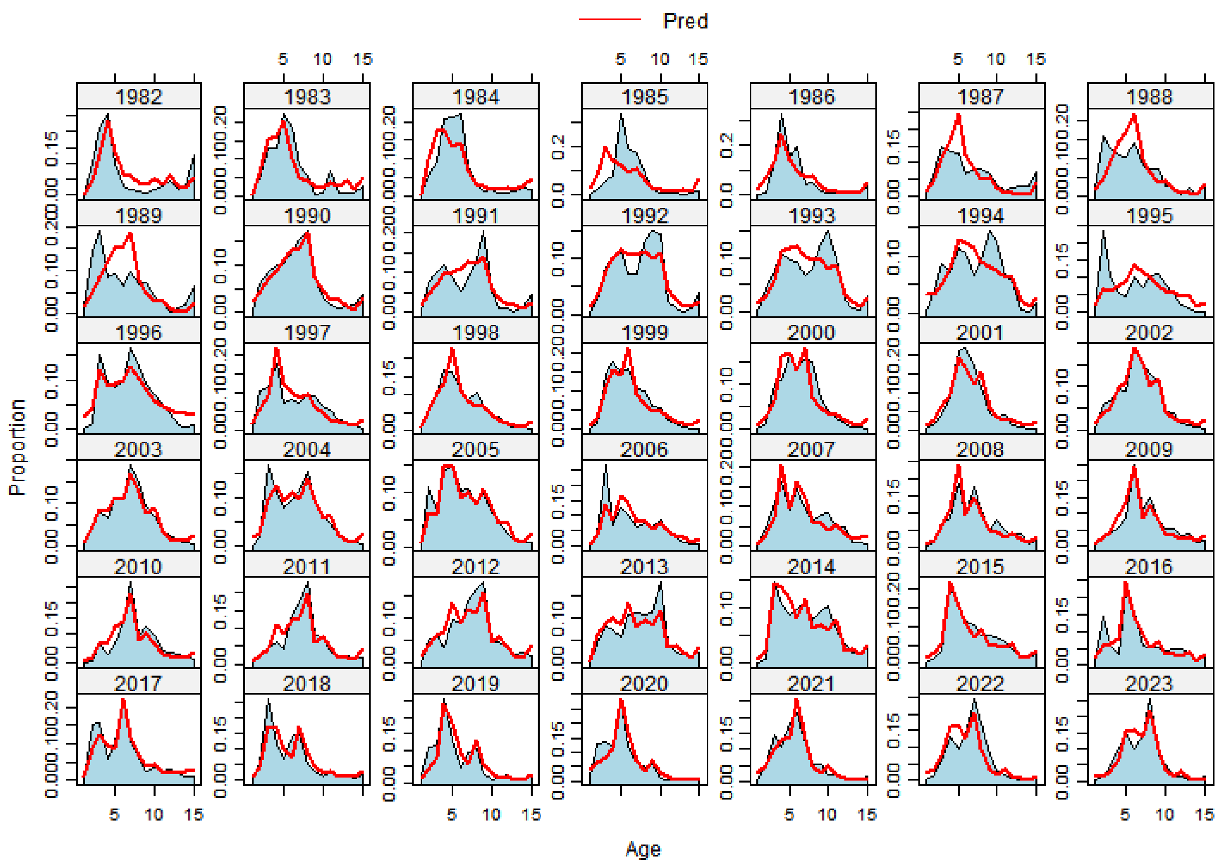
2017 2018 2019 2020 2021 2022 2023
Standardized Residual
Age


Fleet 1 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
Year
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021

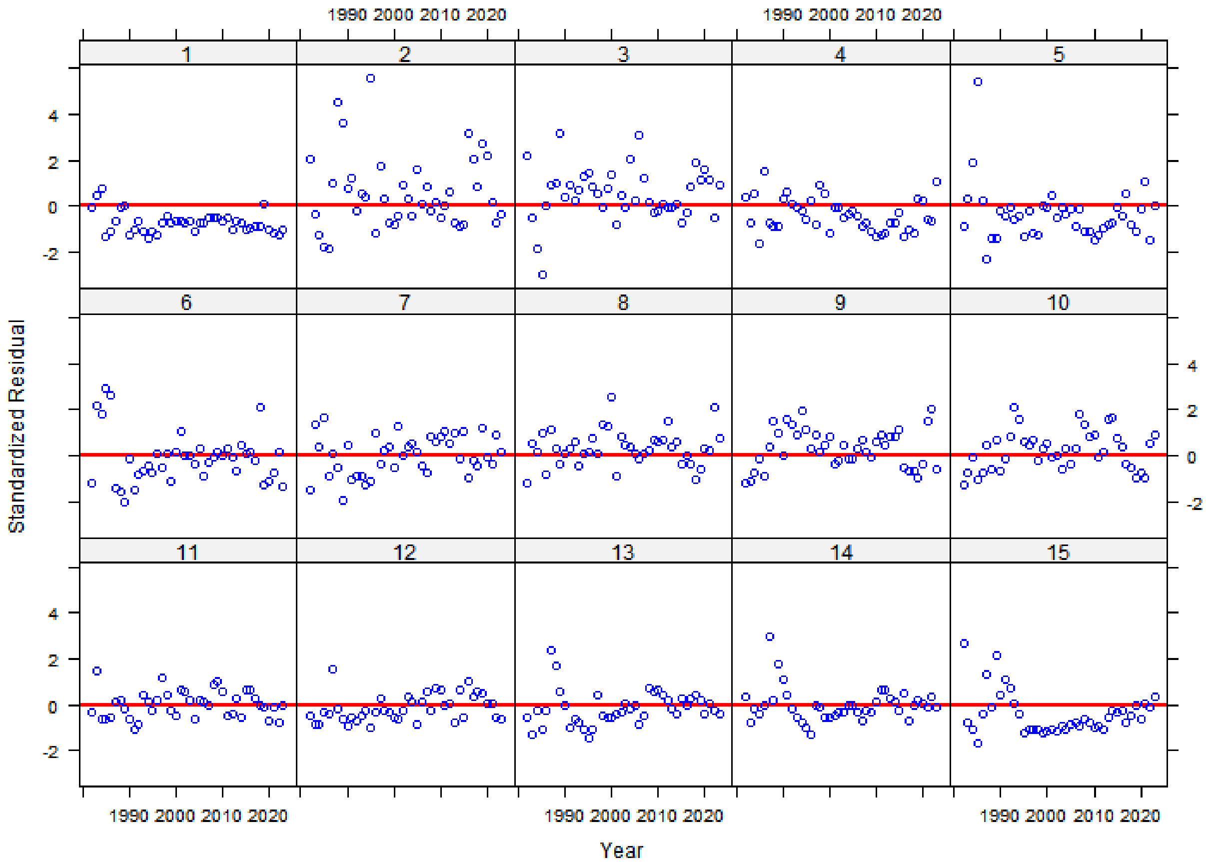
Fleet 2 Catch Age Composition By Age



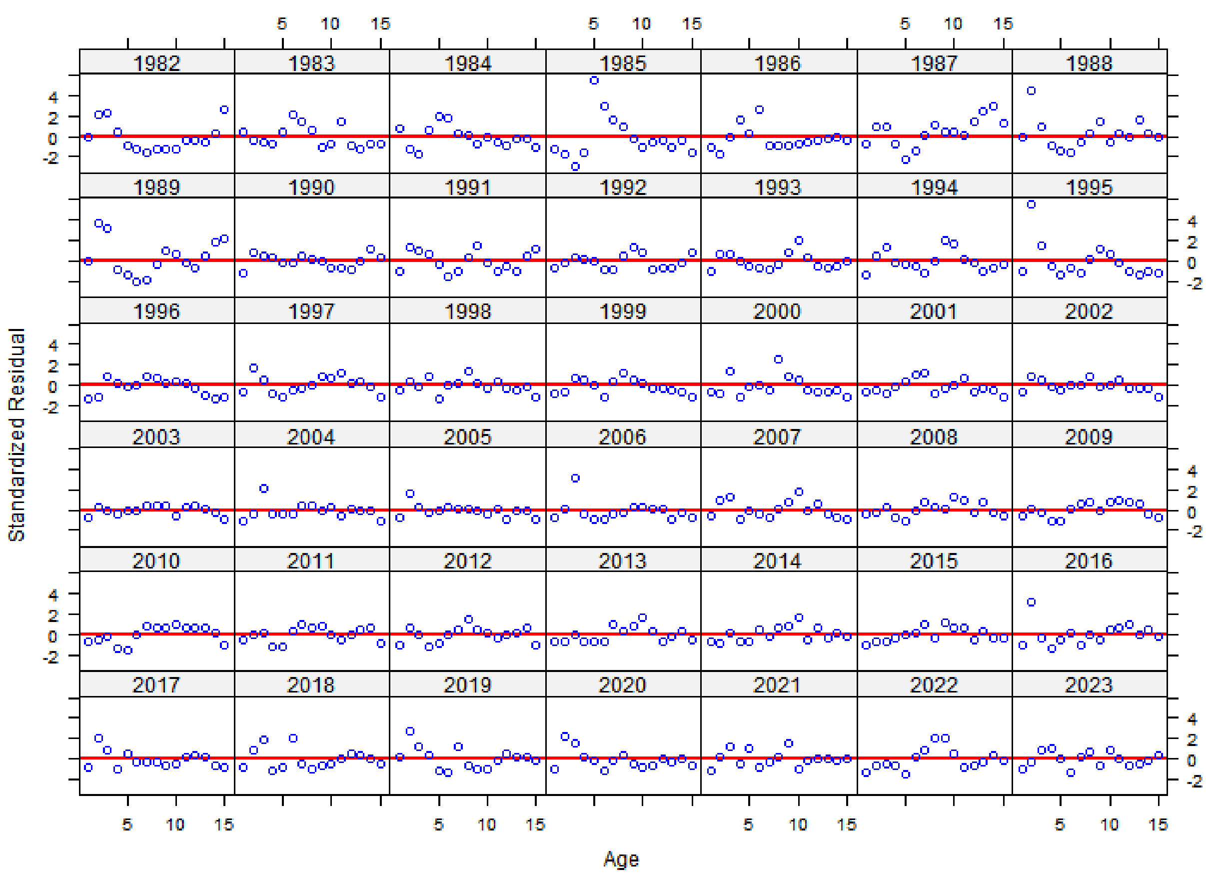
Fleet 2 Catch Age Composition By Year

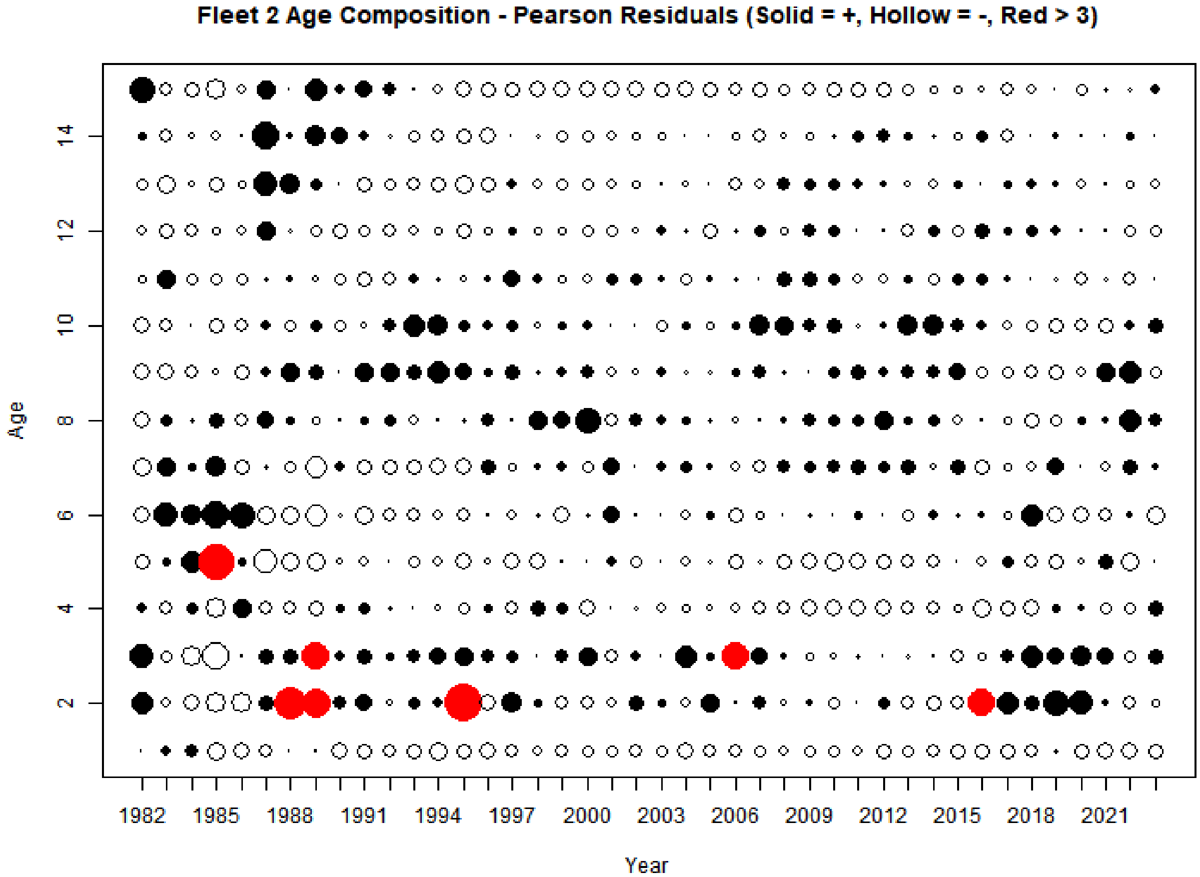


Fleet 2 Residuals of Age Composition By Age



Fleet 2 Residuals of Age Composition By Year




Fleet 2 Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
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12
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Year
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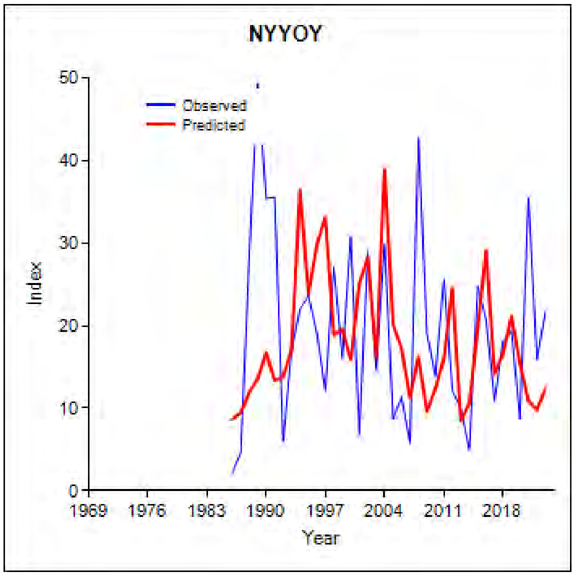
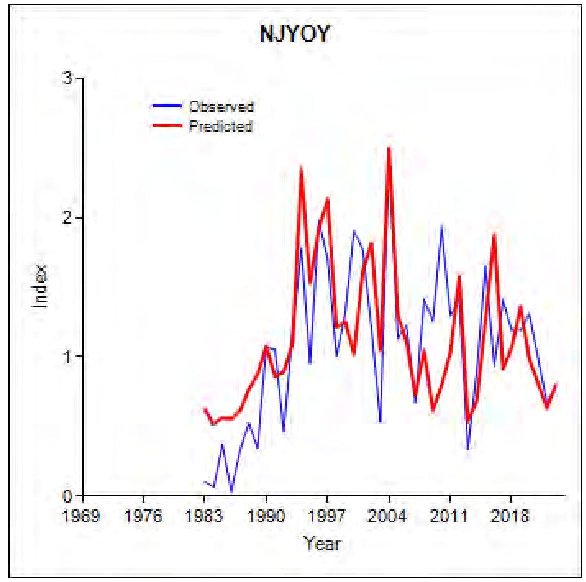
2009
2012
2015
2018
2021


NYYOY
Observed
Predicted
Index
Year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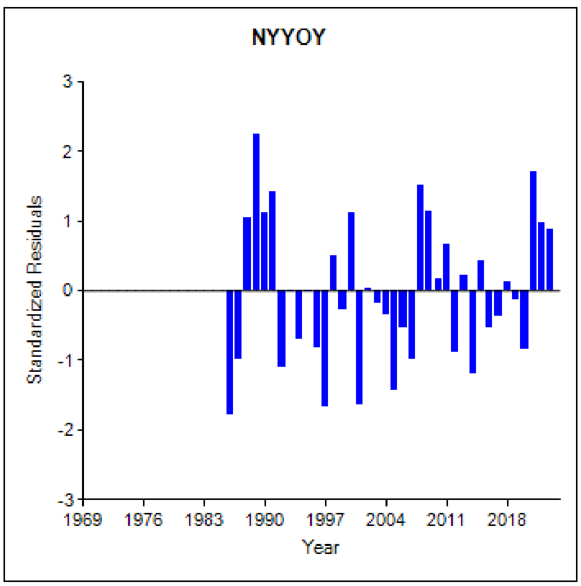
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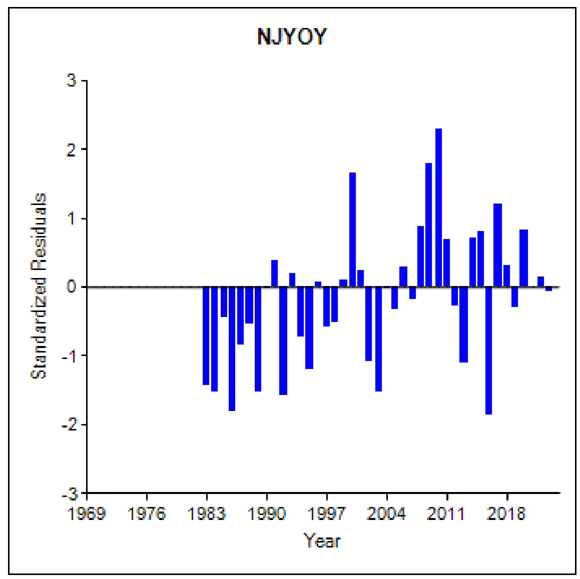
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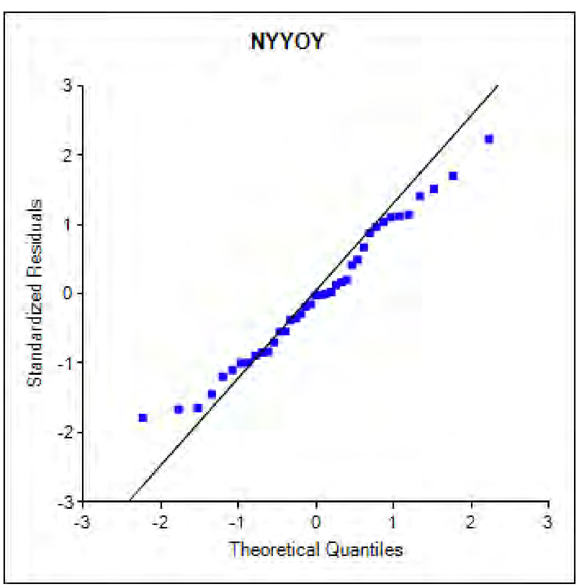
Year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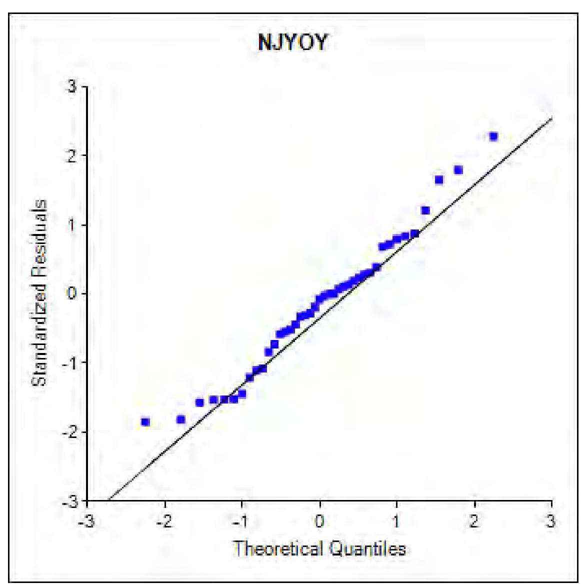
Standardized Residuals
Theoretical Quantiles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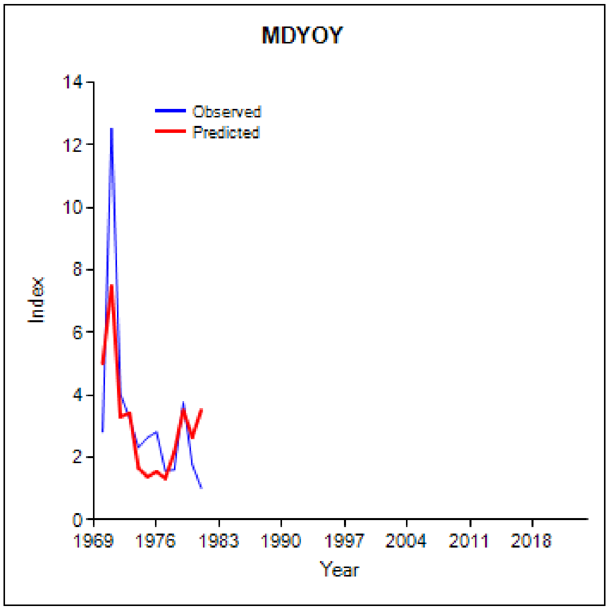
MDYOY
Observed
Predicted
Index
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2018
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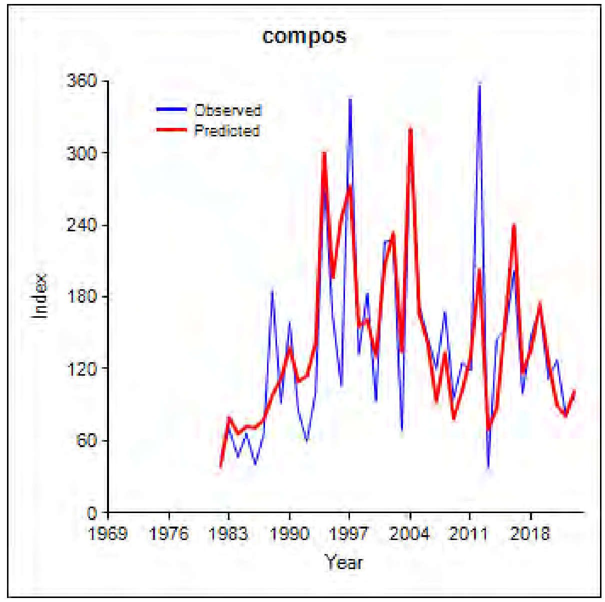
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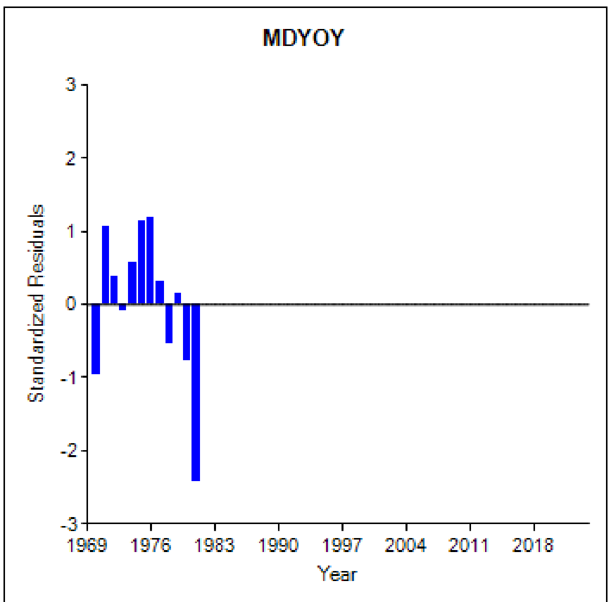
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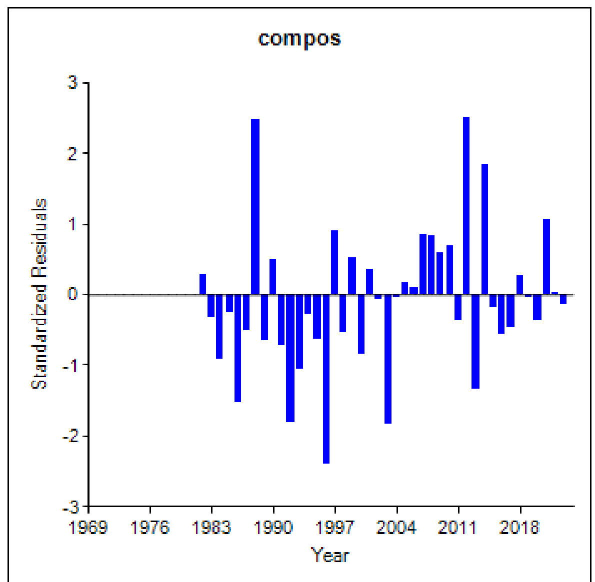
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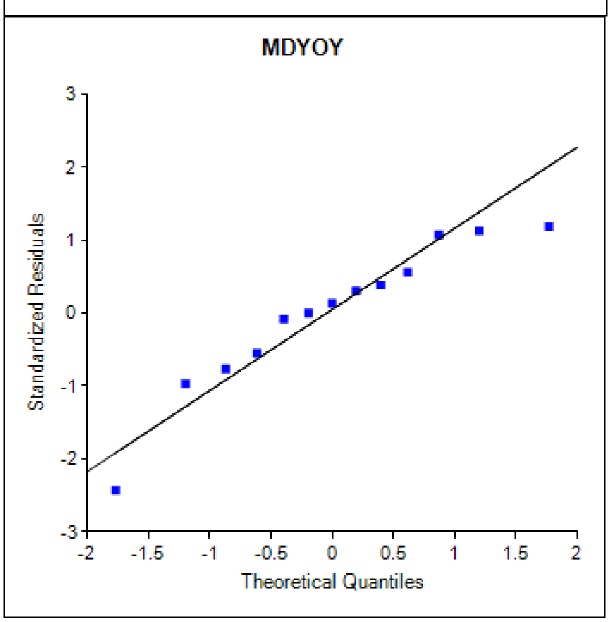
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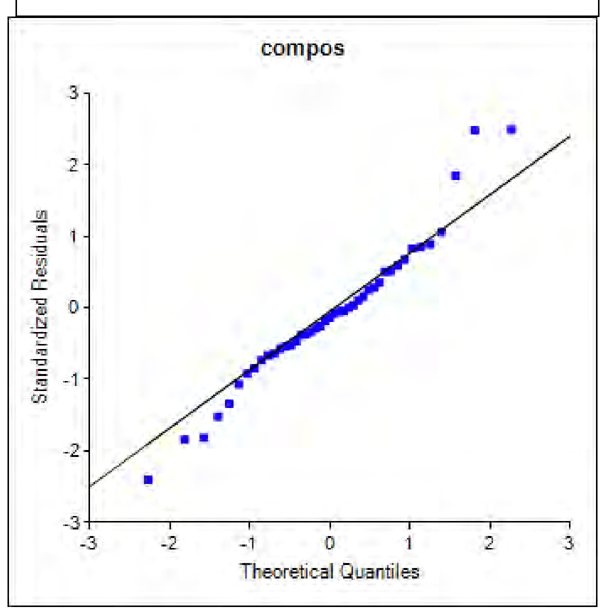
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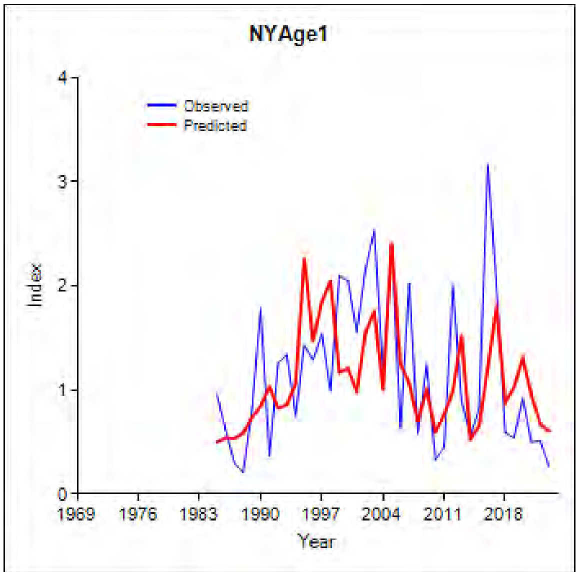
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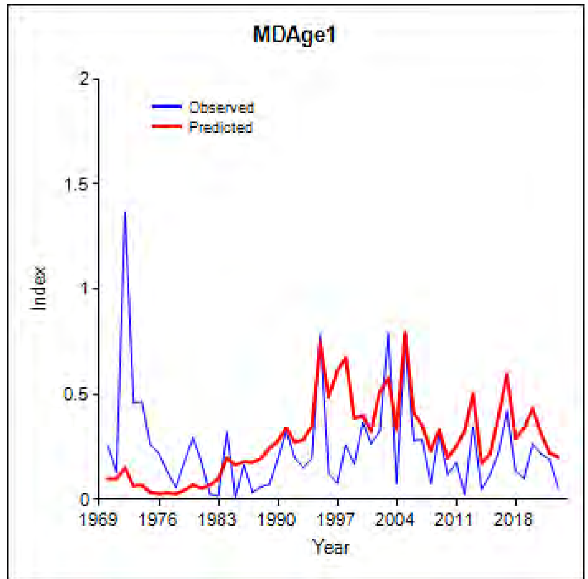
Year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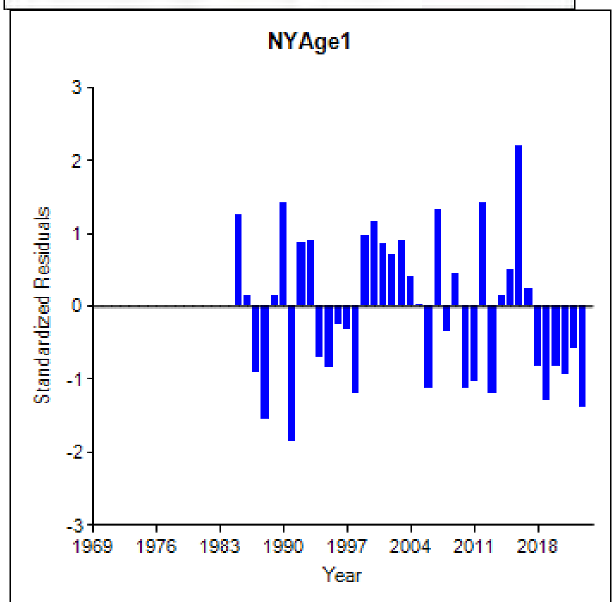
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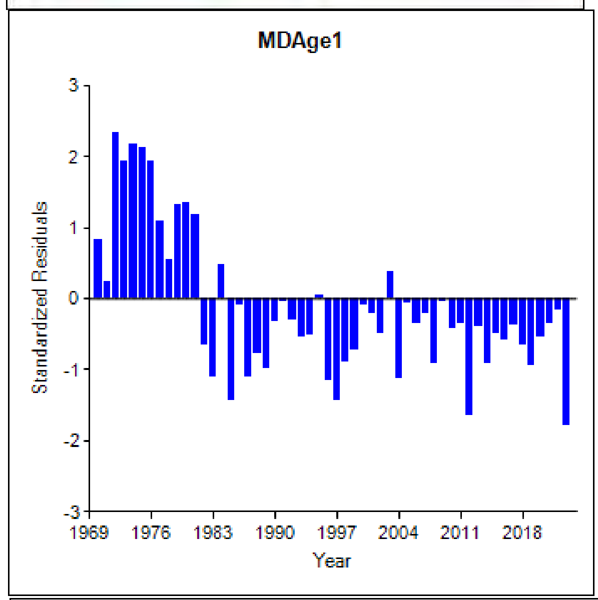
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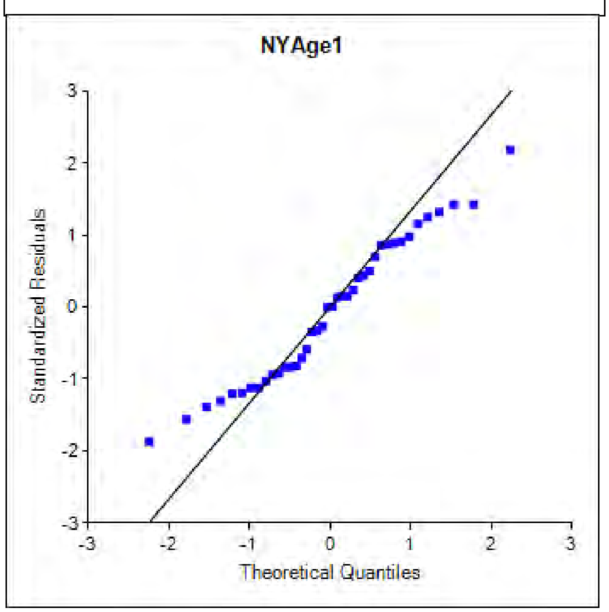
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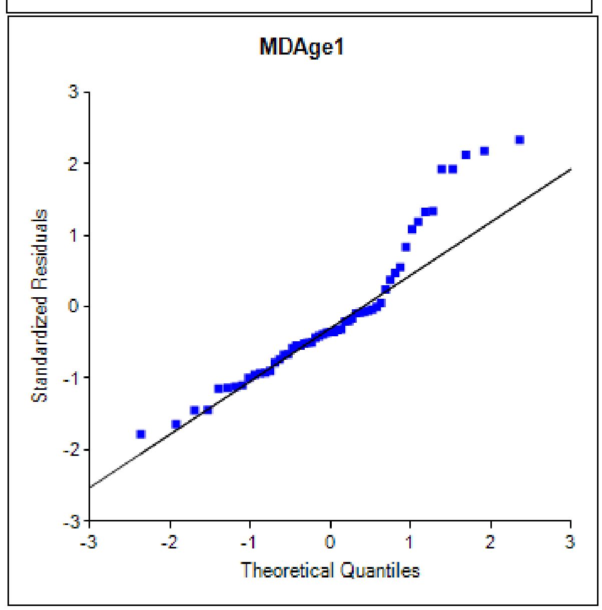
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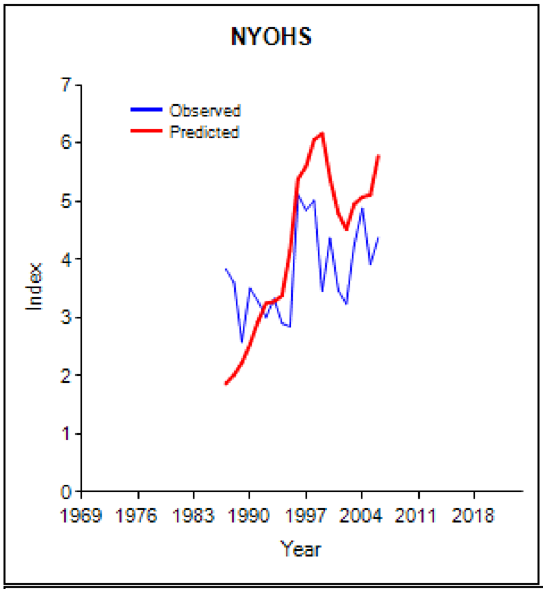
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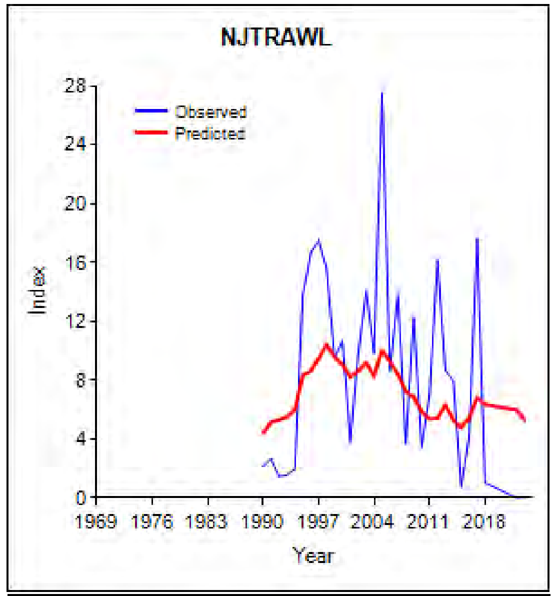
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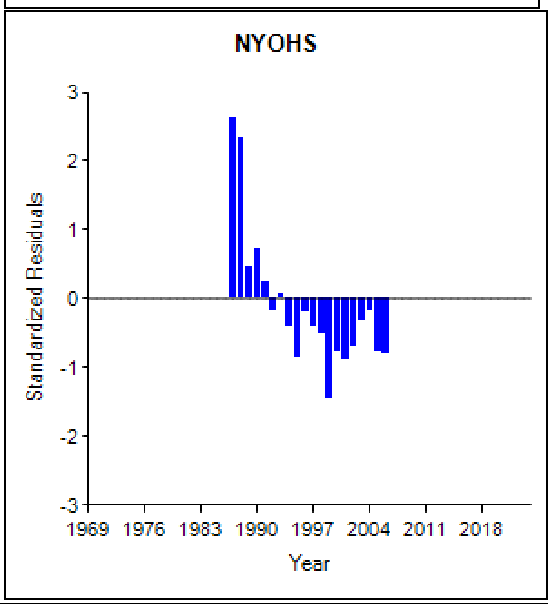
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Year
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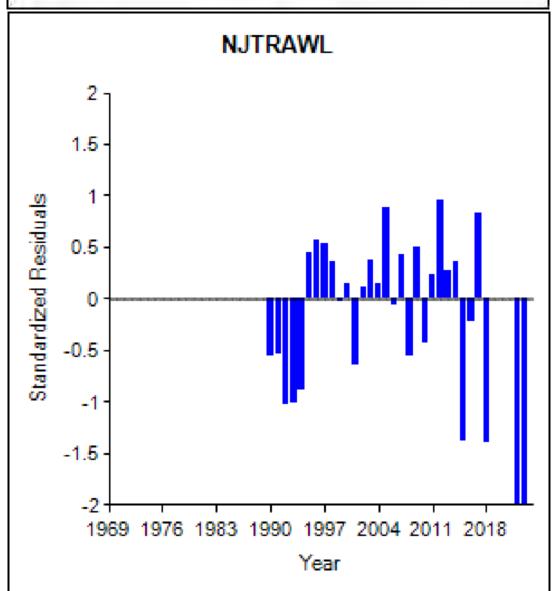
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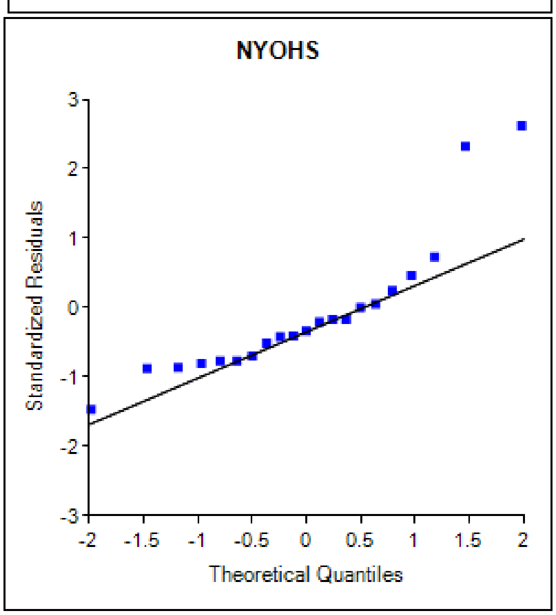
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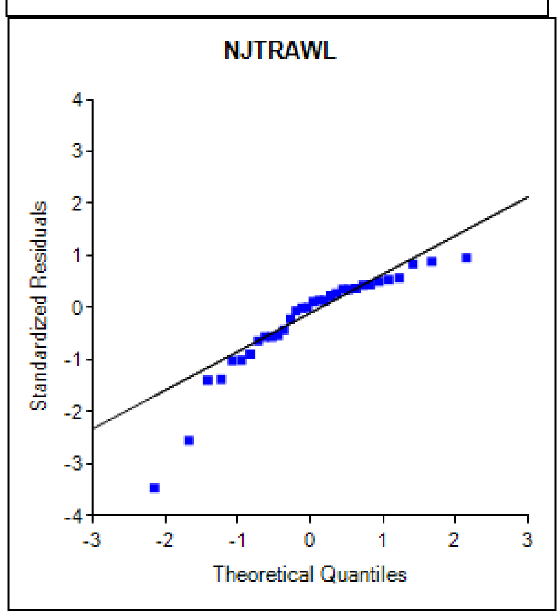
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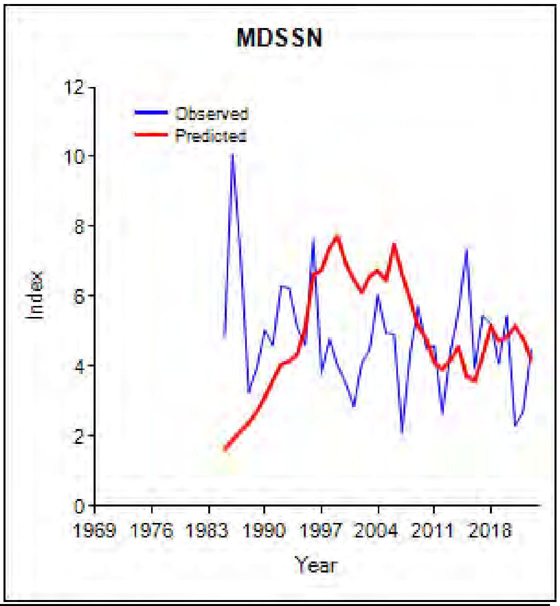
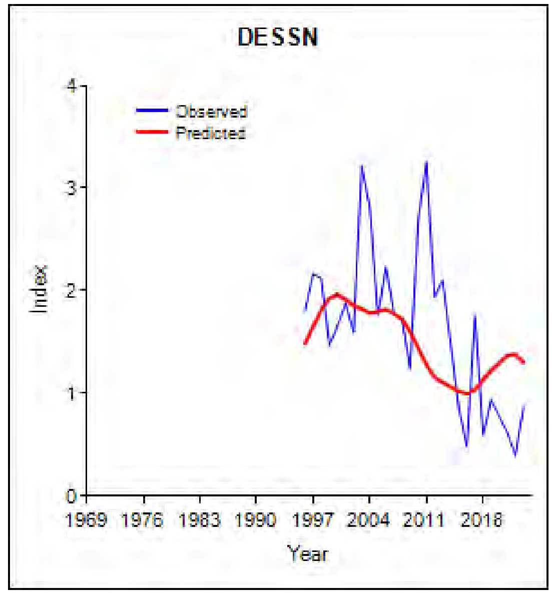
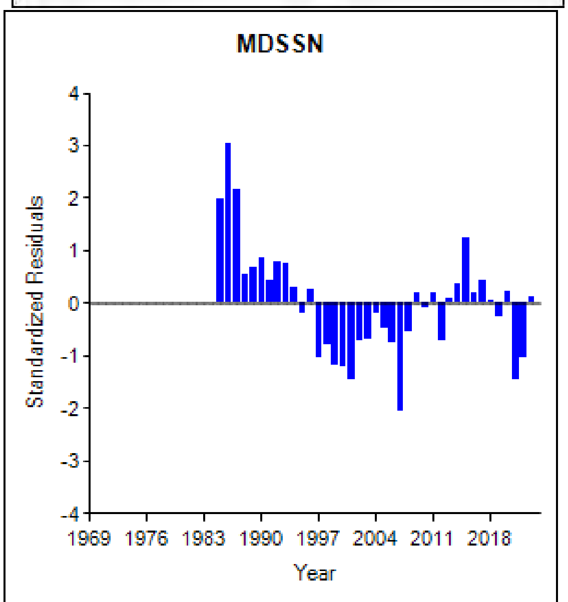
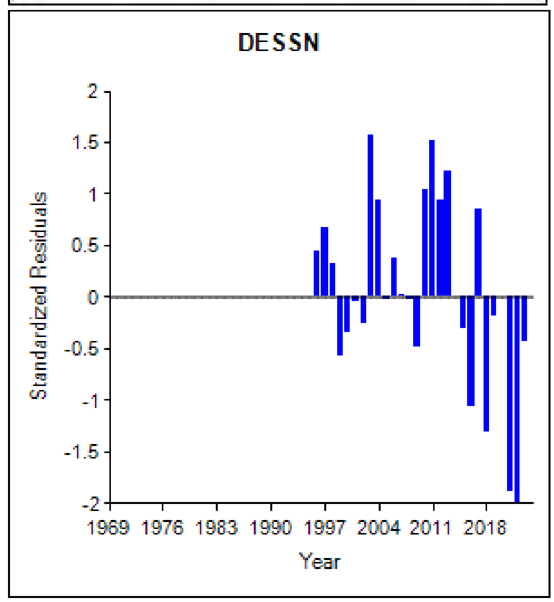
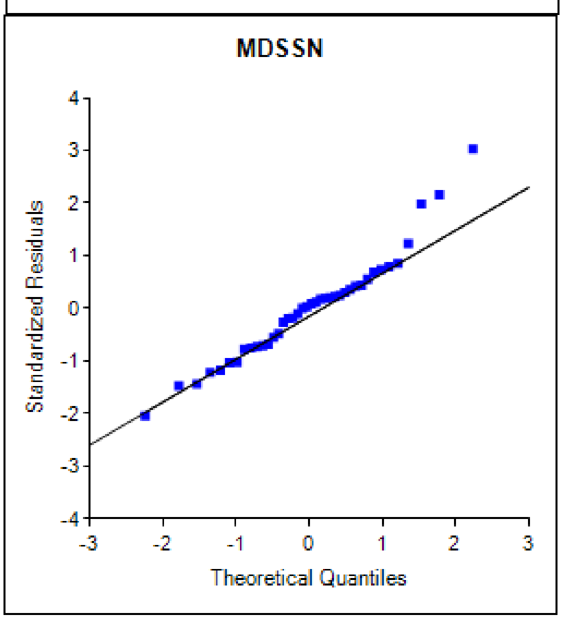
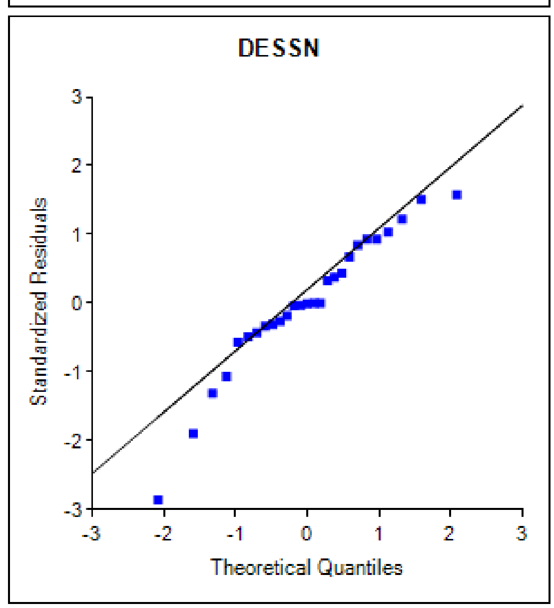

MDSSN
Observed
Predicted
Index
Year
0 2 4 6 8 10 12
1969 1976 1983 1990 1997 2004 2011 2018

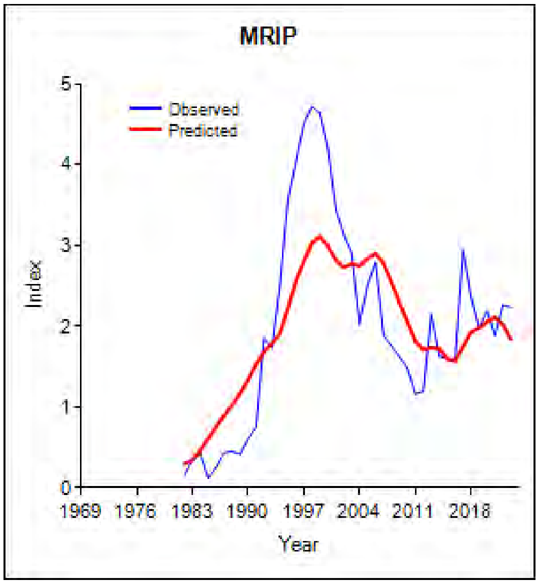

DESSN
Observed
Predicted
Index
Year
0 1 2 3 4
1969 1976 1983 1990 1997 2004 2011 2018

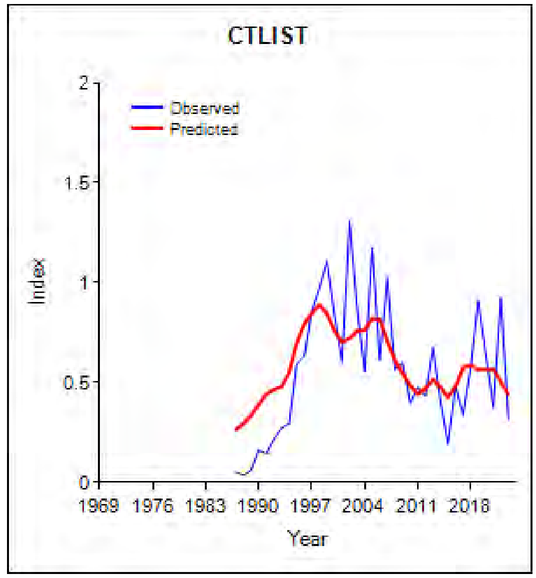

MDSSN
Standardized Residuals
Year
-4 -3 -2 -1 0 1 2 3 4
1969 1976 1983 1990 1997 2004 2011 2018

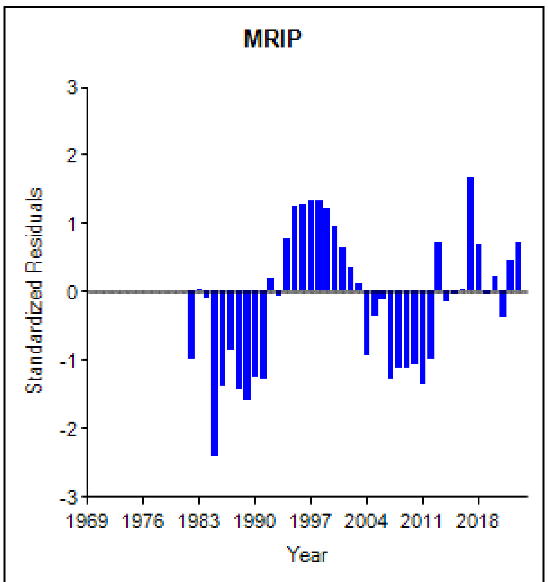

DESSN
Standardized Residuals
Year
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2
1969 1976 1983 1990 1997 2004 2011 2018

