Atlantic States Marine Fisheries Commission

Tautog Management Board

October 18, 2021
1:30 – 4:00 p.m.
Webinar

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 (*W. Hyatt*)	1:30 p.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from August 2021	1:30 p.m.
3.	Public Comment	1:35 p.m.
4.	Review 2021 Stock Assessment Update (*N. Ares*)	1:45 p.m.
5.	Consider Management Response to 2021 Stock Assessment Update (*W. Hyatt*) **Possible Action**	2:45 p.m.
6.	Review and Provide Feedback on Risk and Uncertainty Decision Tool for Tautog (*J. McNamee*)	3:00 p.m.
7.	Develop Guidance for Law Enforcement Committee Review of Commercial Tagging Program (*K. Rootes-Murdy*)	3:45 p.m.
8.	Other Business/Adjourn	4:00 p.m.

MEETING OVERVIEW

Tautog Management Board
October 18, 2021
1:30 - 4:00 p.m.
Webinar

Chair: Bill Hyatt (CT) Assumed Chairmanship: 11/19	Technical Committee Chair: Coly Ares (RI)	Law Enforcement Committee Representative: Jason Snellbaker (NJ)
Vice-Chair: Mike Luisi (MD)	Advisory Panel Chair: VACANT	Previous Board Meeting: August 3, 2021
Voting Members: MA, RI, CT, NY, NJ, DE, MD, VA, NMFS, USFWS (10 votes)		

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 should use the webinar raise your hand function and the Board Chair will let you know when to speak. 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 Board 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.

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 3, 2021

4. Review 2021 Stock Assessment Update (1:45-2:45 p.m.)
Background • The 2017 Stock Assessment Update was updated with data through 2020. The assessment updates the statistical catch-at-age model for each management region. Results and stock status for each region will be presented (**Briefing Materials**).
Presentations • 2021 Stock Assessment Update by N. Ares

5. Consider Management Response to 2021 Stock Assessment Update (2:45-3:00 p.m.) Possible Action
Background • The 2021 Stock Assessment updates the stock status and reference points for all management regions. • The Board should determine if they wish to take management action in any region or request additional analysis from the Technical Committee (TC).
Board Actions for consideration • Consider management action, if necessary.

6. Review and Provide Feedback on Risk and Uncertainty Decision Tool for Tautog (3:00-3:45 p.m.)
Background • In February, the ISFMP Policy Board indicated support for using Tautog as pilot case for the Risk and Uncertainty Policy. The pilot case is to be developed in conjunction with the 2021 Stock Assessment Update in order to use the most current information to help inform management decisions. • The Tautog TC and the Committee on Economics and Social Sciences provided technical inputs for the Tautog Risk and Uncertainty Decision Tools. The preliminary Tautog Risk and Uncertainty Report (**Supplemental Materials**), which summarizes the technical inputs, will be presented. • The Board met via webinar in September to provide input on weightings for the decision tool's components. The preliminary weightings (**Supplemental Materials**) will be presented for additional Board review.
Presentations • Risk and Uncertainty Decision Tool for Tautog by J. McNamee

7. Develop Guidance for Law Enforcement Committee Review of Commercial Tagging Program (2:15-2:30 p.m.)
Background • The Law Enforcement Committee (LEC) provided preliminary feedback on the implementation of the commercial harvest tagging program to the Board in August 2021. • To better assess the impact of the tagging program on the illegal harvest and sale of tautog, Board Chair Bill Hyatt has drafted additional questions (**Supplemental Materials**) for LEC to address.
Presentations • Overview of the Draft Question to LEC on Commercial Harvest Tagging Program by K. Rootes-Murdy
Board Actions for consideration • Provide Feedback on Draft Questions.

8. Other Business/Adjourn

Tautog 2021 Tasks

Activity Level: High

Committee Overlap Score: High (Menhaden, BERP, Summer Flounder, Scup, and Black Sea Bass)

Current Committee Tasks:

- TC – Evaluate biological sampling requirements (assess the feasibility of adding pelvic spines as an acceptable ageing structure)
- Annually administer commercial tagging program
- TC – May 1, 2021: compliance reports due
- 2021: Complete stock assessment update and contribute feedback to Risk and Uncertainty Decision Tool

TC Members: Alexa Kretsch (VA), Coly Ares (Chair, RI), Linda Barry (NJ), Sandra Dumais (NY), Scott Newlin (DE), David Ellis (CT), Craig Weedon (Vice-Chair, MD), Sam Truesdell (MA), Kirby Rootes-Murdy (ASMFC Staff)

SAS Members: Coly Ares (RI), Linda Barry (NJ), Alexei Sharov (MD), Sam Truesdell (MA), Jacob Kasper (UCONN), Katie Drew (ASMFC Staff), Kirby Rootes-Murdy (ASMFC Staff)

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

TAUTOG MANAGEMENT BOARD

Webinar
August 3, 2021

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

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

2. **Approval of proceedings** from September 2020 by consent (Page 1).