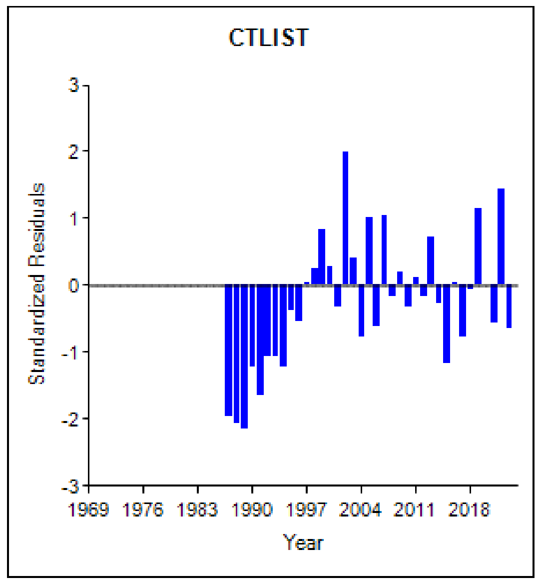

MDSSN
Standardized Residuals
Theoretical Quantiles
-4 -3 -2 -1 0 1 2 3 4
-3 -2 -1 0 1 2 3

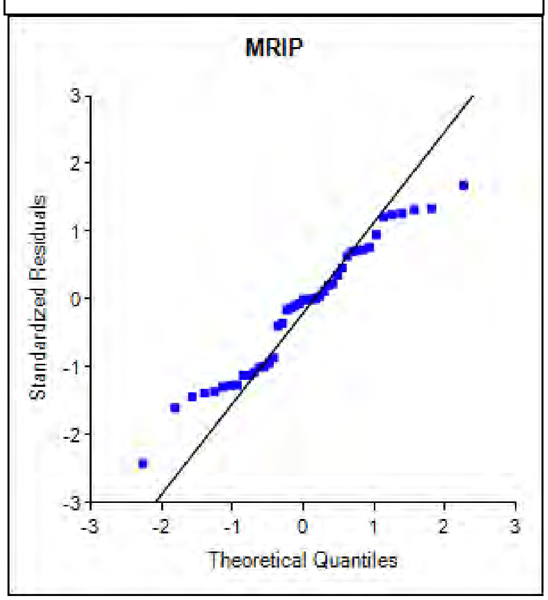

DESSN
Standardized Residuals
Theoretical Quantiles
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3

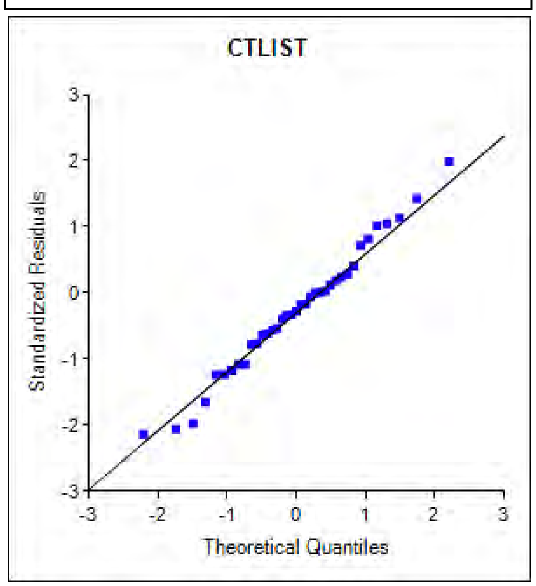

MRIP
Observed
Predicted
Index
Year

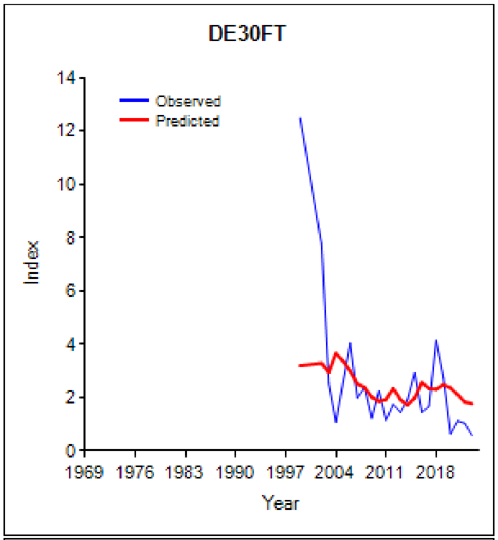

CTLIST
Observed
Predicted
Index
Year

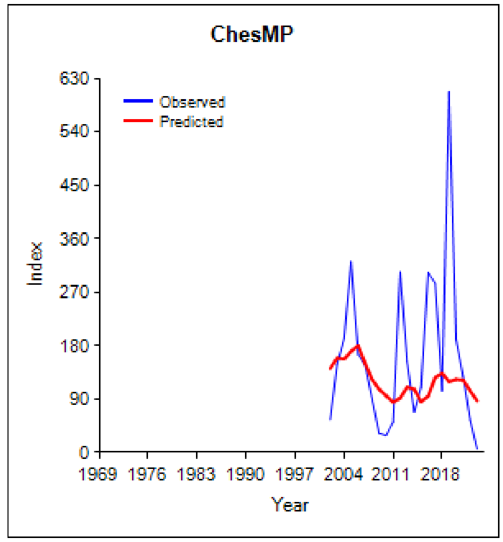

MRIP
Standardized Residuals
Year

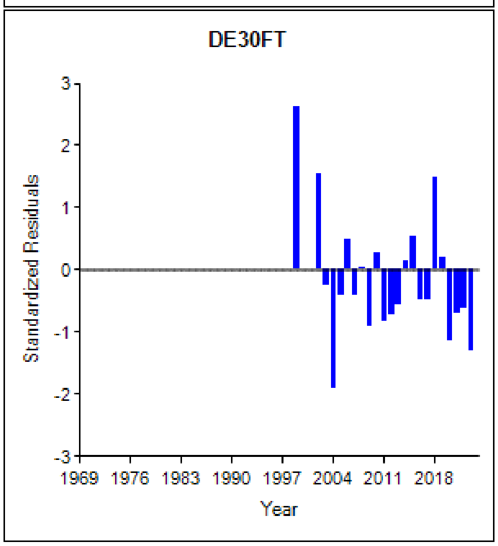

CTLIST
Standardized Residuals
Year

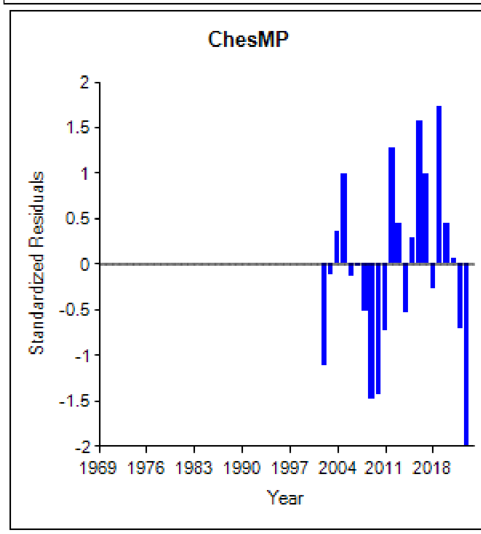

MRIP
Standardized Residuals
Theoretical Quantiles

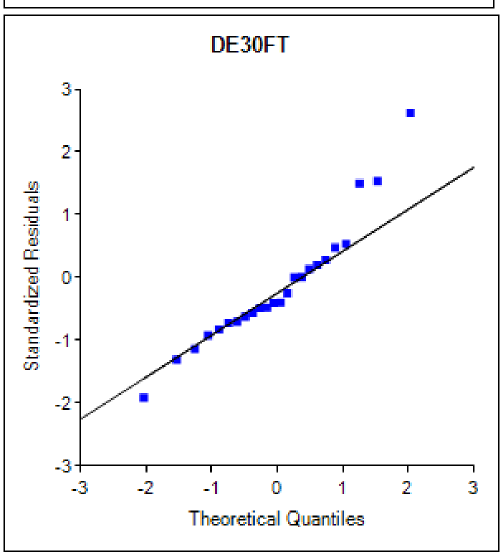

CTLIST
Standardized Residuals
Theoretical Quantiles


DE30FT
Observed
Predicted
Index
0
2
4
6
8
10
12
14
1969 1976 1983 1990 1997 2004 2011 2018
Year


ChesMP
Observed
Predicted
Index
0
90
180
270
360
450
540
630
1969 1976 1983 1990 1997 2004 2011 2018
Year


DE30FT
Standardized Residuals
-3
-2
-1
0
1
2
3
1969 1976 1983 1990 1997 2004 2011 2018
Year


ChesMP
Standardized Residuals
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
1969 1976 1983 1990 1997 2004 2011 2018
Year


DE30FT
Standardized Residuals
-3
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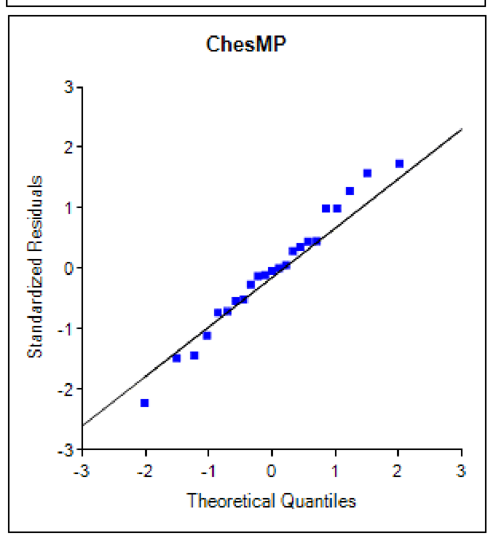
-1
0
1
2
3
-3 -2 -1 0 1 2 3
Theoretical Quantiles


ChesMP
Standardized Residuals
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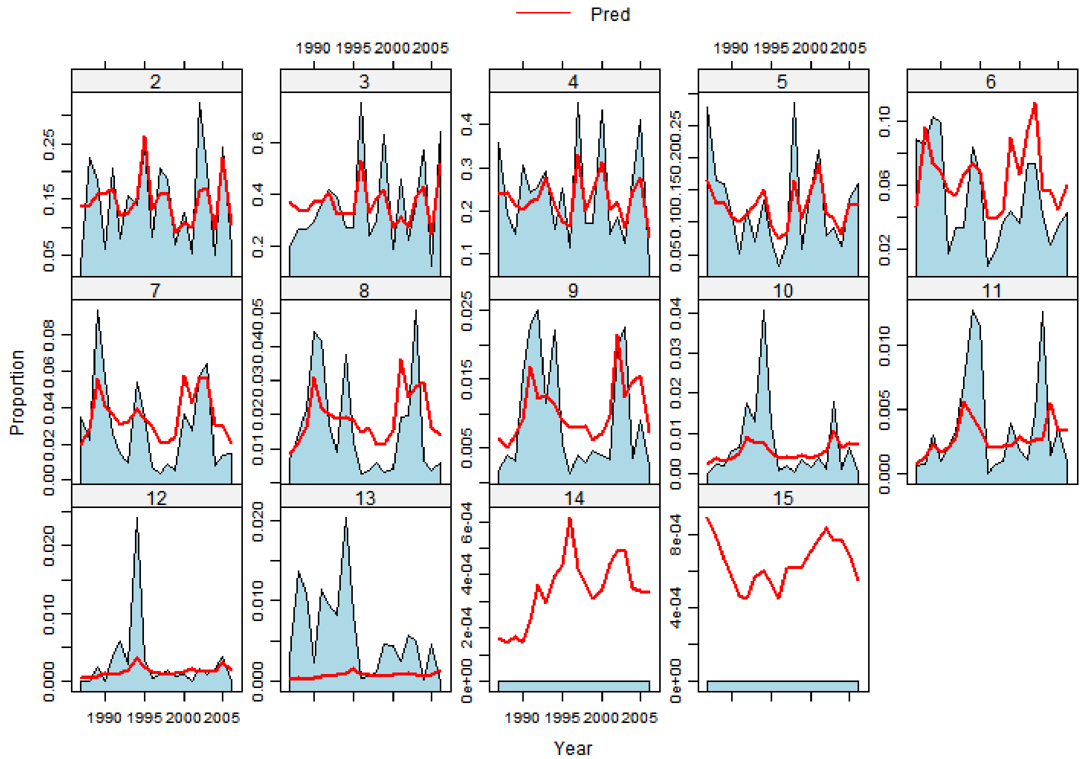
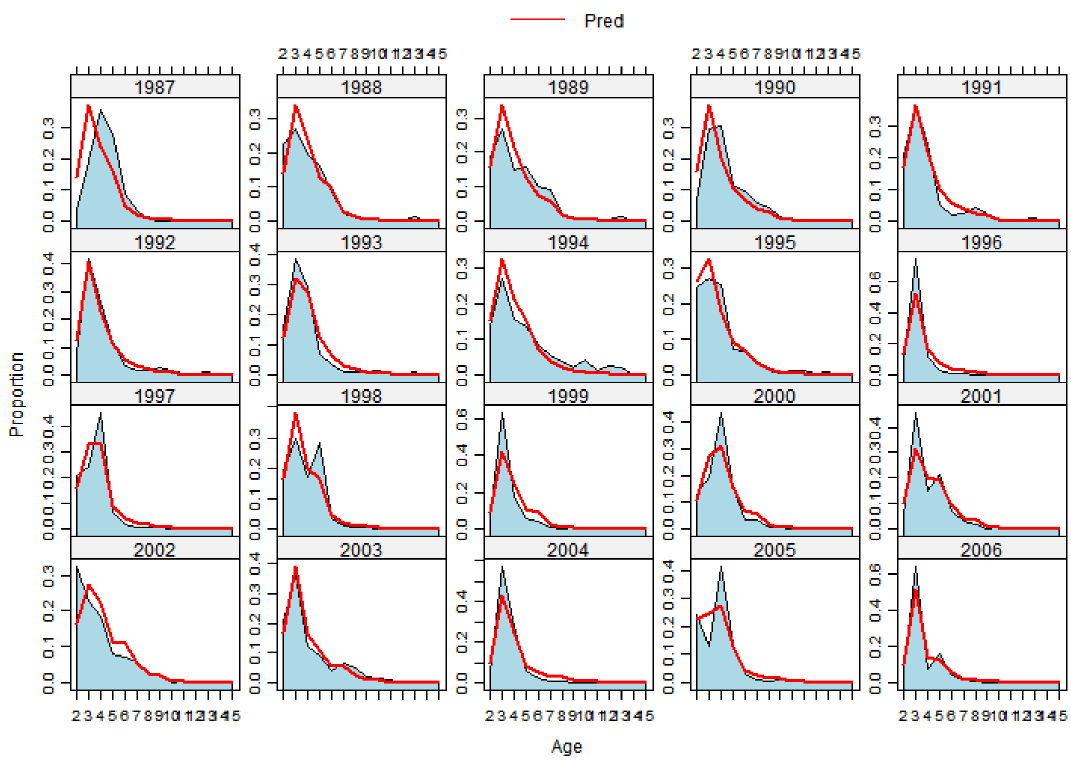
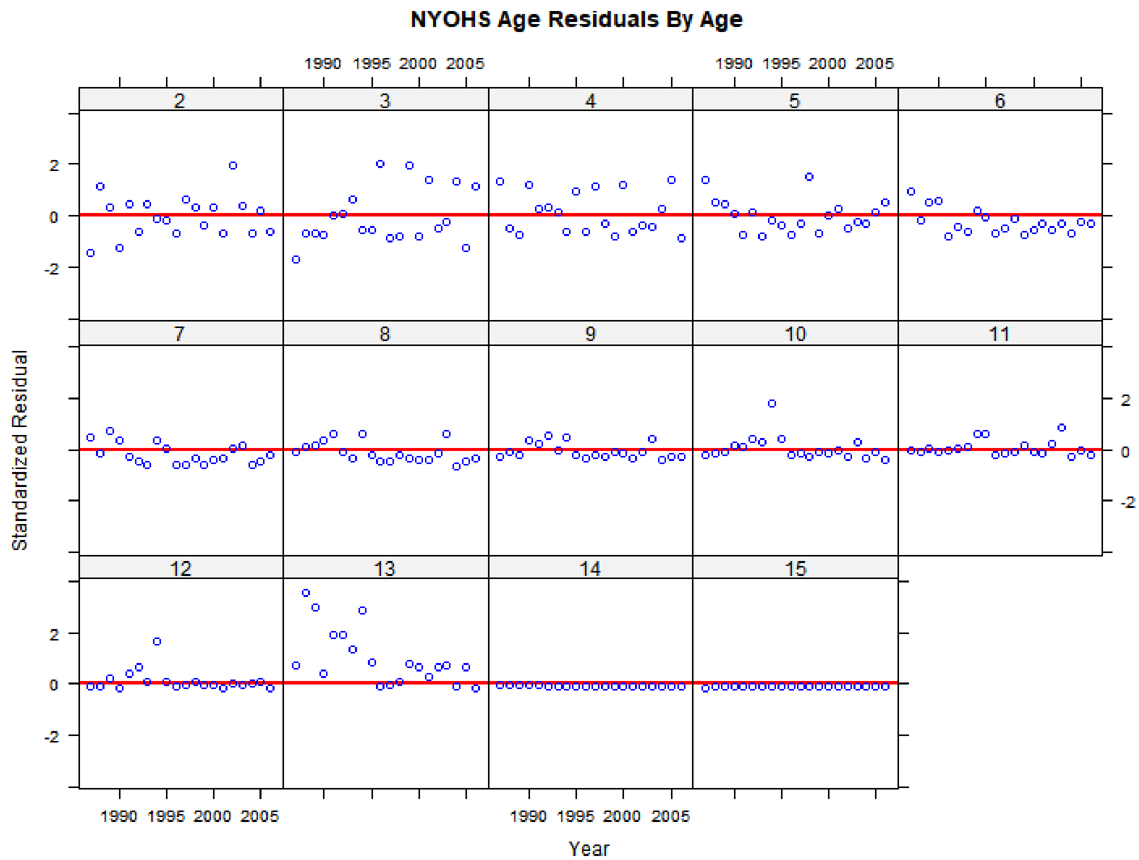
-2
-1
0
1
2
3
-3 -2 -1 0 1 2 3
Theoretical Quantiles

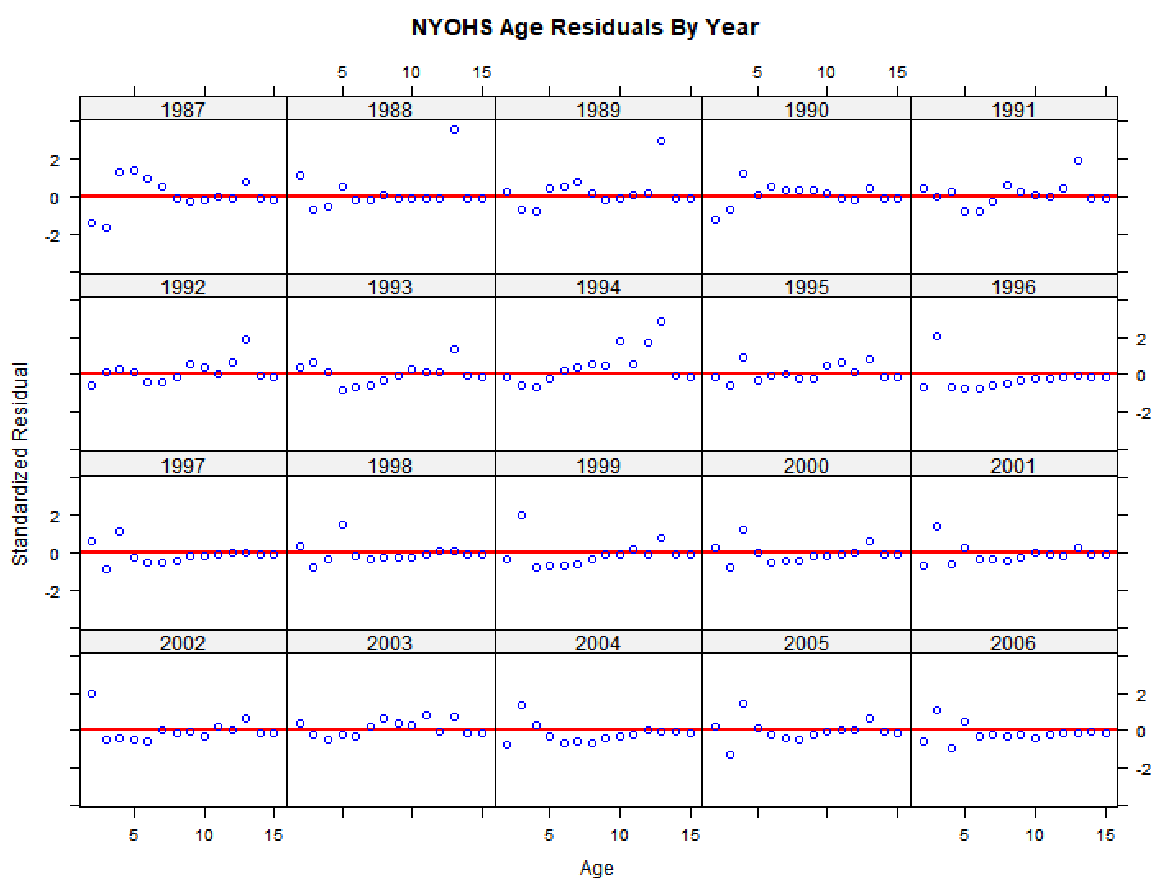
NYOHS Age Composition By Age

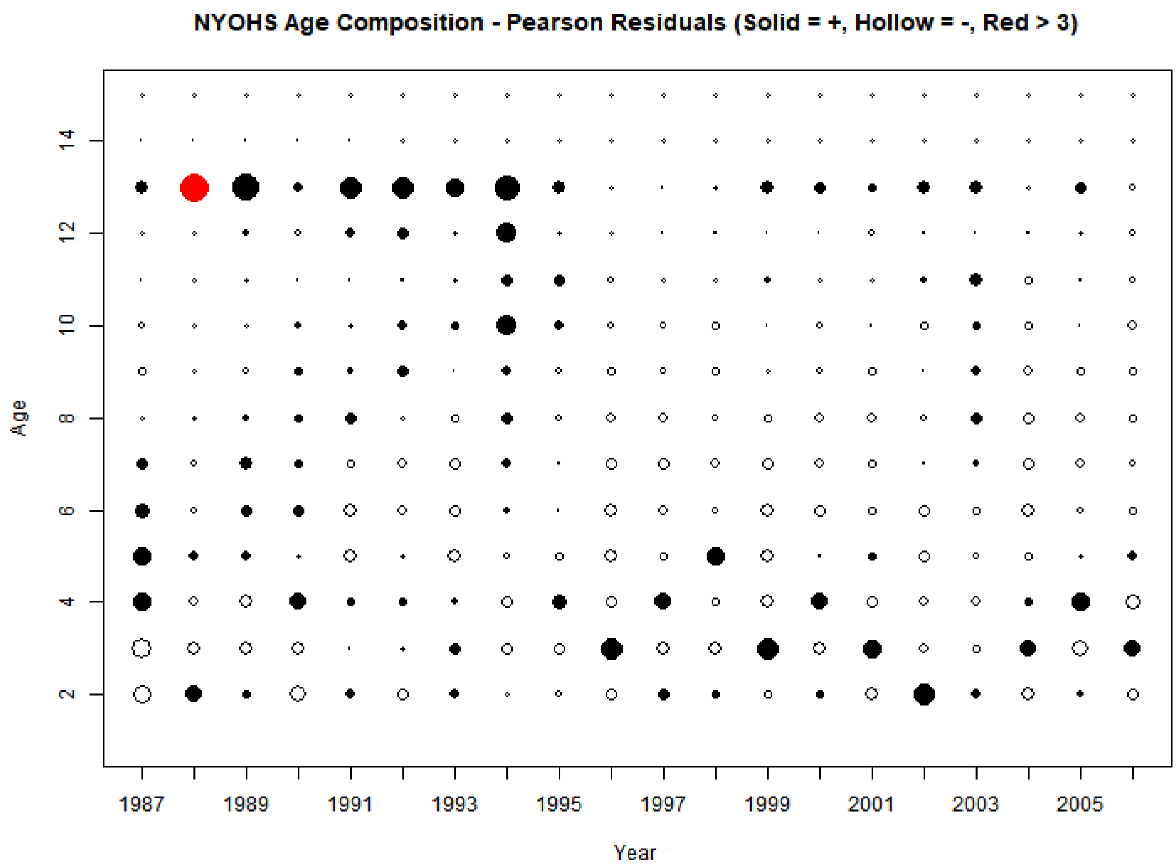


NYOHS Age Composition By Year

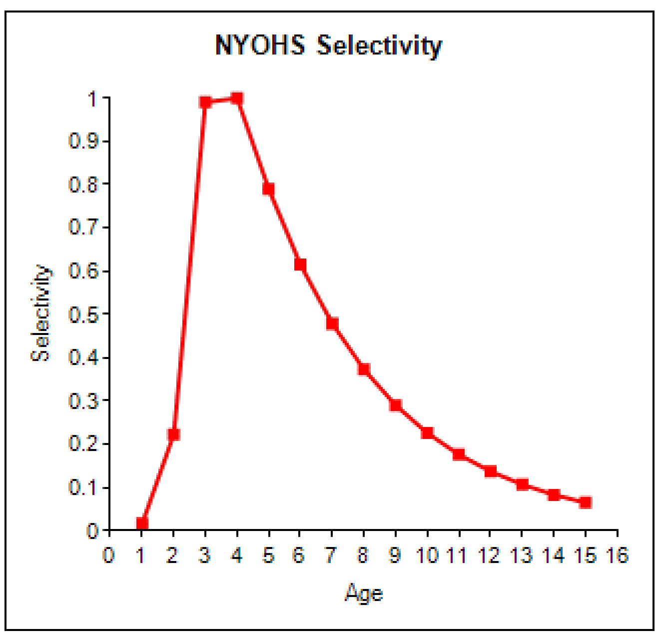



NYOHS Age Residuals By Age
Standardized Residual
Year
1990 1995 2000 2005
2 3 4 5 6 7 8 9 10 11 12 13 14 15


NYOHS Age Residuals By Year
Standardized Residual
Age
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006

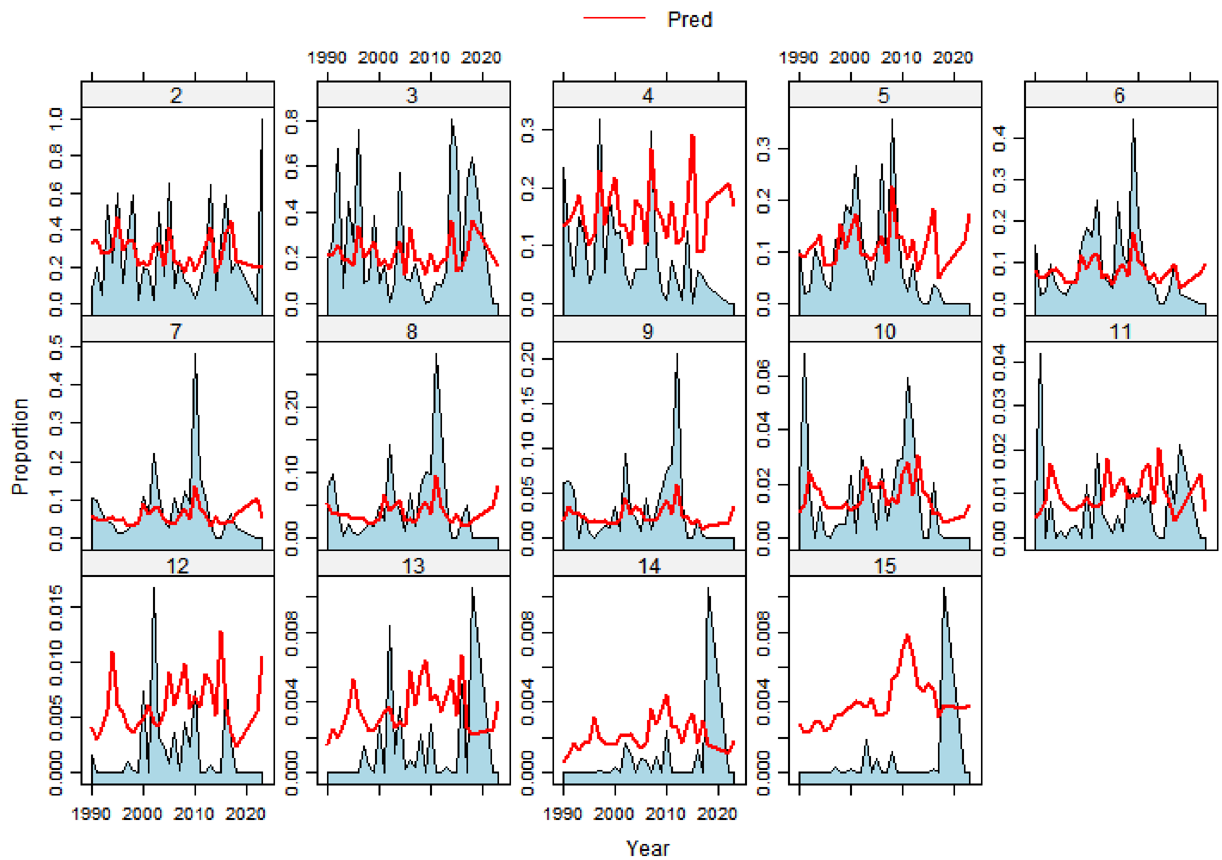


NYOHS Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
Year

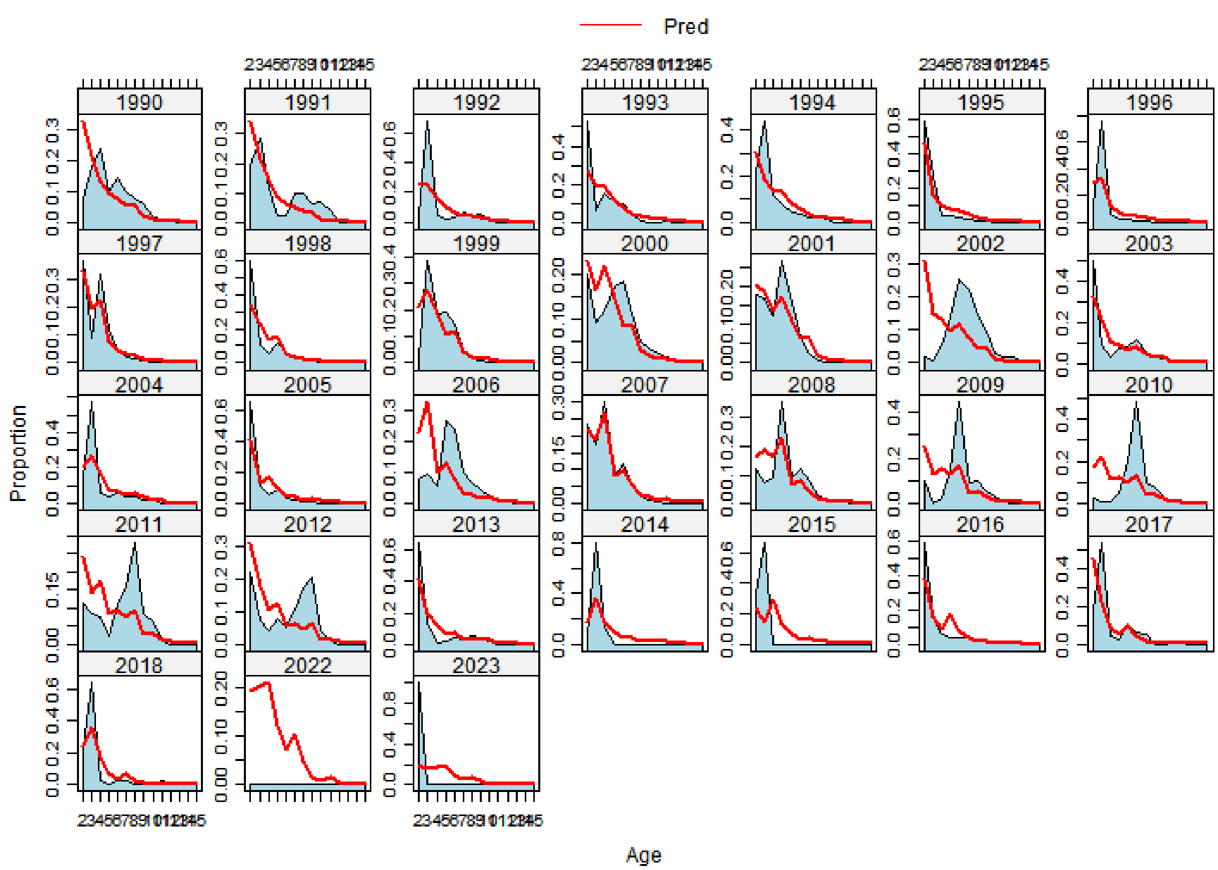


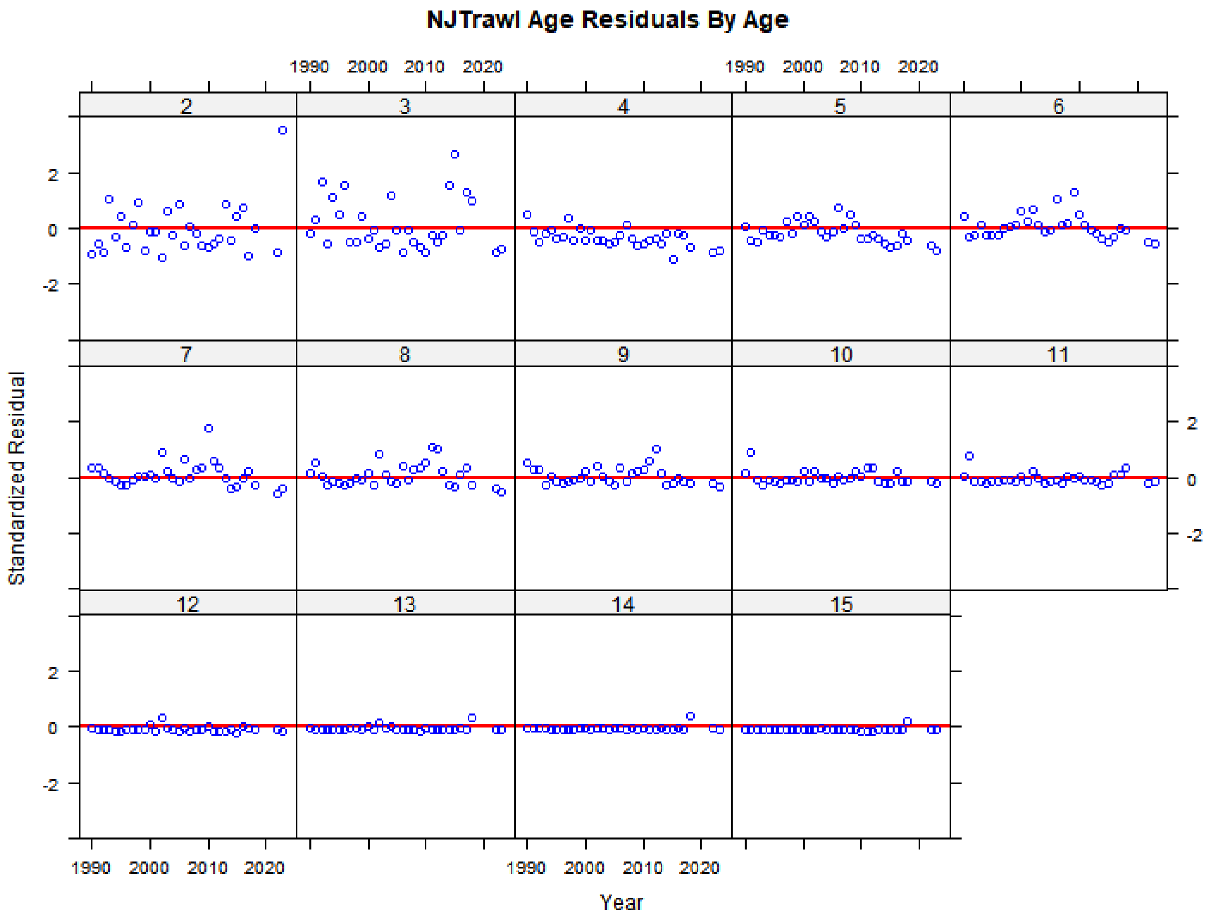
NYOHS Selectivity
Selectivity
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age

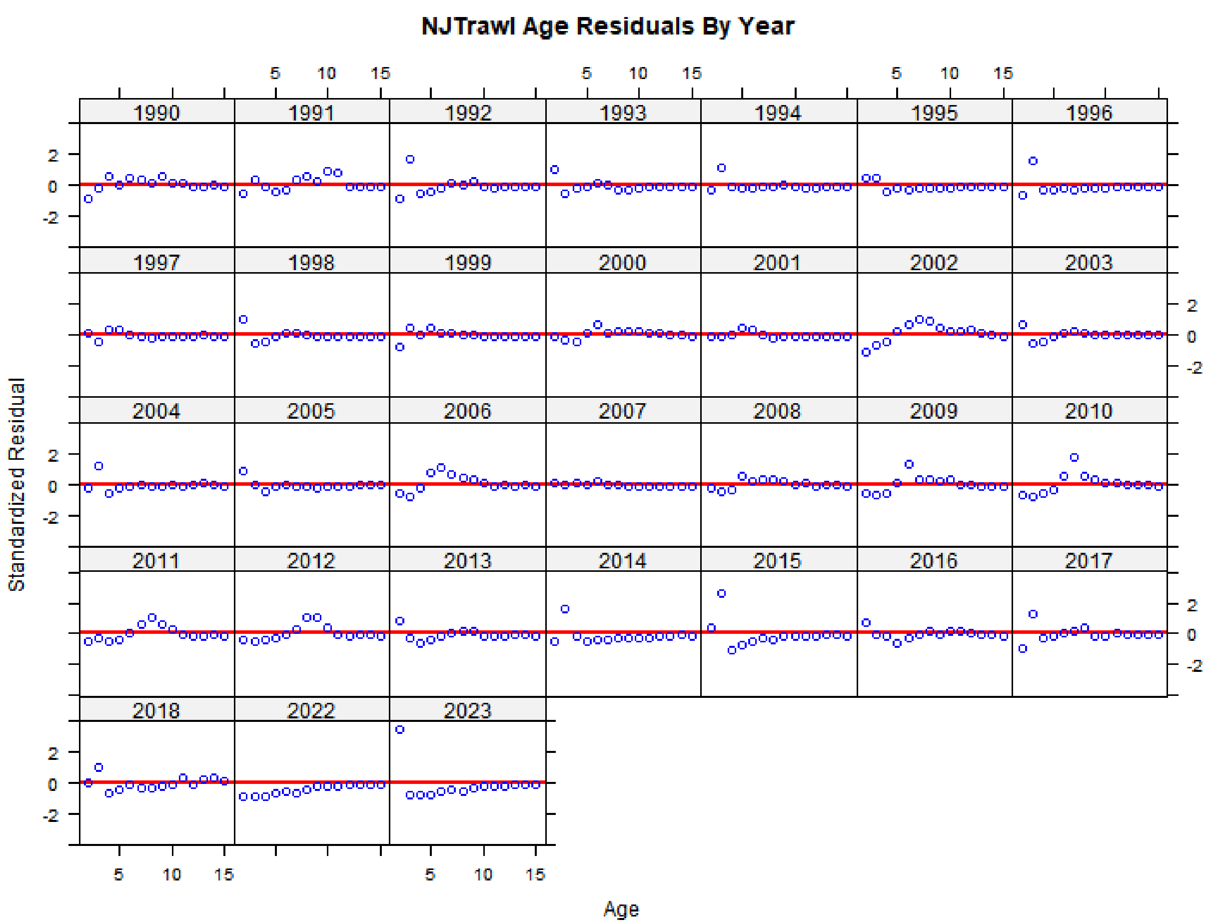
NJTrawl Age Composition By Age

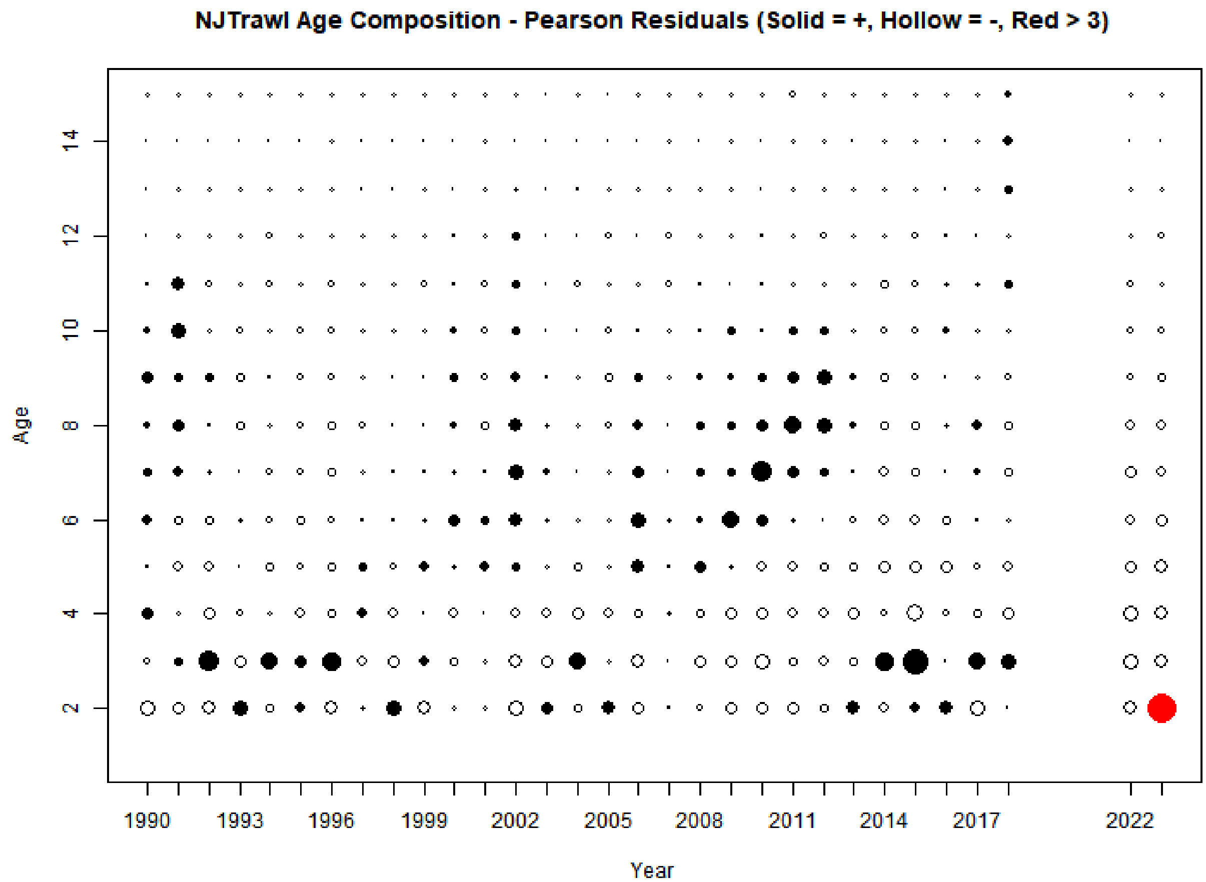


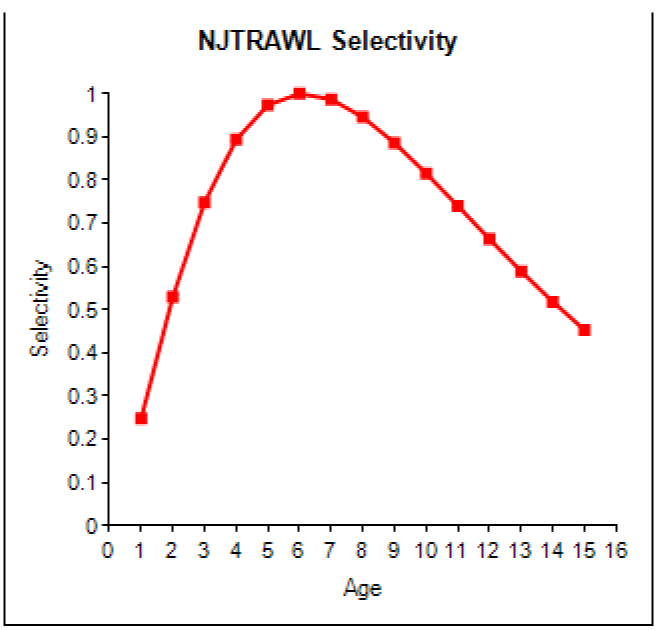
NJTrawl Age Composition By Year

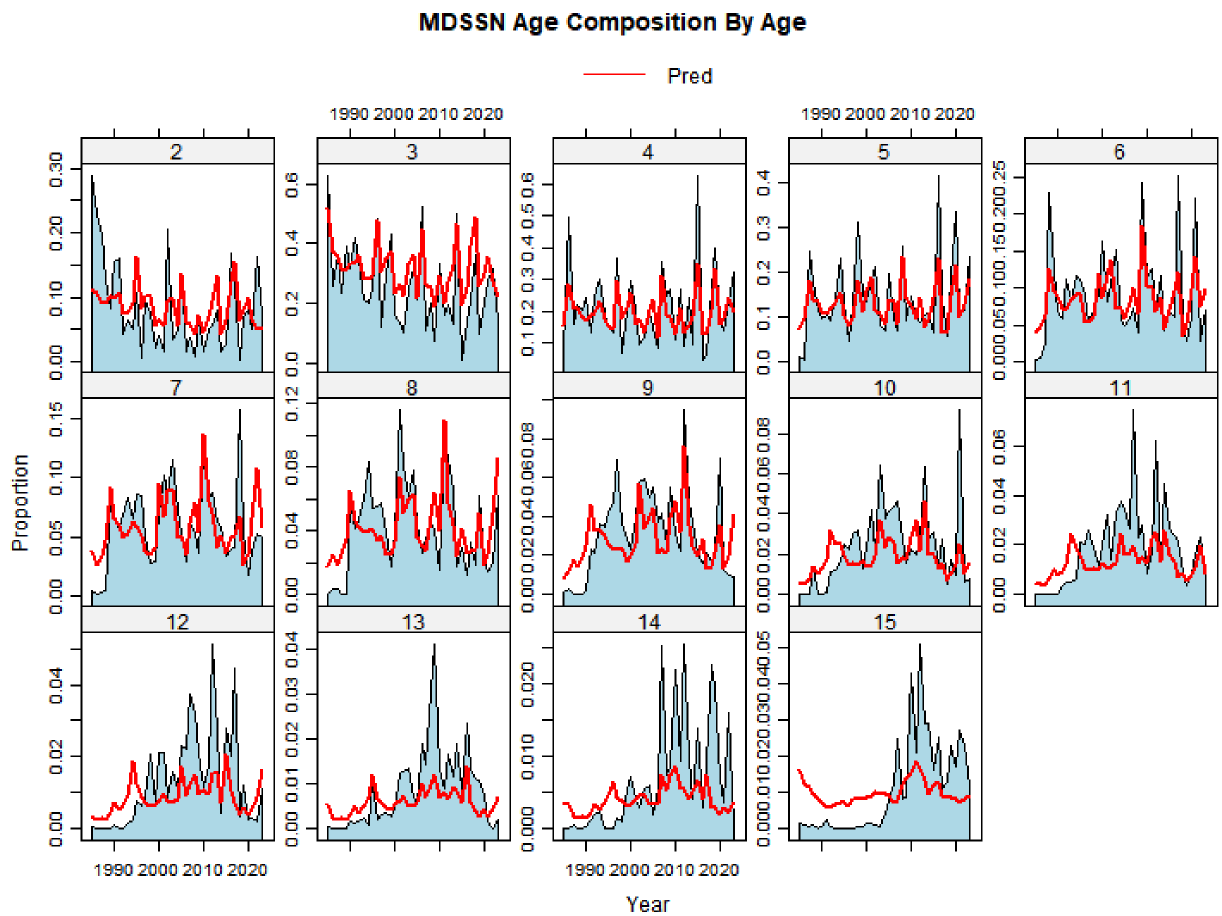


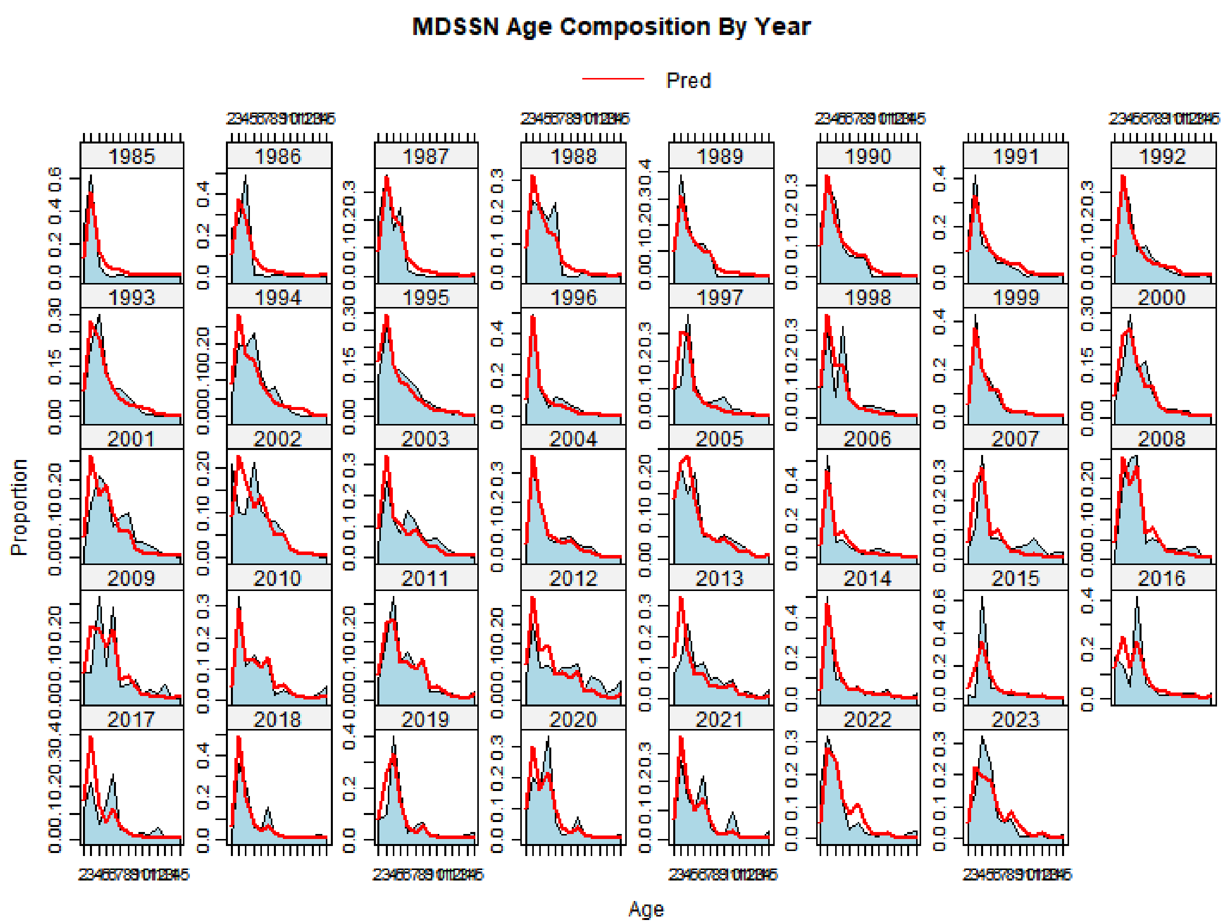

NJTrawl Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990
2000
2010
2020


NJTrawl Age Residuals By Year
Standardized Residual
Age
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2022
2023