3. **Move to accept the FMP Review for the 2020 fishing year, state compliance reports, and *de minimis* requests from Delaware and Maryland** (Page 9). Motion by Justin Davis; second by Roy Miller. Motion carried (Page 9).

4. **Move to adjourn** by consent (Page 19).

ATTENDANCE

Board Members

Dan McKiernan, MA (AA)
Raymond Kane, MA (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Jason McNamee, RI (AA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Justin Davis, CT (AA)
Bill Hyatt, CT (GA)
Maureen Davidson, NY, proxy for J. Gilmore (AA)
Emerson Hasbrouck, NY (GA)
Joe Cimino, NJ (AA)
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, proxy for Asm. Houghtaling (LA)
John Clark, DE, proxy for D. Saveikis (AA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Mike Luisi, MD, proxy for B. Anderson (AA)
Russell Dize, MD (GA)
David Sikorski, MD, proxy for Del. Stein (LA)
Pat Geer, VA, proxy for S. Bowman (AA)

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

Ex-Officio Members

Jason Snellbaker, Law Enforcement Representative

Staff

Robert Beal
Toni Kerns
Tina Berger
Laura Leach
Lisa Carty
Maya Drzewicki
Emilie Franke
Lisa Havel
Chris Jacobs
Jeff Kipp
Savannah Lewis
Kirby Rootes-Murdy
Sarah Murray
Mike Rinaldi
Caitlin Starks
Deke Tompkins
Geoff White

Guests

Michael Addis, FL FWC
Mike Armstrong, MA DMF
Pat Augustine, Coram, NY
Richard Balouskus, RI DEM
Chris Batsavage, NC DENR
Katherine Becker, FL FWC
Dick Brame
Mike Celestino, NJ DEP
Margaret Conroy, DE DFW
Nicole Lengyel-Costa
Jessica Daher, NJ DEP
Taylor Deihl
Steve Doctor, MD DNR
G. Warren Elliott, PA (LA)
Jennifer Farmer, VMRC
Lynn Fegley, MD DNR
Dawn Franco, GA DNR
Anthony Friedrich, SGA
Alexa Galvan, VMRC
Matt Gates, CT DEEP
Lewis Gillingham, VMRC
Helen Takade-Heumacher

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The Board will review the minutes during its next meeting.

Guests (continued)

Carol Hoffman, NYS DEC
Harry Hornick, MD DNR
Jesse Hornstein, NYS DEC
Adam Kenyon, VMRC
Carl LoBue, TNC
Loren Lustig, PA (GA)
Chip Lynch, NOAA
Shanna Madsen, VMRC
Jerry Mannen, NC (GA)
Conor McManus, RI DEM
Nichola Meserve, MA DMF
Steve Meyers
Chris Moore, CBF
Allison Murphy, NOAA
Kennedy Neill
Gerry O'Neill, Cape Seafoods
Derek Orner, NOAA
Nick Popoff, FL FWS
Will Poston, SGA
Harry Rickabaugh, MD DNR
Scott Schaffer, MA DMF
Alexei Sharov, MD DNR
Olivia Siegal, VMRC
Somers Smott, VMRC
Renee St. Amand, CT DEP
David Stormer, DE DFW
Mike Waine, ASA
Craig Weedon, MD DNR
Angel Willey, MD DNR
Chris Wright, NOAA
Renee Zobel, NH F & G

The Tautog Management Board of the Atlantic States Marine Fisheries Commission convened via webinar; Tuesday, August 3, 2021, and was called to order at 1:30 p.m. by Chair William Hyatt.

CALL TO ORDER

CHAIR WILLIAM HYATT: Good afternoon everyone. This meeting of the Tautog Management Board is called to order. My name is Bill Hyatt; I am the Governor's Appointee from Connecticut, and the current Chair of this Board.

APPROVAL OF AGENDA

CHAIR HYATT: First item to deal with is approval of the agenda.

There are a few changes, the first is that in Item Number 5, Review and Discuss Risk and Uncertainty Decision Tool for Tautog. That presentation will be given by Jay McNamee instead of Sara Murray. The second change, also with that same item, is it's listed as Review and Discuss. But we've talked about it, and it really should be an update.