NJTrawl Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2022


NJTRAWL Selectivity
Selectivity
Age


MDSSN Age Composition By Age
Pred
Proportion
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990 2000 2010 2020


MDSSN Age Composition By Year
Pred
Proportion
Age
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
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2003
2004
2005
2006
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2014
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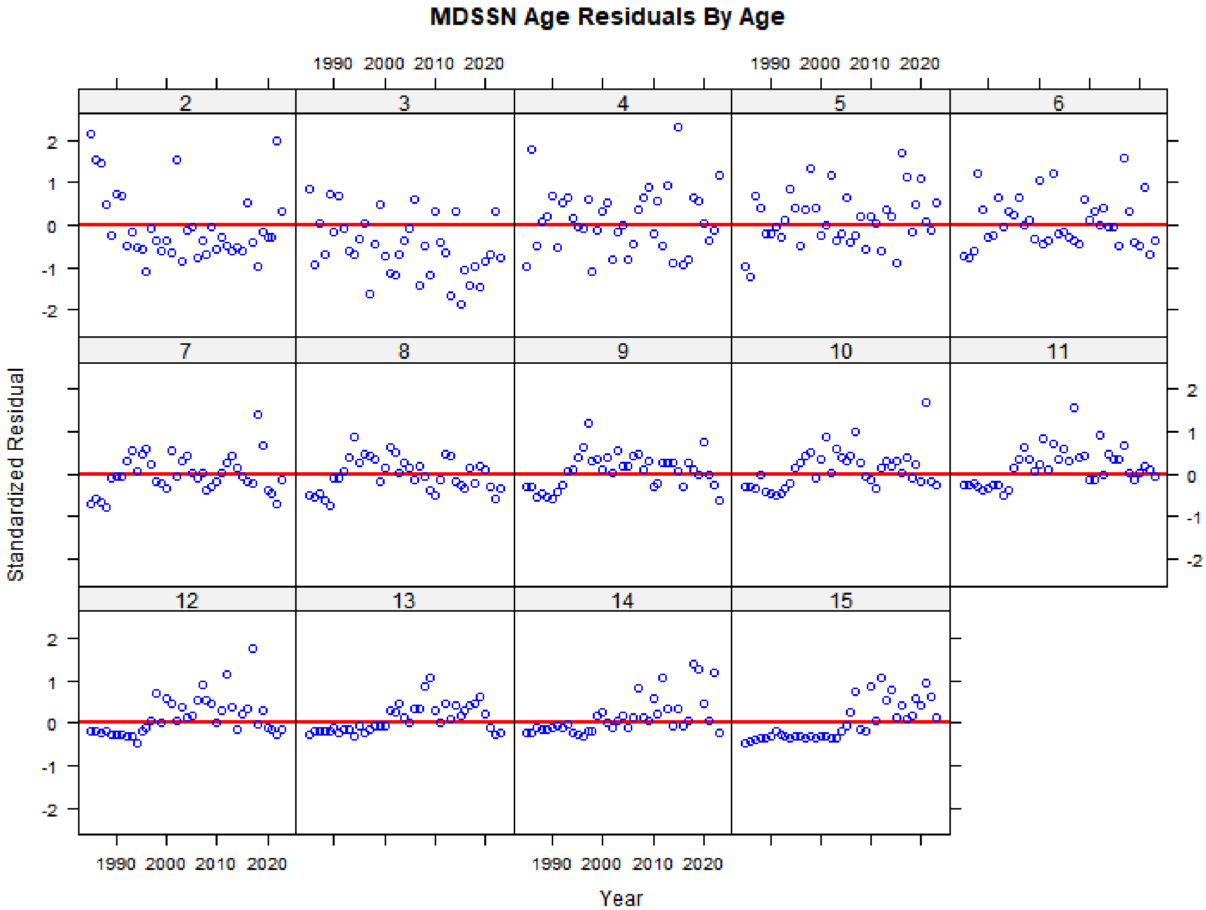
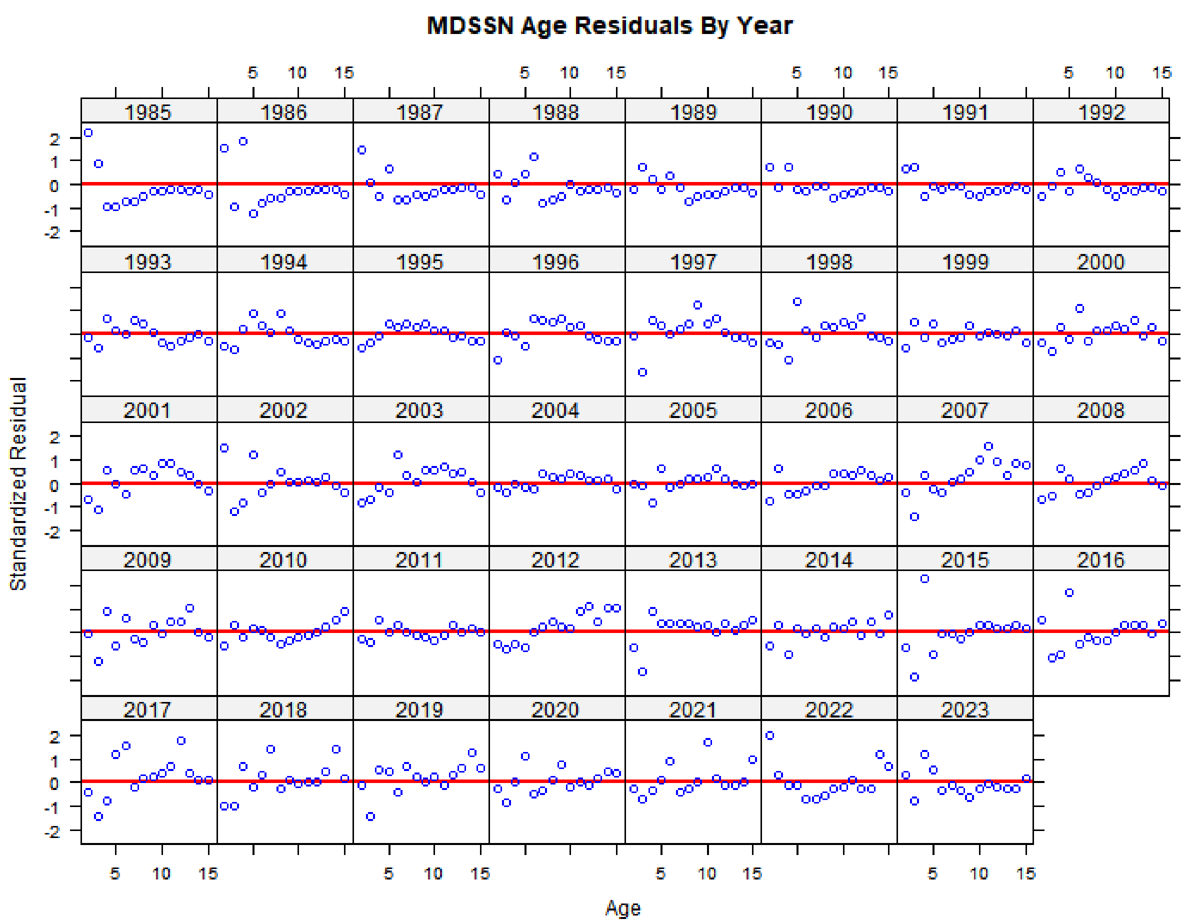
2016
2017
2018
2019
2020
2021
2022
2023


MDSSN Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1990 2000 2010 2020


MDSSN Age Residuals By Year
Standardized Residual
Age
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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2006
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2012
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2014
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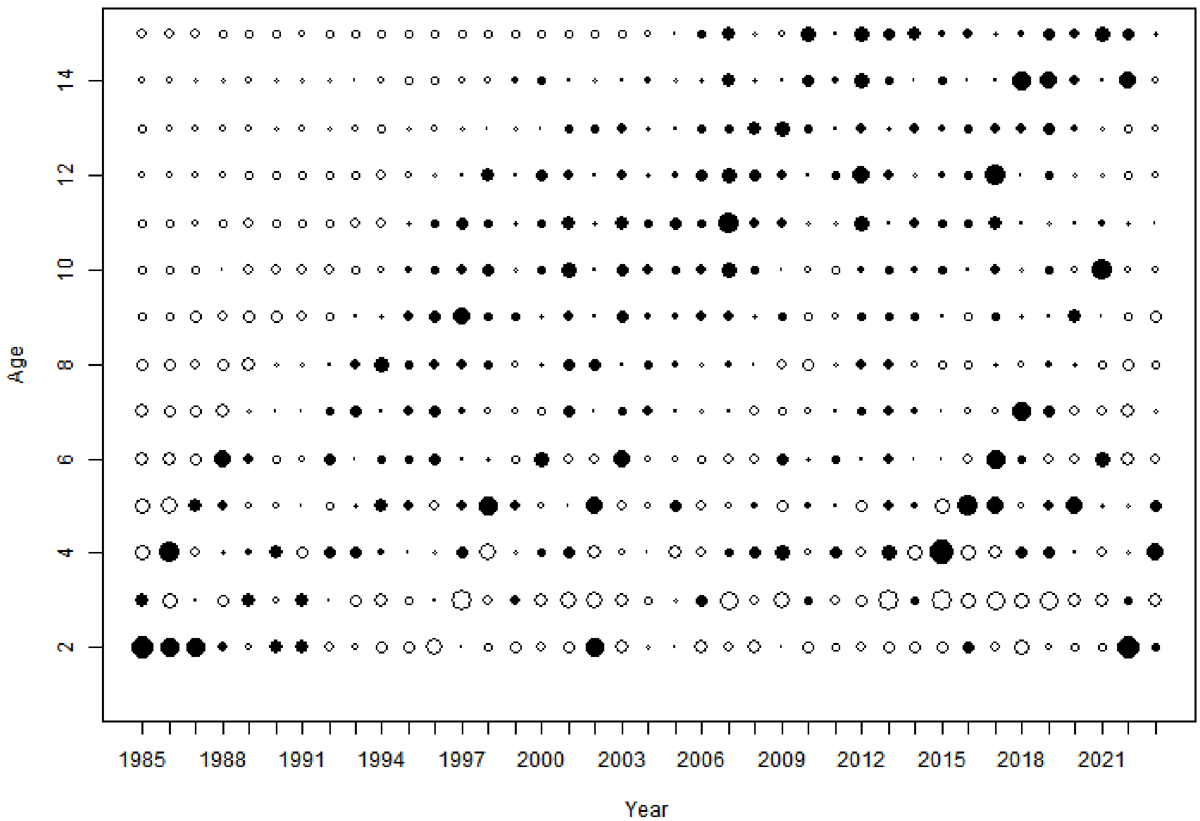
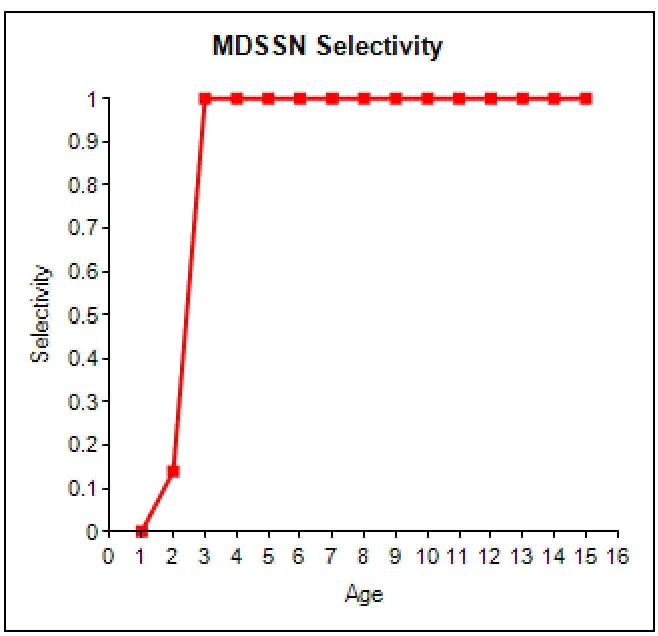
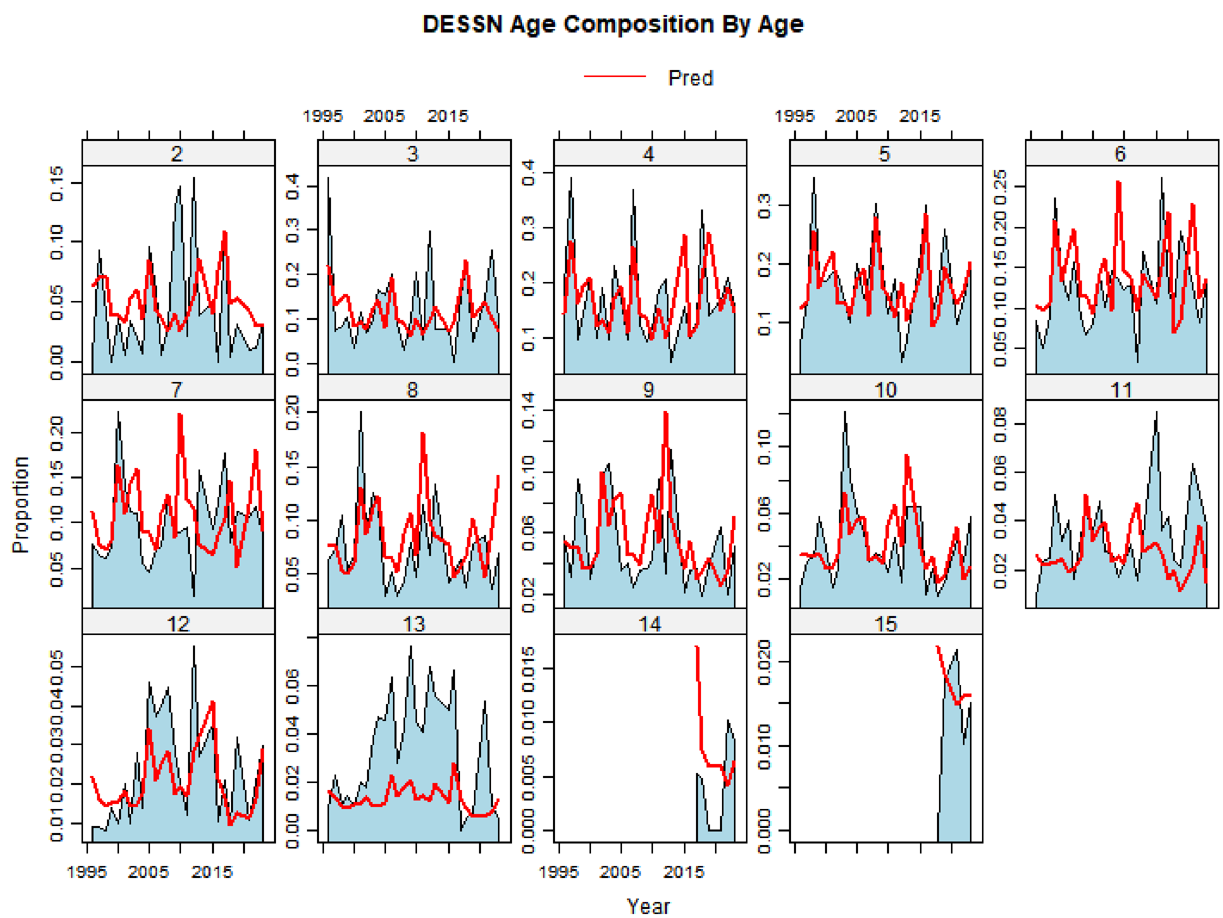
2016
2017
2018
2019
2020
2021
2022
2023
5 10 15

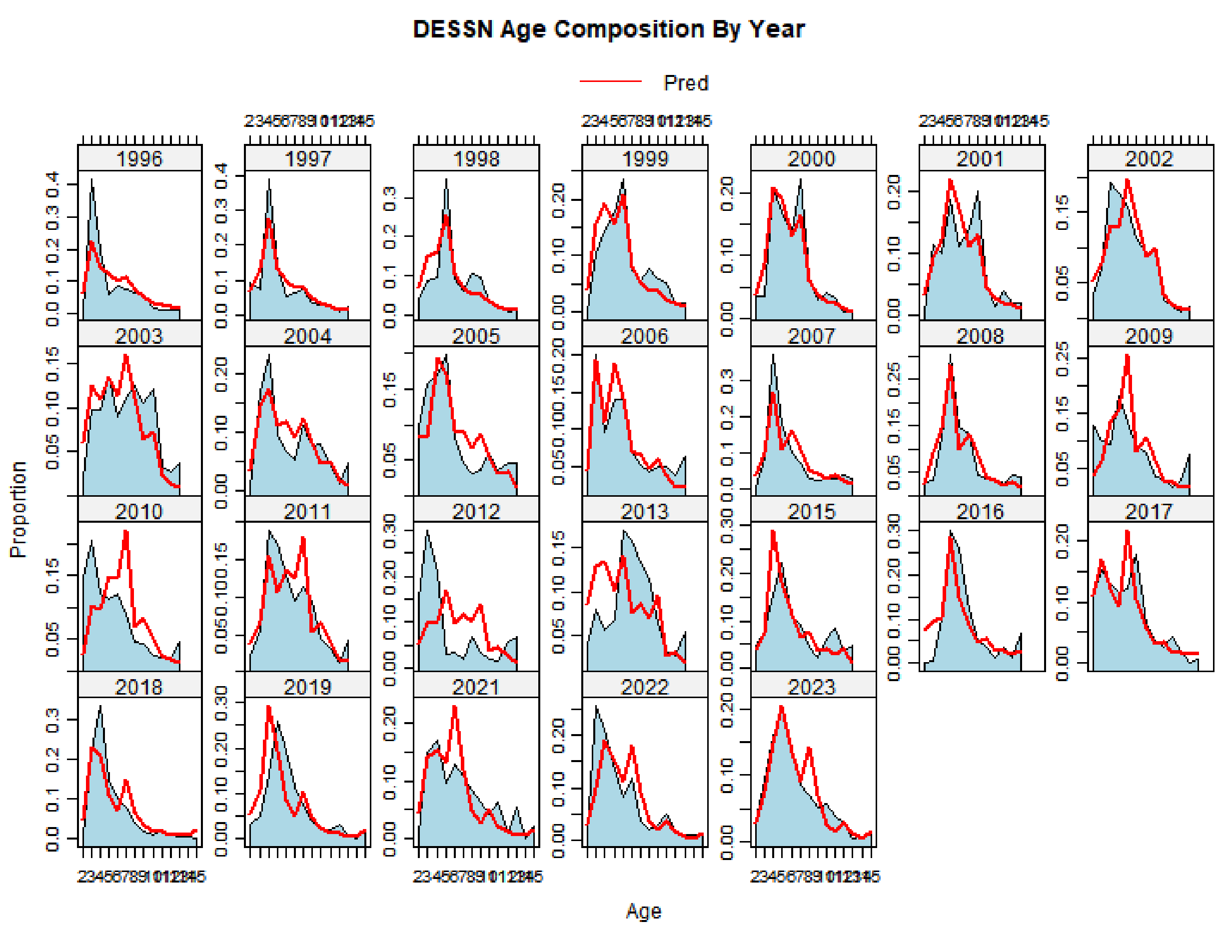
MDSSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)



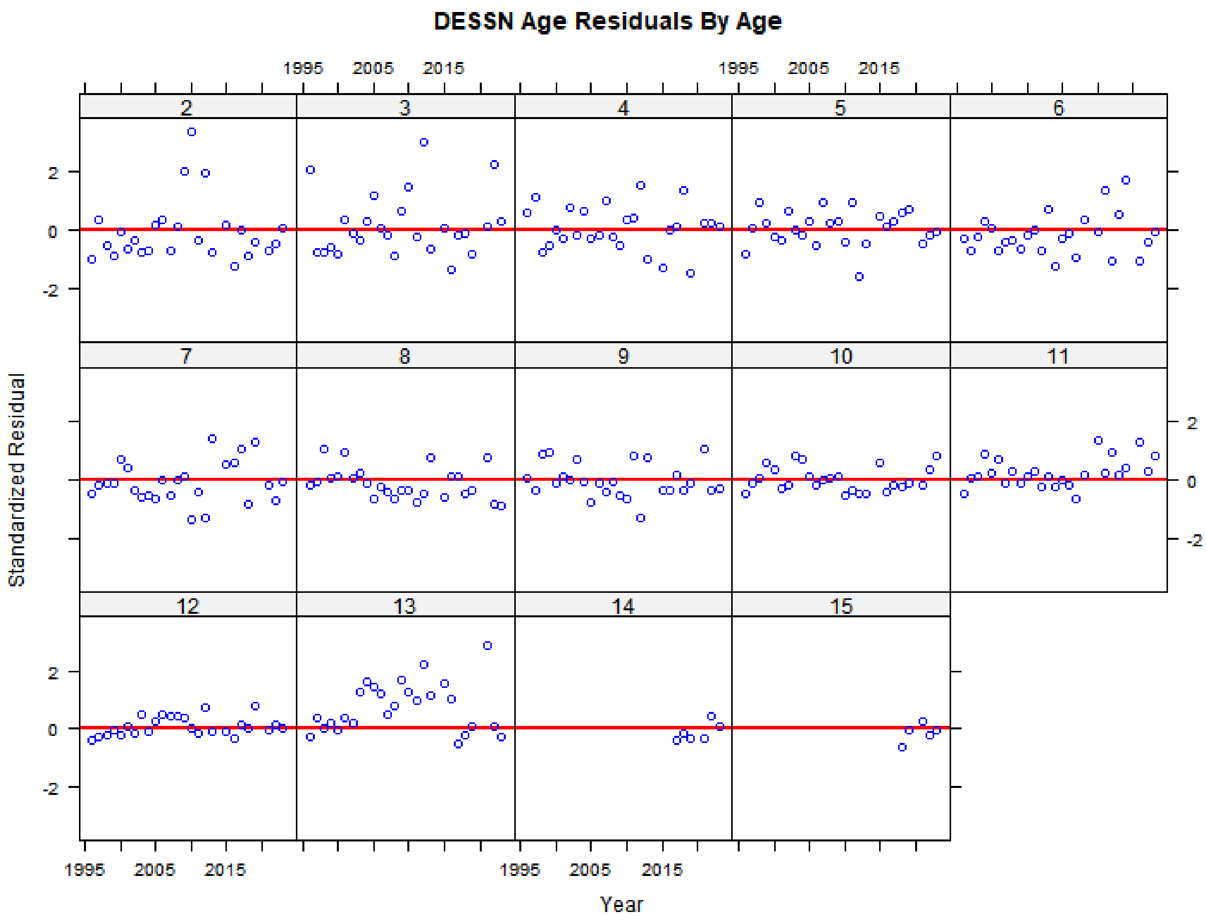


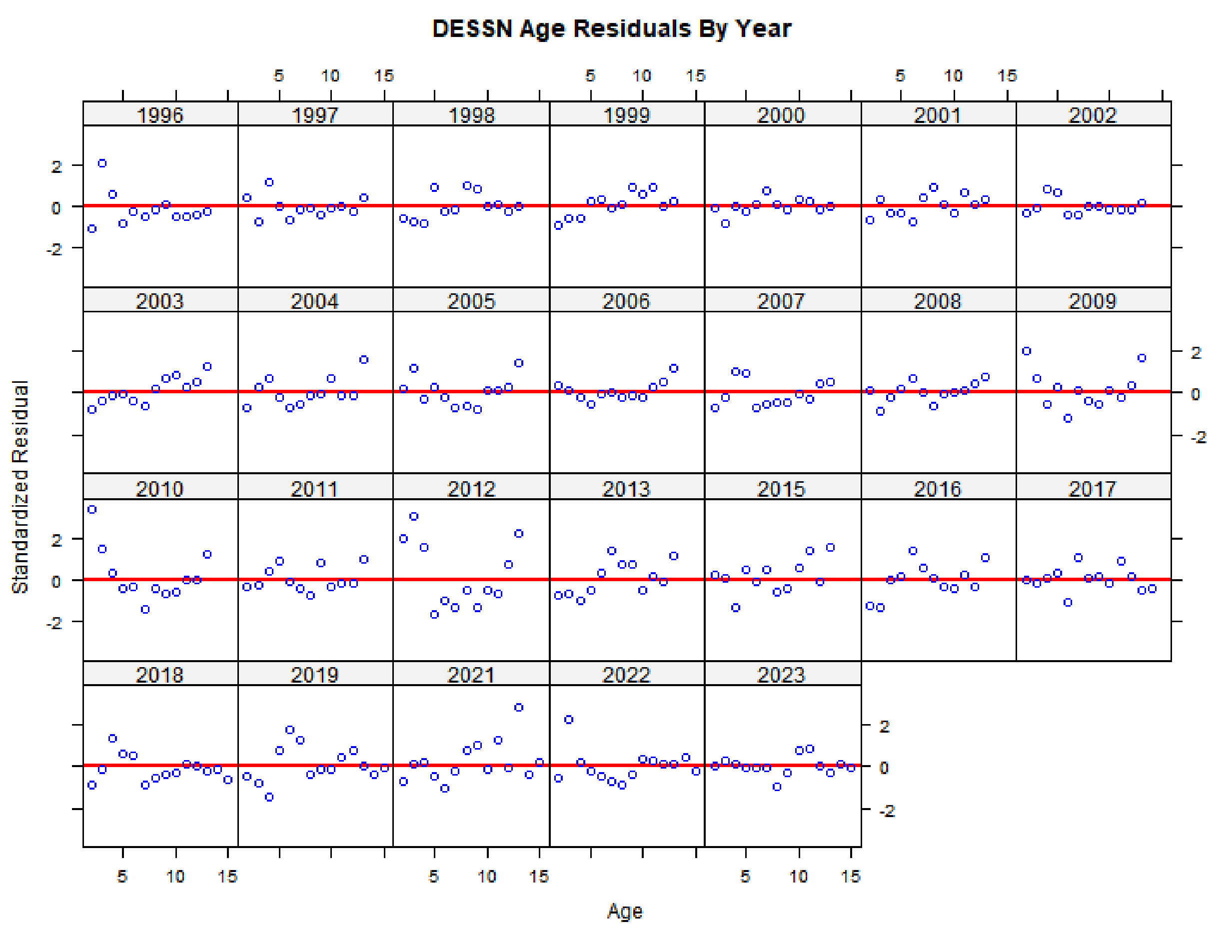


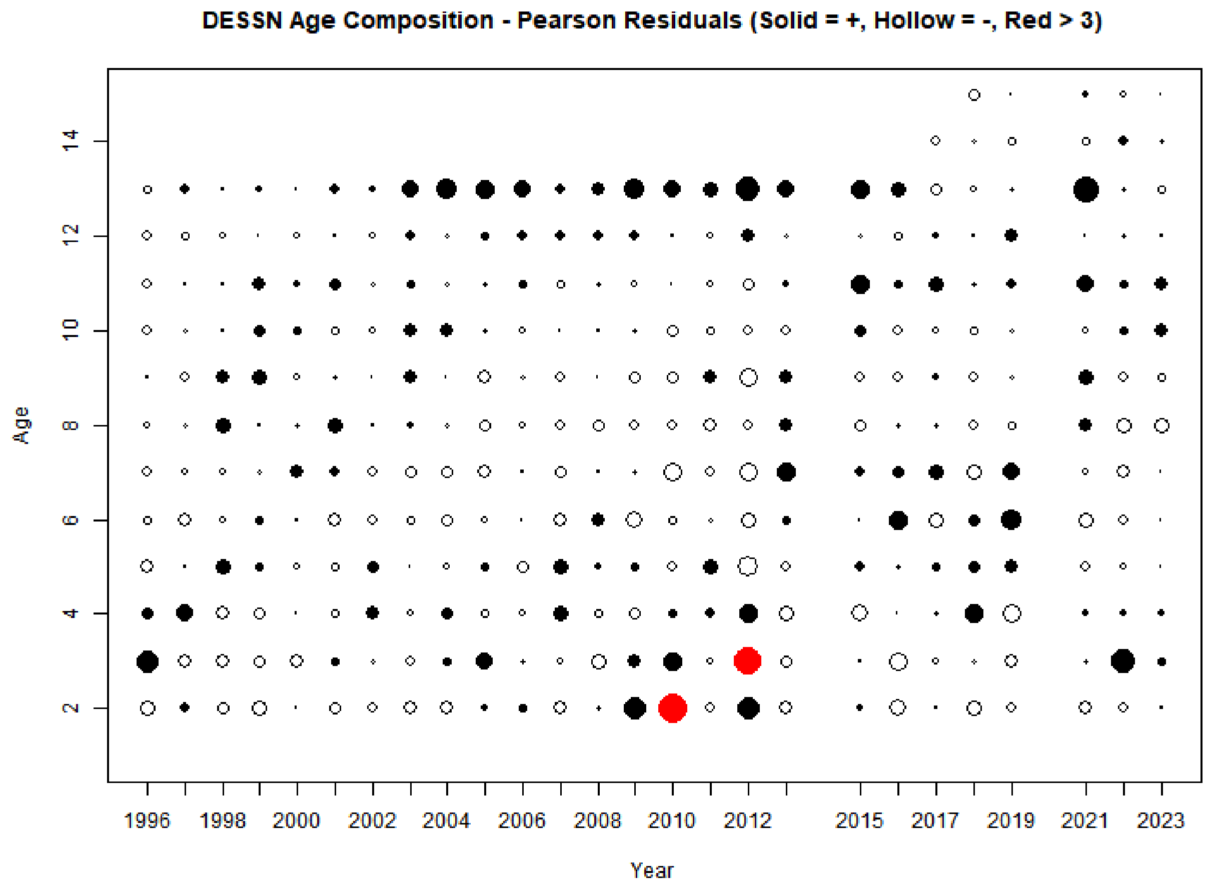
DESSN Age Composition By Age
Pred
Proportion
Year

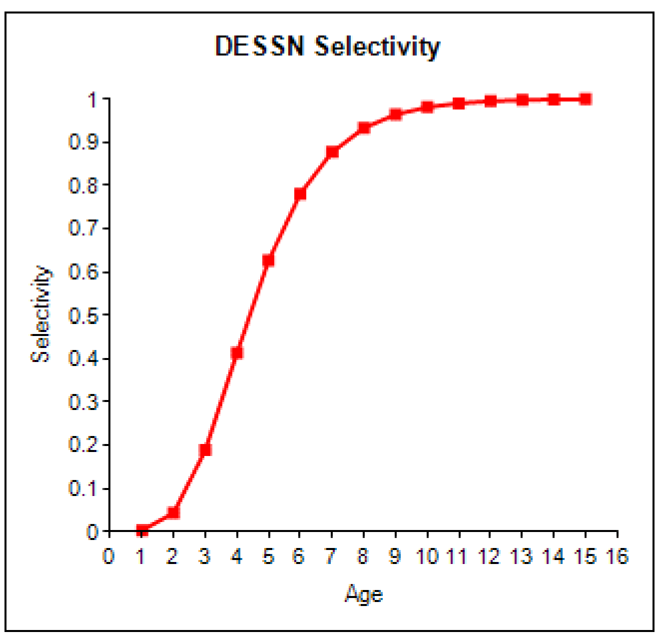


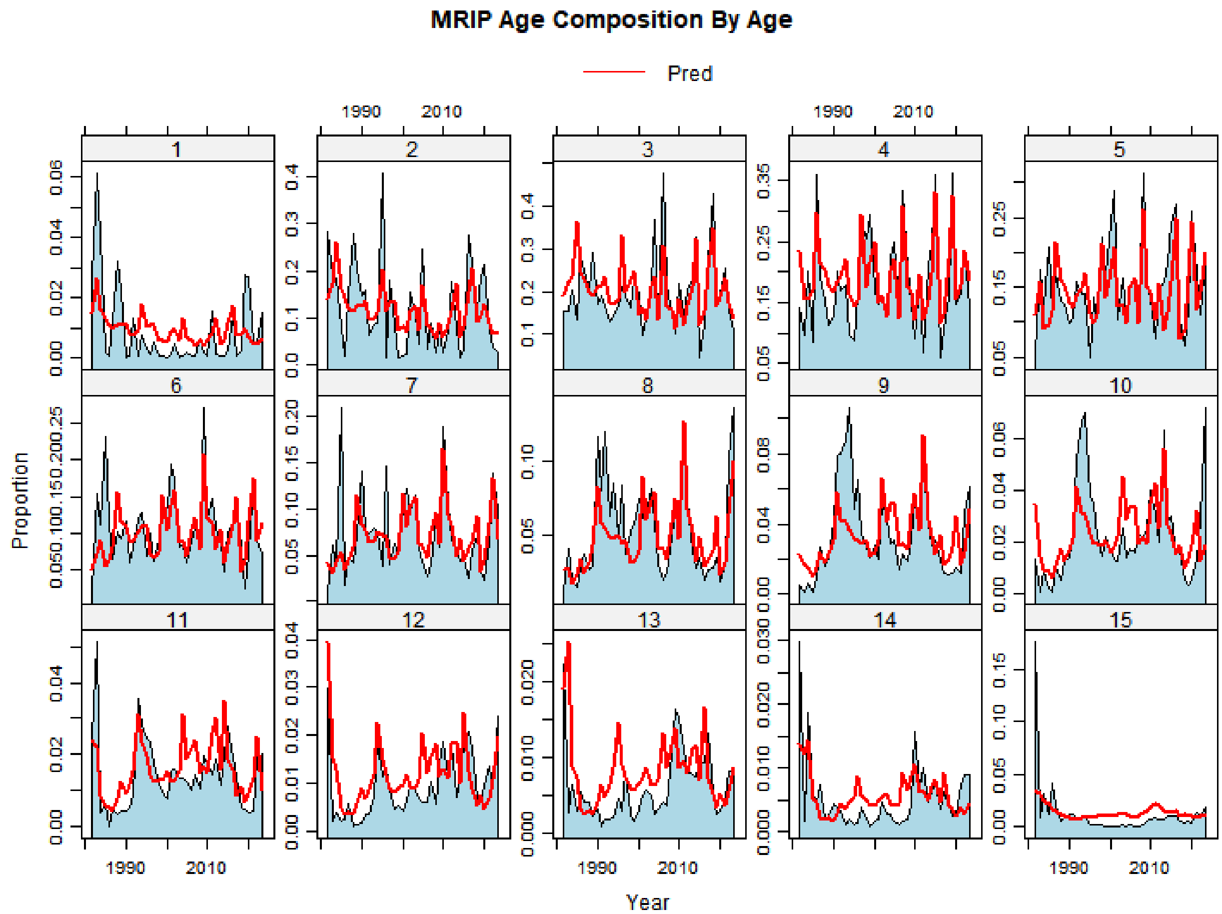
DESSN Age Composition By Year
Pred
Proportion
Age

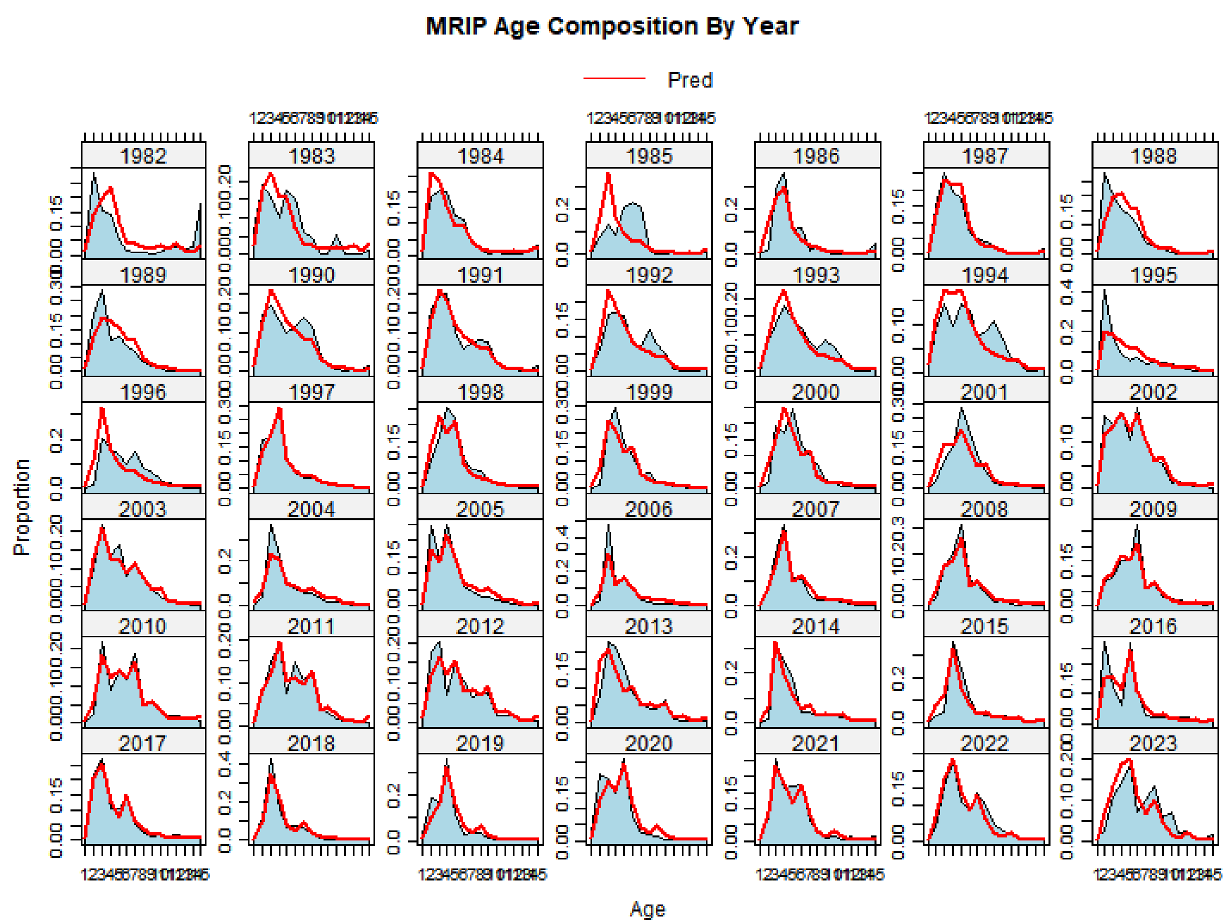

DESSN Age Residuals By Age
Standardized Residual
Year
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1995
2005
2015


DESSN Age Residuals By Year
Standardized Residual
Age
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2018
2019
2021
2022
2023

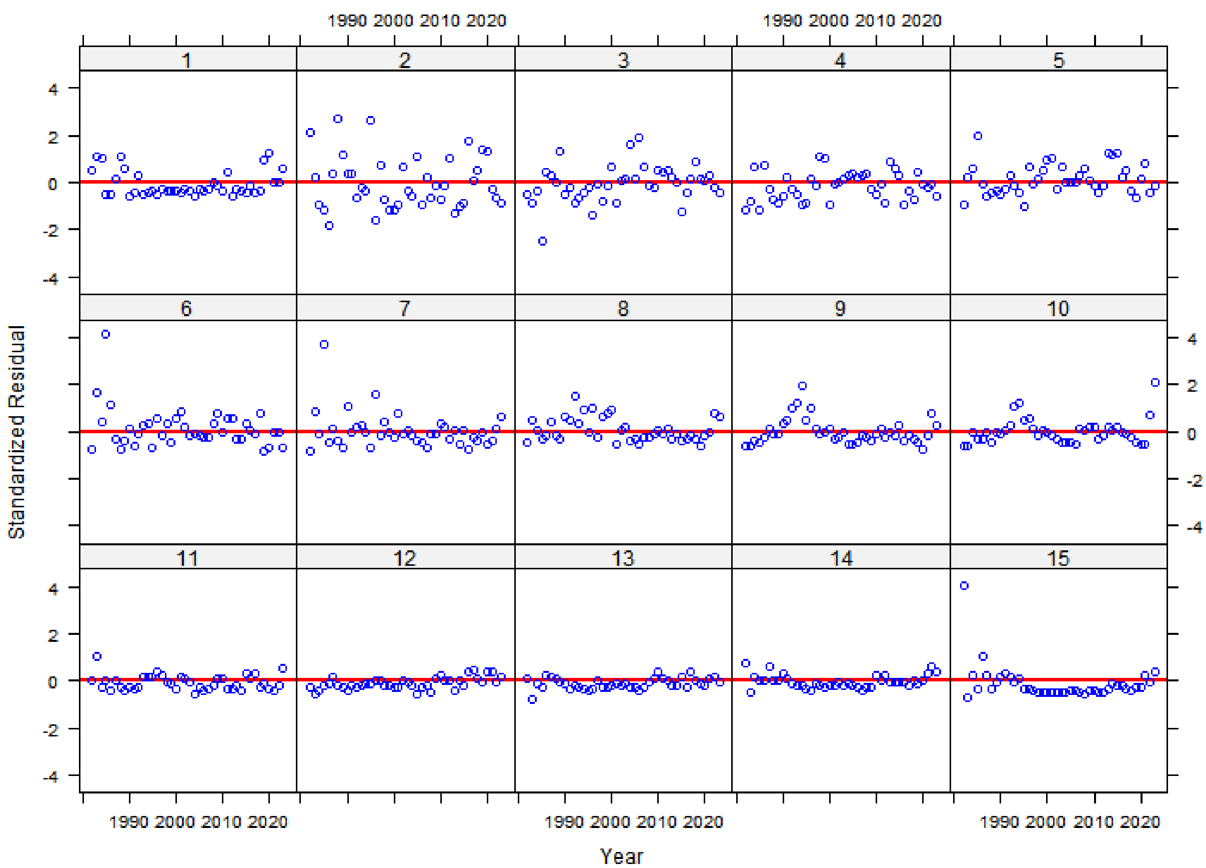

DESSN Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1996
1998
2000
2002
2004
2006
2008
2010
2012
2015
2017
2019
2021
2023


DESSN Selectivity
Selectivity
Age

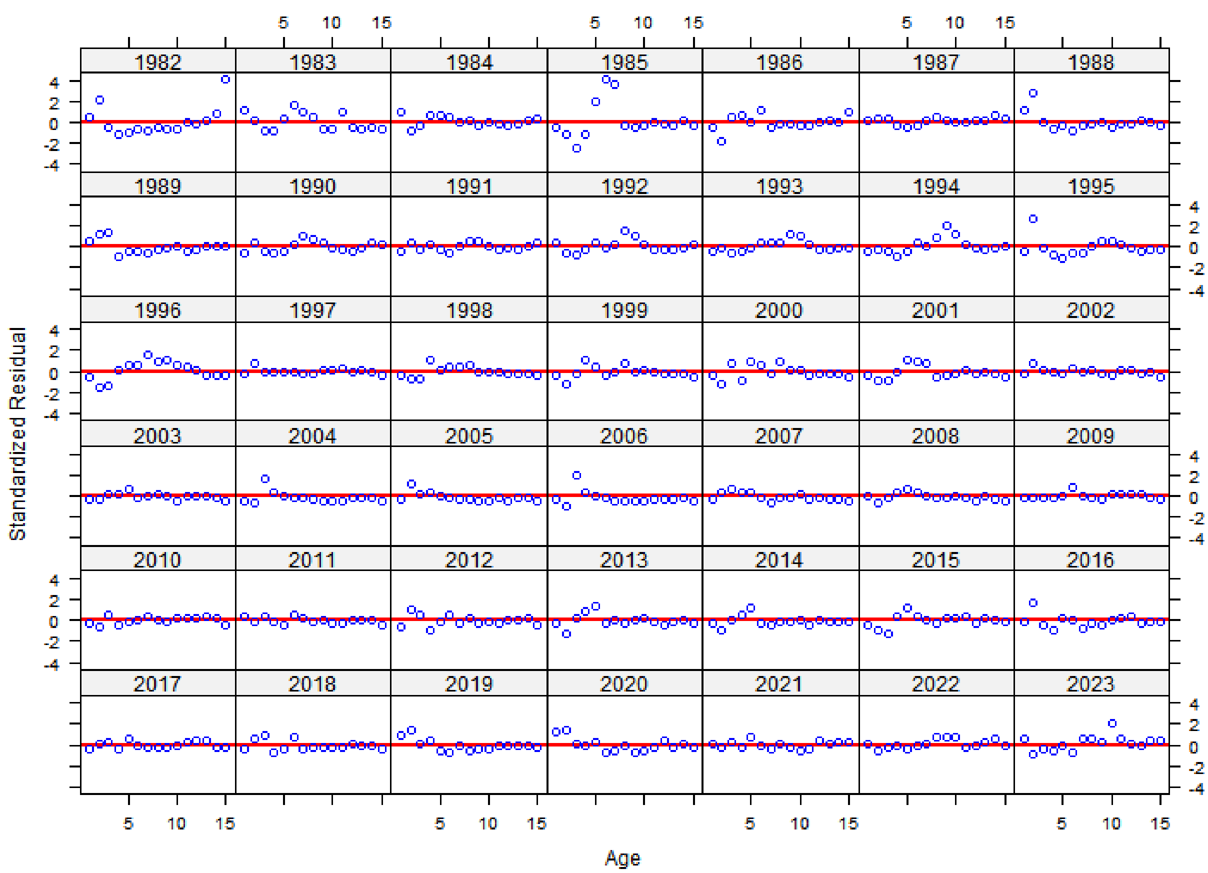

MRIP Age Composition By Age
Pred
Proportion
Year
1990
2010

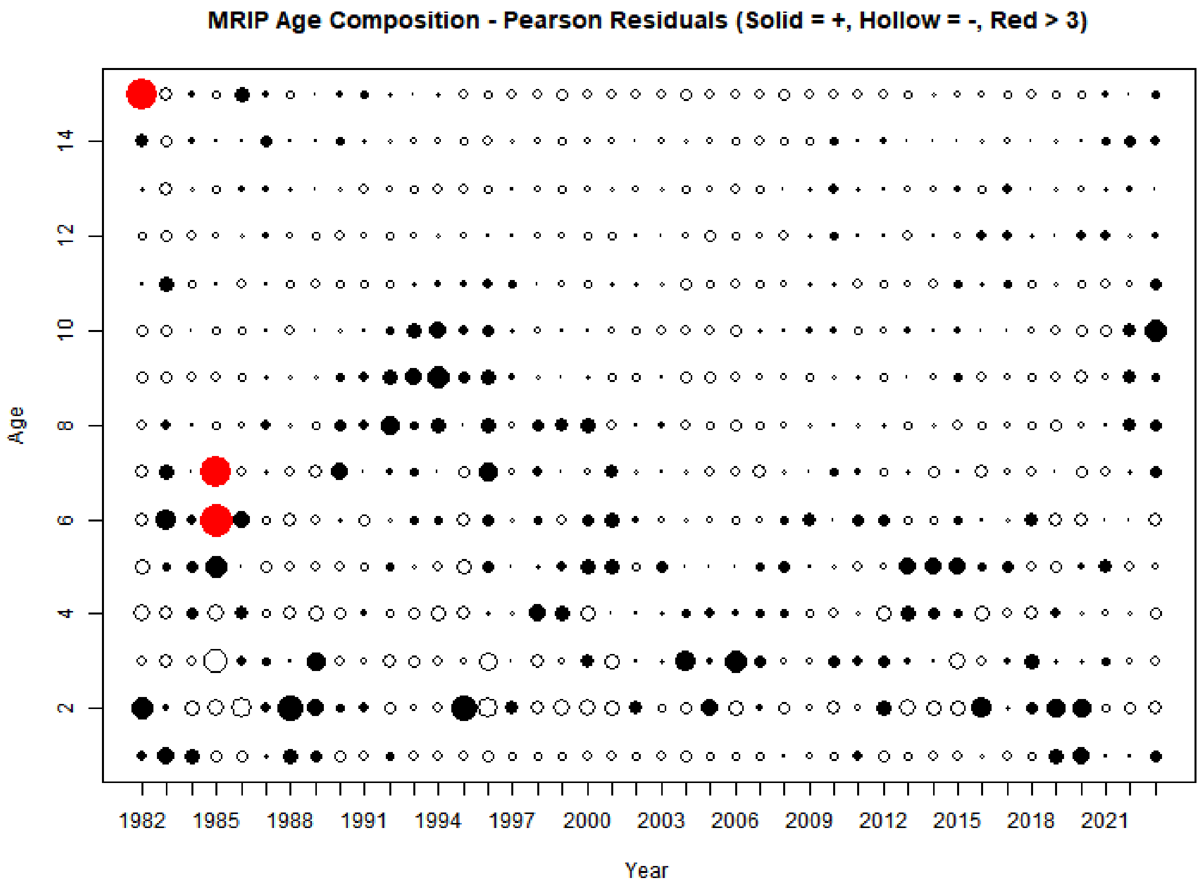

MRIP Age Composition By Year
Pred
Proportion
Age

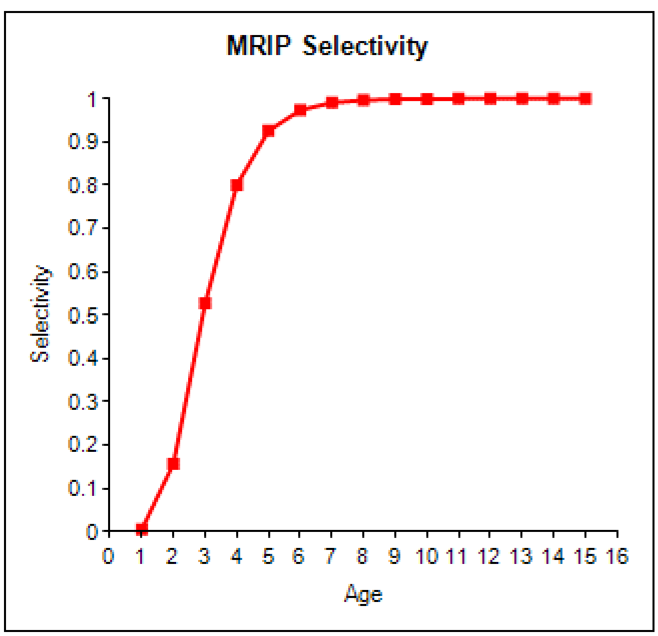
MRIP Age Residuals By Age

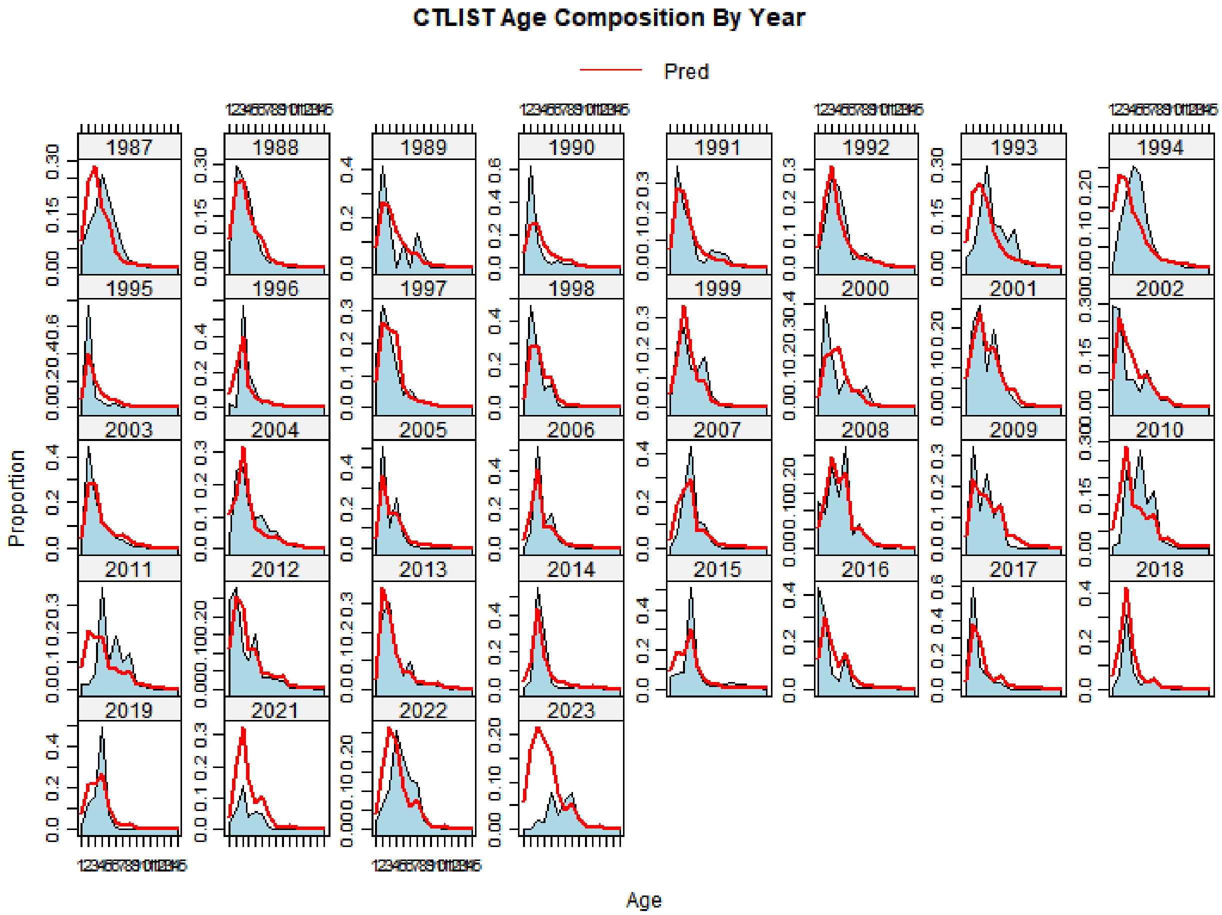


MRIP Age Residuals By Year




MRIP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018 2021
2 4 6 8 10 12 14


MRIP Selectivity
Selectivity
Age
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


CTLIST Age Composition By Year
Pred
Proportion
Age
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
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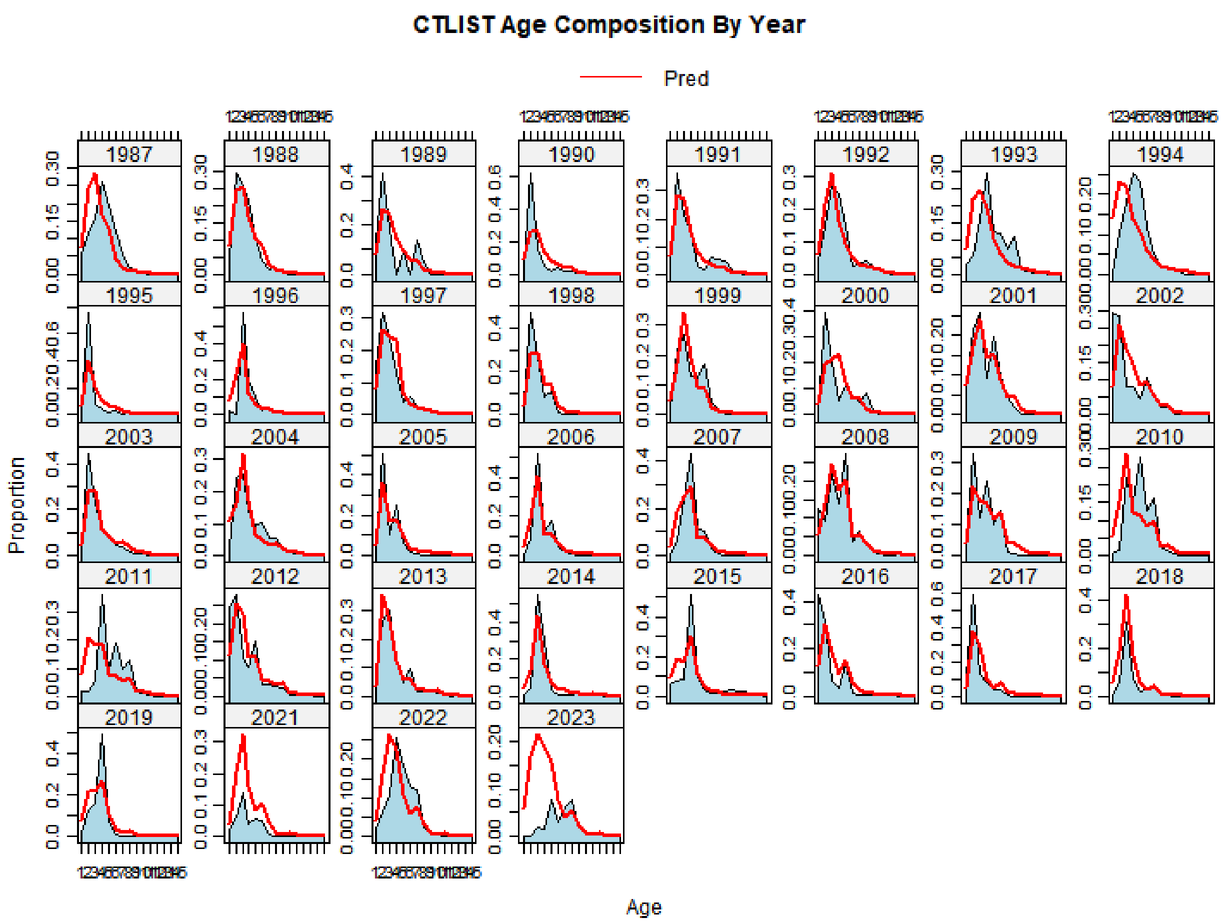
2021
2022
2023


CTLIST Age Composition By Year
Pred
Proportion
Age
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
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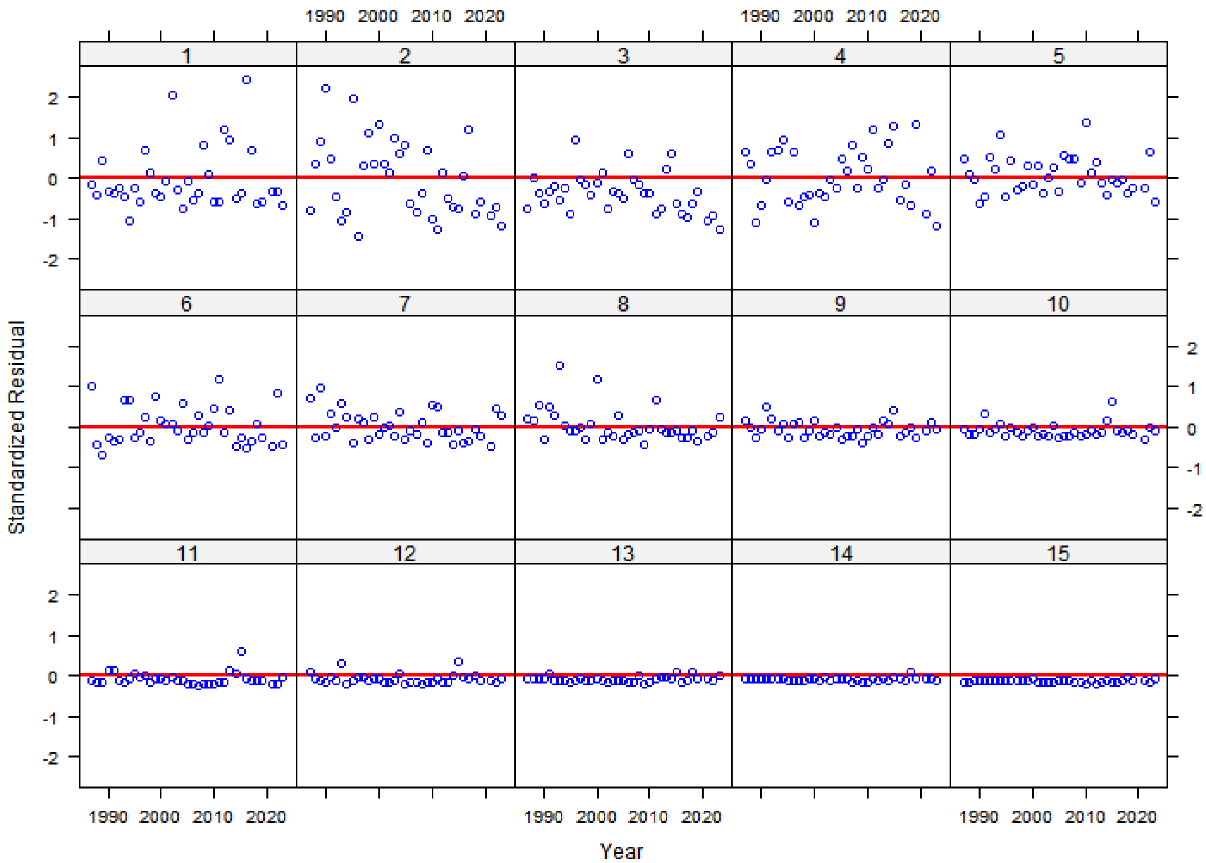
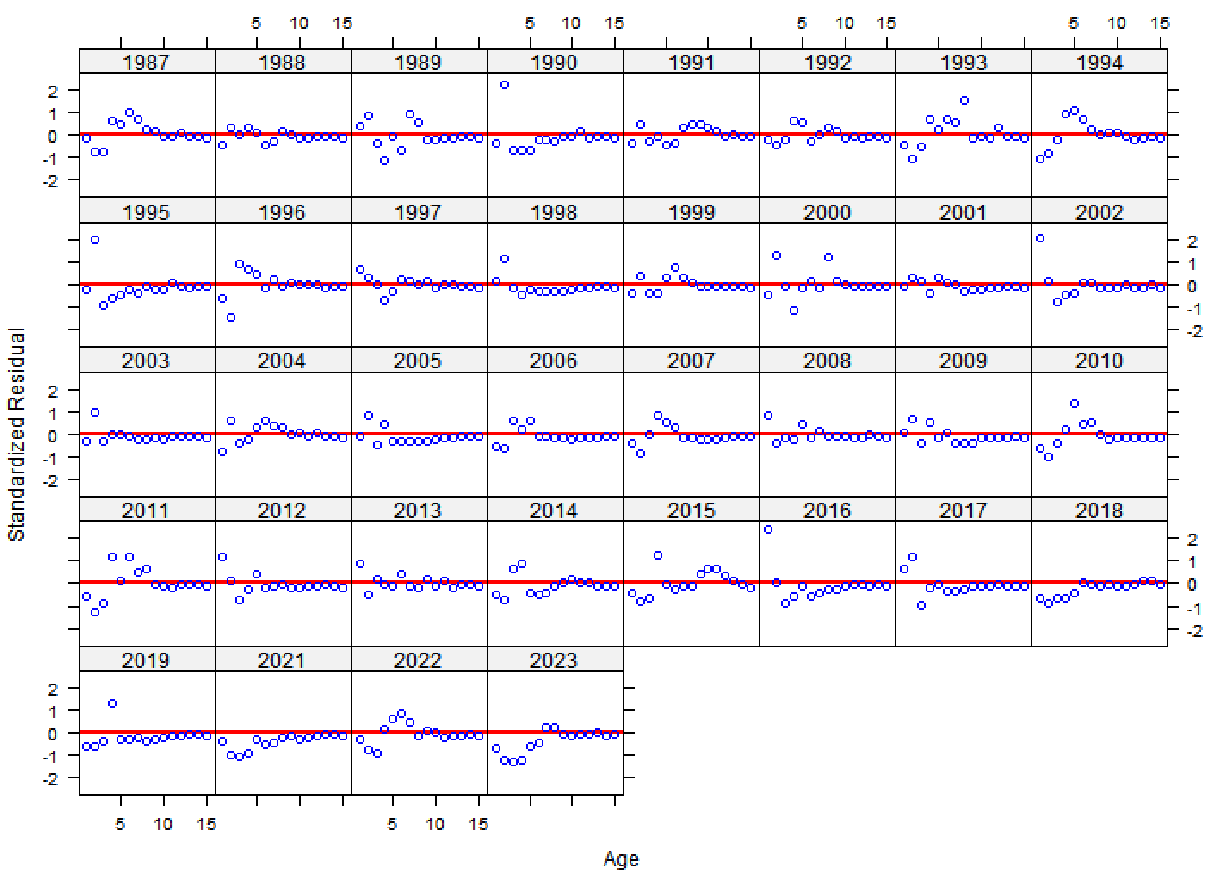
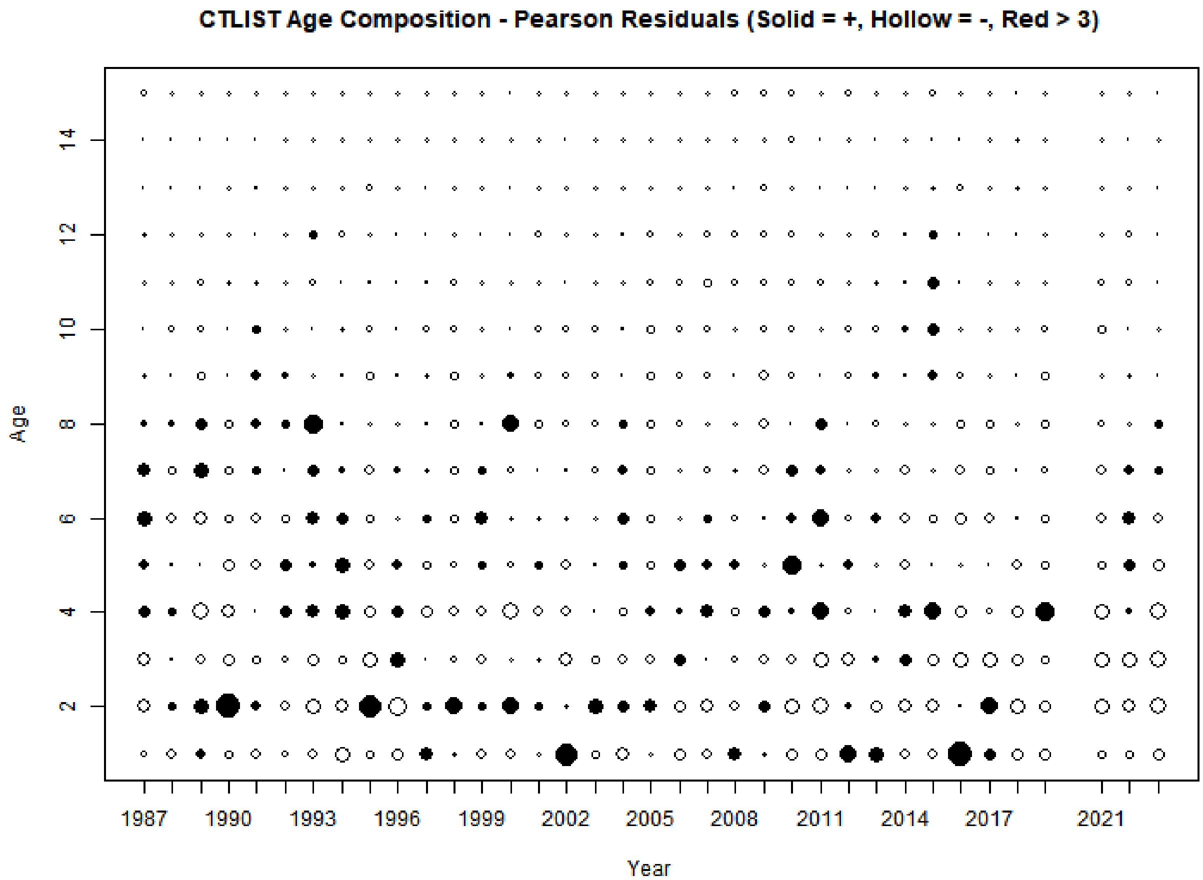
2019
2021
2022
2023

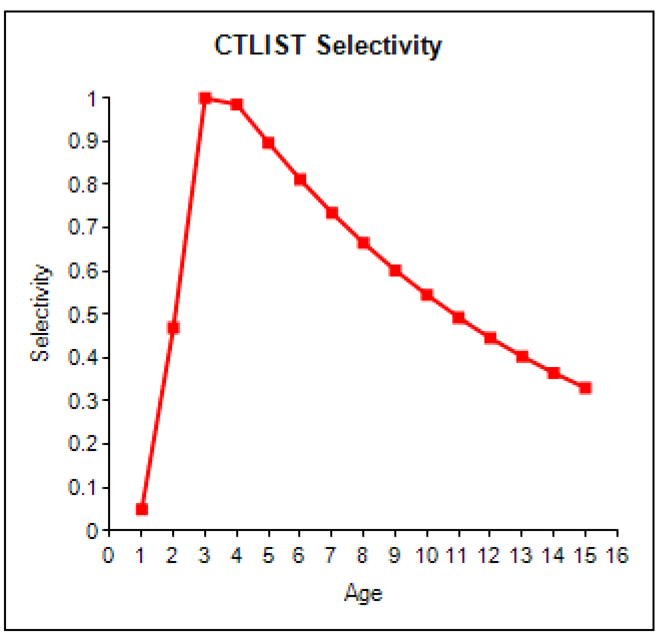
CTLIST Age Residuals By Age



CTLIST Age Residuals By Year




CTLIST Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
Year
2
4
6
8
10
12
14
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2021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Selectivity
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1
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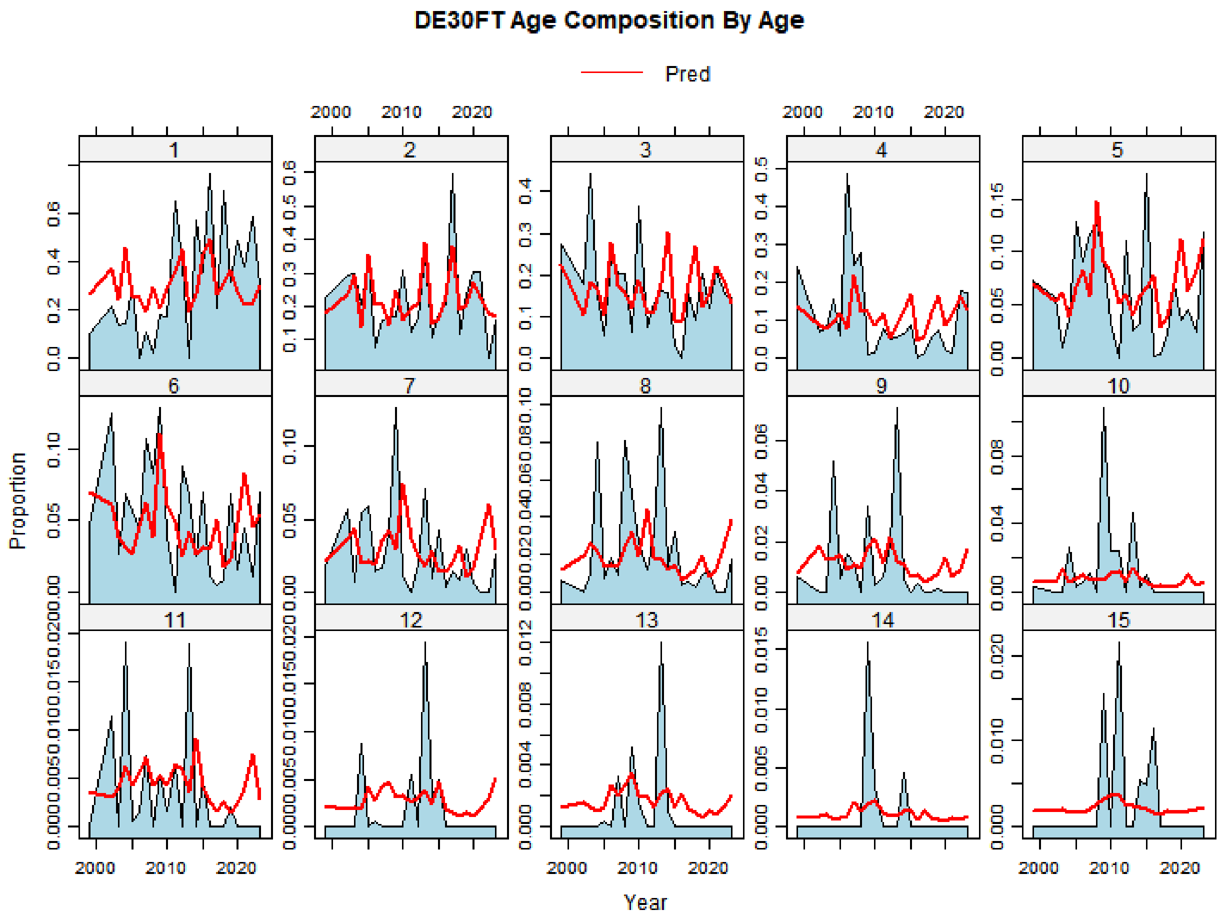
DE30FT Age Composition By Age
Pred
Proportion
Year
1
2
3
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6
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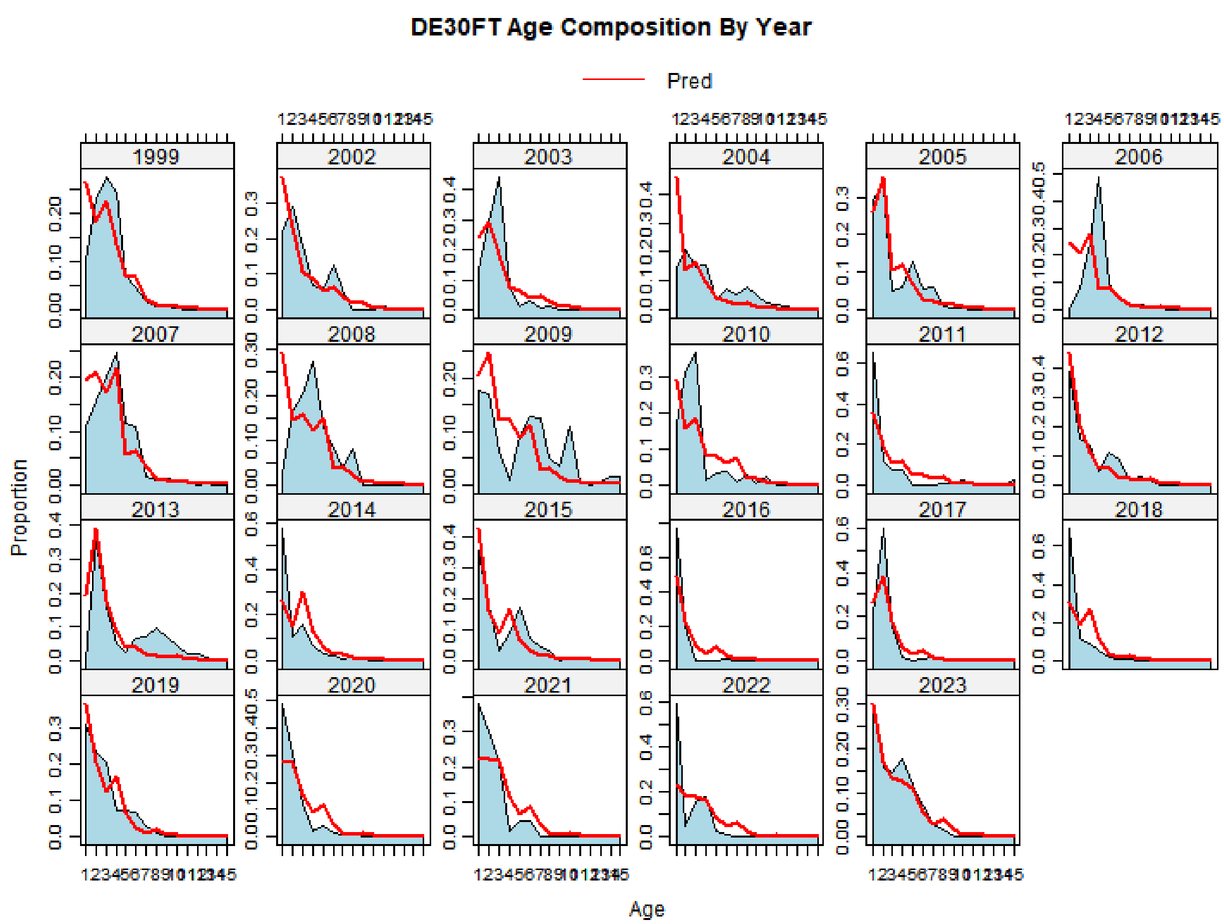
9
10
11
12
13
14
15
2000
2010
2020


DE30FT Age Composition By Year
Pred
Proportion
Age
1999
2002
2003
2004
2005
2006
2007
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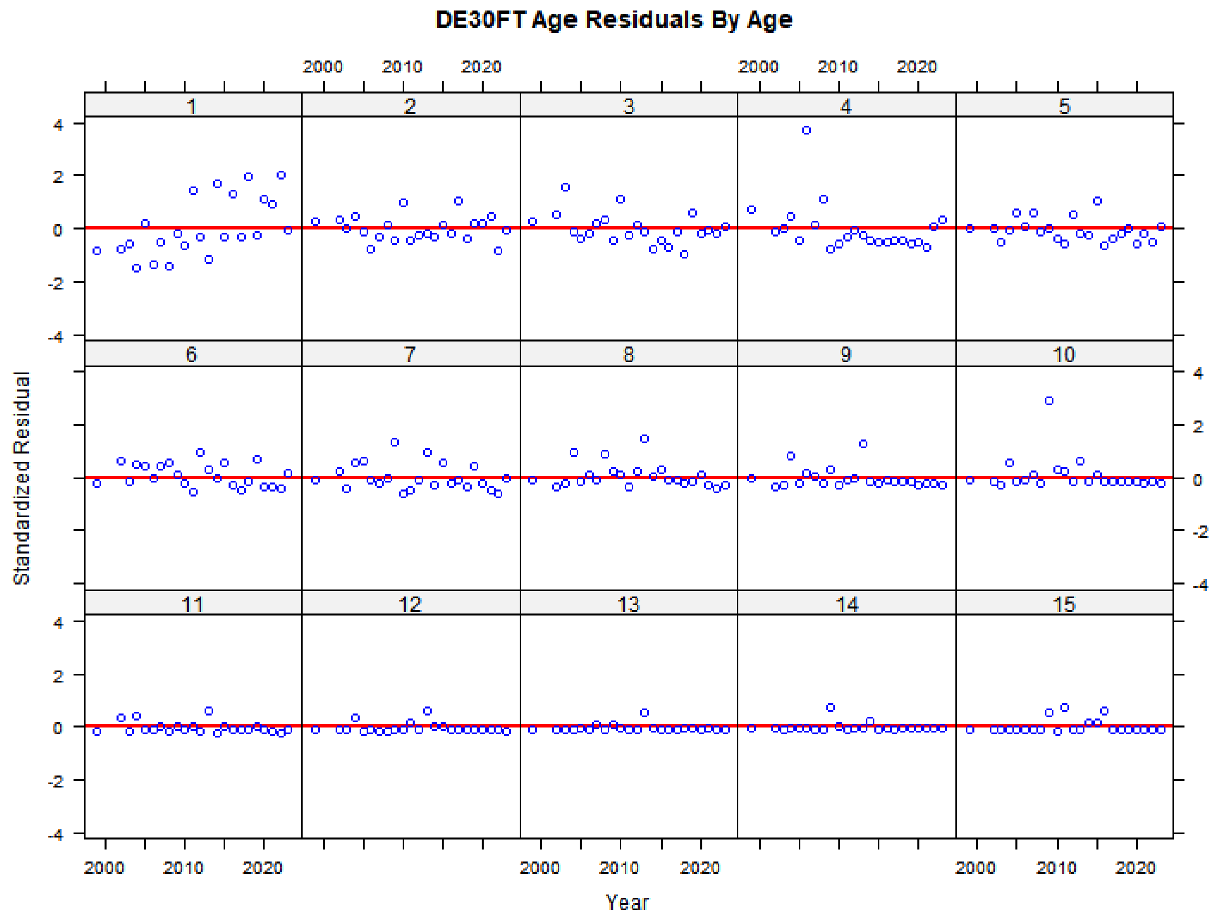
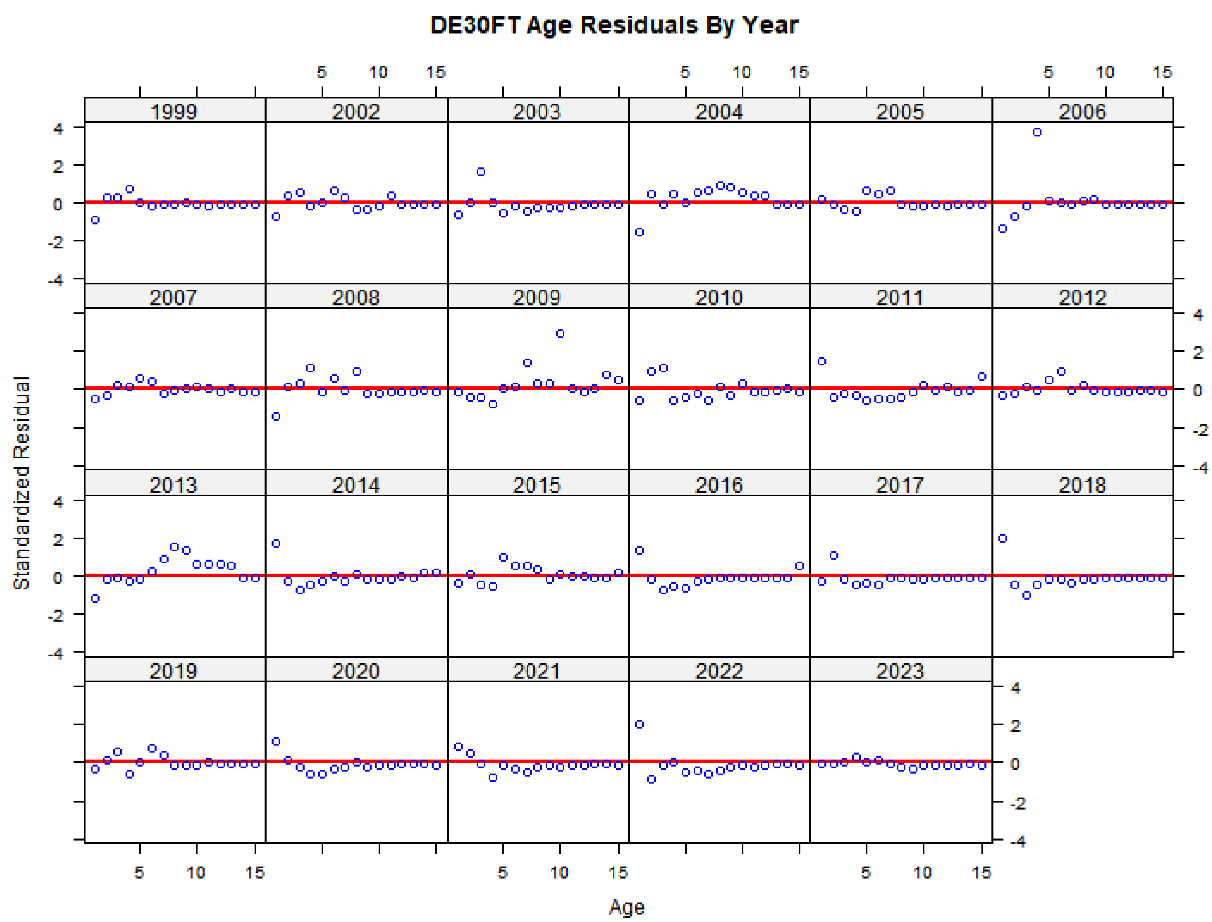
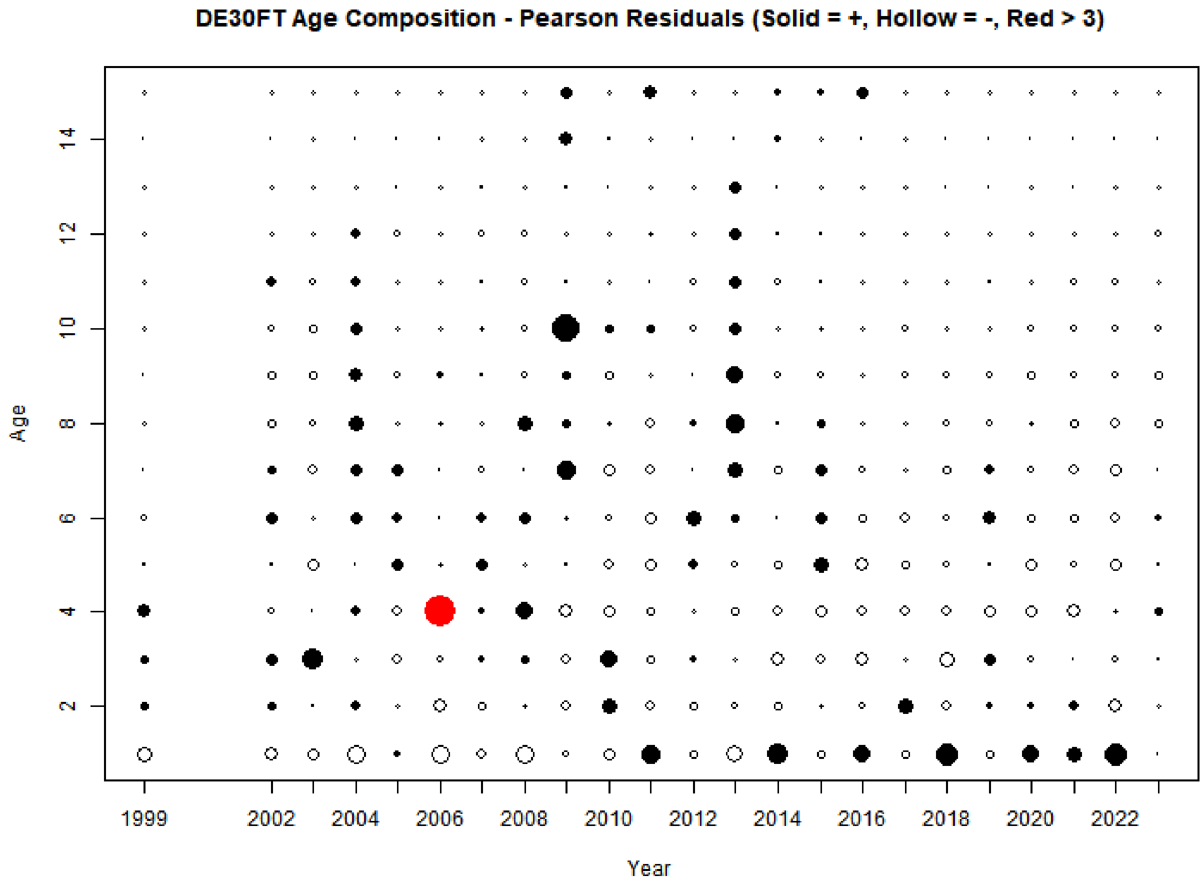
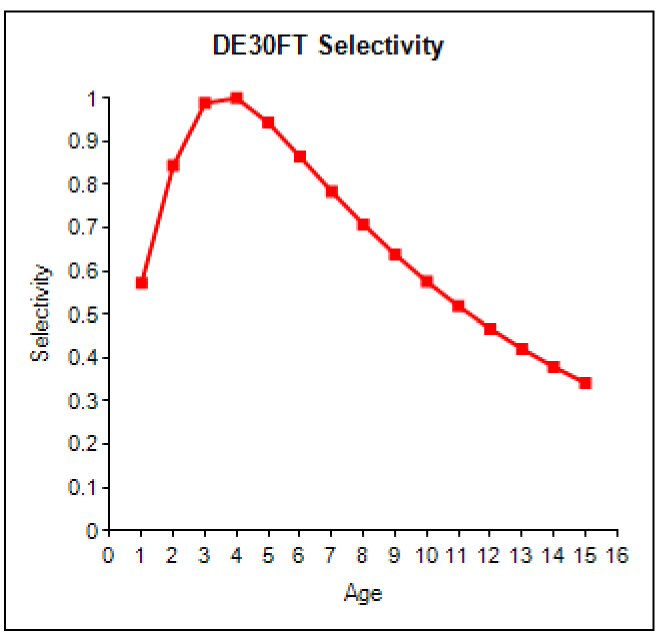
2015
2016
2017
2018
2019
2020
2021
2022
2023


DE30FT Age Residuals By Age
Standardized Residual
Year


DE30FT Age Residuals By Year
Standardized Residual
Age


DE30FT Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
6
8
10
12
14
1999
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Year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1
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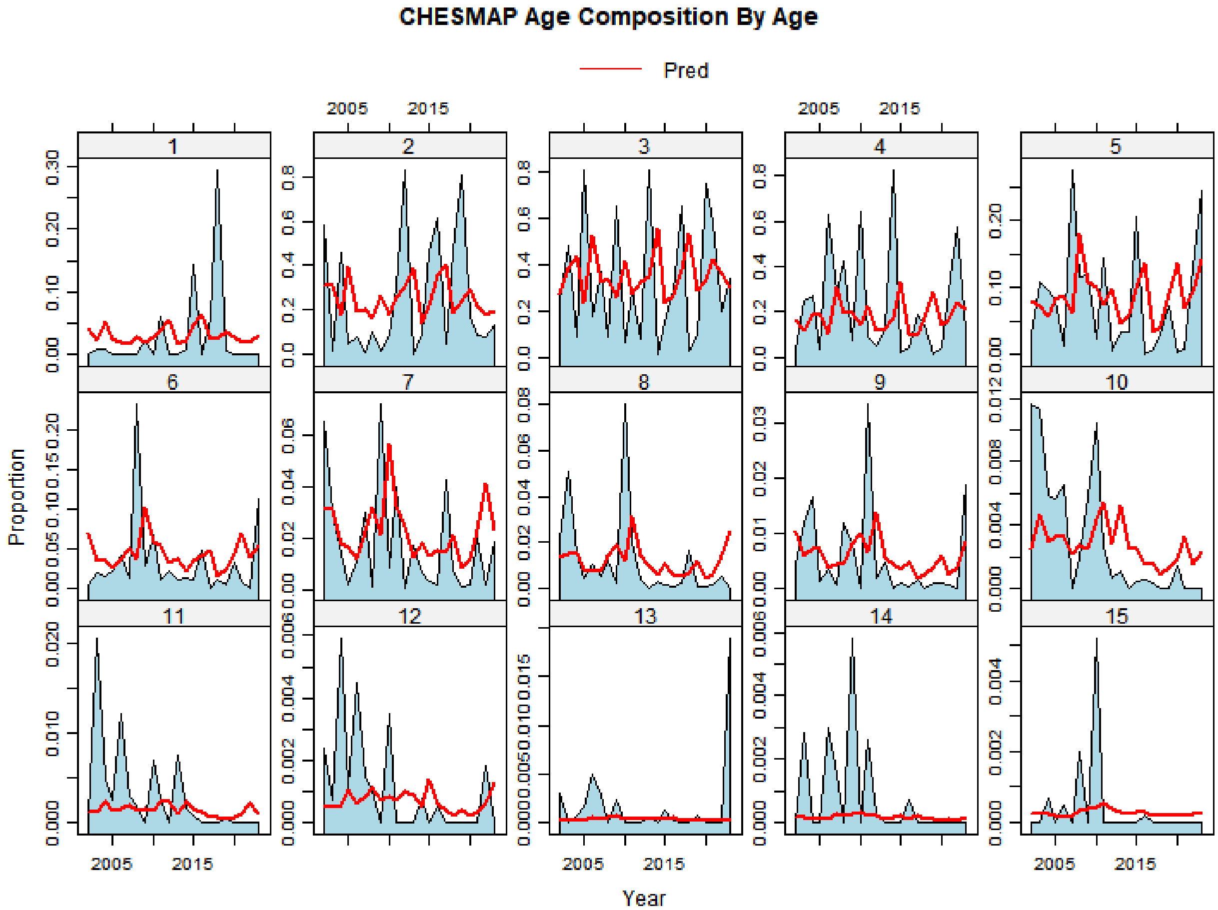
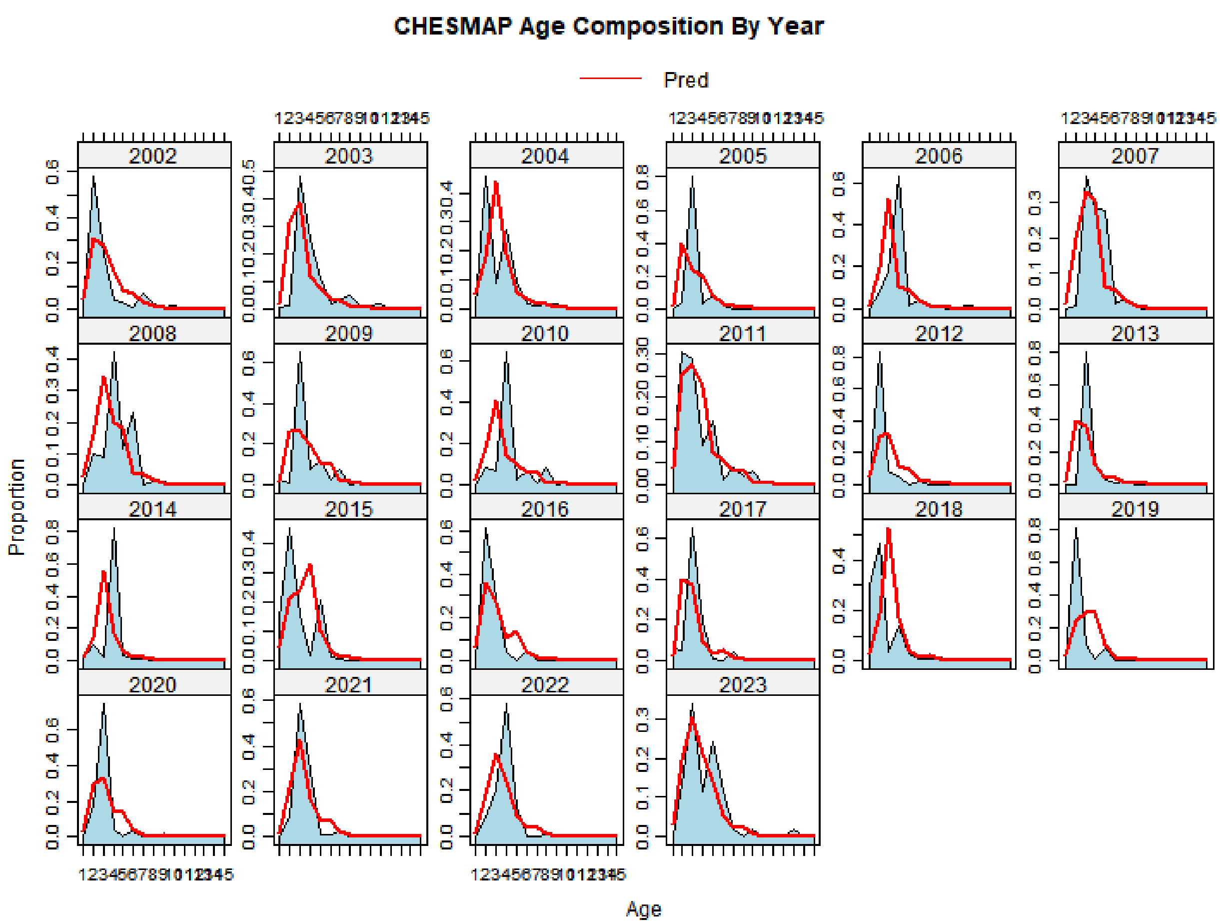
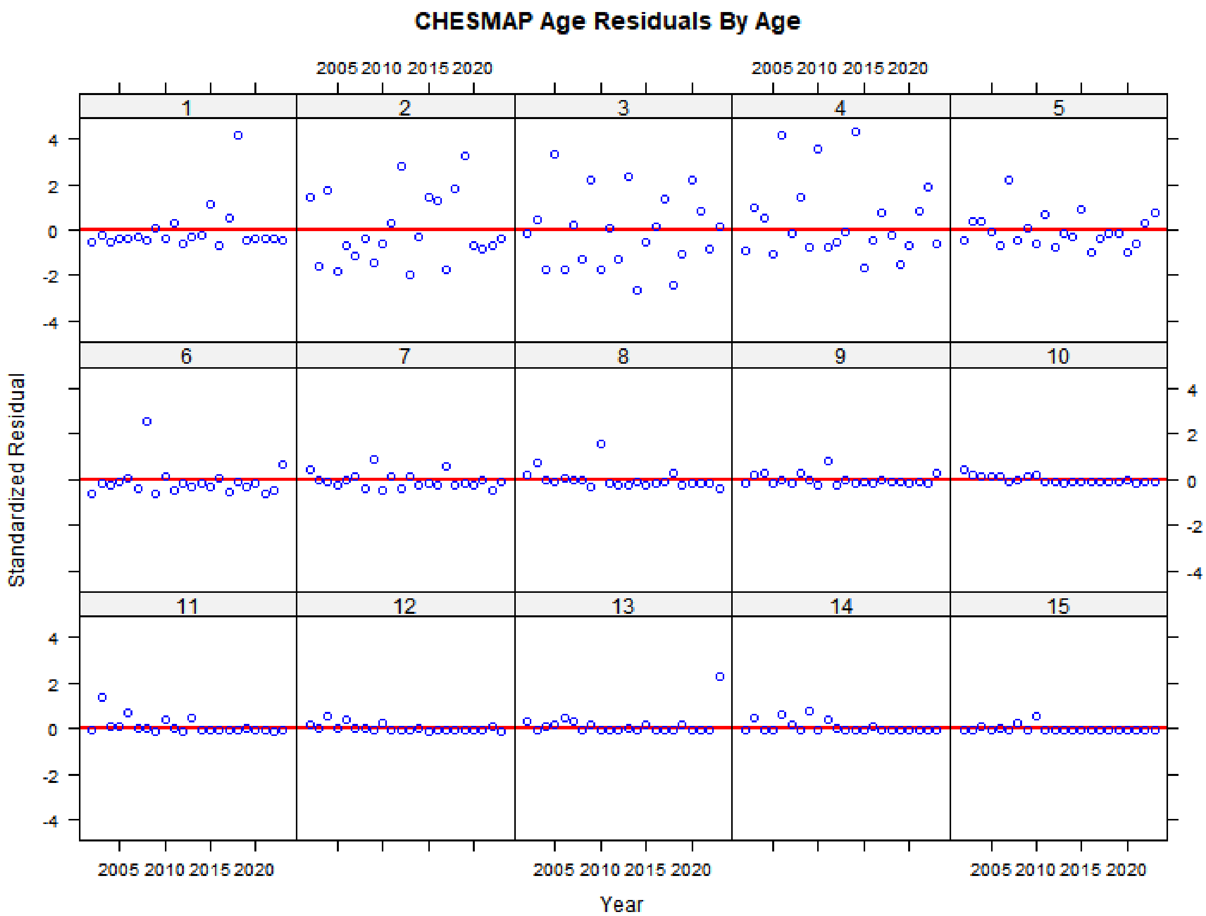
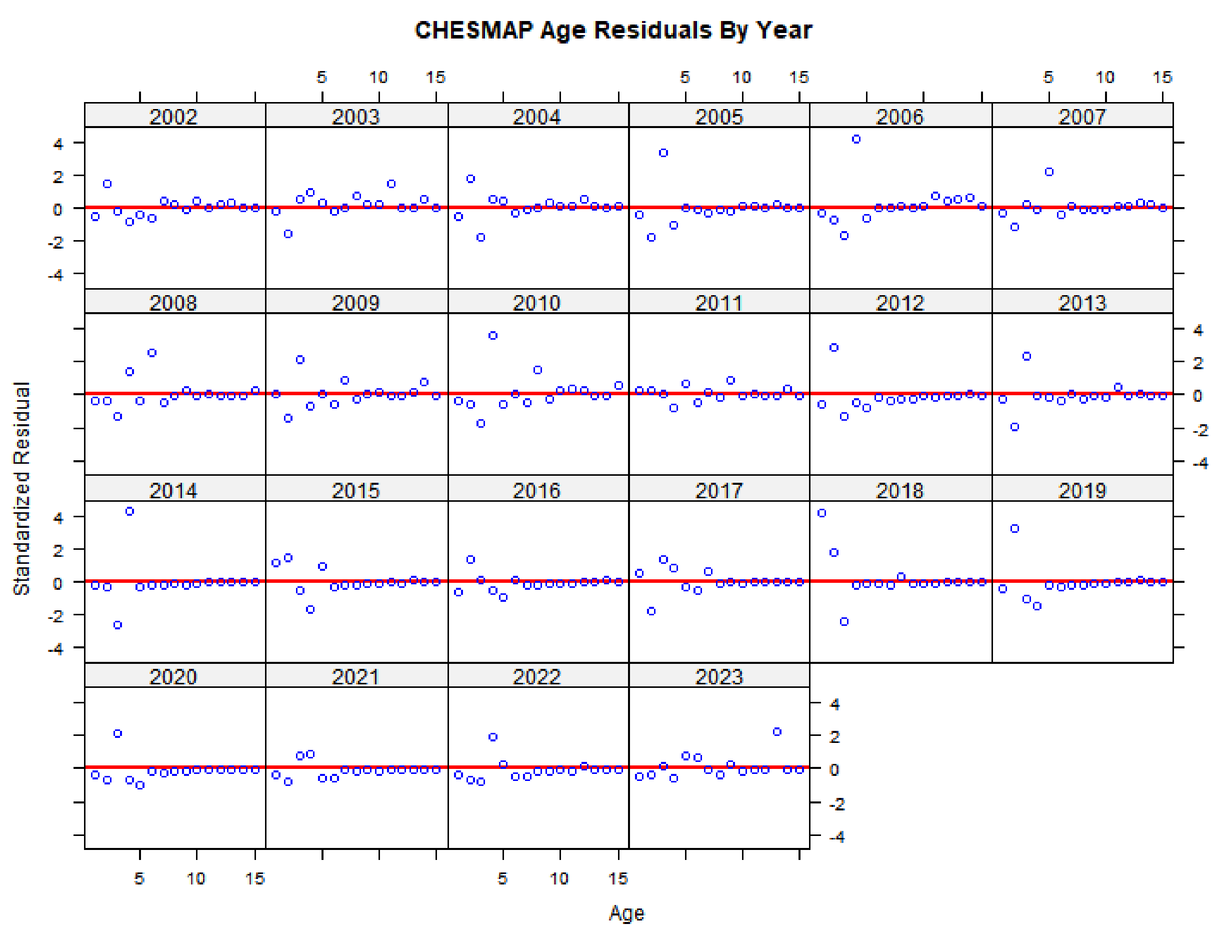
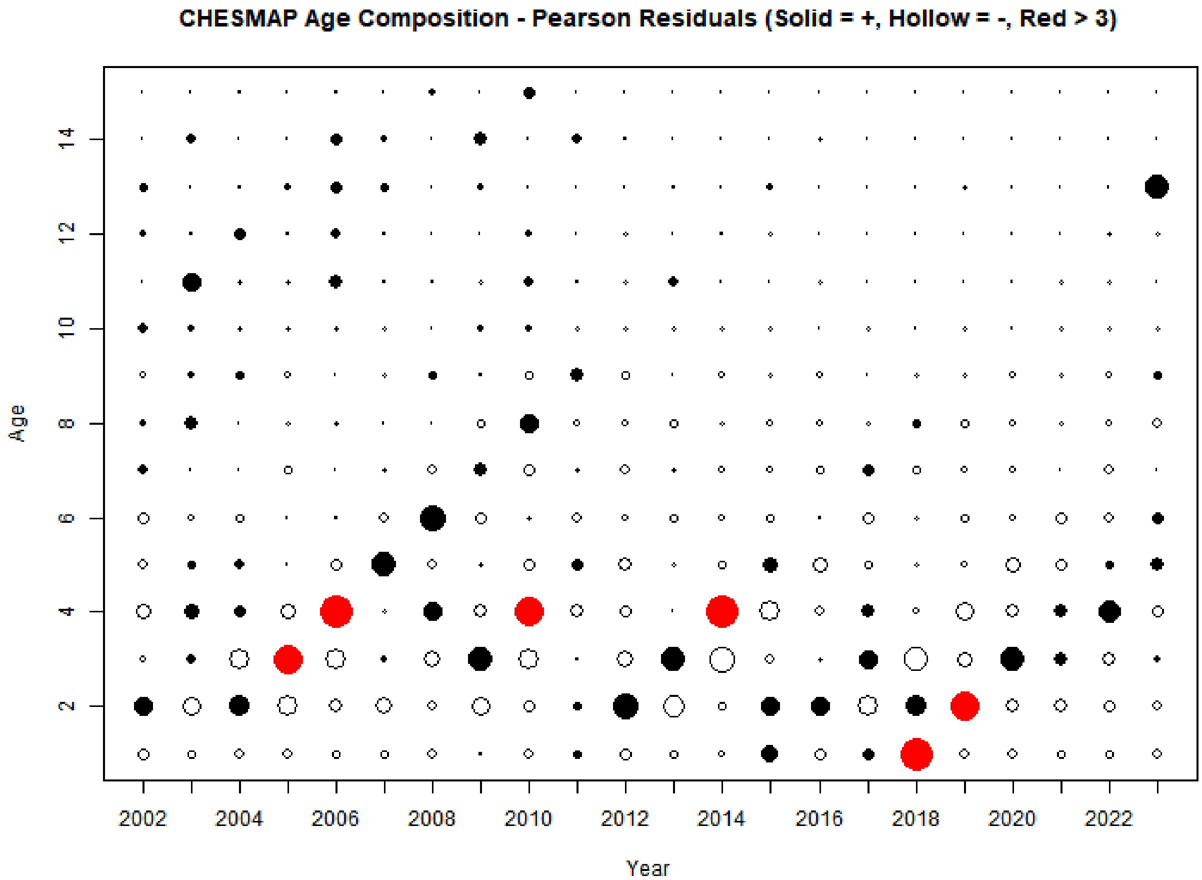
Age


CHESMAP Age Composition By Age
Pred
Proportion
Year


CHESMAP Age Composition By Year
Pred
Proportion
Age


CHESMAP Age Residuals By Age
Standardized Residual
Year


CHESMAP Age Residuals By Year
Standardized Residual
Age


CHESMAP Age Composition - Pearson Residuals (Solid = +, Hollow = -, Red > 3)
Age
2
4
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8
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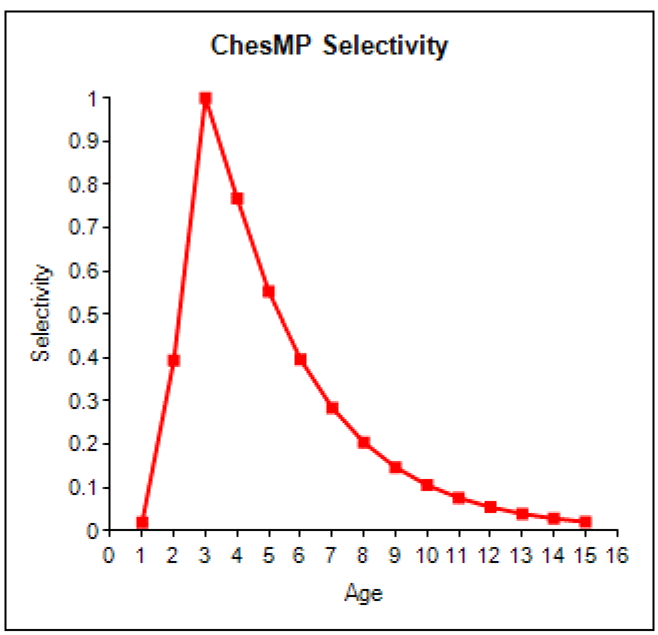
12
14
Year
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022


ChesMP Selectivity
Selectivity
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0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Age
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Results and Projections

Table X2. Comparison of RMSE, CV weights and effective sample sizes from the 2018 benchmark and 2022 update assessments.

2024 Update Assessment

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	38	1.00932	2.97	
NJYOY	40	1.01128	1.63	
MDYOY	12	1.0054	1.96	
compos	42	1.01242	1.00	
NYAge1	39	1.00882	1.19	
MDAge1	54	1.00057	3.25	
NYOHS	20	0.996985	2.55	21.34
NJTRAWL	31	0.999935	5.85	2.98
MDSSN	39	1.00736	2.40	15.57
DESSN	26	1.00552	1.42	19.45
MRIP	42	0.994992	2.27	27.47
CTLIST	36	1.00365	3.05	7.22
DE30FT	23	0.998003	0.85	5.62
ChesMP	22	0.995453	3.40	6.10

2022 Update

Index	n	RMSE	CV Weight	Effective Sample Size
NYYOY	36	0.990985	2.97	
NJYOY	38	1.00901	1.73	
MDYOY	12	1.00507	2.11	
compos	40	1.00575	0.96	
NYAge1	37	1.00193	1.19	
MDAge1	52	0.998121	3.25	
NYOHS	20	0.996071	2.65	21.80
NJTRAWL	29	1.00117	2.95	5.66
MDSSN	37	0.998646	2.50	14.95
DESSN	24	1.00934	1.17	18.55
MRIP	40	1.00898	2.27	29.64
CTLIST	34	0.996705	3.00	12.93
DE30FT	21	1.00132	0.85	5.81
ChesMP	17	1.00111	2.45	15.10

Table X3. Summary of likelihood component values.

	Likelihood Weight	RSS
Fleet 1 Total Catch:	2	0.231403
Fleet 2 Total Catch:	2	1.85817
Aggregate Abundance Indices		
NYYOY	1	30.7183
NJYOY	1	32.6827
MDYOY	1	10.5312
Composite	1	40.9288
NYAge1	1	34.4667
MDAge1	1	26.6986
Age Comp Abundance Indices		
NYOHS	1	18.9014
NJTrawl	1	6.55357
MDSSN	1	33.8027
DESSN	1	23.2213
MRIP	1	36.7523
CTLIST	1	29.0973
DE30FT	1	18.5411
CHESMAP	1	13.9466
Total RSS		358.932
No. of Obs		548
Conc. Likel.		-115.941
Age Composition Data		
Fleet 1 Age Comp	1	6468.26
Fleet 2 Age Comp	1	6799.73
NYOHS	1	711.306
NJTrawl	1	168.126
MDSSN	1	1241.94
DESSN	1	1159.93
MRIP	1	2483.06
CTLIST	1	463.211
DE30FT	1	241.603
CHESMAP	1	235.109
Recr Devs	1	41.5586
Total Likelihood		19825.3
AIC		40052.7

Table X4. Estimates of Bay and Ocean fully-recruited fishing mortality and total fully-recruited fishing mortality with associated standard errors.

	Bay			Ocean			Total		
	Fully-recruited			Fully-recruited			Fully-recruited		
Year	F	SD	CV	F	SD	CV	F	SD	CV
1982	0.057	0.014	0.240	0.179	0.004	0.020	0.180	0.029	0.161
1983	0.062	0.029	0.463	0.144	0.012	0.085	0.145	0.039	0.269
1984	0.060	0.008	0.128	0.060	0.004	0.062	0.074	0.014	0.190
1985	0.004	0.039	10.655	0.190	0.016	0.085	0.190	0.069	0.360
1986	0.006	0.013	2.250	0.051	0.004	0.076	0.052	0.013	0.256
1987	0.002	0.012	4.653	0.030	0.015	0.506	0.031	0.006	0.208
1988	0.005	0.001	0.132	0.036	0.005	0.131	0.036	0.007	0.207
1989	0.005	0.068	14.825	0.046	0.018	0.377	0.047	0.009	0.185
1990	0.040	0.002	0.049	0.063	0.004	0.061	0.064	0.011	0.174
1991	0.044	0.013	0.301	0.090	0.013	0.148	0.091	0.015	0.169
1992	0.049	0.001	0.013	0.109	0.003	0.028	0.110	0.018	0.166
1993	0.042	0.006	0.152	0.085	0.015	0.173	0.086	0.013	0.153
1994	0.055	0.001	0.018	0.111	0.004	0.037	0.113	0.016	0.145
1995	0.079	0.007	0.094	0.202	0.013	0.064	0.205	0.031	0.154
1996	0.057	0.001	0.018	0.234	0.007	0.029	0.261	0.036	0.137
1997	0.061	0.009	0.141	0.167	0.016	0.095	0.201	0.013	0.067
1998	0.053	0.005	0.101	0.181	0.005	0.026	0.209	0.014	0.068
1999	0.055	0.011	0.202	0.166	0.016	0.098	0.195	0.013	0.068
2000	0.059	0.007	0.120	0.162	0.007	0.041	0.194	0.013	0.066
2001	0.047	0.015	0.328	0.168	0.017	0.099	0.192	0.012	0.063
2002	0.051	0.005	0.101	0.181	0.006	0.031	0.208	0.013	0.061
2003	0.067	0.018	0.270	0.186	0.025	0.133	0.222	0.013	0.060
2004	0.065	0.004	0.061	0.213	0.009	0.040	0.248	0.017	0.068
2005	0.058	0.013	0.228	0.215	0.020	0.094	0.244	0.016	0.067
2006	0.079	0.005	0.059	0.248	0.006	0.025	0.290	0.018	0.064
2007	0.060	0.016	0.270	0.184	0.018	0.100	0.216	0.014	0.065
2008	0.052	0.006	0.123	0.203	0.009	0.045	0.229	0.016	0.068
2009	0.070	0.031	0.446	0.186	0.021	0.114	0.224	0.014	0.063
2010	0.074	0.004	0.049	0.224	0.007	0.031	0.264	0.017	0.065
2011	0.072	0.035	0.478	0.232	0.027	0.117	0.270	0.017	0.064
2012	0.084	0.003	0.040	0.224	0.005	0.024	0.269	0.018	0.068
2013	0.093	0.012	0.132	0.324	0.020	0.063	0.372	0.026	0.070
2014	0.107	0.003	0.026	0.233	0.004	0.017	0.294	0.022	0.075
2015	0.089	0.014	0.152	0.207	0.018	0.089	0.256	0.020	0.078
2016	0.120	0.003	0.023	0.229	0.004	0.017	0.299	0.024	0.081
2017	0.084	0.012	0.147	0.293	0.017	0.056	0.337	0.029	0.087
2018	0.071	0.003	0.047	0.209	0.003	0.015	0.246	0.022	0.090
2019	0.056	0.012	0.211	0.187	0.017	0.090	0.216	0.020	0.092
2020	0.052	0.002	0.047	0.103	0.003	0.033	0.151	0.018	0.122
2021	0.042	0.012	0.276	0.114	0.025	0.221	0.152	0.018	0.122
2022	0.041	0.003	0.071	0.170	0.006	0.038	0.207	0.027	0.131
2023	0.044	0.012	0.273	0.212	0.047	0.221	0.237	0.049	0.205

Table X4 cont.

Year	Recruitment	SD	CV
1982	37,364,100	3,561,750	0.095
1983	75,602,800	6,004,810	0.079
1984	62,859,700	4,971,380	0.079
1985	68,479,300	5,140,620	0.075
1986	67,611,600	5,071,660	0.075
1987	74,169,300	5,384,940	0.073
1988	93,300,800	6,426,560	0.069
1989	106,655,000	7,274,910	0.068
1990	130,941,000	8,472,950	0.065
1991	104,485,000	7,631,770	0.073
1992	108,762,000	8,080,020	0.074
1993	133,935,000	9,225,910	0.069
1994	285,297,000	14,524,200	0.051
1995	186,734,000	11,447,800	0.061
1996	234,018,000	13,186,100	0.056
1997	258,960,000	13,727,900	0.053
1998	148,052,000	9,929,320	0.067
1999	152,875,000	9,909,210	0.065
2000	124,486,000	8,956,900	0.072
2001	196,467,000	11,283,100	0.057
2002	221,336,000	11,926,200	0.054
2003	127,967,000	8,776,480	0.069
2004	304,432,000	13,794,500	0.045
2005	158,153,000	9,576,770	0.061
2006	135,236,000	8,615,300	0.064
2007	88,441,000	6,659,590	0.075
2008	126,912,000	8,010,310	0.063
2009	75,196,700	5,917,220	0.079
2010	96,903,000	6,899,820	0.071
2011	125,307,000	8,087,160	0.065
2012	192,360,000	10,784,700	0.056
2013	66,597,300	5,843,220	0.088
2014	82,938,200	6,642,880	0.080
2015	153,154,000	10,612,200	0.069
2016	228,067,000	15,322,400	0.067
2017	111,488,000	9,507,160	0.085
2018	130,105,000	11,341,500	0.087
2019	165,265,000	14,827,500	0.090
2020	120,143,000	12,559,800	0.105
2021	85,158,100	11,605,200	0.136
2022	76,967,300	10,874,800	0.141
2023	96,681,400	16,032,400	0.166

Catch Selectivity Parameters

Bay	Estimate	SD	CV
1982-1984			
α	-5.451	0.197	0.04
β	2.551	0.043	0.02
ϒ	0.830	0.020	0.02
1985-1989			
α	-3.922	0.496	0.13
β	2.292	0.090	0.04
ϒ	0.958	0.013	0.01
1990-1995			
α	-2.060	0.101	0.05
β	4.468	0.188	0.04
ϒ	0.816	0.033	0.04
1996-2022			
α	-1.783	0.059	0.03
β	3.710	0.085	0.02
ϒ	0.953	0.010	0.01
2023			
α	-1.985	0.318	0.16
β	3.801	0.377	0.10
ϒ	0.888	0.054	0.06

Ocean	Estimate	SD	CV
1982-1984			
α	3.484	0.194	0.06
β	0.820	0.086	0.10
1985-1989			
α	4.713	0.383	0.08
β	0.473	0.051	0.11
1990-1996			
α	6.186	0.508	0.08
β	0.345	0.034	0.10
1997-2019			
α	4.932	0.170	0.03
β	0.450	0.022	0.05
2020-2022			
α	-1.196	0.173	0.14
β	4.656	0.722	0.16
ϒ	0.970	0.065	0.07
2023			
α	-1.160	0.179	0.15
β	6.232	1.050	0.17
ϒ	0.884	0.128	0.14

Survey Selectivity Parameters

NYOHS	Estimate	SD	CV
α	-3.025	0.511	-0.17
β	2.620	0.154	0.06
ϒ	0.917	0.026	0.03
NJ Trawl			
α	1.43E+00	7.41E-01	0.52
β	2.34E-01	1.57E-01	0.67
MDSSN			
	0.14	0.02	0.14
DE SSN			
α	3.80E+00	2.44E-01	0.06
β	6.35E-01	8.62E-02	0.14
MRIP			
α	2.58E+00	7.63E-02	0.03
β	1.06E+00	6.42E-02	0.06
CTLIST			
α	-2.806	0.393	-0.14
β	2.163	0.160	0.07
ϒ	0.964	0.017	0.02
DE30FT			
α	-1.011	0.755	-0.75
β	1.445	1.173	0.81
ϒ	0.897	0.153	0.17
ChesMap			
α	-3.661	0.595	-0.16
β	2.281	0.138	0.06
ϒ	0.909	0.027	0.03

Catchability Coefficients

Survey	Estimate	SD	CV
Y	1.28E-07	1.26E-08	0.10
Y	8.21E-09	4.98E-10	0.06
)Y	1.32E-07	2.06E-08	0.16
os	1.05E-06	4.65E-08	0.04
e1	2.45E-08	1.79E-09	0.07
ge1	8.07E-09	1.33E-09	0.16
IS	8.83E-08	8.15E-09	0.09
AWL	9.38E-08	2.74E-08	0.29
N	7.70E-08	6.42E-09	0.08
N	4.26E-08	5.60E-09	0.13
	4.39E-08	2.97E-09	0.07
T	7.97E-09	7.41E-10	0.09
T	2.66E-08	4.56E-09	0.17
MP	2.46E-06	4.39E-07	0.18

Table X5. Region-specific and total fishing mortality-at-age, 1982-2021

Bay Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0075	0.0574	0.0246	0.0098	0.0039	0.0015	0.0006	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0012
1983	0.0001	0.0081	0.0620	0.0266	0.0105	0.0042	0.0017	0.0007	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1984	0.0001	0.0079	0.0605	0.0260	0.0103	0.0041	0.0016	0.0006	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0013
1985	0.0000	0.0011	0.0037	0.0033	0.0028	0.0024	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009	0.0007	0.0006	0.0005
1986	0.0001	0.0018	0.0060	0.0054	0.0046	0.0039	0.0033	0.0028	0.0024	0.0020	0.0017	0.0014	0.0012	0.0010	0.0009
1987	0.0000	0.0008	0.0025	0.0022	0.0019	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0005	0.0004	0.0004
1988	0.0000	0.0014	0.0046	0.0041	0.0035	0.0029	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1989	0.0000	0.0014	0.0046	0.0042	0.0035	0.0030	0.0025	0.0021	0.0018	0.0015	0.0013	0.0011	0.0009	0.0008	0.0007
1990	0.0002	0.0010	0.0053	0.0216	0.0402	0.0352	0.0249	0.0171	0.0117	0.0080	0.0055	0.0038	0.0026	0.0018	0.0012
1991	0.0002	0.0011	0.0058	0.0237	0.0440	0.0385	0.0273	0.0188	0.0129	0.0088	0.0060	0.0041	0.0028	0.0019	0.0013
1992	0.0002	0.0013	0.0065	0.0266	0.0494	0.0432	0.0307	0.0211	0.0144	0.0099	0.0067	0.0046	0.0032	0.0022	0.0015
1993	0.0002	0.0011	0.0055	0.0226	0.0419	0.0367	0.0260	0.0179	0.0122	0.0084	0.0057	0.0039	0.0027	0.0018	0.0013
1994	0.0003	0.0014	0.0072	0.0294	0.0546	0.0478	0.0339	0.0233	0.0159	0.0109	0.0075	0.0051	0.0035	0.0024	0.0016
1995	0.0004	0.0020	0.0105	0.0427	0.0792	0.0693	0.0492	0.0338	0.0231	0.0158	0.0108	0.0074	0.0051	0.0035	0.0024
1996	0.0007	0.0036	0.0162	0.0426	0.0568	0.0566	0.0528	0.0486	0.0448	0.0412	0.0379	0.0349	0.0321	0.0295	0.0271
1997	0.0008	0.0039	0.0175	0.0460	0.0614	0.0611	0.0570	0.0525	0.0484	0.0445	0.0409	0.0377	0.0346	0.0319	0.0293
1998	0.0007	0.0034	0.0152	0.0398	0.0532	0.0529	0.0494	0.0455	0.0419	0.0386	0.0355	0.0326	0.0300	0.0276	0.0254
1999	0.0007	0.0035	0.0157	0.0411	0.0548	0.0546	0.0509	0.0469	0.0432	0.0397	0.0366	0.0336	0.0309	0.0285	0.0262
2000	0.0007	0.0038	0.0167	0.0439	0.0586	0.0583	0.0544	0.0501	0.0461	0.0425	0.0391	0.0359	0.0331	0.0304	0.0280
2001	0.0006	0.0030	0.0133	0.0349	0.0466	0.0464	0.0433	0.0399	0.0368	0.0338	0.0311	0.0286	0.0263	0.0242	0.0223
2002	0.0006	0.0033	0.0146	0.0384	0.0512	0.0510	0.0476	0.0439	0.0404	0.0371	0.0342	0.0314	0.0289	0.0266	0.0245
2003	0.0008	0.0043	0.0191	0.0501	0.0668	0.0665	0.0621	0.0572	0.0527	0.0485	0.0446	0.0410	0.0377	0.0347	0.0319
2004	0.0008	0.0042	0.0187	0.0489	0.0652	0.0649	0.0606	0.0559	0.0514	0.0473	0.0435	0.0400	0.0368	0.0339	0.0312
2005	0.0007	0.0037	0.0165	0.0431	0.0575	0.0573	0.0534	0.0493	0.0454	0.0417	0.0384	0.0353	0.0325	0.0299	0.0275
2006	0.0010	0.0051	0.0226	0.0592	0.0790	0.0787	0.0734	0.0677	0.0623	0.0573	0.0527	0.0485	0.0446	0.0410	0.0377
2007	0.0007	0.0038	0.0171	0.0449	0.0599	0.0596	0.0556	0.0513	0.0472	0.0434	0.0399	0.0368	0.0338	0.0311	0.0286
2008	0.0006	0.0033	0.0149	0.0390	0.0521	0.0518	0.0484	0.0446	0.0410	0.0378	0.0347	0.0320	0.0294	0.0270	0.0249
2009	0.0009	0.0045	0.0200	0.0525	0.0700	0.0697	0.0650	0.0600	0.0552	0.0508	0.0467	0.0430	0.0395	0.0364	0.0335
2010	0.0009	0.0047	0.0212	0.0555	0.0741	0.0738	0.0688	0.0634	0.0584	0.0537	0.0494	0.0455	0.0418	0.0385	0.0354
2011	0.0009	0.0046	0.0207	0.0543	0.0725	0.0722	0.0673	0.0621	0.0571	0.0526	0.0483	0.0445	0.0409	0.0376	0.0346
2012	0.0010	0.0054	0.0240	0.0629	0.0840	0.0836	0.0780	0.0719	0.0662	0.0609	0.0560	0.0515	0.0474	0.0436	0.0401
2013	0.0011	0.0059	0.0265	0.0693	0.0926	0.0921	0.0859	0.0793	0.0729	0.0671	0.0617	0.0568	0.0522	0.0481	0.0442
2014	0.0013	0.0069	0.0307	0.0805	0.1075	0.1070	0.0998	0.0920	0.0847	0.0779	0.0717	0.0660	0.0607	0.0558	0.0513
2015	0.0011	0.0057	0.0255	0.0669	0.0893	0.0889	0.0829	0.0764	0.0703	0.0647	0.0595	0.0548	0.0504	0.0464	0.0426
2016	0.0015	0.0077	0.0344	0.0900	0.1202	0.1196	0.1116	0.1029	0.0947	0.0871	0.0801	0.0737	0.0678	0.0624	0.0574
2017	0.0010	0.0054	0.0241	0.0632	0.0844	0.0840	0.0784	0.0723	0.0665	0.0612	0.0563	0.0518	0.0477	0.0438	0.0403
2018	0.0009	0.0045	0.0202	0.0529	0.0706	0.0703	0.0656	0.0605	0.0557	0.0512	0.0471	0.0433	0.0399	0.0367	0.0337
2019	0.0007	0.0036	0.0159	0.0418	0.0557	0.0555	0.0518	0.0477	0.0439	0.0404	0.0372	0.0342	0.0315	0.0289	0.0266
2020	0.0006	0.0033	0.0148	0.0387	0.0517	0.0515	0.0480	0.0443	0.0407	0.0375	0.0345	0.0317	0.0292	0.0268	0.0247
2021	0.0005	0.0027	0.0119	0.0312	0.0417	0.0415	0.0387	0.0357	0.0329	0.0302	0.0278	0.0256	0.0235	0.0217	0.0199
2022	0.0005	0.0026	0.0116	0.0304	0.0406	0.0405	0.0377	0.0348	0.0320	0.0295	0.0271	0.0249	0.0229	0.0211	0.0194
2023	0.0005	0.0025	0.0127	0.0358	0.0440	0.0380	0.0308	0.0247	0.0198	0.0159	0.0127	0.0102	0.0082	0.0066	0.0053

Table X5 cont.

Ocean Fishing Mortality-At-Age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0001	0.0058	0.0402	0.0933	0.1347	0.1580	0.1695	0.1747	0.1770	0.1781	0.1785	0.1787	0.1788	0.1788	0.1788
1983	0.0001	0.0047	0.0324	0.0751	0.1085	0.1273	0.1365	0.1408	0.1426	0.1435	0.1438	0.1440	0.1440	0.1441	0.1441
1984	0.0000	0.0020	0.0135	0.0313	0.0451	0.0530	0.0568	0.0586	0.0593	0.0597	0.0598	0.0599	0.0599	0.0599	0.0599
1985	0.0006	0.0048	0.0185	0.0434	0.0748	0.1055	0.1312	0.1507	0.1646	0.1740	0.1803	0.1843	0.1870	0.1887	0.1898
1986	0.0002	0.0013	0.0050	0.0118	0.0202	0.0286	0.0355	0.0408	0.0446	0.0471	0.0488	0.0499	0.0506	0.0511	0.0514
1987	0.0001	0.0008	0.0030	0.0069	0.0119	0.0168	0.0210	0.0241	0.0263	0.0278	0.0288	0.0294	0.0299	0.0301	0.0303
1988	0.0001	0.0009	0.0035	0.0081	0.0140	0.0197	0.0246	0.0282	0.0308	0.0326	0.0337	0.0345	0.0350	0.0353	0.0355
1989	0.0001	0.0012	0.0045	0.0106	0.0183	0.0258	0.0321	0.0369	0.0403	0.0426	0.0441	0.0451	0.0458	0.0462	0.0465
1990	0.0002	0.0010	0.0033	0.0079	0.0147	0.0227	0.0310	0.0387	0.0453	0.0506	0.0547	0.0579	0.0602	0.0619	0.0632
1991	0.0002	0.0014	0.0047	0.0113	0.0209	0.0324	0.0442	0.0551	0.0645	0.0721	0.0780	0.0824	0.0858	0.0882	0.0900
1992	0.0003	0.0017	0.0057	0.0136	0.0252	0.0391	0.0533	0.0665	0.0777	0.0869	0.0940	0.0994	0.1034	0.1064	0.1085
1993	0.0002	0.0013	0.0045	0.0107	0.0198	0.0307	0.0419	0.0522	0.0611	0.0682	0.0738	0.0781	0.0812	0.0836	0.0852
1994	0.0003	0.0017	0.0058	0.0139	0.0258	0.0400	0.0546	0.0681	0.0796	0.0890	0.0963	0.1018	0.1059	0.1090	0.1112
1995	0.0006	0.0031	0.0106	0.0253	0.0470	0.0728	0.0994	0.1240	0.1450	0.1620	0.1753	0.1854	0.1929	0.1984	0.2024
1996	0.0006	0.0036	0.0123	0.0293	0.0543	0.0843	0.1150	0.1434	0.1677	0.1874	0.2028	0.2145	0.2231	0.2295	0.2341
1997	0.0005	0.0042	0.0164	0.0389	0.0669	0.0943	0.1170	0.1340	0.1460	0.1541	0.1594	0.1629	0.1651	0.1665	0.1674
1998	0.0005	0.0045	0.0178	0.0421	0.0725	0.1022	0.1268	0.1452	0.1582	0.1670	0.1728	0.1765	0.1789	0.1804	0.1814
1999	0.0005	0.0041	0.0162	0.0385	0.0663	0.0934	0.1159	0.1328	0.1447	0.1527	0.1580	0.1614	0.1636	0.1650	0.1658
2000	0.0005	0.0040	0.0159	0.0377	0.0649	0.0914	0.1134	0.1299	0.1416	0.1494	0.1546	0.1579	0.1600	0.1614	0.1623
2001	0.0005	0.0042	0.0165	0.0391	0.0673	0.0948	0.1177	0.1348	0.1468	0.1550	0.1603	0.1638	0.1660	0.1674	0.1683
2002	0.0005	0.0045	0.0177	0.0420	0.0724	0.1020	0.1266	0.1450	0.1579	0.1667	0.1724	0.1762	0.1785	0.1801	0.1810
2003	0.0005	0.0046	0.0183	0.0433	0.0746	0.1050	0.1303	0.1493	0.1626	0.1716	0.1775	0.1814	0.1838	0.1854	0.1864
2004	0.0006	0.0053	0.0209	0.0495	0.0853	0.1202	0.1491	0.1708	0.1860	0.1964	0.2031	0.2075	0.2103	0.2121	0.2133
2005	0.0006	0.0053	0.0210	0.0498	0.0858	0.1209	0.1500	0.1718	0.1872	0.1975	0.2044	0.2088	0.2116	0.2134	0.2145
2006	0.0007	0.0062	0.0243	0.0575	0.0991	0.1396	0.1732	0.1985	0.2162	0.2282	0.2360	0.2411	0.2444	0.2465	0.2478
2007	0.0005	0.0046	0.0180	0.0427	0.0736	0.1037	0.1286	0.1473	0.1605	0.1694	0.1752	0.1790	0.1815	0.1830	0.1840
2008	0.0006	0.0050	0.0198	0.0471	0.0811	0.1142	0.1417	0.1623	0.1768	0.1866	0.1931	0.1972	0.1999	0.2016	0.2027
2009	0.0005	0.0046	0.0182	0.0431	0.0742	0.1046	0.1297	0.1486	0.1619	0.1709	0.1768	0.1806	0.1830	0.1846	0.1856
2010	0.0006	0.0056	0.0220	0.0521	0.0897	0.1264	0.1568	0.1796	0.1957	0.2065	0.2137	0.2183	0.2212	0.2231	0.2243
2011	0.0007	0.0058	0.0227	0.0538	0.0928	0.1306	0.1621	0.1857	0.2023	0.2135	0.2209	0.2256	0.2287	0.2306	0.2319
2012	0.0006	0.0056	0.0219	0.0519	0.0895	0.1260	0.1564	0.1791	0.1952	0.2060	0.2131	0.2177	0.2206	0.2225	0.2237
2013	0.0009	0.0081	0.0317	0.0752	0.1295	0.1824	0.2263	0.2593	0.2824	0.2981	0.3084	0.3150	0.3193	0.3220	0.3237
2014	0.0007	0.0058	0.0228	0.0542	0.0933	0.1315	0.1631	0.1869	0.2036	0.2148	0.2223	0.2271	0.2301	0.2321	0.2333
2015	0.0006	0.0051	0.0202	0.0480	0.0827	0.1165	0.1445	0.1656	0.1804	0.1903	0.1969	0.2012	0.2039	0.2056	0.2067
2016	0.0007	0.0057	0.0225	0.0532	0.0917	0.1292	0.1603	0.1836	0.2000	0.2111	0.2184	0.2231	0.2262	0.2281	0.2293
2017	0.0008	0.0073	0.0287	0.0680	0.1171	0.1649	0.2046	0.2344	0.2554	0.2695	0.2788	0.2848	0.2887	0.2912	0.2927
2018	0.0006	0.0052	0.0204	0.0484	0.0835	0.1175	0.1459	0.1671	0.1820	0.1921	0.1987	0.2030	0.2058	0.2075	0.2086
2019	0.0005	0.0047	0.0183	0.0435	0.0749	0.1055	0.1309	0.1500	0.1634	0.1724	0.1784	0.1822	0.1847	0.1863	0.1873
2020	0.0017	0.0052	0.0152	0.0380	0.0704	0.0941	0.1028	0.1034	0.1010	0.0979	0.0946	0.0914	0.0882	0.0852	0.0822
2021	0.0018	0.0057	0.0167	0.0417	0.0774	0.1034	0.1130	0.1136	0.1111	0.1076	0.1040	0.1004	0.0970	0.0936	0.0904
2022	0.0028	0.0086	0.0251	0.0625	0.1159	0.1549	0.1693	0.1702	0.1664	0.1612	0.1558	0.1504	0.1452	0.1402	0.1353
2023	0.0014	0.0039	0.0108	0.0287	0.0694	0.1360	0.1945	0.2124	0.2014	0.1808	0.1594	0.1397	0.1222	0.1068	0.0933

Table X5 cont.

Total Fishing Mortality-At-Age

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1982	0.0002	0.0133	0.0976	0.1179	0.1444	0.1619	0.1710	0.1753	0.1773	0.1782	0.1785	0.1787	0.1788	0.1788	0.1801
1983	0.0002	0.0127	0.0944	0.1018	0.1190	0.1315	0.1382	0.1414	0.1429	0.1436	0.1439	0.1440	0.1441	0.1441	0.1454
1984	0.0001	0.0098	0.0739	0.0572	0.0554	0.0570	0.0584	0.0592	0.0596	0.0598	0.0599	0.0599	0.0599	0.0600	0.0613
1985	0.0006	0.0059	0.0221	0.0467	0.0775	0.1078	0.1332	0.1524	0.1660	0.1752	0.1813	0.1852	0.1877	0.1893	0.1903
1986	0.0002	0.0031	0.0110	0.0171	0.0248	0.0324	0.0388	0.0436	0.0469	0.0491	0.0505	0.0514	0.0518	0.0521	0.0523
1987	0.0001	0.0015	0.0054	0.0092	0.0138	0.0185	0.0223	0.0252	0.0273	0.0286	0.0295	0.0300	0.0304	0.0306	0.0307
1988	0.0002	0.0023	0.0080	0.0122	0.0175	0.0227	0.0270	0.0303	0.0326	0.0341	0.0350	0.0356	0.0359	0.0361	0.0362
1989	0.0002	0.0026	0.0091	0.0148	0.0218	0.0288	0.0347	0.0390	0.0421	0.0441	0.0454	0.0462	0.0467	0.0470	0.0471
1990	0.0004	0.0020	0.0086	0.0295	0.0548	0.0579	0.0560	0.0558	0.0570	0.0586	0.0602	0.0616	0.0628	0.0637	0.0644
1991	0.0005	0.0025	0.0105	0.0350	0.0649	0.0709	0.0715	0.0739	0.0773	0.0808	0.0840	0.0866	0.0886	0.0902	0.0913
1992	0.0005	0.0029	0.0122	0.0402	0.0746	0.0823	0.0840	0.0875	0.0921	0.0967	0.1007	0.1040	0.1066	0.1085	0.1100
1993	0.0004	0.0024	0.0100	0.0332	0.0617	0.0673	0.0679	0.0701	0.0733	0.0766	0.0796	0.0820	0.0839	0.0854	0.0865
1994	0.0006	0.0031	0.0130	0.0433	0.0804	0.0878	0.0885	0.0914	0.0956	0.0999	0.1037	0.1069	0.1094	0.1113	0.1128
1995	0.0009	0.0051	0.0211	0.0680	0.1262	0.1422	0.1486	0.1578	0.1681	0.1779	0.1861	0.1928	0.1980	0.2019	0.2048
1996	0.0013	0.0072	0.0285	0.0718	0.1112	0.1408	0.1678	0.1921	0.2125	0.2286	0.2407	0.2493	0.2552	0.2590	0.2613
1997	0.0012	0.0081	0.0339	0.0848	0.1283	0.1554	0.1740	0.1866	0.1944	0.1986	0.2003	0.2005	0.1997	0.1983	0.1967
1998	0.0012	0.0079	0.0330	0.0820	0.1257	0.1551	0.1762	0.1908	0.2001	0.2055	0.2082	0.2091	0.2089	0.2080	0.2068
1999	0.0011	0.0076	0.0319	0.0796	0.1211	0.1480	0.1668	0.1797	0.1879	0.1924	0.1945	0.1950	0.1945	0.1934	0.1920
2000	0.0012	0.0078	0.0326	0.0815	0.1235	0.1497	0.1678	0.1801	0.1877	0.1919	0.1936	0.1938	0.1931	0.1918	0.1902
2001	0.0010	0.0072	0.0298	0.0740	0.1140	0.1413	0.1610	0.1747	0.1836	0.1888	0.1914	0.1924	0.1923	0.1916	0.1906
2002	0.0011	0.0078	0.0324	0.0804	0.1236	0.1530	0.1741	0.1888	0.1983	0.2038	0.2066	0.2076	0.2075	0.2067	0.2055
2003	0.0013	0.0089	0.0374	0.0933	0.1414	0.1715	0.1924	0.2065	0.2153	0.2201	0.2221	0.2224	0.2216	0.2201	0.2183
2004	0.0014	0.0095	0.0395	0.0984	0.1505	0.1851	0.2097	0.2266	0.2374	0.2436	0.2466	0.2475	0.2472	0.2460	0.2444
2005	0.0013	0.0090	0.0375	0.0929	0.1434	0.1782	0.2034	0.2211	0.2325	0.2393	0.2427	0.2441	0.2441	0.2433	0.2420
2006	0.0017	0.0112	0.0469	0.1167	0.1781	0.2183	0.2466	0.2661	0.2784	0.2854	0.2887	0.2896	0.2890	0.2875	0.2856
2007	0.0013	0.0084	0.0351	0.0876	0.1335	0.1633	0.1842	0.1986	0.2077	0.2128	0.2152	0.2158	0.2153	0.2141	0.2126
2008	0.0012	0.0084	0.0347	0.0861	0.1332	0.1660	0.1901	0.2069	0.2179	0.2244	0.2278	0.2292	0.2293	0.2287	0.2276
2009	0.0014	0.0091	0.0382	0.0956	0.1443	0.1743	0.1948	0.2086	0.2171	0.2217	0.2235	0.2236	0.2226	0.2210	0.2191
2010	0.0015	0.0103	0.0431	0.1076	0.1638	0.2001	0.2256	0.2431	0.2541	0.2602	0.2631	0.2637	0.2631	0.2616	0.2597
2011	0.0015	0.0104	0.0434	0.1081	0.1652	0.2028	0.2294	0.2478	0.2594	0.2660	0.2692	0.2701	0.2696	0.2683	0.2665
2012	0.0017	0.0109	0.0459	0.1148	0.1734	0.2096	0.2344	0.2510	0.2613	0.2668	0.2691	0.2692	0.2680	0.2661	0.2638
2013	0.0020	0.0140	0.0582	0.1445	0.2220	0.2745	0.3123	0.3385	0.3554	0.3652	0.3701	0.3718	0.3715	0.3701	0.3680
2014	0.0020	0.0127	0.0536	0.1347	0.2008	0.2385	0.2629	0.2789	0.2883	0.2928	0.2939	0.2930	0.2908	0.2879	0.2847
2015	0.0017	0.0109	0.0458	0.1149	0.1719	0.2053	0.2274	0.2420	0.2507	0.2551	0.2564	0.2559	0.2543	0.2520	0.2494
2016	0.0021	0.0134	0.0568	0.1433	0.2119	0.2488	0.2719	0.2865	0.2947	0.2982	0.2985	0.2969	0.2940	0.2905	0.2867
2017	0.0019	0.0127	0.0528	0.1312	0.2015	0.2490	0.2830	0.3067	0.3219	0.3307	0.3351	0.3366	0.3364	0.3350	0.3330
2018	0.0015	0.0097	0.0406	0.1014	0.1541	0.1879	0.2114	0.2276	0.2377	0.2433	0.2458	0.2464	0.2456	0.2442	0.2424
2019	0.0012	0.0082	0.0343	0.0852	0.1306	0.1610	0.1827	0.1977	0.2073	0.2128	0.2156	0.2164	0.2162	0.2152	0.2139
2020	0.0023	0.0085	0.0300	0.0767	0.1221	0.1456	0.1508	0.1476	0.1418	0.1354	0.1291	0.1231	0.1174	0.1120	0.1069
2021	0.0024	0.0084	0.0287	0.0730	0.1191	0.1450	0.1517	0.1493	0.1439	0.1379	0.1318	0.1260	0.1205	0.1153	0.1103
2022	0.0033	0.0112	0.0367	0.0930	0.1565	0.1954	0.2070	0.2050	0.1984	0.1907	0.1829	0.1754	0.1682	0.1613	0.1547
2023	0.0019	0.0065	0.0235	0.0645	0.1134	0.1740	0.2253	0.2371	0.2212	0.1967	0.1721	0.1499	0.1303	0.1133	0.0986

Table X6. Estimates of age-specific population abundance, 1982-2021

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	8+
1982	37,364,100	8,588,370	3,226,070	2,476,530	984,780	404,374	330,079	213,479	185,704	275,932	192,122	313,355	151,055	108,728	278,367	55,093,045	1,718,742
1983	75,602,800	12,068,000	4,293,690	1,865,850	1,582,410	663,821	284,418	239,450	154,199	133,873	198,742	138,323	225,568	108,728	278,367	97,838,239	1,477,250
1984	62,859,700	24,418,600	6,036,480	2,491,240	1,211,610	1,094,090	481,314	213,208	178,921	115,049	99,817	148,139	103,090	168,103	288,191	99,907,552	1,314,518
1985	68,479,300	20,303,500	12,250,200	3,574,720	1,691,400	892,742	854,611	390,767	172,963	145,090	93,277	80,920	120,090	83,569	369,578	109,502,727	1,456,254
1986	67,611,600	22,107,700	10,225,700	7,640,310	2,452,660	1,218,990	662,796	643,827	288,791	126,101	104,810	66,973	57,873	85,672	322,502	113,616,305	1,696,549
1987	74,169,300	21,836,200	11,165,400	6,448,960	5,399,460	1,863,340	975,896	548,761	530,513	237,174	103,335	85,769	54,759	47,295	333,442	123,799,604	1,941,048
1988	93,300,800	23,956,400	11,045,800	7,080,820	4,594,000	4,147,350	1,512,740	821,426	460,560	444,341	198,380	86,357	71,638	45,722	317,811	148,084,146	2,446,236
1989	106,655,000	30,134,800	12,109,200	6,987,030	5,028,780	3,515,920	3,352,810	1,267,300	685,903	383,703	369,638	164,873	71,731	59,485	301,786	171,087,958	3,304,418
1990	130,941,000	34,446,800	15,227,600	7,650,960	4,949,430	3,831,890	2,824,960	2,787,500	1,049,010	566,020	315,996	304,018	135,495	58,921	296,639	205,386,239	5,513,599
1991	104,485,000	42,283,100	17,416,500	9,626,300	5,340,420	3,648,980	2,990,600	2,299,140	2,268,960	852,882	459,454	256,089	246,034	109,526	286,987	192,569,972	6,779,072
1992	108,762,000	33,736,700	21,367,700	10,989,000	6,682,810	3,897,720	2,810,970	2,396,330	1,837,910	1,807,590	677,075	363,605	202,143	193,811	311,598	196,036,962	7,790,062
1993	133,935,000	35,115,100	17,041,600	13,459,400	7,589,240	4,830,600	2,968,700	2,224,620	1,889,700	1,442,670	1,412,390	526,927	282,048	156,400	389,927	223,264,322	8,324,682
1994	285,297,000	43,246,700	17,747,600	10,758,100	9,360,100	5,556,950	3,734,550	2,387,510	1,785,150	1,511,540	1,150,150	1,122,690	417,829	223,222	431,404	384,730,495	9,029,495
1995	186,734,000	92,108,400	21,841,600	11,169,900	7,406,490	6,726,490	4,209,160	2,942,140	1,875,510	1,396,460	1,177,330	892,402	868,332	322,356	503,596	340,174,166	9,978,126
1996	234,018,000	60,265,400	46,424,800	13,636,700	7,502,680	5,084,410	4,825,430	3,122,640	2,162,740	1,364,470	1,006,110	841,231	633,409	613,151	579,924	382,081,095	10,323,675
1997	258,960,000	75,495,500	30,311,800	28,770,400	9,124,160	5,228,440	3,652,350	3,511,810	2,218,020	1,505,120	934,388	680,720	564,275	422,380	791,697	422,171,060	10,628,410
1998	148,052,000	83,550,900	37,939,400	18,683,000	19,001,600	6,250,310	3,701,530	2,641,650	2,508,220	1,571,870	1,062,170	658,237	479,458	397,761	857,909	327,356,015	10,177,275
1999	152,875,000	47,770,300	41,994,900	23,406,800	12,374,800	13,050,100	4,426,050	2,671,330	1,878,780	1,767,290	1,101,560	742,368	459,644	334,876	878,539	305,732,337	9,834,387
2000	124,486,000	49,327,600	24,017,400	25,936,300	15,540,800	8,538,000	9,307,430	3,224,210	1,921,000	1,340,130	1,254,870	780,533	525,764	325,695	861,605	267,387,337	10,233,807
2001	196,467,000	40,166,100	24,796,600	14,822,600	17,186,200	10,697,600	6,078,890	6,773,450	2,317,780	1,370,470	952,107	889,963	553,441	373,069	844,523	324,289,793	14,074,803
2002	221,336,000	63,399,200	20,203,500	15,346,600	9,895,990	11,942,900	7,681,040	4,454,190	4,895,320	1,660,330	976,643	676,713	631,928	393,004	865,851	364,359,209	14,553,979
2003	127,967,000	71,418,000	31,870,300	12,472,000	10,180,700	6,810,750	8,475,350	5,554,690	3,174,080	3,455,590	1,165,570	683,709	473,270	442,005	881,917	285,024,931	15,830,831
2004	304,432,000	41,282,400	35,860,800	19,576,300	8,167,420	6,883,390	4,744,390	6,018,290	3,888,990	2,202,830	2,386,730	803,399	471,137	326,394	915,468	437,959,938	17,013,238
2005	158,153,000	98,204,900	20,717,200	21,979,700	12,755,300	5,471,910	4,730,500	3,311,210	4,129,550	2,639,810	1,486,030	1,605,270	539,860	316,713	836,755	336,877,708	14,865,198
2006	135,236,000	51,022,000	49,305,900	12,724,200	14,399,600	8,607,120	3,786,610	3,322,170	2,284,690	2,816,970	1,788,640	1,003,380	1,082,440	364,028	779,111	288,522,859	13,441,429
2007	88,441,000	43,613,400	25,560,400	29,999,900	8,139,960	9,384,600	5,722,040	2,546,890	2,191,350	1,488,530	1,822,530	1,153,420	646,466	697,828	739,045	222,147,359	11,286,059
2008	126,912,000	28,533,800	21,910,400	15,735,400	19,759,200	5,547,320	6,591,680	4,096,400	1,797,270	1,532,390	1,035,610	1,264,970	800,086	448,662	999,156	236,964,344	11,974,544
2009	75,196,700	40,947,600	14,335,200	13,493,800	10,379,600	13,470,000	3,885,600	4,691,510	2,866,800	1,244,090	1,053,860	709,776	865,771	547,530	992,185	184,680,022	12,971,522
2010	96,903,000	24,257,700	20,557,000	8,798,030	8,816,910	6,997,620	9,357,590	2,752,480	3,277,760	1,985,960	857,921	725,405	488,521	596,480	1,063,820	187,436,197	11,748,347
2011	125,307,000	31,255,000	12,163,300	12,554,200	5,679,980	5,829,110	4,737,180	6,427,480	1,857,870	2,188,230	1,317,670	567,614	479,621	323,219	1,101,440	211,788,914	14,263,144
2012	192,360,000	40,416,400	15,670,500	7,426,080	8,100,520	3,749,890	3,935,670	3,241,530	4,318,180	1,233,720	1,443,490	866,465	372,911	315,259	938,971	284,389,586	12,730,526
2013	66,597,300	62,036,200	20,253,000	9,543,610	4,759,560	5,304,120	2,514,580	2,679,760	2,170,600	2,861,980	813,181	949,314	569,765	245,504	828,725	182,127,199	11,118,829
2014	82,938,200	21,469,400	30,992,700	12,184,300	5,938,020	2,968,680	3,333,300	1,583,840	1,644,160	1,309,510	1,709,760	483,413	563,369	338,219	639,654	168,096,525	8,271,925
2015	153,154,000	26,739,200	10,739,800	18,731,000	7,655,810	3,783,210	1,934,150	2,205,700	1,031,450	1,060,750	841,052	1,096,820	310,403	362,540	632,440	230,278,325	7,541,155
2016	228,067,000	49,391,300	13,400,400	6,541,700	12,005,000	5,020,460	2,547,850	1,326,140	1,490,430	690,928	707,461	560,155	730,875	207,182	666,741	323,353,622	6,379,912
2017	111,488,000	73,518,300	24,689,800	8,072,670	4,075,320	7,564,400	3,237,260	1,670,930	857,067	955,370	441,338	451,755	358,299	468,845	564,197	238,413,551	5,767,801
2018	130,105,000	35,947,600	36,776,500	14,933,400	5,090,040	2,594,660	4,876,880	2,099,530	1,058,330	534,662	590,752	271,701	277,691	220,307	636,724	236,013,777	5,689,697
2019	165,265,000	41,967,500	18,035,800	22,516,400	9,701,210	3,398,080	1,778,200	3,397,620	1,439,300	718,223	360,807	397,648	182,792	186,956	578,611	269,924,147	7,261,957
2020	120,143,000	53,321,800	21,087,400	11,112,700	14,865,000	6,630,030	2,392,210	1,274,980	2,399,780	1,006,890	499,670	250,332	275,651	126,746	531,867	235,918,056	6,365,916
2021	85,158,100	38,720,900	26,784,800	13,048,600	7,399,390	10,246,600	4,740,090	1,770,770	946,785	1,792,490	756,905	377,985	190,510	210,977	508,908	192,653,810	6,555,330
2022	76,967,300	27,444,300	19,452,800	16,596,400	8,720,710	5,115,800	7,330,100	3,505,450	1,312,700	705,664	1,344,130	571,010	286,811	145,358	554,104	170,052,637	8,425,227
2023	96,681,400	24,782,200	13,749,300	11,957,000	10,872,400	5,807,770	3,479,720	5,129,420	2,458,020	926,552	501,940	963,536	412,419	208,649	515,022	178,445,348	11,115,558

Table X7. Estimates of female spawning stock biomass, 1982-2023.

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	0.0	0.0	0.0	142.0	365.4	409.4	891.1	825.6	886.1	2,010.4	1,860.7	3,105.7	1,861.0	1,496.7	4,454.6	18,308.5
1983	0.0	0.0	0.0	100.3	558.8	548.4	616.4	845.9	758.0	875.4	1,654.2	1,320.5	2,550.2	1,419.7	4,156.7	15,404.5
1984	0.0	0.0	0.0	147.0	457.3	926.4	1,270.7	742.6	950.2	728.9	747.4	1,603.8	1,194.6	2,238.1	4,503.3	15,510.3
1985	0.0	0.0	0.0	249.0	572.5	808.9	2,202.7	1,415.2	921.9	907.7	718.3	738.3	1,361.3	1,043.0	5,204.1	16,142.8
1986	0.0	0.0	0.0	627.8	910.6	953.3	1,486.0	2,205.4	1,310.8	687.1	723.5	561.0	547.9	905.0	3,673.1	14,591.5
1987	0.0	0.0	0.0	502.6	2,241.1	1,422.8	1,977.9	1,700.8	2,392.1	1,285.9	681.0	728.4	522.7	501.7	4,122.3	18,079.2
1988	0.0	0.0	0.0	539.9	2,179.3	4,058.2	3,481.6	2,472.2	1,964.7	2,169.3	1,430.1	768.1	703.3	495.5	3,938.9	24,201.0
1989	0.0	0.0	0.0	547.2	2,313.0	3,974.6	9,739.7	4,940.8	3,245.1	2,559.1	2,648.3	1,429.6	745.6	667.4	3,847.7	36,658.0
1990	0.0	0.0	0.0	576.5	1,917.6	3,789.9	7,889.0	11,043.2	5,091.2	2,950.0	2,195.9	2,522.9	1,232.7	595.9	3,228.6	43,033.1
1991	0.0	0.0	0.0	743.8	2,195.9	2,927.9	7,873.4	8,530.3	11,938.2	4,518.8	3,473.2	1,892.8	2,285.9	1,110.4	3,310.0	50,800.7
1992	0.0	0.0	0.0	801.6	2,934.7	3,582.7	7,148.7	9,008.8	10,071.3	12,053.6	5,293.0	3,859.0	2,274.1	2,521.3	5,053.7	64,602.5
1993	0.0	0.0	0.0	1,009.2	3,206.0	4,441.8	7,723.6	8,763.3	10,521.6	9,694.1	11,610.1	5,067.5	3,267.3	2,014.1	5,592.1	72,910.8
1994	0.0	0.0	0.0	871.8	4,062.9	4,995.6	9,846.1	9,439.7	9,804.0	9,698.6	9,538.2	10,651.2	4,569.9	2,734.1	5,963.6	82,175.8
1995	0.0	0.0	0.0	952.5	3,215.8	6,250.9	11,693.7	11,582.6	10,790.7	9,960.9	7,898.8	7,862.8	8,824.6	3,619.8	6,198.2	88,851.2
1996	0.0	0.0	0.0	1,151.4	3,648.4	5,508.0	15,383.4	13,936.6	13,051.0	10,128.6	8,165.6	7,118.3	6,641.2	7,095.5	7,619.0	99,447.0
1997	0.0	0.0	0.0	2,589.7	4,052.5	4,996.3	9,452.3	12,703.9	12,430.5	11,381.0	8,073.1	6,158.8	6,159.8	5,238.5	11,340.4	94,576.7
1998	0.0	0.0	0.0	1,164.0	7,251.0	4,927.2	9,343.1	9,508.8	13,039.2	9,375.6	7,609.6	5,883.8	4,769.0	4,503.7	10,724.9	88,099.9
1999	0.0	0.0	0.0	1,340.9	3,763.8	8,627.5	8,262.0	8,897.5	9,763.0	11,503.8	8,049.9	6,194.1	4,801.3	3,955.2	12,335.9	87,495.0
2000	0.0	0.0	0.0	1,464.5	4,678.3	5,864.2	18,622.0	9,967.9	10,295.7	8,240.1	10,237.9	7,178.6	5,829.2	4,189.1	13,283.0	99,850.5
2001	0.0	0.0	0.0	962.3	5,676.3	8,298.9	13,047.0	21,508.7	11,464.5	8,965.6	7,018.2	6,948.6	5,419.6	4,142.0	10,148.8	103,600.5
2002	0.0	0.0	0.0	895.4	3,387.6	9,359.6	17,321.8	15,302.2	23,150.9	10,313.1	7,564.8	5,789.9	6,254.2	4,519.6	11,802.3	115,661.3
2003	0.0	0.0	0.0	677.3	3,375.9	5,347.1	18,653.5	18,391.8	15,450.6	20,386.1	8,507.7	5,754.1	4,682.8	4,989.4	11,299.7	117,516.0
2004	0.0	0.0	0.0	1,047.1	2,860.8	5,294.6	10,524.9	19,693.5	18,573.9	12,893.9	16,680.8	6,435.4	4,483.7	3,520.5	11,205.9	113,215.0
2005	0.0	0.0	0.0	1,268.1	4,177.9	4,442.2	10,501.5	11,600.4	20,454.0	15,585.5	10,672.8	13,753.4	5,356.9	3,575.1	11,045.5	112,433.3
2006	0.0	0.0	0.0	683.1	4,453.6	6,112.7	7,928.6	11,163.5	11,942.5	17,109.8	12,906.5	8,250.7	10,961.6	4,179.1	10,355.2	106,046.9
2007	0.0	0.0	0.0	1,441.6	2,536.7	6,960.5	12,685.4	8,400.0	11,626.0	9,617.5	14,272.8	10,119.2	6,865.7	8,541.0	10,700.2	103,766.5
2008	0.0	0.0	0.0	843.1	6,187.0	4,587.4	16,830.6	14,265.2	9,304.3	10,356.3	8,083.4	11,082.9	8,434.5	5,409.3	13,700.9	109,084.9
2009	0.0	0.0	0.0	733.0	3,064.9	10,744.7	9,362.1	17,524.2	15,274.3	7,943.4	8,077.6	6,022.5	8,820.9	6,373.8	13,118.1	107,059.4
2010	0.0	0.0	0.0	476.2	2,659.8	5,480.1	21,359.5	9,252.0	16,413.7	12,616.6	6,529.6	5,911.7	4,827.8	6,743.9	13,722.0	105,992.8
2011	0.0	0.0	0.0	743.2	1,719.7	4,333.3	10,524.1	21,079.2	9,227.6	13,433.0	9,345.8	4,956.1	4,775.4	3,709.0	14,697.7	98,544.1
2012	0.0	0.0	0.0	457.1	2,786.5	2,903.9	9,091.2	11,653.4	21,759.0	8,190.9	10,984.5	7,636.2	3,989.1	3,815.7	13,325.2	96,592.6
2013	0.0	0.0	0.0	506.7	1,643.7	4,352.2	5,542.8	9,012.1	11,364.4	17,617.7	6,385.6	8,506.0	6,096.1	3,004.7	11,775.6	85,807.5
2014	0.0	0.0	0.0	597.5	1,884.5	2,267.1	7,644.9	5,265.4	8,726.4	8,859.6	13,111.7	4,846.8	6,593.1	4,569.5	10,466.8	74,833.3
2015	0.0	0.0	0.0	1,068.9	2,667.6	3,322.6	4,557.5	7,827.3	5,483.3	6,798.1	6,534.9	10,046.6	3,440.8	4,537.0	8,823.7	65,108.1
2016	0.0	0.0	0.0	313.4	3,963.2	4,235.7	6,478.9	4,984.0	8,107.3	4,924.4	5,826.7	5,326.4	8,533.0	2,756.8	10,642.6	66,092.4
2017	0.0	0.0	0.0	445.0	1,406.0	5,996.2	7,653.5	5,741.3	4,376.0	6,607.5	3,688.0	4,278.1	4,146.6	6,247.6	8,346.1	58,932.0
2018	0.0	0.0	0.0	801.6	1,649.1	2,287.1	10,427.1	7,096.9	5,954.6	3,760.5	5,238.2	2,950.9	3,245.4	2,813.7	10,386.1	56,611.0
2019	0.0	0.0	0.0	1,187.0	3,062.5	2,608.5	4,082.7	12,657.6	8,172.5	5,174.1	3,171.1	4,142.5	2,398.8	2,492.5	8,721.2	57,871.0
2020	0.0	0.0	0.0	680.4	4,646.6	4,701.2	5,561.3	4,953.1	13,133.7	7,331.8	4,506.5	2,664.9	3,362.3	1,653.9	7,747.4	60,943.1
2021	0.0	0.0	0.0	749.8	2,613.1	6,928.7	9,921.4	6,003.7	4,507.4	12,309.2	4,616.4	3,748.5	2,392.2	2,767.1	7,812.8	64,370.2
2022	0.0	0.0	0.0	1,088.0	3,150.1	4,703.4	16,627.5	11,287.4	6,904.6	4,338.2	11,170.6	5,171.3	3,409.7	1,836.5	8,349.5	78,036.8
2023	0.0	0.0	0.0	812.7	4,129.0	5,057.2	8,575.3	16,799.3	11,975.3	5,484.7	4,261.4	9,240.8	4,700.0	2,708.4	6,993.8	80,738.0

Table x8. Estimate of total female spawning stock biomass with associated standard errors and coefficients of variation.

Year	Total	SE	CV
1982	18,308.5	2,575.7	0.141
1983	15,404.4	2,285.6	0.148
1984	15,510.3	2,286.7	0.147
1985	16,142.8	2,221.6	0.138
1986	14,591.5	1,899.4	0.130
1987	18,079.2	2,093.3	0.116
1988	24,201.0	2,368.9	0.098
1989	36,658.0	3,084.6	0.084
1990	43,033.1	3,264.2	0.076
1991	50,800.7	3,659.9	0.072
1992	64,602.5	4,647.2	0.072
1993	72,910.7	5,027.9	0.069
1994	82,175.7	5,342.5	0.065
1995	88,851.2	5,491.2	0.062
1996	99,447.0	6,244.7	0.063
1997	94,576.7	6,356.5	0.067
1998	88,099.9	5,493.2	0.062
1999	87,495.0	5,457.6	0.062
2000	99,850.6	5,896.1	0.059
2001	103,601.0	5,575.4	0.054
2002	115,661.0	6,163.8	0.053
2003	117,516.0	6,258.5	0.053
2004	113,215.0	6,196.8	0.055
2005	112,433.0	6,387.2	0.057
2006	106,047.0	6,239.6	0.059
2007	103,766.0	6,304.1	0.061
2008	109,085.0	6,239.6	0.057
2009	107,059.0	5,976.9	0.056
2010	105,993.0	5,802.6	0.055
2011	98,544.2	5,661.3	0.057
2012	96,592.7	5,868.2	0.061
2013	85,807.5	5,684.1	0.066
2014	74,833.3	5,719.4	0.076
2015	65,108.1	5,188.6	0.080
2016	66,092.5	5,535.9	0.084
2017	58,932.0	5,264.8	0.089
2018	56,611.0	5,485.0	0.097
2019	57,871.0	5,674.1	0.098
2020	60,943.1	5,955.9	0.098
2021	64,370.1	6,342.3	0.099
2022	78,036.8	7,687.2	0.099
2023	80,738.0	8,574.5	0.106

Table x9 . Estimates of exploitable biomass, 1982-2021.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1982	2,362	4,535	3,137	3,074	2,044	1,512	1,513	1,213	1,007	2,281	2,115	3,342	1,964	1,550	4,766	36,416
1983	8,730	3,227	3,330	2,280	3,023	1,873	1,069	1,218	910	949	1,811	1,465	2,653	1,493	4,432	38,463
1984	9,463	8,459	5,820	3,074	2,317	3,101	1,966	984	1,077	786	824	1,630	1,195	2,265	4,761	47,722
1985	1,333	7,769	9,815	5,987	3,186	2,764	3,487	2,056	1,070	1,030	780	767	1,478	1,105	5,573	48,199
1986	4,036	4,088	9,000	12,244	4,936	3,186	2,496	3,206	1,574	810	796	608	592	979	3,880	52,431
1987	6,954	7,169	10,010	10,557	13,226	4,965	3,275	2,374	2,801	1,409	711	747	534	506	4,345	69,583
1988	17,676	10,220	10,166	11,831	11,787	13,148	5,401	3,384	2,295	2,475	1,480	776	728	506	4,154	96,027
1989	7,235	15,286	12,759	10,943	12,378	13,218	15,578	6,620	3,655	2,588	2,620	1,507	773	678	4,062	109,900
1990	3,089	12,999	14,812	12,100	11,330	13,118	13,323	15,770	6,251	3,399	2,539	2,739	1,309	639	3,414	116,832
1991	12,105	11,471	18,662	15,141	12,377	9,959	12,836	12,099	14,079	5,087	3,453	2,012	2,358	1,133	3,510	136,281
1992	3,945	12,842	23,458	17,339	16,502	12,086	11,079	12,646	11,515	13,116	5,287	3,944	2,139	2,414	5,369	153,682
1993	2,421	9,681	16,202	21,731	17,548	15,321	12,460	12,172	12,056	10,772	12,447	5,403	3,478	2,126	5,927	159,745
1994	40,093	11,725	20,114	18,305	22,291	17,303	15,705	13,025	11,507	10,998	10,154	11,332	4,732	2,845	6,337	216,463
1995	27,000	37,753	26,004	21,440	18,325	21,695	18,265	16,230	12,592	10,839	8,889	8,683	9,399	3,868	6,647	247,630
1996	15,569	32,677	47,093	24,133	19,909	17,991	23,304	19,313	15,001	11,159	9,138	7,356	6,810	7,327	8,218	264,997
1997	13,833	22,242	33,740	54,711	23,297	17,928	16,490	19,989	15,343	12,737	8,935	6,647	6,287	5,408	12,153	269,739
1998	38,009	26,434	32,725	25,831	44,704	17,996	15,294	13,347	14,749	10,812	8,960	6,520	5,047	4,851	11,505	276,783
1999	100,633	28,302	38,824	30,769	21,768	31,013	13,935	12,975	11,448	12,931	8,610	6,461	4,933	4,022	13,213	339,836
2000	45,450	28,805	23,897	32,904	26,109	19,710	29,083	13,334	11,488	9,318	10,950	7,527	5,849	4,245	14,225	282,893
2001	22,583	15,061	19,462	20,566	30,765	26,999	20,610	29,932	13,187	10,199	7,602	7,981	5,844	4,532	10,869	246,193
2002	11,878	14,120	12,823	19,958	19,329	31,611	28,345	21,165	26,933	11,513	8,218	6,215	6,178	4,583	12,659	235,526
2003	7,044	19,164	17,745	15,193	18,556	17,989	30,555	25,928	18,352	22,769	9,343	6,320	4,888	5,270	12,135	231,250
2004	47,490	7,499	25,459	23,163	15,064	18,005	17,269	27,708	21,849	14,517	18,317	7,039	4,692	3,716	12,066	263,852
2005	12,025	33,303	12,707	25,798	22,487	15,330	17,056	16,000	23,717	17,464	11,567	14,519	5,453	3,672	11,890	242,988
2006	15,227	11,340	31,378	15,785	25,817	21,459	13,336	15,710	14,044	19,369	14,068	8,974	11,501	4,380	11,196	233,585
2007	4,169	12,550	15,277	30,785	13,706	23,020	19,878	11,512	13,305	10,788	15,203	10,748	6,912	8,717	11,485	208,051
2008	15,511	6,053	15,155	18,244	32,957	14,975	25,954	19,963	10,722	11,560	8,790	12,147	8,732	5,693	14,728	221,183
2009	11,915	14,775	9,760	16,340	17,199	35,742	15,337	25,259	17,638	8,947	8,990	6,621	9,140	6,710	14,089	218,462
2010	8,600	10,349	17,054	10,603	14,769	17,720	35,073	13,313	19,664	14,397	7,144	6,513	5,006	7,102	14,798	202,105
2011	16,177	9,015	10,378	16,467	9,538	14,431	17,530	30,082	10,737	15,046	10,436	5,371	4,886	3,858	15,861	189,813
2012	6,218	12,523	11,357	9,787	15,295	9,560	14,554	15,916	25,069	9,004	11,924	8,005	4,101	3,928	14,376	171,617
2013	7,437	12,283	13,748	11,308	9,267	14,789	9,224	12,999	13,614	20,157	7,133	9,228	6,400	3,173	12,837	163,596
2014	52,826	6,940	20,467	13,454	10,265	7,837	12,678	7,419	10,007	9,834	14,226	5,077	6,688	4,643	11,316	193,678
2015	13,568	10,080	7,640	22,282	13,642	10,742	7,237	10,885	6,269	7,777	7,305	10,783	3,705	4,891	9,506	146,310
2016	23,074	12,544	6,373	7,015	22,299	14,637	10,753	6,965	9,446	5,448	6,213	5,616	8,692	2,804	11,508	153,388
2017	13,968	21,001	16,669	8,990	7,190	20,181	12,606	8,392	5,325	7,431	4,122	4,704	4,339	6,619	9,067	150,603
2018	20,262	12,653	25,223	18,061	9,301	7,747	17,465	10,159	6,679	4,042	5,631	3,055	3,322	2,978	11,181	157,760
2019	19,932	15,522	14,792	26,185	16,593	8,726	6,862	16,756	9,086	5,812	3,463	4,459	2,503	2,607	9,362	162,658
2020	31,069	17,685	16,000	15,008	25,245	16,182	8,892	6,579	15,573	8,196	4,809	2,801	3,470	1,784	8,228	181,521
2021	5,006	15,333	19,463	16,221	14,317	24,114	15,832	8,503	5,653	13,509	5,613	4,078	2,467	2,900	8,300	161,310
2022	7,146	6,722	14,854	22,177	16,919	15,395	25,425	15,773	7,865	4,645	12,132	4,890	3,470	1,975	8,910	168,297
2023	29,847	7,714	11,042	17,548	23,209	17,115	14,489	24,463	13,889	6,375	4,478	9,885	4,935	2,846	7,421	195,258

Table X10. Reference points and probability of female spawning stock biomass being greater or equal to the SSB target and SSBthreshold over a ten-year projection under the current fully-recruited 2023 F, Ftarget and Fthreshold.

Reference Points

	SSB	F
Target	111064.0	0.193
Threshold	88851.2	0.235
Current	80738.0	0.237

	Current F		Ftarget		Fthreshold	
Year	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget	Pr SSB>= SSBthreshold	Pr SSB>= SSBtarget
2023	0.111	0.000	0.114	0.000	0.109	0.000
2024	0.353	0.001	0.363	0.001	0.352	0.001
2025	0.430	0.004	0.607	0.012	0.432	0.004
2026	0.430	0.005	0.722	0.030	0.437	0.007
2027	0.356	0.004	0.767	0.046	0.388	0.005
2028	0.294	0.003	0.777	0.051	0.318	0.003
2029	0.247	0.002	0.774	0.057	0.269	0.003

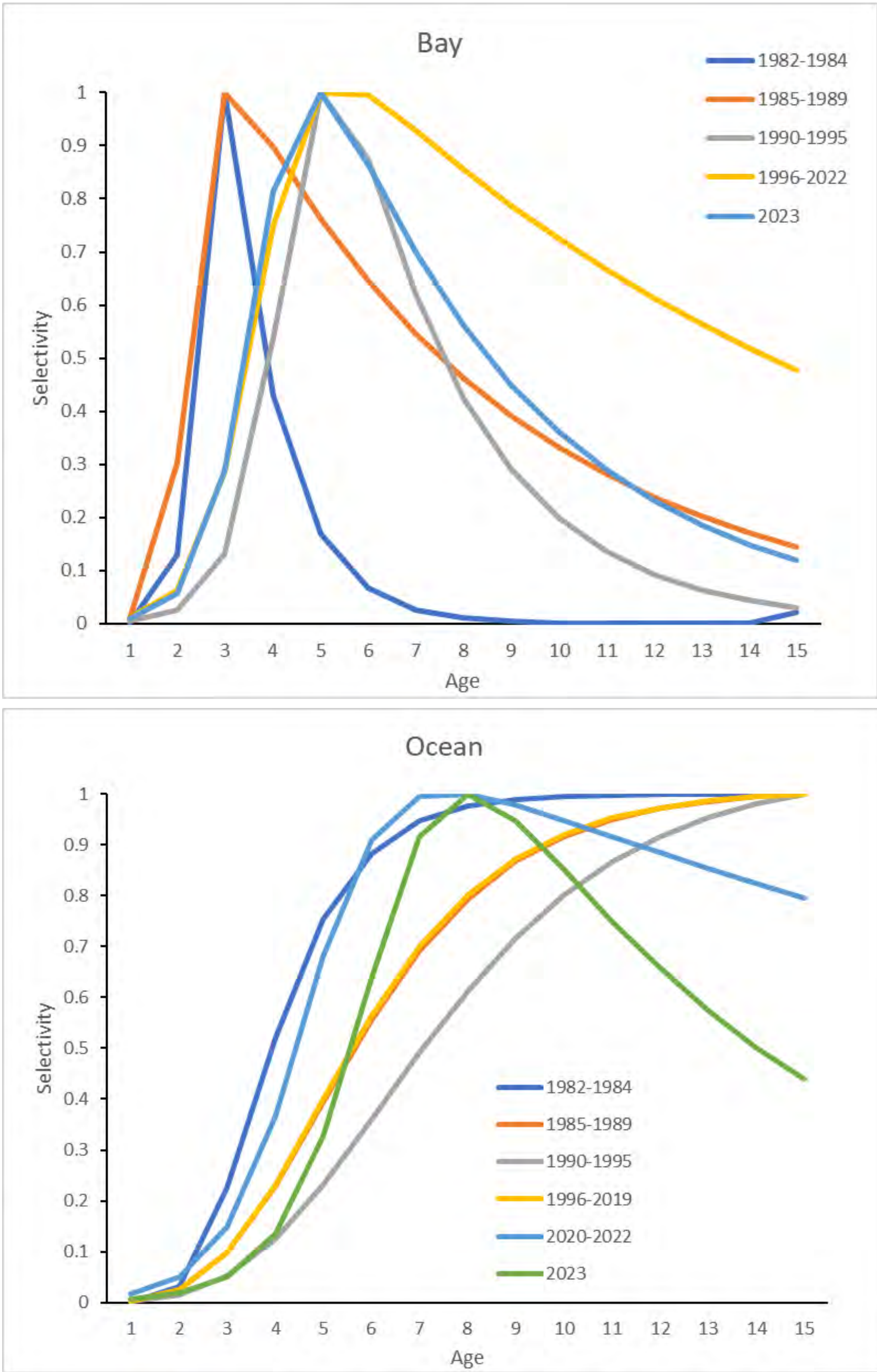

Figure 1. Estimates of selectivity patterns for the five Bay and Ocean time blocks.

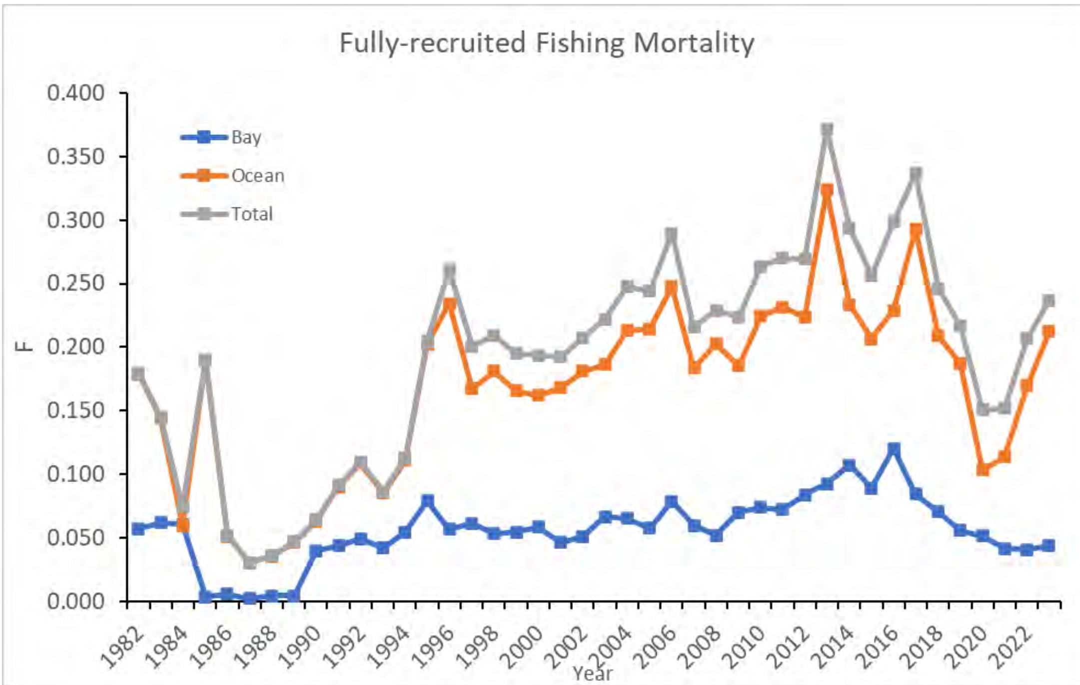

Figure 2. Estimates of region-specific and total fully-recruited fishing mortality in the Bay and Ocean, 1982-2023.

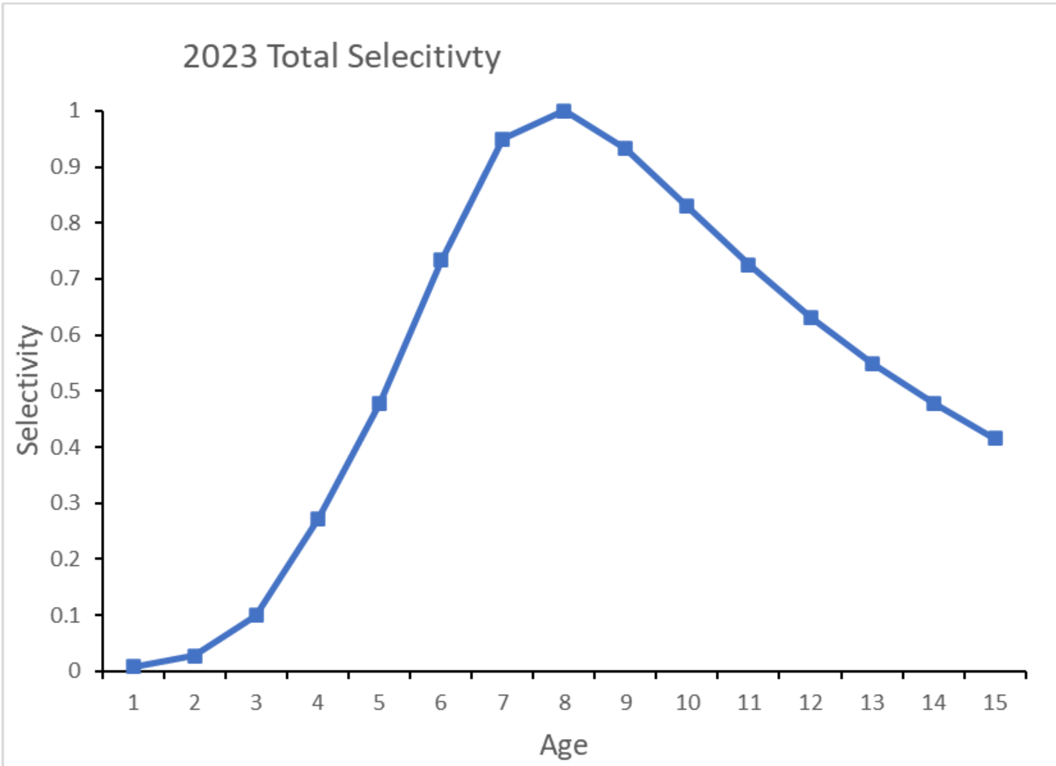

Figure 3. Total selectivity pattern for 2023 (Bay and Ocean combined) derived from total fishing mortality-at-age.

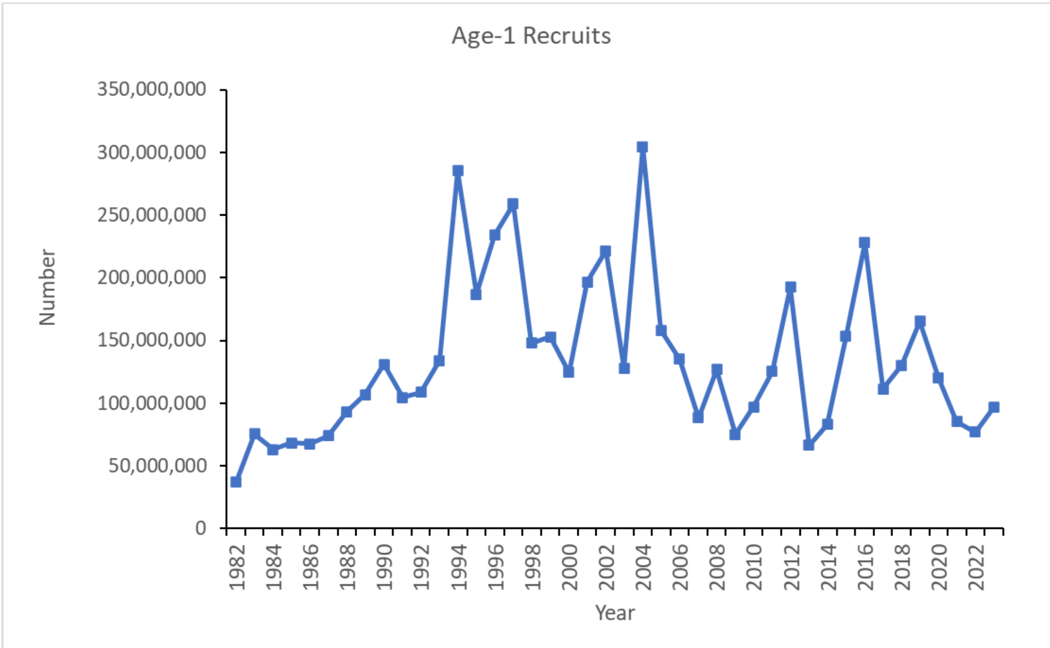

Figure 4. Estimates of recruit (age-1) abundance, 1982-2023.

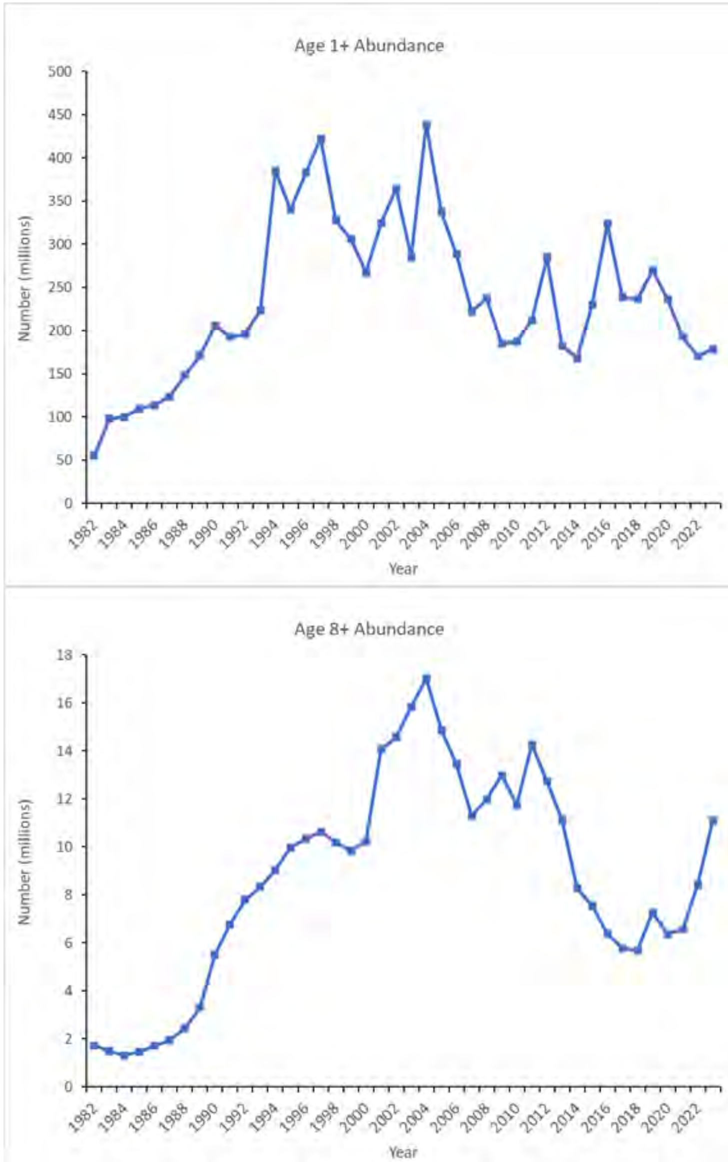

Figure 5. Estimates of total (top) and age-8 + (bottom) abundance from the updated stock assessment, 1982-2023.

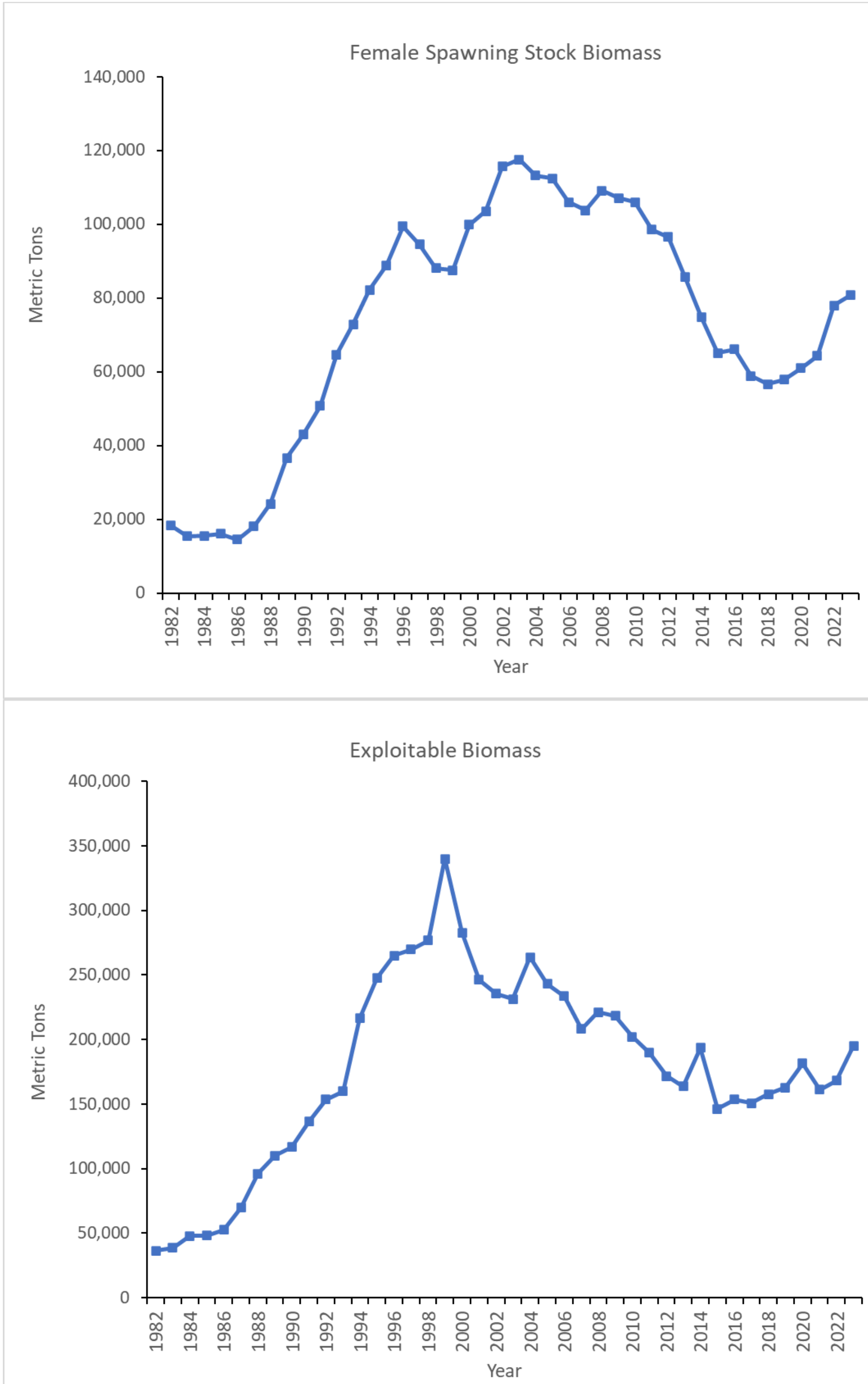

Figure 6. Estimates of female spawning stock biomass (top) and exploitable biomass (bottom), 1982-2023

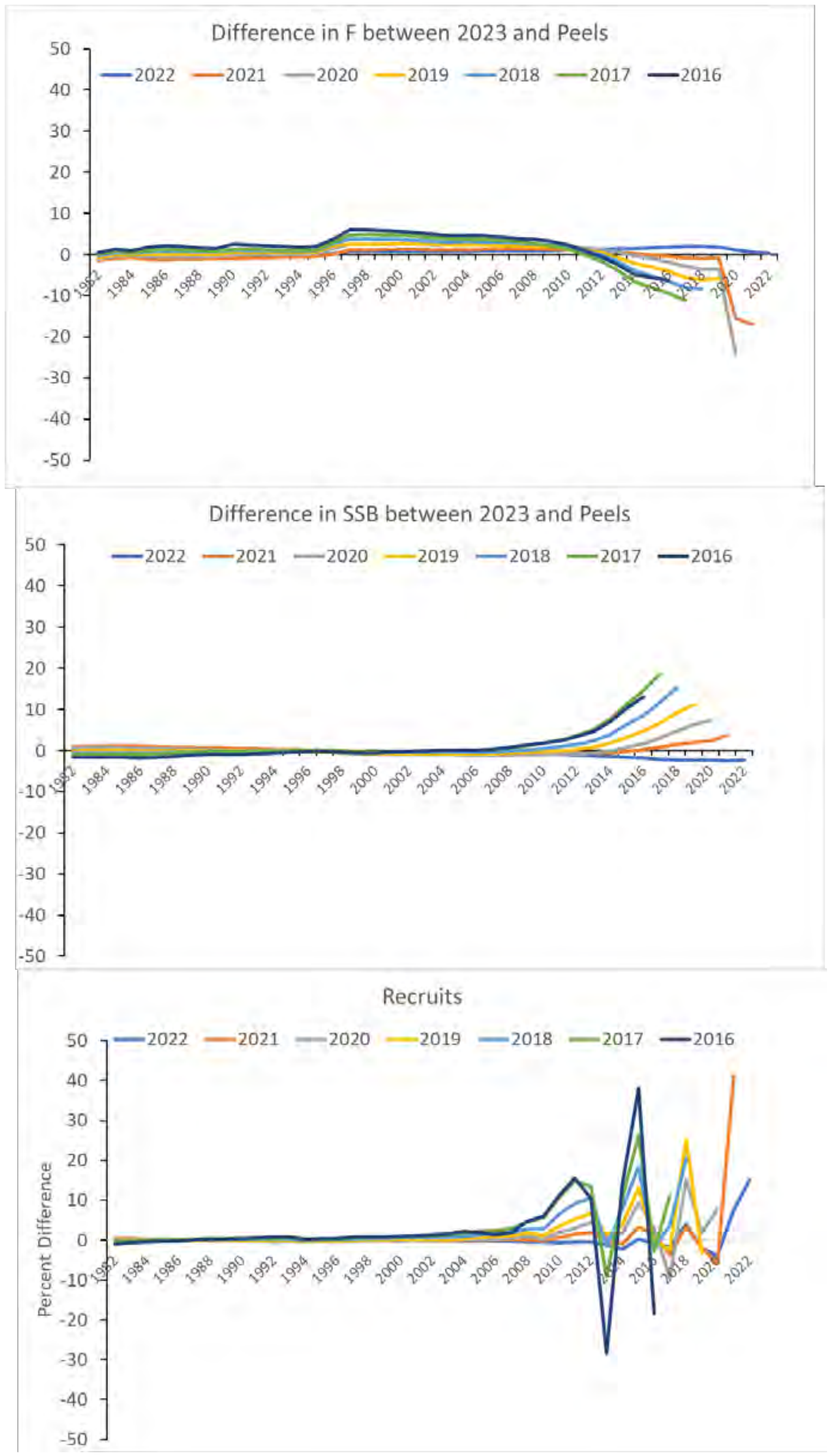

Figure 7. Retrospective plots of seven-year peels for fishing mortality, female spawning stock biomass and recruitment.

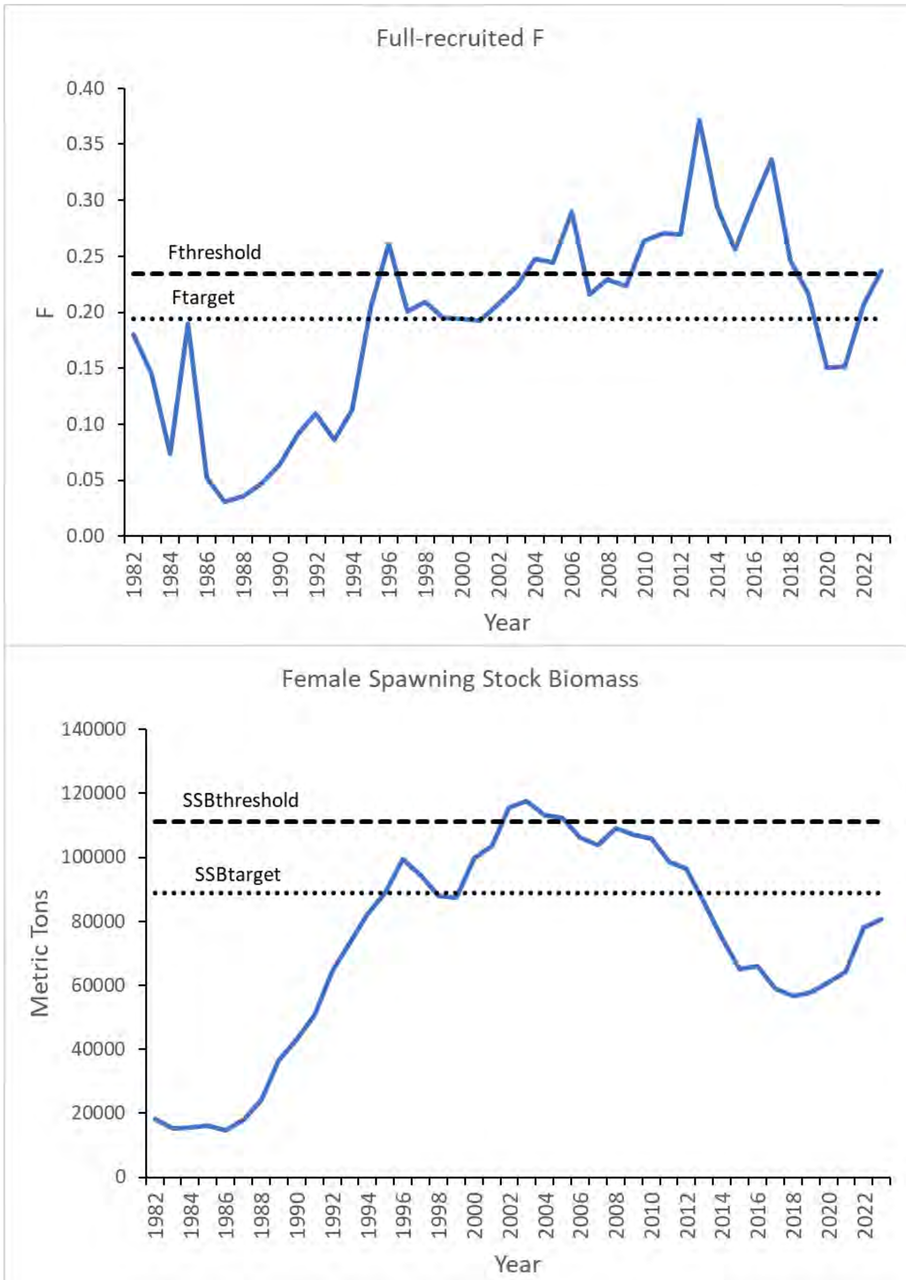

Figure 13. Comparison of SSB and F estimates to SSB and F reference points.

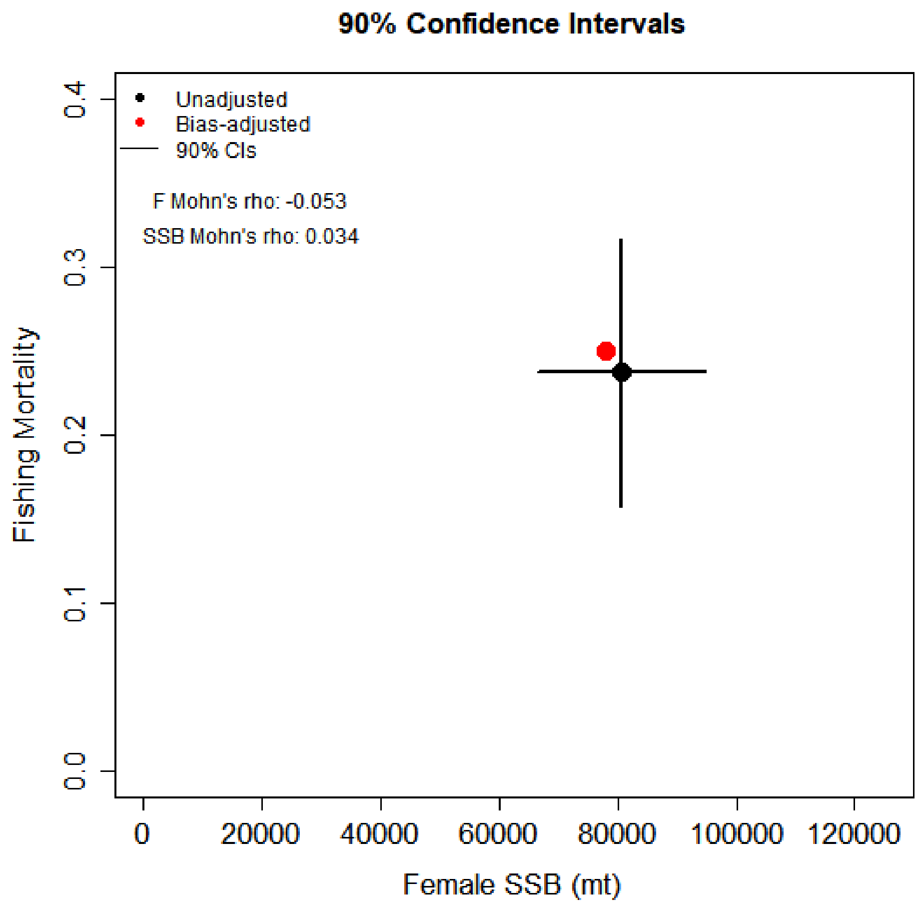

Figure 14. Plot comparing the 2023 bias-corrected F and female SSB values the uncorrected F and SSB estimates and their associated 90% confidence intervals. Because the retrospective adjusted values fall within the 90% confidence intervals, bias-correction is not needed.

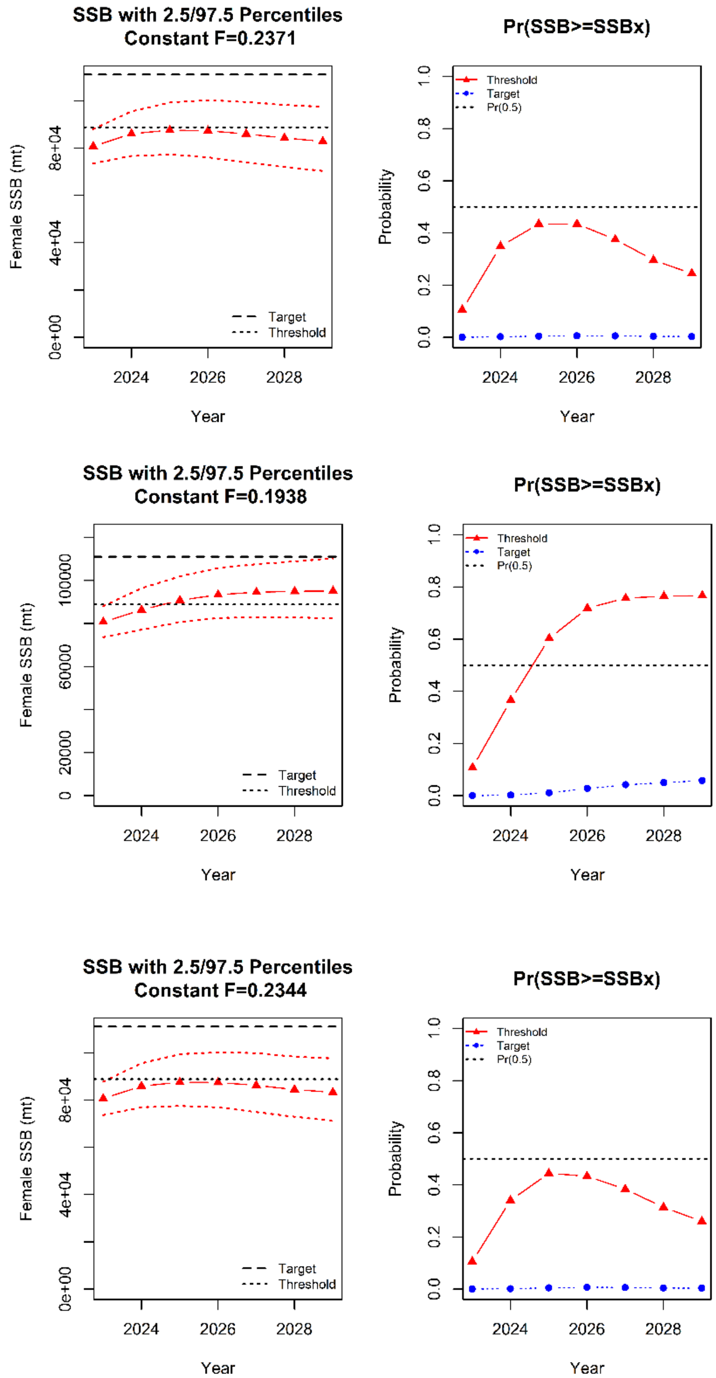

Figure 15. Projections of female spawning stock biomass through 2029 under current, target and threshold fishing mortality (left) and the probability of female SSB being above the target and threshold values of 111,064 and 88,851 metric tons, respectively, over time (right).

ASMFC Striped Bass - Estimating New Selectivity from the Two-Time Block 2024 Stock Assessment Update

Gary Nelson

2024-10-04

Method

1) Combine state ALK keys that have been expanded to the total number across each component (Rec Harvest, Rec Dead Releases, Comm Harvest). Dead Commercial Discards are included by using the ALK of the Comm Harvest.
2) Within an age, calculate the fraction that each length interval of each component comprises of the summed total of all components
3) Within an age, multiply step 2 fractions for each length interval of each component by the age-specific F
4) Apply the new slot to recreational harvest component, make lengths outside slot zero, but transfer F*0.09 to the Rec Dead Releases
5) Sum the age-specific Fs across components, standardize new F vector to one (F/max(F))

Load Functions

```
library(readxl)
library(writexl)
library(fishmethods)
library(kableExtra)
```

Constant_F_projection Code

```
Constant_F_Projections <-function(maxage=max_age,M=Nat_Mortality,sex=female_sex_fraction,
                            fmat=female_mature_fraction,Nages_base=N2024,
                            Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                            avgwgt=average_wgt,
                            cursel=select_current,avgselect=current_select,
                            recruits=recruits_series,
                            curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                            Fcur=F2024,FcurCV=F_current_CV,Fcur_bias=F_bias,
                            Fproj=F2024,
                            SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                            SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                            pyears=6,nsims=5000,usebias=1,
```

```
                            catch_current=pcatch){
if(usebias==1){
  Nages<-Nages_base
  F_base<-Fcur
}
if(usebias==2){
  Nages<-Nages_base
  Nages$N<-Nages$N*(1-Nbias)
  F_base<-Fcur*(1-F_bias)
}
if(length(Fproj)==1) F_p<-c(F_base,rep(Fproj,pyears-1))    #F to project
if(length(Fproj)>1){
  F_p<-c(F_base,Fproj)    #F to project
  if(length(F_p)!=pyears) stop("Number of pyears does not equal the number of Fs (Fcur+Fproj)")
}
F_CV<-FcurCV
F_SD<-F_base*F_CV
recruits_short<-recruits[recruits$year>=recruit_start_year &
                           recruits$year<=recruit_end_year,2]
N<-matrix(0,nrow=pyears,ncol=maxage)
SSB<-matrix(0,nrow=pyears,ncol=maxage)
catch<-matrix(0,nrow=pyears,ncol=maxage)
SSBout<-matrix(0,nrow=nsims,ncol=pyears)
catchout<-matrix(0,nrow=nsims,ncol=pyears)

#!!! Begin projections !!!#
for(nrep in 1:nsims){
  F_proj<-rnorm(length(F_p),mean=F_p,sd=F_p*F_CV)
  F_proj<-ifelse(F_proj<0,0,F_proj)
  # generate January 1 abundance and SSB estimates in current year
    for(a in 1:maxage){
    N[1,a]<-rnorm(1,mean=Nages[a,1],sd=Nages[a,2]*Nages[a,1])
    #calculate F given catch
    SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*F_proj[1])-(M[a]*pM))*sex[a]*fmat[a]*
      curwgt[a]/1000 #metric tons
    }
  catch[1,1]<-catch_current

  for(i in 2:as.numeric(pyears)){
      for(a in 1:maxage){
        if(a==1) N[i,1]<-sample(recruits_short,1,replace=FALSE)
        if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-F_proj[i-1]*avgselect[a-1]-M[a-1])
        if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-F_proj[i-1]*avgselect[a-1]-M[a-1])+
            N[i-1,a]*exp(-F_proj[i-1]*avgselect[a]-M[a]) #plus group calculation
        if(N[i,a]<0) N[i,a]<-0
        catch[i,a]<-(avgselect[a]*F_proj[i])/(avgselect[a]*F_proj[i]+M[a])*
          (1-exp(-(avgselect[a]*F_proj[i])-(M[a])))*N[i,a]
      }
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*F_proj[i])-(M[a]*pM))*
          sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }

  SSBout[nrep,]<-rowSums(SSB)
```

```
  catchout[nrep,]<-rowSums(catch)
}
SSBprob_threshold<-NULL
for(i in 1:pyears) SSBprob_threshold[i]<-pgen(SSBout[,i],limit=SSBthreshold,
                          limSD=SSBthreshold*SSBthresholdCV,dist=1,comp=4)
#Plot results
SSBmed<-apply(SSBout,2,median)
SSBpercent<-apply(SSBout,2,function(x){quantile(x,prob=c(0.025,0.975))})
SSBmean<-apply(SSBout,2,mean)
SSBSE<-apply(SSBout,2,sd)
SSBLCI<-SSBmean-SSBSE*1.96
SSBUCI<-SSBmean+SSBSE*1.96
catchmed<-apply(catchout,2,median)
catchpercent<-apply(catchout,2,function(x){quantile(x,prob=c(0.025,0.975))})
catchmean<-apply(catchout,2,mean)
catchSE<-apply(catchout,2,sd)
catchLCI<-catchmean-catchSE*1.96
catchUCI<-catchmean+catchSE*1.96
SSBprob_target<-NULL
for(i in 1:pyears) SSBprob_target[i]<-pgen(SSBout[,i],limit=SSBtarget,
                                    limSD=SSBtarget*SSBtargetCV,dist=1,comp=4)

yrs<-seq(as.Date(paste(curyear,"/01/01",sep="")),by="1 year", length.out=pyears)
 outtables<-list(type="Constant_F_Projections",SSBthreshold=SSBthreshold,
          SSBtarget=SSBtarget,Fproj=Fproj,SSBmed=SSBmed,SSBpercentiles=SSBpercent,
          SSBmean=SSBmean,SSBSE=SSBSE,SSBLCI=SSBLCI,SSBUCI=SSBUCI,
          catchmed=catchmed, catchpercentiles=catchpercent,catchmean=catchmean,
          catchSE=catchSE,catchLCI=catchLCI,catchUCI=catchUCI,
          SSBprob_threshold=SSBprob_threshold,SSBprob_target=SSBprob_target,
          axis_yrs=yrs)
 return(outtables)
}
```

Plot Function

```
Plot_Projection_Results<-function(results=NULL,export_as_tif=FALSE,
                    tiff_attributes=list(name="C:/temp/outs.tif",width=16,height=12,
                                     zoom=12,pointsize=10,units="cm")){

    word.tif = function(filename="C:/Temp/Word_Figure_%03d.tif", zoom=12, width=16,
                        height=12, pointsize=10,units="cm", ...) {
      if (!grepl("[.]ti[f]+$", filename, ignore.case=TRUE))
      filename = paste0(filename,".tif")
      tiff(filename=filename, compression="lzw", res=96*zoom,
       width=width, height=height, units=units, pointsize=pointsize,...)}

  if(results$type=="Constant_Catch_Projections_1"){
    if(results$trajectory_target_label %in% c("Ftarget","Fthreshold")){
      if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                       width=tiff_attributes$width,
                                       height=tiff_attributes$height,
```

```
                                   zoom=tiff_attributes$zoom,
                                   pointsize=tiff_attributes$pointsize,
                                   units=tiff_attributes$units)

      par(mfrow=c(1,2),mai=c(0.8,0.8,0.6,0.6))
      plot(results$results$FM~results$results$year, main="",type="o",pch=16,
      ylim=c(min(results$results$FM),max(results$results$FM)*1.05),
      ylab="Fishing Mortality",xlab="Year")
      abline(h=results$trajectory_target,lty=3)
      temp<-paste(results$conditions[1]," = ",round(results$constant_catch,0),
                  " fish",sep="")
      mtext(text=temp,side=3,line=1,at=max(results$results$year)+2)
      text(x=results$results$year[2],y=results$trajectory_target*1.01,
           labels=results$trajectory_target_label,cex=0.7)
      plot(results$results$SSB~results$results$year, main="",type="o",pch=16,
           ylim=c(min(results$results$SSB),max(results$results$SSB)*1.05),
           ylab="Spawning Stock Biomass",xlab="Year")

    if(export_as_tif==TRUE) dev.off()
  }
  if(results$trajectory_target_label %in% c("SSBtarget","SSBthreshold")){
    if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                   width=tiff_attributes$width,
                                   height=tiff_attributes$height,
                                   zoom=tiff_attributes$zoom,
                                   pointsize=tiff_attributes$pointsize,
                                   units=tiff_attributes$units)

    par(mfrow=c(1,2),mai=c(0.8,0.8,0.6,0.6))
    plot(results$results$FM~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$FM),max(results$results$FM)*1.05),
         ylab="Fishing Mortality",xlab="Year")
    abline(h=results$trajectory_value,lty=3)
    temp<-paste(results$conditions[1]," = ",round(results$constant_catch,0),
                " fish",sep="")
    mtext(text=temp,side=3,line=1,at=max(results$results$year)+2)
      plot(results$results$SSB~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$SSB),max(results$results$SSB)*1.05),
         ylab="Spawning Stock Biomass",xlab="Year")
             abline(h=results$trajectory_target,lty=3)
          text(x=results$results$year[2],y=results$trajectory_target*1.01,
               labels=results$trajectory_target_label,cex=0.7)
   if(export_as_tif==TRUE) dev.off()
 }
}#Constant_Catch_Projections_1

if(results$type=="Constant_Catch_Projections_2"){
  if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                 width=tiff_attributes$width,
                                 height=tiff_attributes$height,
                                 zoom=tiff_attributes$zoom,
                                 pointsize=tiff_attributes$pointsize,
                                 units=tiff_attributes$units)
```

```r
    par(mfrow=c(2,2),mai=c(0.7,0.7,0.5,0.4))
    plot(results$results$Fmed~results$results$year, main="",type="o",pch=16,
        ylim=c(0,max(results$results$F97_5)*1.10),ylab="Fishing Mortality",xlab="Years")
    lines(results$results$F2_5~results$results$year,lty=3,lwd=1.5)
    lines(results$results$F97_5~results$results$year,lty=3,lwd=1.5)
    abline(h=results$Ftarget,col="red",lwd=1.5)
    abline(h=results$Fthreshold,lty=2,col="blue",lwd=1.5)
    legend("bottomright",legend=c("Target","Threshold"),col=c("red","blue"),
           lty=c(1,2),bty="n",cex=0.7)
    mtext(text=paste("Constant Catch = ",round(results$results$catch[1],0),
                     " fish",sep=""),side=3,line=1, at=max(results$results$year)+2)

    plot(results$results$Prob_F_greater_Ftarget~results$results$year, main="",
         type="o",pch=16,
         ylim=c(0,1),ylab="Pr(F>Fx)",xlab="Year",col="red")
    lines(results$results$Prob_F_greater_Fthreshold~results$results$year,col="blue")
    points(results$results$Prob_F_greater_Fthreshold~results$results$year,
           col="blue",pch=16)
    legend("topleft",legend=c("F Target","F Threshold"),col=c("red","blue"),
           lty=c(1,2),pch=c(16,16),bty="n",cex=0.7,lwd=1.5)

    plot(results$results$SSBmed~results$results$year, main="",type="o",pch=16,
         ylim=c(min(results$results$SSB2_5,SSB_threshold)*0.95,
                max(results$results$SSB97_5,SSB_target)*1.10),
         ylab="Spawning Stock Biomass",
         xlab="Years")
    lines(results$results$SSB2_5~results$results$year,lty=3,lwd=1.5)
    lines(results$results$SSB97_5~results$results$year,lty=3,lwd=1.5)
    abline(h=results$SSBtarget,col="red",lwd=1.5)
    abline(h=results$SSBthreshold,col="blue",lty=2,lwd=1.5)
    legend("topleft",legend=c("SSB Target","SSB Threshold"),col=c("red","blue"),
           bty="n",pch=c(16,16),lty=c(1,2),cex=0.7)

    plot(results$results$Prob_SSB_less_SSBtarget~results$results$year, main="",
         type="o",pch=16,
         ylim=c(0,1),ylab="Pr(SSB<SSBx)",xlab="Year",col="red")
    lines(results$results$Prob_SSB_less_SSBthreshold~results$results$year,col="blue")
    points(results$results$Prob_SSB_less_SSBthreshold~results$results$year,
           col="blue",pch=16)
    legend("topright",legend=c("SSB Target","SSB Threshold"),col=c("red","blue"),
           bty="n",pch=c(16,NA),lty=c(1,1),cex=0.7)

    if(export_as_tif==TRUE) dev.off()
  }

  if(results$type=="Constant_F_Projections"){
    if(export_as_tif==TRUE) word.tif(filename=tiff_attributes$name,
                                     width=tiff_attributes$width,
                                     height=tiff_attributes$height,
                                     zoom=tiff_attributes$zoom,
                                     pointsize=tiff_attributes$pointsize,
                                     units=tiff_attributes$units)
```

```
    par(mfrow=c(1,2))
    if(length(results$Fproj)==1) mainlabel<-paste("SSB with 2.5/97.5 Percentiles","\n Constant F=",
                    round(results$Fproj,4),sep="")

    if(length(results$Fproj)>1){
        fslabels<-paste(as.character(round(results$Fproj,4)),collapse=" ")
        mainlabel<-paste("SSB with 2.5/97.5 Percentiles", "\n F=",fslabels,sep="")

    }

    plot(y=results$SSBmed,x=results$axis_yrs,type="b",col="red",

        main=mainlabel,

         xlab="Year",ylim=c(0,max(results$SSBpercent)*1.10),pch=17,
         ylab="Female SSB (mt)")
    lines(results$SSBpercent[1,]~results$axis_yrs,col="red",lty=3,lwd=1.5)
    lines(results$SSBpercent[2,]~results$axis_yrs,col="red",lty=3,lwd=1.5)
    abline(h=results$SSBthreshold,lty=3,lwd=1.5)
    abline(h=results$SSBtarget,lty=2,lwd=1.5)
    legend("bottomright",legend=c("Target","Threshold"),lwd=1.5,lty=c(2,3),bty="n",
           cex=0.8)
    plot(results$SSBprob_threshold~results$axis_yrs,type="b",col="red",
         main="Pr(SSB>=SSBx)",pch=17,
         xlab="Year",ylim=c(0,1),ylab="Probability")
    abline(h=0.5,lty=3,lwd=1.5)

    par(new=TRUE)
     plot(results$SSBprob_target~results$axis_yrs,type="b",col="blue",lty=3,pch=16,
         xlab="",ylim=c(0,1),ylab="")
    legend("topleft",legend=c("Threshold","Target","Pr(0.5)"),
           col=c("red","blue","black"),pch=c(17,16,NA),lty=c(1,3,3),bty="n",
           cex=0.7,lwd=1.5)
    if(export_as_tif==TRUE) dev.off()
  }#Constant F
}#function
```

Constant_Catch_Projections Function

```
Constant_Catch_Projections<-function(maxage=max_age,M=Nat_Mortality,
                  sex=female_sex_fraction,fmat=female_mature_fraction,
                  Nages_base=N_at_age_estimates,Nbias=N_bias,pF=F_fraction,
                  pM=M_fraction,curwgt=wgt_current,avgwgt=average_wgt,
                  cursel=select_current,avgselect=average_select,
                  recruits=recruits_series,curyear=2023,recruit_start_year=2008,
                  recruit_end_year=2023,Fcur=F_current,FcurCV1=F_current_CV,
                  Fcur_bias=F_bias,total_current_catch=sum(catch_at_age_current),
                  SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
                  SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                  Ftarget=F_target, FtargetCV=F_target_CV,
                  Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
```

```
                solve_catch=2,
                objective_function_value_solve_catch_1=2,
                pyears=7,nsims=5000,Nerr=1,Ferr=1,usebias=1,
                rcentral=1){
pcatch<-NULL
if(usebias==1) {
  Fuse<-Fcur
  Nages<-Nages_base
}
if(usebias==2){
  Nages$N<-Nages_base$N*(1-Nbias)
  Fuse<-Fcur*(1-Fcur_bias)
}
recruits_short<-recruits[recruits$year>=recruit_start_year &
                           recruits$year<=recruit_end_year,2]
if(solve_catch==1){#solve for catch
  #storage matrices
  parm<-total_current_catch
  getsolution<-function(parm){
    N<-matrix(0,nrow=pyears,ncol=maxage)
    SSB<-matrix(0,nrow=pyears,ncol=maxage)
    prob<-matrix(0,nrow=pyears,ncol=1)
    SSBout<<-matrix(0,nrow=1,ncol=pyears)
    Fout<<-matrix(0,nrow=1,ncol=pyears)
    for(a in 1:maxage){
      N[1,a]<-Nages[a,1]
      Fran<-Fuse
      #SSB metric tons
      SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*Fran)-(M[a]*pM))*sex[a]*fmat[a]*
        curwgt[a]/1000
    }
    Fout[1,1]<-Fran
    # January 1 abundance for years > current
    for(i in 2:as.numeric(pyears)){
      if(i==2){
        for(a in 1:maxage){
          if(a==1){
            if(rcentral==1) N[i,1]<-mean(recruits_short) else
              N[i,1]<-median(recruits_short)
          }
          if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*cursel[a-1]-M[a-1])
          if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*cursel[a-1]-M[a-1])+
              N[i-1,a]*exp(-Fout[1,i-1]*cursel[a]-M[a]) #plus group calculation
          if(N[i,a]<0) N[i,a]<-0
        }
        # solve for F given total_current_catch
        Nin<-N[i,]
        solveF1<-function(x){
          for(a in 1:maxage){
            pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*
              (1-exp(-avgselect[a]*x-M[a]))*Nin[a]
          }
          (log(sum(pcatch))-log(parm))^2
```

```
        }
        outs<-optimize(solveF1,interval=c(0.001,2))
        Fout[1,i]<-outs$minimum
        for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout[1,i])-
                        (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
      }
      if(i>2){
        for(a in 1:maxage){
          if(a==1){
            if(rcentral==1) N[i,1]<-mean(recruits_short) else
              N[i,1]<-median(recruits_short)
          }
          if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*avgselect[a-1]-M[a-1])
          if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout[1,i-1]*avgselect[a-1]-M[a-1])+
              N[i-1,a]*exp(-Fout[1,i-1]*avgselect[a]-M[a]) #plus group calculation
          if(N[i,a]<0) N[i,a]<-0
        }
        # solve for F given total_current_catch
        Nin<-N[i,]
        solveF1<-function(x){
          for(a in 1:maxage){
            pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*
              (1-exp(-avgselect[a]*x-M[a]))*Nin[a]
          }
          (log(sum(pcatch))-log(parm))^2
        }
        outs<-optimize(solveF1,interval=c(0.001,2))
        Fout[1,i]<-outs$minimum
        for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout[1,i])-
                         (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
      }
    }
    SSBout[1,]<<-rowSums(SSB)
    Fout2<<-Fout[1,]
    if(objective_function_value_solve_catch_1==1)
      return((Ftarget-Fout[1,pyears])^2)
    if(objective_function_value_solve_catch_1==2)
      return((Fthreshold-Fout[1,pyears])^2)
    if(objective_function_value_solve_catch_1==3)
      return((SSBtarget-SSBout[1,pyears])^2)
    if(objective_function_value_solve_catch_1==4)
      return((SSBthreshold-SSBout[1,pyears])^2)
  }#getsolution
  results<-optimize(getsolution,c(1,total_current_catch*10))
  constcatch<-round(results$minimum,1)
  labs<-NULL
  if(objective_function_value_solve_catch_1==1) {outparm<-Ftarget;labs<-"Ftarget"}
  if(objective_function_value_solve_catch_1==2)
    {outparm<-Fthreshold;labs<-"Fthreshold"}
  if(objective_function_value_solve_catch_1==3)
    {outparm<-SSBtarget;labs<-"SSBtarget"}
  if(objective_function_value_solve_catch_1==4)
    {outparm<-SSBthreshold;labs<-"SSBthreshold"}
```

```
  dataset<-data.frame(year=c(curyear:c(curyear+pyears-1)),SSB=SSBout[1,],FM=Fout2)
  condata<-paste("Constant catch to obtain ",paste(labs," (",outparm,")",sep=""),
           " by year ",c(curyear+pyears-1),sep="")
  condata1<-paste("Recruit values from ",recruit_start_year,
                  " to ", recruit_end_year,sep="")
  condata2<-ifelse(usebias==1,"N & F not bias-corrected","N & F bias-corrected")
  condata3<-ifelse(rcentral==1,"Mean recruits used","Median recruits used")
  cons<-c(condata,condata1,condata2,condata3)


  outpt<-list(type="Constant_Catch_Projections_1",trajectory_target=outparm,
              trajectory_target_label=labs,conditions=cons,
              constant_catch=constcatch,results=dataset)
  return(outpt)
}#solve_catch==1

if(solve_catch==2){
  #storage matrices
  N<-matrix(0,nrow=pyears,ncol=maxage)
  SSB<-matrix(0,nrow=pyears,ncol=maxage)
  prob<-matrix(0,nrow=pyears,ncol=1)
  SSBout1<-matrix(0,nrow=nsims,ncol=pyears)
  Fout1<-matrix(0,nrow=nsims,ncol=pyears)

  for(nrep in 1:nsims){
    for(a in 1:maxage){
      if(Nerr==1) N[1,a]<-Nages[a,1]
      if(Nerr==2) N[1,a]<-rnorm(1,mean=Nages[a,1],sd=Nages[a,2]*Nages[a,1])

      if(Ferr==1) Fran<-Fuse
      if(Ferr==2) Fran<-rnorm(1,mean=Fuse,sd=Fuse*FcurCV)
      #calculate F given catch
      SSB[1,a]<-N[1,a]*exp(-(pF*cursel[a]*Fran)-(M[a]*pM))*sex[a]*fmat[a]*
        curwgt[a]/1000 #metric tons
    }
    Fout1[nrep,1]<-Fran
    # January 1 abundance for years > 2014
    for(i in 2:as.numeric(pyears)){
      if(i==2){
        for(a in 1:maxage){
          if(a==1){
            N[i,1]<-sample(recruits_short,1,replace=FALSE)
          }
          if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*cursel[a-1]-M[a-1])
          if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*cursel[a-1]-M[a-1])+
              N[i-1,a]*exp(-Fout1[nrep,i-1]*cursel[a]-M[a]) #plus group calculation
          if(N[i,a]<0) N[i,a]<-0
        }
        # solve for F given total_current_catch
        Nin<-N[i,]
        solveF2<-function(x){
          for(a in 1:maxage){
            pcatch[a]<-(avgselect[a]*x)/(avgselect[a]*x+M[a])*(1-exp(-avgselect[a]*
```

```
                                x-M[a]))*Nin[a]
        }
        (log(sum(pcatch))-log(total_current_catch))^2
      }
      outs<-optimize(solveF2,interval=c(0.001,2))
      Fout1[nrep,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout1[nrep,i])-
                  (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
    if(i>2){
      for(a in 1:maxage){
        if(a==1){
          N[i,1]<-sample(recruits_short,1,replace=FALSE)
        }
        if(a>1 & a<maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*
                                                  avgselect[a-1]-M[a-1])
        #plusgrp
        if(a==maxage) N[i,a]<-N[i-1,a-1]*exp(-Fout1[nrep,i-1]*avgselect[a-1]-
                        M[a-1])+N[i-1,a]*exp(-Fout1[nrep,i-1]*avgselect[a]-M[a])
        if(N[i,a]<0) N[i,a]<-0
      }
      # solve for F given total_current_catch
      Nin<-N[i,]
      outs<-optimize(solveF2,interval=c(0.001,2))
      Fout1[nrep,i]<-outs$minimum
      for(a in 1:maxage) SSB[i,a]<-N[i,a]*exp(-(pF*avgselect[a]*Fout1[nrep,i])-
                      (M[a]*pM))*sex[a]*fmat[a]*avgwgt[a]/1000 #metric tons
    }
  }
  SSBout1[nrep,]<-rowSums(SSB)
}#nrep
Fprob_target<-NULL
for(i in 1:pyears) Fprob_target[i]<-pgen(Fout1[,i],limit=Ftarget,
                                limSD=Ftarget*FtargetCV,dist=1,comp=4)
SSBprob_target<-NULL
for(i in 1:pyears) SSBprob_target[i]<-pgen(SSBout1[,i],limit=SSBtarget,
                                limSD=SSBtarget*SSBtargetCV,dist=1,comp=2)

Fprob_threshold<-NULL
for(i in 1:pyears) Fprob_threshold[i]<-pgen(Fout1[,i],limit=Fthreshold,
                                limSD=Fthreshold*FthresholdCV,dist=1,comp=4)
SSBprob_threshold<-NULL
for(i in 1:pyears) SSBprob_threshold[i]<-pgen(SSBout1[,i],limit=SSBthreshold,
                                limSD=SSBthreshold*SSBthresholdCV,dist=1,comp=2)

#Plot results
SSBmed<-apply(SSBout1,2,median)
SSBpercent<-as.data.frame(t(apply(SSBout1,2,function(x){quantile(x,
                                          prob=c(0.025,0.975))})))

Fmed<-apply(Fout1,2,median)
Fpercent<-as.data.frame(t(apply(Fout1,2,function(x){quantile(x,
                                          prob=c(0.025,0.975))})))
```

```r
    dataout<-data.frame(year=c(curyear:(curyear+pyears-1)),
                        catch=total_current_catch,Fmed=Fmed,
                        F2_5=Fpercent[,1],F97_5=Fpercent[,2],
                        Prob_F_greater_Ftarget=Fprob_target,
                        Prob_F_greater_Fthreshold=Fprob_threshold,
                        SSBmed=SSBmed,SSB2_5=SSBpercent[,1],
                        SSB97_5=SSBpercent[,2],
                        Prob_SSB_less_SSBtarget=SSBprob_target,
                        Prob_SSB_less_SSBthreshold=SSBprob_threshold)

    if(Ferr==1) errorF<-"Off" else errorF<-"On"
    if(Nerr==1) errorN<-"Off" else errorN<-"On"
    if(usebias==1) bias_on<-"No" else bias_on<-"Yes"
    conout<-paste("F error: ",errorF,", N error: ",errorN,
                  ", F & N Bias-Corrected?: ",bias_on,sep="")
    outpt<-list(type="Constant_Catch_Projections_2",Ftarget=Ftarget,
                Fthreshold=Fthreshold,SSBtarget=SSBtarget,
                SSBthreshold=SSBthreshold,
                condition=conout,results=dataout)
    return(outpt)
  }#solve_catch==2
}#function
```

Data

```r
maxage<-15
# Natural Mortality-at-age
Nat_Mortality<-M<-c(1.13,0.68,0.45,0.33,0.25,0.19,0.15,0.15,0.15,0.15,0.15,0.15,0.15,
                 0.15,0.15)

# Female Sex proportions-at-age
female_sex_fraction<-c(0.53,0.56,0.56,0.52,0.57,0.65,0.73,0.81,0.88,0.92,0.95,0.97,
                       1.00,1.00,1.00)

#Female maturity
female_mature_fraction<-c(0,0,0,0.09,0.32,0.45,0.84,0.89,1,1,1,1,1,1,1)

# Proportion F and M for SSB calculations
F_fraction<-0.1
M_fraction<-0.33
maxage<-max_age<-15


# SSB rivard wgts  #2024

# Average of 2019-2023
average_wgt<-c(0.170912897,0.417823556,0.927379714,1.458463863,2.071445994,2.897995624,
            3.990014283,5.182445546,6.319665235,7.741211998,9.069336065,10.90477891,
            13.0331813,13.87866685,15.67380948)
```

```r
# All recruits 1982-2023
recruits_series<-data.frame(year=1982:2023,
            recr=c(37364100,75602800,62859700,68479300,67611600,74169300,93300800,
                   106655000,130941000,104485000,108762000,133935000,285297000,
                   186734000,234018000,258960000,148052000,152875000,
                   124486000,196467000,221336000,127967000,304432000,158153000,
                   135236000,88441000,126912000,75196700,96903000,125307000,
                   192360000,66597300,82938200,153154000,228067000,111488000,
                   130105000,165265000,120143000,85158100,76967300,96681400))
```

Bay - New Selectivity

```r
dir<-getwd()
bayfile<-paste(dir,"/BAYALKS_2021.xlsx",sep="") # data 2021 only
MD_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2020.xlsx",sep="") # data 2020 only
MD_Bay_R_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2020 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2021.xlsx",sep="") # data 2021 only
MD_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2021 <-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

bayfile<-paste(dir,"/BAYALKS_2022.xlsx",sep="") # data 2022 only
MD_Bay_R_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Harvest"))
VA_Bay_R_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Harvest"))
MD_Bay_R_DR_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Rec Dead Rel"))
VA_Bay_R_DR_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Rec Dead Rel"))
MD_Bay_Comm_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="MD Bay Comm Harvest"))
VA_Bay_Comm_Har_2022 <-as.data.frame(read_xlsx(bayfile,sheet="VA Bay Comm Harvest"))
PRFC_Comm_Har_2022<-as.data.frame(read_xlsx(bayfile,sheet="PRFC Comm Harvest"))

Bay_Rec_Har<-MD_Bay_R_Har_2020[,c(2:16)]+VA_Bay_R_Har_2020[,c(2:16)]+
  MD_Bay_R_Har_2021[,c(2:16)]+ VA_Bay_R_Har_2021[,c(2:16)]+
```

```
  MD_Bay_R_Har_2022[,c(2:16)]+ VA_Bay_R_Har_2022[,c(2:16)]
Bay_Rec_Har[is.na(Bay_Rec_Har)]<-0

Bay_Comm_Har<-MD_Bay_Comm_Har_2020[,c(2:16)]+VA_Bay_Comm_Har_2020[,c(2:16)]+
  PRFC_Comm_Har_2020[,c(2:16)]+MD_Bay_Comm_Har_2021[,c(2:16)]+
  VA_Bay_Comm_Har_2021[,c(2:16)]+PRFC_Comm_Har_2021[,c(2:16)]+
  MD_Bay_Comm_Har_2022[,c(2:16)]+VA_Bay_Comm_Har_2022[,c(2:16)]+
  PRFC_Comm_Har_2022[,c(2:16)]
Bay_Comm_Har[is.na(Bay_Comm_Har)]<-0

Bay_Rec_Dead_Rel<-MD_Bay_R_DR_2020[,c(2:16)]+VA_Bay_R_DR_2020[,c(2:16)]+
  MD_Bay_R_DR_2021[,c(2:16)]+VA_Bay_R_DR_2021[,c(2:16)]+
  MD_Bay_R_DR_2022[,c(2:16)]+VA_Bay_R_DR_2022[,c(2:16)]
Bay_Rec_Dead_Rel[is.na(Bay_Rec_Dead_Rel)]<-0

#Comm Dead Discards
Bay_Comm_DD_2020<-c(0,58,1862,6633,17003,8297,2237,944,2775,736,160,39,13,23,427)
Bay_Comm_DD_2021<-c(0,201,7015,14559,15476,29719,5787,1421,1138,2102,155,0,112,0,157)
Bay_Comm_DD_2022<-c(0,12,2410,10018,7896,5568,9263,2878,565,523,1118,387,64,190,606)
Bay_Comm_DD<-Bay_Comm_DD_2020+Bay_Comm_DD_2021+Bay_Comm_DD_2022

#Don't have ALK for commercial discards
Bay_Comm_Dead_Dis<-as.matrix(Bay_Comm_Har)
for(cc in 1:ncol(Bay_Comm_Dead_Dis)){
  Bay_Comm_Dead_Dis[,cc]<-Bay_Comm_Dead_Dis[,cc]/sum(Bay_Comm_Dead_Dis[,cc])*
    Bay_Comm_DD[cc]
}
Bay_Comm_Dead_Dis[is.nan(Bay_Comm_Dead_Dis)]<-0

Bay_Rec_Har_Prop<-as.matrix(Bay_Rec_Har)
Bay_Rec_Har_Prop[is.nan(Bay_Rec_Har_Prop)]<-0
Bay_Rec_Dead_Rel_Prop<-as.matrix(Bay_Rec_Dead_Rel)
Bay_Rec_Dead_Rel[is.nan(Bay_Rec_Dead_Rel_Prop)]<-0
Bay_Comm_Har_Prop<-as.matrix(Bay_Comm_Har)
Bay_Comm_Har_Prop[is.nan(Bay_Comm_Har_Prop)]<-0
Bay_Comm_Dead_Dis_Prop<-as.matrix(Bay_Comm_Dead_Dis)
Bay_Comm_Dead_Dis_Prop[is.nan(Bay_Comm_Dead_Dis_Prop)]<-0


bayF2020<-c(0.00063,0.00331,0.01478,0.03872,0.05169,0.05146,0.048,0.04426,0.04074,
            0.03748,0.03448,0.03172,0.02918,0.02684,0.02469)

bayF2021<-c(0.000506789,0.00266759,0.011922,0.0312385,0.041701,0.0415123,0.038724,
            0.0357083,0.0328629,0.0302343,0.0278144,0.0255879,0.0235397,0.0216553,
            0.0199219)

bayF2022<-c(0.000493889,0.00259968,0.0116186,0.0304433,0.0406395,0.0404556,0.0377383,
            0.0347993,0.0320264,0.0294647,0.0271064,0.0249366,0.0229405,0.0211041,
            0.0194147)


bayFavg<-exp((log(bayF2020)+log(bayF2021)+log(bayF2022))/3)
```

```r
for(cc in 1:ncol(Bay_Comm_Dead_Dis)){
  coltotal<-sum(Bay_Rec_Har[,cc],Bay_Rec_Dead_Rel[,cc],Bay_Comm_Har[,cc],
                Bay_Comm_Dead_Dis[,cc])
  Bay_Rec_Har_Prop[,cc]<-Bay_Rec_Har[,cc]/coltotal*bayFavg[cc]
  Bay_Rec_Har_Prop[is.nan(Bay_Rec_Har_Prop)]<-0
  Bay_Rec_Dead_Rel_Prop[,cc]<-Bay_Rec_Dead_Rel[,cc]/coltotal*bayFavg[cc]
  Bay_Rec_Dead_Rel_Prop[is.nan(Bay_Rec_Dead_Rel_Prop)]<-0
  Bay_Comm_Har_Prop[,cc]<-Bay_Comm_Har[,cc]/coltotal*bayFavg[cc]
  Bay_Comm_Har_Prop[is.nan(Bay_Comm_Har_Prop)]<-0
  Bay_Comm_Dead_Dis_Prop[,cc]<-Bay_Comm_Dead_Dis[,cc]/coltotal*bayFavg[cc]
  Bay_Comm_Dead_Dis_Prop[is.nan(Bay_Comm_Dead_Dis_Prop)]<-0
}

#New Bay Regulations
new_Bay_slot<-c(19,24)

new_Bay_Rec_Har_Prop<-Bay_Rec_Har_Prop
new_Bay_Rec_Dead_Rel_Prop<-Bay_Rec_Dead_Rel_Prop

newbelow<-new_Bay_Rec_Har_Prop[1:c(new_Bay_slot[1]-1),]
newabove<-new_Bay_Rec_Har_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Har_Prop),]

newbelow_adjusted<-newbelow*0.09
newabove_adjusted<-newabove*0.09

new_Bay_Rec_Har_Prop[1:c(new_Bay_slot[1]-1),]<-0
new_Bay_Rec_Har_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Har_Prop),]<-0

#Add to Releases
new_Bay_Rec_Dead_Rel_Prop[1:c(new_Bay_slot[1]-1),]<-
  Bay_Rec_Dead_Rel_Prop[1:c(new_Bay_slot[1]-1),]+
  newbelow_adjusted
new_Bay_Rec_Dead_Rel_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Dead_Rel_Prop),]<-
  new_Bay_Rec_Dead_Rel_Prop[c(new_Bay_slot[2]+1):nrow(Bay_Rec_Dead_Rel_Prop),]+
  newabove_adjusted

#Get New F trajectory
newBayF<-vector()
for(cc in 1:ncol(Bay_Comm_Har_Prop)){
newBayF[cc]<-sum(Bay_Comm_Har_Prop[,cc],Bay_Comm_Dead_Dis_Prop[,cc],
    new_Bay_Rec_Har_Prop[,cc],new_Bay_Rec_Dead_Rel_Prop[,cc])
}
newBayF[is.nan(newBayF)]<-0
new_bay_select<-newBayF/max(newBayF)
```

Coast - New Selectivity

```r
dir<-getwd()
#--------------------2020
cstfile<-paste(dir,"/CSTALKS_2020.xlsx",sep="")
ME_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
```

```r
ME_R_Har_2020[is.na(ME_R_Har_2020)]<-0
NH_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2020[is.na(NH_R_Har_2020)]<-0
MA_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2020[is.na(MA_R_Har_2020)]<-0
RI_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2020[is.na(RI_R_Har_2020)]<-0
CT_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2020[is.na(CT_R_Har_2020)]<-0
NY_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2020[is.na(NY_R_Har_2020)]<-0
NJ_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2020[is.na(NJ_R_Har_2020)]<-0
DE_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2020[is.na(DE_R_Har_2020)]<-0
MD_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2020[is.na(MD_R_Har_2020)]<-0
VA_R_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2020[is.na(VA_R_Har_2020)]<-0

#rec releases
ME_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2020[is.na(ME_R_Dead_Rel_2020)]<-0
NH_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2020[is.na(NH_R_Dead_Rel_2020)]<-0
MA_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2020[is.na(MA_R_Dead_Rel_2020)]<-0
RI_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2020[is.na(RI_R_Dead_Rel_2020)]<-0
CT_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2020[is.na(CT_R_Dead_Rel_2020)]<-0
NY_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2020[is.na(NY_R_Dead_Rel_2020)]<-0
NJ_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2020[is.na(NJ_R_Dead_Rel_2020)]<-0
DE_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2020[is.na(DE_R_Dead_Rel_2020)]<-0
MD_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2020[is.na(MD_R_Dead_Rel_2020)]<-0
VA_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2020[is.na(VA_R_Dead_Rel_2020)]<-0
NC_R_Dead_Rel_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2020[is.na(NC_R_Dead_Rel_2020)]<-0

#com harvest
MA_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2020[is.na(MA_R_Comm_Har_2020)]<-0
RI_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2020[is.na(RI_R_Comm_Har_2020)]<-0
NY_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2020[is.na(NY_R_Comm_Har_2020)]<-0
DE_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2020[is.na(DE_R_Comm_Har_2020)]<-0
```

```r
MD_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2020[is.na(MD_R_Comm_Har_2020)]<-0
VA_R_Comm_Har_2020 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2020[is.na(VA_R_Comm_Har_2020)]<-0


#2021
cstfile<-paste(dir,"/CSTALKS_2021.xlsx",sep="")
ME_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
ME_R_Har_2021[is.na(ME_R_Har_2021)]<-0
NH_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2021[is.na(NH_R_Har_2021)]<-0
MA_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2021[is.na(MA_R_Har_2021)]<-0
RI_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2021[is.na(RI_R_Har_2021)]<-0
CT_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2021[is.na(CT_R_Har_2021)]<-0
NY_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2021[is.na(NY_R_Har_2021)]<-0
NJ_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2021[is.na(NJ_R_Har_2021)]<-0
DE_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2021[is.na(DE_R_Har_2021)]<-0
MD_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2021[is.na(MD_R_Har_2021)]<-0
VA_R_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2021[is.na(VA_R_Har_2021)]<-0

#rec releases
ME_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2021[is.na(ME_R_Dead_Rel_2021)]<-0
NH_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2021[is.na(NH_R_Dead_Rel_2021)]<-0
MA_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2021[is.na(MA_R_Dead_Rel_2021)]<-0
RI_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2021[is.na(RI_R_Dead_Rel_2021)]<-0
CT_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2021[is.na(CT_R_Dead_Rel_2021)]<-0
NY_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2021[is.na(NY_R_Dead_Rel_2021)]<-0
NJ_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2021[is.na(NJ_R_Dead_Rel_2021)]<-0
DE_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2021[is.na(DE_R_Dead_Rel_2021)]<-0
MD_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2021[is.na(MD_R_Dead_Rel_2021)]<-0
VA_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2021[is.na(VA_R_Dead_Rel_2021)]<-0
NC_R_Dead_Rel_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2021[is.na(NC_R_Dead_Rel_2021)]<-0
```

```r
#com harvest
MA_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2021[is.na(MA_R_Comm_Har_2021)]<-0
RI_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2021[is.na(RI_R_Comm_Har_2021)]<-0
NY_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2021[is.na(NY_R_Comm_Har_2021)]<-0
DE_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2021[is.na(DE_R_Comm_Har_2021)]<-0
MD_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2021[is.na(MD_R_Comm_Har_2021)]<-0
VA_R_Comm_Har_2021 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2021[is.na(VA_R_Comm_Har_2021)]<-0

#2022

cstfile<-paste(dir,"/CSTALKS_2022.xlsx",sep="")
ME_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Harvest"))
ME_R_Har_2022[is.na(ME_R_Har_2022)]<-0
NH_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Harvest"))
NH_R_Har_2022[is.na(NH_R_Har_2022)]<-0
MA_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Harvest"))
MA_R_Har_2022[is.na(MA_R_Har_2022)]<-0
RI_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Harvest"))
RI_R_Har_2022[is.na(RI_R_Har_2022)]<-0
CT_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Harvest"))
CT_R_Har_2022[is.na(CT_R_Har_2022)]<-0
NY_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Harvest"))
NY_R_Har_2022[is.na(NY_R_Har_2022)]<-0
NJ_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Harvest"))
NJ_R_Har_2022[is.na(NJ_R_Har_2022)]<-0
DE_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Harvest"))
DE_R_Har_2022[is.na(DE_R_Har_2022)]<-0
MD_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Harvest"))
MD_R_Har_2022[is.na(MD_R_Har_2022)]<-0
VA_R_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Harvest"))
VA_R_Har_2022[is.na(VA_R_Har_2022)]<-0

#rec releases
ME_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="ME Rec Dead Rel"))
ME_R_Dead_Rel_2022[is.na(ME_R_Dead_Rel_2022)]<-0
NH_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NH Rec Dead Rel"))
NH_R_Dead_Rel_2022[is.na(NH_R_Dead_Rel_2022)]<-0
MA_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Rec Dead Rel"))
MA_R_Dead_Rel_2022[is.na(MA_R_Dead_Rel_2022)]<-0
RI_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Rec Dead Rel"))
RI_R_Dead_Rel_2022[is.na(RI_R_Dead_Rel_2022)]<-0
CT_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="CT Rec Dead Rel"))
CT_R_Dead_Rel_2022[is.na(CT_R_Dead_Rel_2022)]<-0
NY_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Rec Dead Rel"))
NY_R_Dead_Rel_2022[is.na(NY_R_Dead_Rel_2022)]<-0
NJ_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NJ Rec Dead Rel"))
NJ_R_Dead_Rel_2022[is.na(NJ_R_Dead_Rel_2022)]<-0
```

```r
DE_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Rec Dead Rel"))
DE_R_Dead_Rel_2022[is.na(DE_R_Dead_Rel_2022)]<-0
MD_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Rec Dead Rel"))
MD_R_Dead_Rel_2022[is.na(MD_R_Dead_Rel_2022)]<-0
VA_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Rec Dead Rel"))
VA_R_Dead_Rel_2022[is.na(VA_R_Dead_Rel_2022)]<-0
NC_R_Dead_Rel_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NC Ocean Rec Dead Rel"))
NC_R_Dead_Rel_2022[is.na(NC_R_Dead_Rel_2022)]<-0

#com harvest
MA_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MA Comm Harvest"))
MA_R_Comm_Har_2022[is.na(MA_R_Comm_Har_2022)]<-0
RI_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="RI Comm Harvest"))
RI_R_Comm_Har_2022[is.na(RI_R_Comm_Har_2022)]<-0
NY_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="NY Comm Harvest"))
NY_R_Comm_Har_2022[is.na(NY_R_Comm_Har_2022)]<-0
DE_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="DE Comm Harvest"))
DE_R_Comm_Har_2022[is.na(DE_R_Comm_Har_2022)]<-0
MD_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="MD Ocean Comm Harvest"))
MD_R_Comm_Har_2022[is.na(MD_R_Comm_Har_2022)]<-0
VA_R_Comm_Har_2022 <-as.data.frame(read_xlsx(cstfile,sheet="VA Ocean Comm Harvest"))
VA_R_Comm_Har_2022[is.na(VA_R_Comm_Har_2022)]<-0

CST_Rec_Har<-ME_R_Har_2021[,c(2:16)]+NH_R_Har_2021[,c(2:16)]+MA_R_Har_2021[,c(2:16)]+
  RI_R_Har_2021[,c(2:16)]+CT_R_Har_2021[,c(2:16)]+NY_R_Har_2021[,c(2:16)]+
  DE_R_Har_2021[,c(2:16)]+MD_R_Har_2021[,c(2:16)]+VA_R_Har_2021[,c(2:16)]+
  ME_R_Har_2020[,c(2:16)]+NH_R_Har_2020[,c(2:16)]+MA_R_Har_2020[,c(2:16)]+
  RI_R_Har_2020[,c(2:16)]+CT_R_Har_2020[,c(2:16)]+NY_R_Har_2020[,c(2:16)]+
  DE_R_Har_2020[,c(2:16)]+MD_R_Har_2020[,c(2:16)]+VA_R_Har_2020[,c(2:16)]+
  ME_R_Har_2022[,c(2:16)]+NH_R_Har_2022[,c(2:16)]+MA_R_Har_2022[,c(2:16)]+
  RI_R_Har_2022[,c(2:16)]+CT_R_Har_2022[,c(2:16)]+NY_R_Har_2022[,c(2:16)]+
  DE_R_Har_2022[,c(2:16)]+MD_R_Har_2022[,c(2:16)]+VA_R_Har_2022[,c(2:16)]

CST_Rec_Dead_Rel<-ME_R_Dead_Rel_2020[,c(2:16)]+NH_R_Dead_Rel_2020[,c(2:16)]+
  MA_R_Dead_Rel_2020[,c(2:16)]+RI_R_Dead_Rel_2020[,c(2:16)]+
  CT_R_Dead_Rel_2020[,c(2:16)]+NY_R_Dead_Rel_2020[,c(2:16)]+
  DE_R_Dead_Rel_2020[,c(2:16)]+MD_R_Dead_Rel_2020[,c(2:16)]+
  VA_R_Dead_Rel_2020[,c(2:16)]+NC_R_Dead_Rel_2020[,c(2:16)]+
  ME_R_Dead_Rel_2021[,c(2:16)]+NH_R_Dead_Rel_2021[,c(2:16)]+
  MA_R_Dead_Rel_2021[,c(2:16)]+RI_R_Dead_Rel_2021[,c(2:16)]+
  CT_R_Dead_Rel_2021[,c(2:16)]+NY_R_Dead_Rel_2021[,c(2:16)]+
  DE_R_Dead_Rel_2021[,c(2:16)]+MD_R_Dead_Rel_2021[,c(2:16)]+
  VA_R_Dead_Rel_2021[,c(2:16)]+NC_R_Dead_Rel_2021[,c(2:16)]+
  ME_R_Dead_Rel_2022[,c(2:16)]+NH_R_Dead_Rel_2022[,c(2:16)]+
  MA_R_Dead_Rel_2022[,c(2:16)]+RI_R_Dead_Rel_2022[,c(2:16)]+
  CT_R_Dead_Rel_2022[,c(2:16)]+NY_R_Dead_Rel_2022[,c(2:16)]+
  DE_R_Dead_Rel_2022[,c(2:16)]+MD_R_Dead_Rel_2022[,c(2:16)]+
  VA_R_Dead_Rel_2022[,c(2:16)]+NC_R_Dead_Rel_2022[,c(2:16)]

CST_Comm_Har<-MA_R_Comm_Har_2020[,c(2:16)]+RI_R_Comm_Har_2020[,c(2:16)]+
  NY_R_Comm_Har_2020[,c(2:16)]+DE_R_Comm_Har_2020[,c(2:16)]+
  MD_R_Comm_Har_2020[,c(2:16)]+VA_R_Comm_Har_2020[,c(2:16)]+
  MA_R_Comm_Har_2021[,c(2:16)]+RI_R_Comm_Har_2021[,c(2:16)]+
```

```
  NY_R_Comm_Har_2021[,c(2:16)]+DE_R_Comm_Har_2021[,c(2:16)]+
  MD_R_Comm_Har_2021[,c(2:16)]+VA_R_Comm_Har_2021[,c(2:16)]+
  MA_R_Comm_Har_2022[,c(2:16)]+RI_R_Comm_Har_2022[,c(2:16)]+
  NY_R_Comm_Har_2022[,c(2:16)]+DE_R_Comm_Har_2022[,c(2:16)]+
  MD_R_Comm_Har_2022[,c(2:16)]+VA_R_Comm_Har_2022[,c(2:16)]

#Dead discards at age - from 2024 update
CST_Comm_DD_2020<-c(0,130,315,945,3810,4369,2443,1989,1378,576,419,928,321,550,984)
CST_Comm_DD_2021<-c(0,64,215,512,1408,3423,2060,1152,506,1360,334,146,65,117,281)
CST_Comm_DD_2022<-c(0,2,35,235,351,727,964,326,122,94,131,53,22,14,52)


CST_Comm_DD<-CST_Comm_DD_2020+CST_Comm_DD_2021+CST_Comm_DD_2022

CST_Comm_Dead_Dis<-as.matrix(CST_Comm_Har)
for(cc in 1:ncol(CST_Comm_Dead_Dis)){
  CST_Comm_Dead_Dis[,cc]<-CST_Comm_Dead_Dis[,cc]/sum(CST_Comm_Dead_Dis[,cc])*
    CST_Comm_DD[cc]
}
CST_Comm_Dead_Dis[is.nan(CST_Comm_Dead_Dis)]<-0

CST_Rec_Har_Prop<-as.matrix(CST_Rec_Har)
CST_Rec_Har_Prop[is.nan(CST_Rec_Har_Prop)]<-0
CST_Rec_Dead_Rel_Prop<-as.matrix(CST_Rec_Dead_Rel)
CST_Rec_Dead_Rel[is.nan(CST_Rec_Dead_Rel_Prop)]<-0
CST_Comm_Har_Prop<-as.matrix(CST_Comm_Har)
CST_Comm_Har_Prop[is.nan(CST_Comm_Har_Prop)]<-0

CST_Comm_Dead_Dis_Prop<-as.matrix(CST_Comm_Dead_Dis)
CST_Comm_Dead_Dis_Prop[is.nan(CST_Comm_Dead_Dis_Prop)]<-0

CSTF2020<-c(0.00168,0.0052,0.01522,0.03797,0.07037,0.0941,0.1028,0.10335,0.10103,
            0.0979,0.09462,0.09137,0.08821,0.08515,0.08219)

CSTF2021<-c(0.00184,0.00572,0.01673,0.04174,0.07736,0.10344,0.11301,0.11362,0.11107,
            0.10763,0.10402,0.10044,0.09697,0.09361,0.09036)

CSTF2022<-c(0.00276,0.00857,0.02505,0.06252,0.11586,0.15492,0.16926,0.17016,0.16635,
            0.16119,0.15578,0.15043,0.14523,0.14019,0.13533)

CSTFavg<-exp((log(CSTF2020)+log(CSTF2021)+log(CSTF2022))/3)


for(cc in 1:ncol(CST_Comm_Dead_Dis)){
  coltotal<-sum(CST_Rec_Har[,cc],CST_Rec_Dead_Rel[,cc],CST_Comm_Har[,cc],
              CST_Comm_Dead_Dis[,cc])
  CST_Rec_Har_Prop[,cc]<-CST_Rec_Har[,cc]/coltotal*CSTFavg[cc]
  CST_Rec_Har_Prop[is.nan(CST_Rec_Har_Prop)]<-0
  CST_Rec_Dead_Rel_Prop[,cc]<-CST_Rec_Dead_Rel[,cc]/coltotal*CSTFavg[cc]
  CST_Rec_Dead_Rel_Prop[is.nan(CST_Rec_Dead_Rel_Prop)]<-0
  CST_Comm_Har_Prop[,cc]<-CST_Comm_Har[,cc]/coltotal*CSTFavg[cc]
  CST_Comm_Har_Prop[is.nan(CST_Comm_Har_Prop)]<-0
  CST_Comm_Dead_Dis_Prop[,cc]<-CST_Comm_Dead_Dis[,cc]/coltotal*CSTFavg[cc]
```

```
  CST_Comm_Dead_Dis_Prop[is.nan(CST_Comm_Dead_Dis_Prop)]<-0
}

#New Regulations
cstslot<-c(28,31)

new_CST_Rec_Har_Prop<-CST_Rec_Har_Prop
new_CST_Rec_Dead_Rel_Prop<-CST_Rec_Dead_Rel_Prop

newbelow<-new_CST_Rec_Har_Prop[1:c(cstslot[1]-1),]
newabove<-new_CST_Rec_Har_Prop[c(cstslot[2]+1):nrow(CST_Rec_Har_Prop),]

newbelow_adjusted<-newbelow*0.09
newabove_adjusted<-newabove*0.09

new_CST_Rec_Har_Prop[1:c(cstslot[1]-1),]<-0
new_CST_Rec_Har_Prop[c(cstslot[2]+1):nrow(CST_Rec_Har_Prop),]<-0

#Add to Releases
new_CST_Rec_Dead_Rel_Prop[1:c(cstslot[1]-1),]<-
  CST_Rec_Dead_Rel_Prop[1:c(cstslot[1]-1),]+newbelow_adjusted
new_CST_Rec_Dead_Rel_Prop[c(cstslot[2]+1):nrow(CST_Rec_Dead_Rel_Prop),]<-
  new_CST_Rec_Dead_Rel_Prop[c(cstslot[2]+1):nrow(CST_Rec_Dead_Rel_Prop),]+
  newabove_adjusted

#Get New F trajectory
newCSTF<-vector()
for(cc in 1:ncol(CST_Comm_Har_Prop)){
  newCSTF[cc]<-sum(CST_Comm_Har_Prop[,cc],CST_Comm_Dead_Dis_Prop[,cc],
      new_CST_Rec_Har_Prop[,cc],new_CST_Rec_Dead_Rel_Prop[,cc])
}

newCSTF[is.nan(newCSTF)]<-0
new_CST_select<-newCSTF/max(newCSTF)
```

New combined Selectivity

```
# 2024 selectivity (from total F)
comb_select_2024<-newBayF+newCSTF
comb_select_2024<-comb_select_2024/max(comb_select_2024)
CombF<-CSTFavg+bayFavg #2020-2022
```

Calculate Numbers-at-age for 2024

```
#Jan-1
N2023<-data.frame(N=c(96681400,24782200,13749300,11957000,10872400,5807770,3479720,
                    5129420,2458020,926552,501940,963536,412419,208649,515022))
```

```r
catch_2023<-data.frame(removals=c(35504.03,111866.23,299326.95,799575.80,
                  1066841.90,567243.77,695959.36,1145467.72,357229.05,236550.82,
                  70131.97,73326.67,26013.12,19799.25,77273.11))

#Predict Age1 in 2024 from MD YOY Index for 2023
# All recruits 1982-2023
recruits_series<-data.frame(year=1982:2023,
            recr=c(37364100,75602800,62859700,68479300,67611600,74169300,93300800,
                   106655000,130941000,104485000,108762000,133935000,285297000,
                   186734000,234018000,258960000,148052000,152875000,
                   124486000,196467000,221336000,127967000,304432000,158153000,
                   135236000,88441000,126912000,75196700,96903000,125307000,
                   192360000,66597300,82938200,153154000,228067000,111488000,
                   130105000,165265000,120143000,85158100,76967300,96681400))
MDYOYlag<-c(0.59,3.57,0.61,1.64,0.91,1.34,1.46,0.73,4.87,1.03,1.52,2.34,13.97,6.40,
            4.41,17.61,3.91,5.50,5.34,7.42,12.57,2.20,10.83,4.85,6.91,
            1.78,5.12,1.26,3.92,2.54,9.57,0.49,3.42,4.06,10.67,1.25,5.88,6.96,1.95,
            1.12,1.65,1.78,0.57)

#Determine Age 1 versus MD YOY relationship
datar<-data.frame(year=1982:2024,age1=c(recruits_series$recr,NA),index=MDYOYlag)
tempdata<-datar[datar$year<2024,]
age1YOY_model<-lm(age1~index, data=tempdata)

# Predict age 1 for 2024
predicted_age1_2024<-as.numeric(predict(age1YOY_model,newdata=
                        data.frame(index=datar[datar$year==2024,3])))

N2024<-N2023
for(a in 1:maxage){
  if(a==1) N2024[1,1]<-predicted_age1_2024
  if(a>1 & a<maxage) N2024[a,1]<-N2023[a-1,1]*exp(-M[a-1])-catch_2023[a-1,1]*
       exp(-M[a-1]/2)
  if(a==maxage) N2024[a,1]<-N2023[a-1,1]*exp(-M[a-1])-catch_2023[a-1,1]*
      exp(-M[a-1]/2)+N2023[a,1]*exp(-M[a])-catch_2023[a,1]*exp(-M[a]/2)#plus group
   if(N2024[a,1]<0) N2024[a,1]<-0
}


N2024$CV<-c(0.166,0.141,0.137,0.107,0.098,0.102,0.107,0.107,0.121,0.135,
                0.149,0.149,0.171,0.193,0.247)
N2024
```

```
##              N    CV
## 1  80936272.2 0.166
## 2  31211128.4 0.141
## 3  12475460.6 0.137
## 4   8527923.3 0.107
## 5   7918215.8 0.098
## 6   7525949.0 0.102
## 7   4286952.3 0.107
## 8   2349351.0 0.107
## 9   3352232.5 0.121
```

```
## 10  1784220.5 0.135
## 11   578032.2 0.149
## 12   366959.3 0.149
## 13   761294.8 0.171
## 14   330838.8 0.193
## 15   532811.2 0.247
```

Reference Points

```
# Reference Points from one block model
SSB_threshold<-89213.4
SSB_threshold_CV<-0.062
SSB_target<-SSB_threshold*1.25
SSB_target_CV<-SSB_threshold_CV
F_threshold<-0.2064
F_threshold_CV<-0.133
F_target<-0.1707
F_target_CV<-0.133
SSB_2023<-86535.7
F_2023<-0.1828

Nbias<-c(0.052569183,0.018336967,0.022521635,0.0262269,0.027848943,0.035054616,
         0.047813092,0.053597387,0.051212845,0.048280795,0.044594976,
         0.040305708,0.035191998,0.029222708,0.010445624)#old

# Bias in F from retrospective analysis
F_bias<--0.053#old
```

Catch Number Scenarios

```
catch_scenario_1<-5862189
catch_scenario_2<-3890793
```

Projections: Catch Scenario 1 (High 2024 Catch)

Solve for F given total catch

```
   pcatch<-vector()
   solveF1<-function(x){
            for(a in 1:maxage){
              pcatch[a]<-(comb_select_2024[a]*x)/(comb_select_2024[a]*x+M[a])*
                (1-exp(-comb_select_2024[a]*x-M[a]))*N2024[a,1]
            }
            (log(sum(pcatch))-log(catch_scenario_1))^2
       }
```

```r
    outs1<-optimize(solveF1,interval=c(0.00001,5))
    F2024_scen_1<-outs1$minimum
```

Projection to 2034 using F2024_scen_1 in year 1 and the same after 2024

```r
cF_current_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_1,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_current_1
```

Projection F in year 1 is F2024_scen_1 and Ftarget thereafter

```r
cF_target_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F_target,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_target_1
```

Solve for catch needed to achieve F target by 2025

```r
ftarget_2025_1<-Constant_Catch_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,cursel=comb_select_2024,
```

```
                        avgselect=comb_select_2024,recruits=recruits_series,
                        curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                        Fcur=F2024_scen_1,FcurCV1=F_target_CV,Fcur_bias=F_bias,
                        total_current_catch=catch_scenario_1,
                        SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
                         SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                         Ftarget=F_target, FtargetCV=F_target_CV,
                         Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
                         solve_catch=1,
                         objective_function_value_solve_catch_1=1,
                         pyears=2,nsims=5000,Nerr=2,Ferr=2,usebias=1,
                         rcentral=1)
#ftarget_2025_1
```

Solve for F needed to achieve rebuilding with 50% probability of SSB being above SSBtarget by 2029

```
cF_Frebuild_1<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_1,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=0.111,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=6,nsims=10000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_Frebuild_1
```

Projections: Catch Scenario 2 (Low 2024 Catch)

Solve for F given total catch

```
   pcatch<-vector()
   solveF1<-function(x){
           for(a in 1:maxage){
             pcatch[a]<-(comb_select_2024[a]*x)/(comb_select_2024[a]*x+M[a])*
               (1-exp(-comb_select_2024[a]*x-M[a]))*N2024[a,1]
           }
           (log(sum(pcatch))-log(catch_scenario_2))^2
       }

    outs2<-optimize(solveF1,interval=c(0.00001,5))
    F2024_scen_2<-outs2$minimum
```

Projection to 2034 using F2024 in year 1 and the same thereafter

```
cF_current_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_2,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_1)
#cF_current_2
```

Projection constant F in year 1 and F target thereafter

```
cF_target_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F_target,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_target_2
```

Solve for catch needed to achieve F target by 2025

```
ftarget_2025_2<-Constant_Catch_Projections(maxage=max_age,M=Nat_Mortality,
                        sex=female_sex_fraction,
                        fmat=female_mature_fraction,Nages_base=N2024,
                        Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                        avgwgt=average_wgt,cursel=comb_select_2024,
                        avgselect=comb_select_2024,recruits=recruits_series,
                        curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                        Fcur=F2024_scen_2,FcurCV1=F_target_CV,Fcur_bias=F_bias,
                        total_current_catch=catch_scenario_2,
                        SSBthreshold=SSB_threshold, SSBthresholdCV=SSB_threshold_CV,
```

```
                              SSBtarget=SSB_target, SSBtargetCV=SSB_target_CV,
                              Ftarget=F_target, FtargetCV=F_target_CV,
                              Fthreshold=F_threshold,FthresholdCV=F_threshold_CV,
                              solve_catch=1,
                              objective_function_value_solve_catch_1=1,
                              pyears=2,nsims=5000,Nerr=2,Ferr=2,usebias=1,
                              rcentral=1)
#ftarget_2025_2
```

Solve for F needed to achieve rebuilding with 50% probability of SSB being above SSBtarget by 2029

```
cF_Frebuild_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=0.126,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=6,nsims=10000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_Frebuild_2
```

```
F2024_scen_3 <- F2024_scen_2 * (1+0.387)

cF_2022pInc_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_3,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_2022pInc_2
```

```
F2024_scen_4 <- F2024_scen_2 * (1+0.172)

cF_2023pInc_2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
```

```
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=F2024_scen_4,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=11,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
#cF_2023pInc_2
```

Additional Projection with variable Fs

Altered Projection Code

```
varFs<-c(F2024_scen_4,0.126,0.126,0.126,0.126)
cf_scen_2_var_Fs2<-Constant_F_Projections(maxage=max_age,M=Nat_Mortality,
                    sex=female_sex_fraction,
                    fmat=female_mature_fraction,Nages_base=N2024,
                    Nbias=N_bias,pF=F_fraction,pM=M_fraction,curwgt=average_wgt,
                    avgwgt=average_wgt,
                    cursel=comb_select_2024,avgselect=comb_select_2024,
                    recruits=recruits_series,
                    curyear=2024,recruit_start_year=2008,recruit_end_year=2023,
                    Fcur=F2024_scen_2,FcurCV=0.133,Fcur_bias=F_bias,
                    Fproj=varFs,
                    SSBtarget=SSB_target,SSBtargetCV=SSB_target_CV,
                    SSBthreshold=SSB_threshold,SSBthresholdCV=SSB_threshold_CV,
                    pyears=6,nsims=5000,usebias=1,
                    catch_current=catch_scenario_2)
```

Tables

Table 1: 2024 Assessment Reference Points

SSB.Refs	SSB	F.Refs	F
Target	111,516.8	Target	0.1707
Threshold	89,213.4	Threshold	0.2064
2023	86,535.7	2023	0.1828

Table 2: Catch and 2024 F Estimates

Catch	Removals	F
Scenario 1	5,862,189	0.1950
Scenario 2	3,890,793	0.1264

Table 3: Projection Results using F2024 in All Years

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.325	0.001	0.126	5,862,189	0.370	0.001
2025	0.195	5,423,865	0.528	0.004	0.126	3,751,468	0.819	0.024
2026	0.195	5,134,366	0.599	0.006	0.126	3,658,378	0.969	0.134
2027	0.195	5,144,004	0.578	0.006	0.126	3,707,293	0.994	0.297
2028	0.195	5,318,206	0.458	0.003	0.126	3,873,952	0.998	0.434
2029	0.195	5,541,406	0.331	0.001	0.126	4,051,657	0.999	0.503
2030	0.195	5,684,011	0.238	0.001	0.126	4,198,552	0.999	0.561
2031	0.195	5,758,484	0.200	0.001	0.126	4,282,790	0.999	0.631
2032	0.195	5,825,179	0.186	0.001	0.126	4,339,902	0.999	0.676
2033	0.195	5,844,425	0.200	0.002	0.126	4,382,267	0.999	0.725
2034	0.195	5,862,793	0.217	0.003	0.126	4,425,940	0.999	0.763

Table 4: Projection Results for 2024 F and Ftarget

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.337	0.000	0.126	3,890,793	0.356	0.001
2025	0.171	4,782,921	0.545	0.004	0.171	4,977,582	0.792	0.020
2026	0.171	4,601,902	0.700	0.012	0.171	4,743,436	0.898	0.055
2027	0.171	4,636,210	0.761	0.020	0.171	4,743,985	0.923	0.074
2028	0.171	4,841,601	0.749	0.019	0.171	4,918,083	0.904	0.062
2029	0.171	5,061,695	0.691	0.015	0.171	5,085,327	0.853	0.041
2030	0.171	5,218,784	0.634	0.013	0.171	5,248,565	0.796	0.032
2031	0.171	5,288,331	0.607	0.016	0.171	5,332,686	0.755	0.032
2032	0.171	5,344,185	0.606	0.021	0.171	5,378,087	0.711	0.037
2033	0.171	5,363,981	0.611	0.037	0.171	5,390,770	0.692	0.049
2034	0.171	5,404,582	0.631	0.053	0.171	5,430,432	0.696	0.064

Table 5: Catch To Reach Ftarget by 2025

	Scenario 1		Scenario 2	
Year	F	Catch	F	Catch
2024	0.195	5,862,189	0.126	3,890,793
2025	0.171	4,786,429	0.171	4,983,814

Table 6: F needed to rebuild SSB by 2029

	Scenario 1				Scenario 2			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.195	5,862,189	0.338	0.001	0.126	3,890,793	0.363	0.001
2025	0.111	3,171,196	0.563	0.004	0.126	3,735,471	0.810	0.024
2026	0.111	3,159,998	0.894	0.052	0.126	3,641,580	0.966	0.133
2027	0.111	3,249,542	0.980	0.196	0.126	3,700,575	0.993	0.304
2028	0.111	3,430,020	0.996	0.361	0.126	3,871,423	0.998	0.428
2029	0.111	3,629,865	0.999	0.517	0.126	4,052,648	0.999	0.504

Table 7: Projection Results if F Increases in 2025

	F Increases by Same Percent as in 2023				F Increases by Same Percent as in 2022			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.126	3,890,793	0.365	0.001	0.126	3,890,793	0.368	0.001
2025	0.148	4,368,599	0.804	0.021	0.175	5,103,863	0.800	0.021
2026	0.148	4,207,073	0.938	0.087	0.175	4,853,542	0.888	0.051
2027	0.148	4,228,542	0.974	0.159	0.175	4,830,779	0.908	0.064
2028	0.148	4,410,957	0.979	0.192	0.175	5,016,984	0.876	0.050
2029	0.148	4,613,175	0.980	0.201	0.175	5,195,578	0.812	0.033
2030	0.148	4,747,809	0.975	0.195	0.175	5,344,763	0.733	0.022
2031	0.148	4,811,663	0.970	0.220	0.175	5,416,288	0.679	0.025
2032	0.148	4,853,165	0.962	0.249	0.175	5,451,445	0.623	0.028
2033	0.148	4,884,653	0.958	0.293	0.175	5,459,675	0.603	0.037
2034	0.148	4,937,977	0.957	0.334	0.175	5,492,176	0.599	0.047

Table 8: Projection results if F increases in 2025 only due to 2018 YC

	F = 0.126 after 2026			
Year	F	Catch	SSB.th.Pr	SSB.tar.Pr
2024	0.126	3,890,793	0.360	0.001
2025	0.148	4,361,188	0.808	0.022
2026	0.126	3,595,776	0.942	0.087
2027	0.126	3,678,054	0.988	0.230
2028	0.126	3,857,024	0.995	0.355
2029	0.126	4,054,539	0.998	0.416

Figures

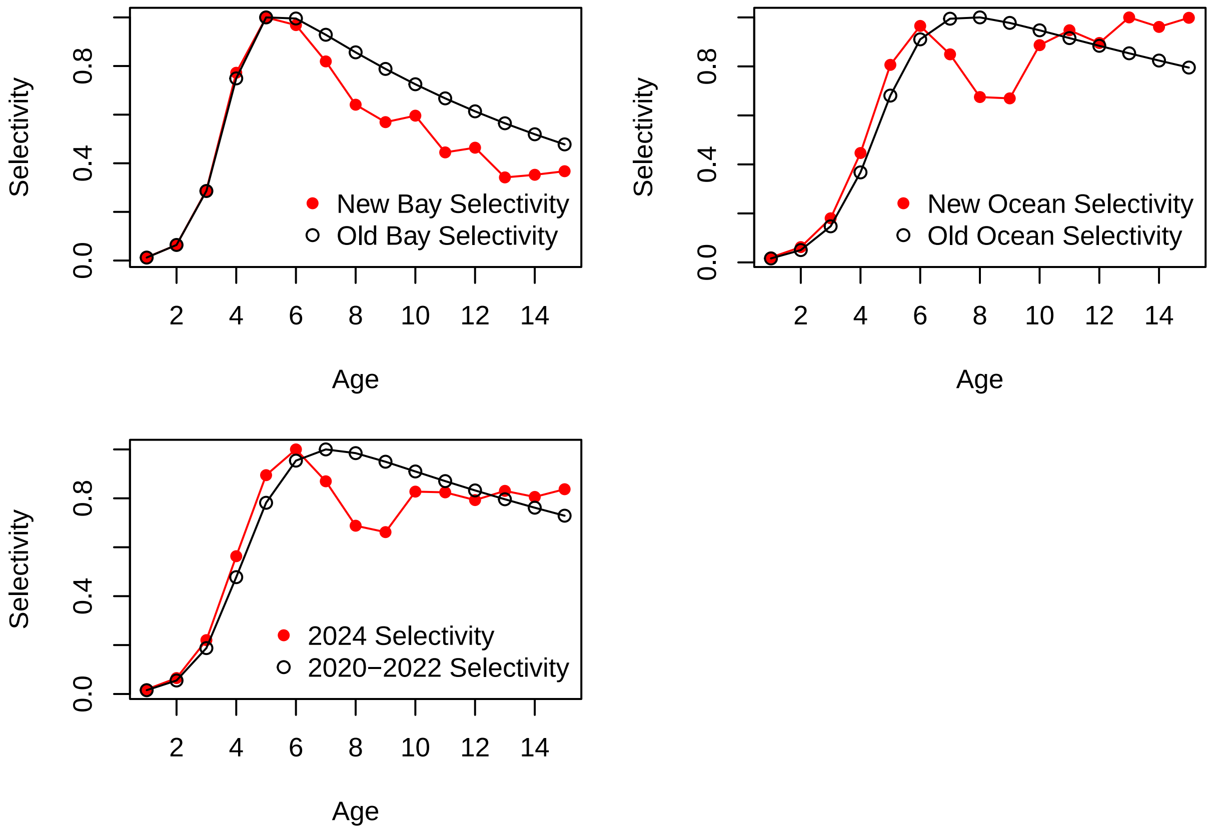

Figure 1. Plots of New Selectivities for Bay, Ocean and Combined.

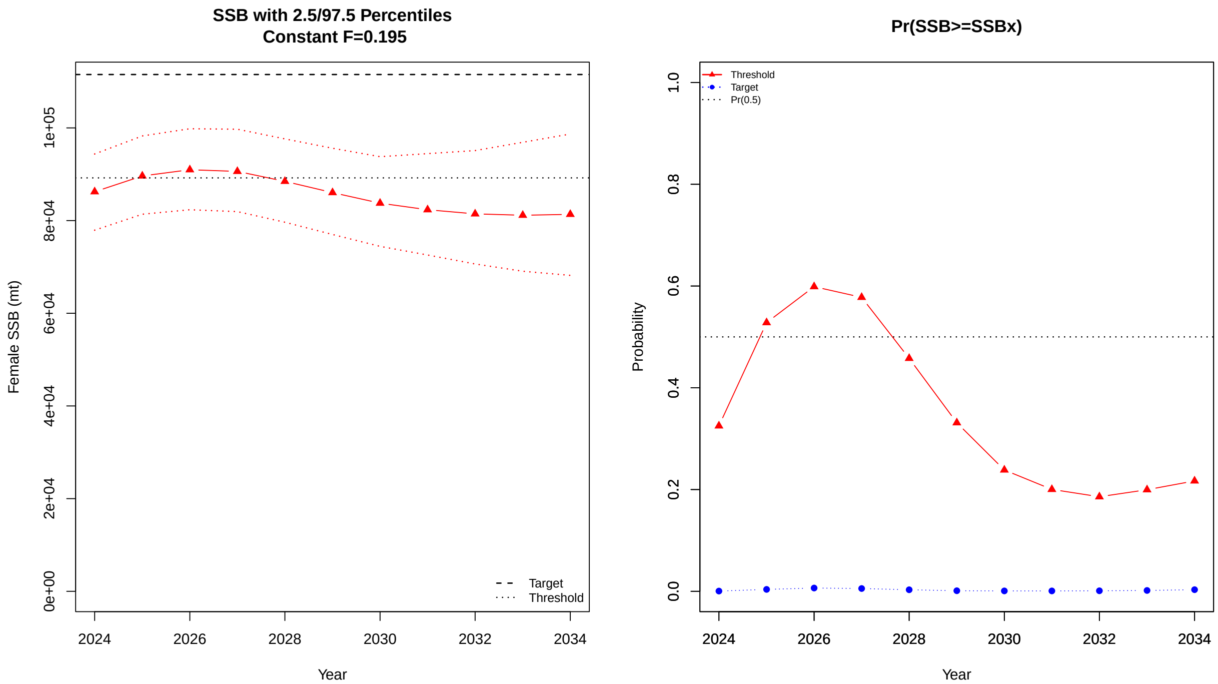

Figure 2. Projections of SSB and probabilities of SSB being >= SSB threshold and SSB target through 2034 under constant F=F2024 for catch scenario 1 .

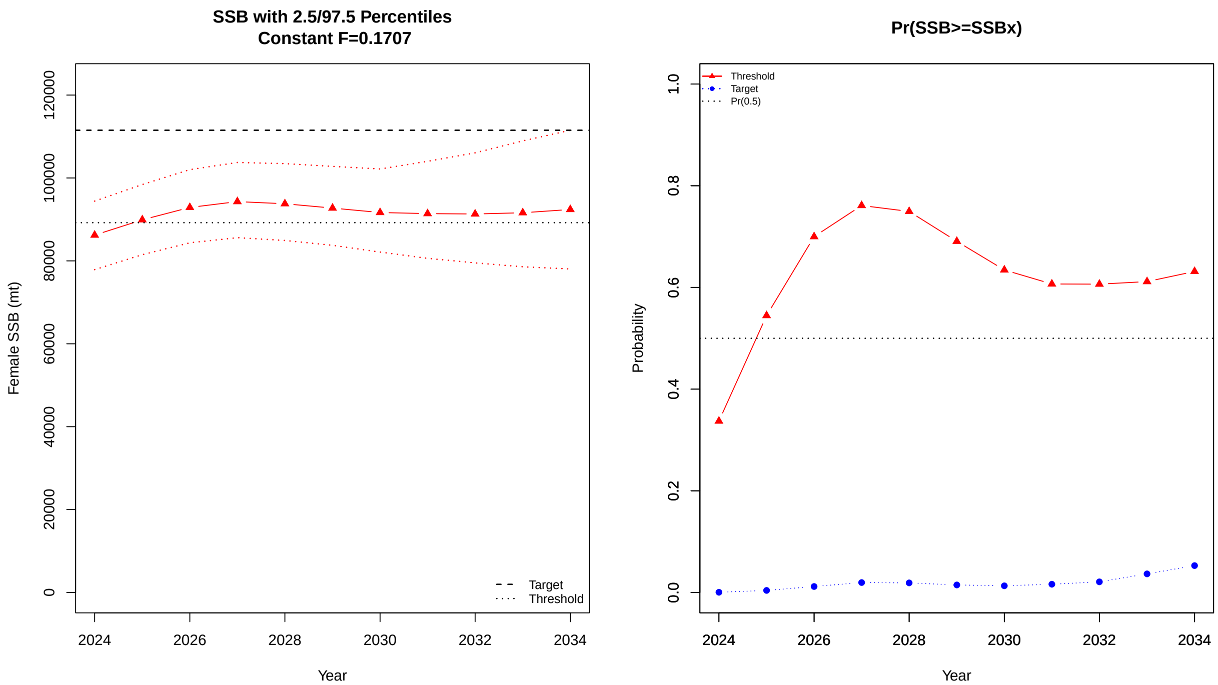

Figure 3. Projection through 2034 of SSB and probabilities of SSB being >= SSB threshold and SSB target under F2024 in 2024 and F-target thereafter for catch scenario 1 .

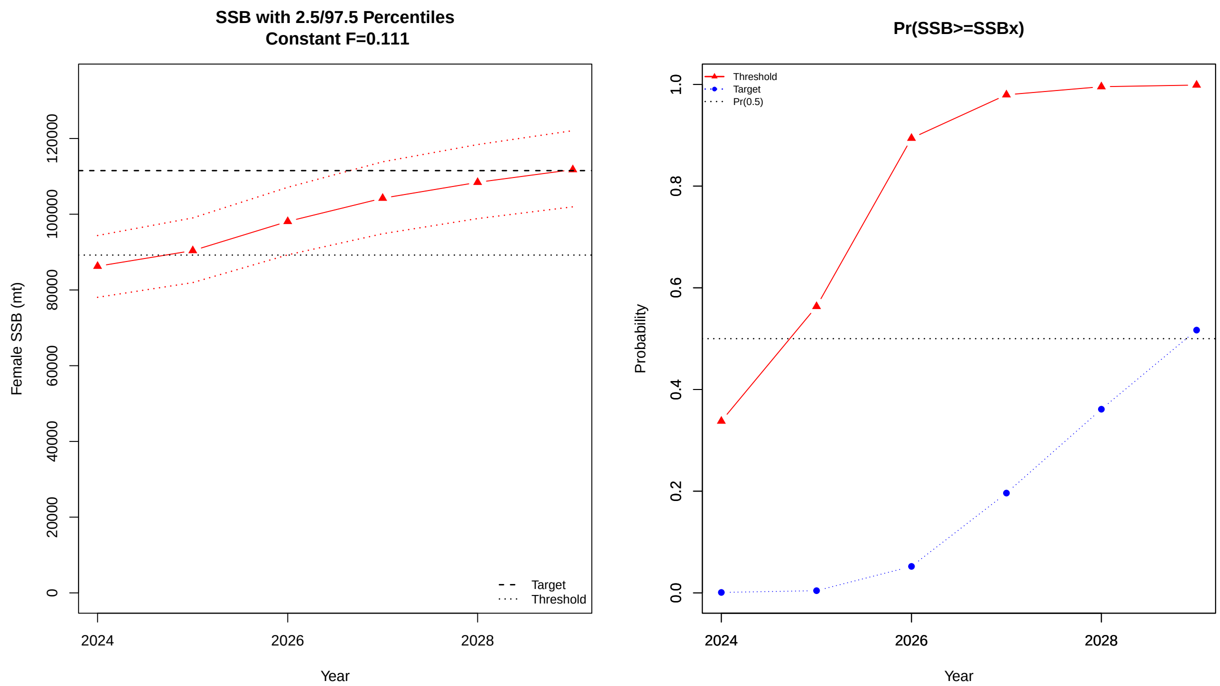

Figure 4. F needed to rebuild SSB with 50% probability that is SSB >= SSB target under catch scenario 1.

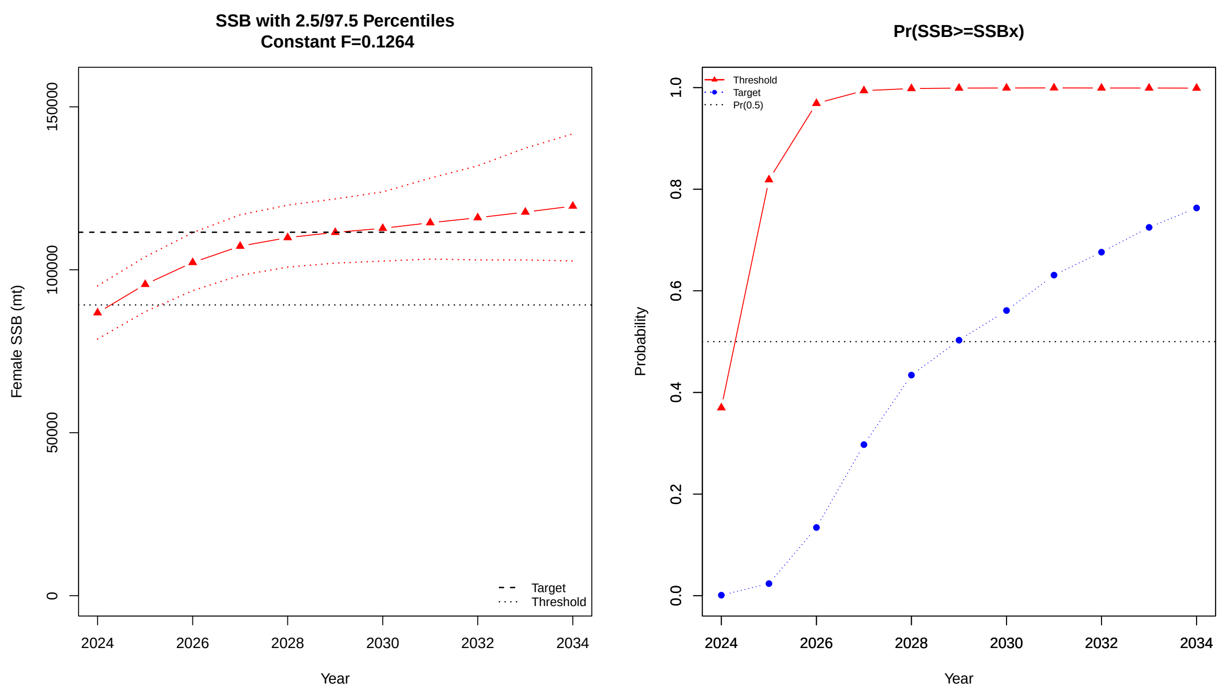

Figure 5. Projections of SSB and probabilities of SSB being >= SSB threshold and SSB target through 2034 under constant F=F2024 for catch scenario 2 .

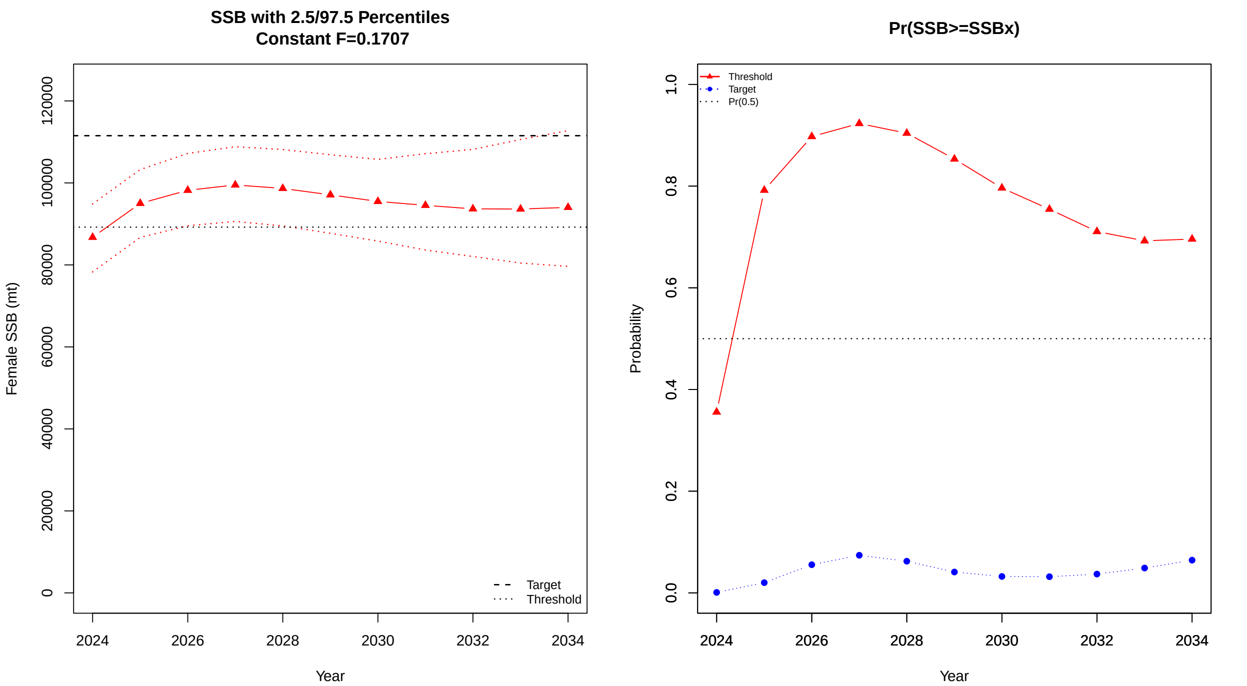

Figure 6. Projection through 2034 of SSB and probabilities of SSB being >= SSB threshold and SSB target under F2024 in 2024 and F-target thereafter for catch scenario 2.

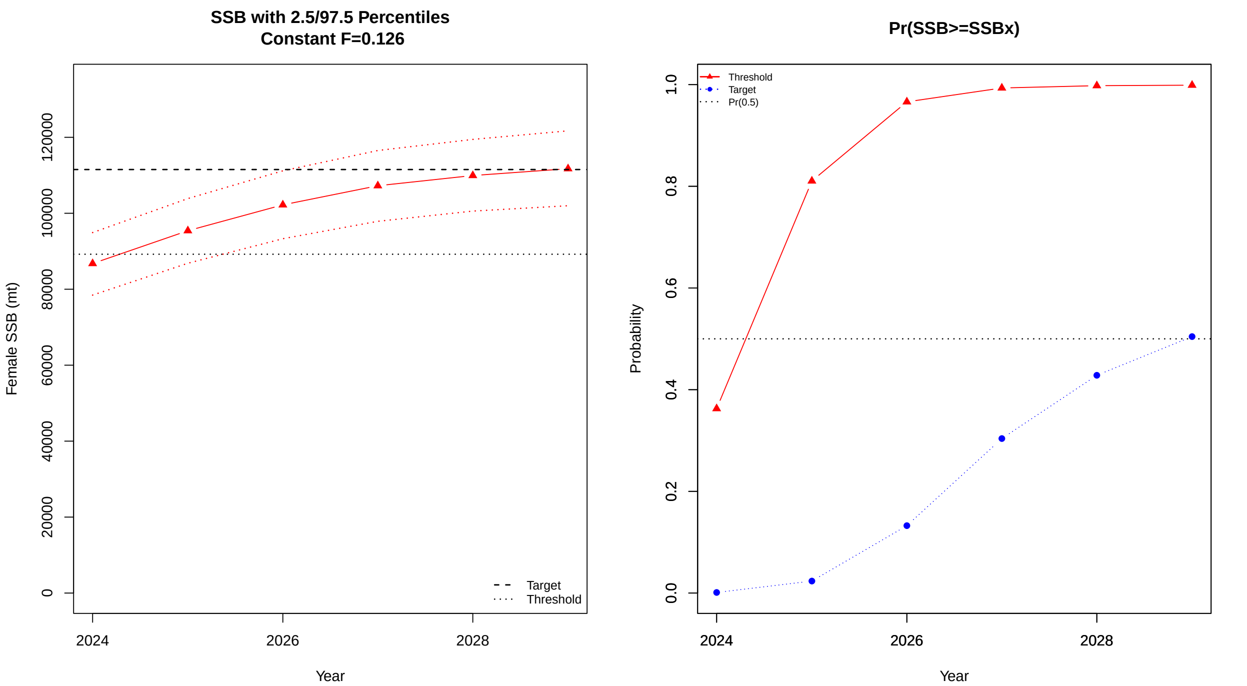

Figure 7. F needed to rebuild SSB with 50% probability that is SSB >= SSB target under catch scenario 2.

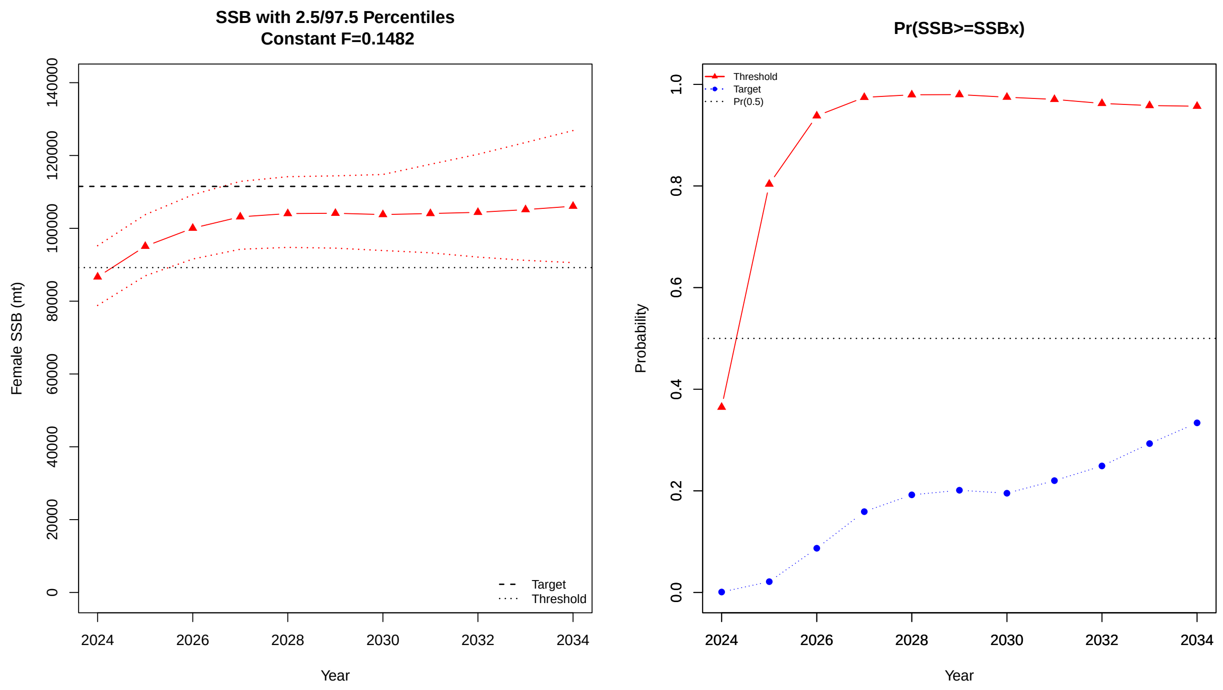

Figure 8. Constant F=F 2025, where F 2025 increases from F 2024 at the same rate seen from 2021 to 2023 under the 28-31" slot

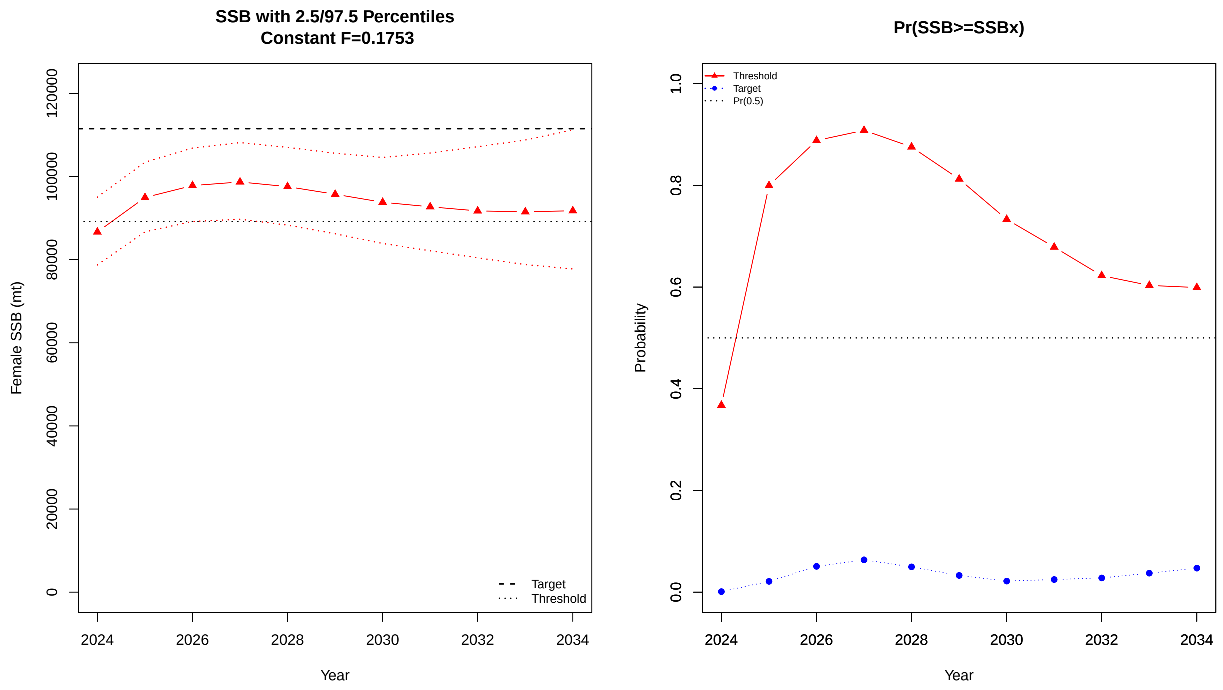

Figure 9. Constant F=F 2025, where F 2025 increases from F 2024 at the same rate seen from 2021 to 2022 when the 2015 year-class turned seven.

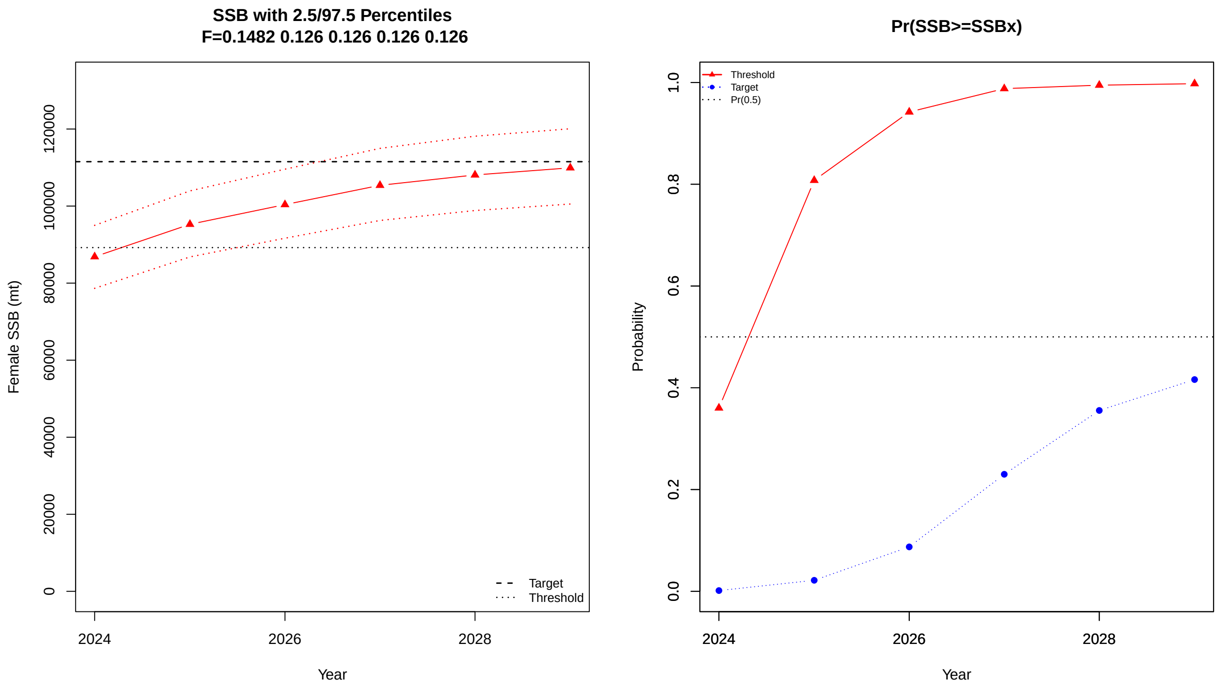

Figure 10. F increases in 2025 only as 2018 Year-class moves through slot. F after 2025 at F=F 2024=0.126