The third change that we have to make is that due to some scheduling conflicts, we're going to have to make a little switch. Item Number 5, the Risk and Uncertainty Decision Tool, will be moved up ahead of Item Number 4, Progress Report on the 2021 stock assessment. Does anyone have any additional modifications? Toni, any hands?

MS. TONI KERNS: I see no hands.

CHAIR HYATT: Seeing none, the agenda as modified is accepted.

APPROVAL OF PROCEEDINGS

CHAIR HYATT: Next is Approval of the Proceedings from September, 2020. Does anyone have any edits? Any hands, Toni?

MS. KERNS: No hands.

CHAIR HYATT: Seeing none, the proceedings are approved.

PUBLIC COMMENT

CHAIR HYATT: Next is Public Comment period. Toni, do we have anyone signed up?

MS. KERNS: I'm not aware of anyone signed up, and I don't have any hands raised at this time to make any comments.

UPDATE ON THE RISK AND UNCERTAINTY DECISION TOOL FOR TAUTOG

CHAIR HYATT: Okay, so having none, we'll move right along into, and again the agenda has been adjusted so that what we're going to move right into is Review and Discuss the Risk and Uncertainty Decision Tool for Tautog. It's going to be Jason McNamee, and just a few real quick things regarding this agenda item. I think I've also already pointed out that it is not really Review and Discuss, I made a mistake in saying that. Again, it's an update. The discussion of the output and any management considerations, will happen at subsequent meetings, either the annual meeting, and probably carry over into the winter meeting. Thirdly, since this is very much a work in progress, and since we'll be revisiting this topic in future meetings. If the discussion does go on long, I might cut it short, just to make sure that we have time in the agenda for some of the later items. With that, Jay, why don't you take it away?

DR. JASON McNAMEE: I very much appreciate the accommodation. I have a quick update on the Risk and Uncertainty Policy that we are going to be applying to tautog, and thank you Maya, I think it's Maya back there, for running the slide show for me. Just a quick background. I'm going to try and go really quick through this stuff.

But just a little bit of background. Remember that the Risk and Uncertainty Policy that we've been working on for a couple years, now is to provide a consistent, and flexible mechanism to account for risk and uncertainty in our (the Commission's) decision making processes. That includes protecting all of our Commission managed stocks from the risk of overfishing, and minimizing adverse social, economic, or ecosystem effects.

You have a working group that has been sort of working behind the scenes on this process. What we have developed so far is, well we had developed a couple things, but the main thing I'm going to talk about here is we've developed the decision tool. The tool incorporates different information related to the risk and uncertainty for a species.

These are like the technical inputs that will be flooding into, and recall that the decision tool, it's basically like a decision tree, so you kind of work through a series of questions. We've got these technical inputs, and then it combines these inputs with the relative importance of each of the pieces of information, and what we'll call that is the weighting of these various aspects.

In the end, we arrive at a single value, and that value represents the recommended probability of achieving, for instance the reference points, or whatever it is that you're running through the decision tool. This recommended probability will then be used with the projection, to develop the management options for the species.

This gets at that discussion we often have of, well, what's the probability, it should be 50 percent, it should be 60 percent. Let's look at 50, 60, and 70 percent. This will jump all of that largely arbitrary discussion, and do it in a more thorough, transparent and defensible way. Just kind of a look at the process, a visual of the process.

Generally, the Board provides the inputs on the weighting, so we're looking for the Board to give us the importance of each of the different questions that exist in the tool. Then the Technical Committee, and the Committee for Economic and Social Science will provide all the responses to their decision tool questions, so that there was technical input.

This is going to be an iterative process though, so once we go through it, the Board can make adjustments to the inputs, if appropriate, through their iterative process. The Board can provide feedback on weightings and the decision tool answers. But the nice thing about it is, it happens all very transparently and above board, not to say we were doing it below board before, but it's all very overt, and it happened in a way that can be captured, so that it can be really transparent, and people will understand why we made the decisions we made. Just a quick slide, these are the various inputs in the decision tool. I won't go through all of them, but you can see there is a bunch of questions on stock status, then there are questions about additional uncertainties, some additional risks, and then a series of socio and economic questions. They are kind of broken up into short term and long-term considerations.

For most of the components, if there is a concern, for instance there is high management uncertainty, some element that we don't have perfect information on. It makes the probability more precautionary. Looking at the slide in front of you, you can see the continuum at the top there with the arrows.

You've got your default, that's your starting point. Then you can see that series of blue arrows, the stock status and model uncertainty and the management uncertainty. The vast majority of the things that we look at make us act in a more precautionary manner, they move to the left. The socioeconomic components, however, allow us to move in both directions.

You can be more precautionary with those, if that is how those questions get answered. But it can also go in the other direction, and so this is unique to our process, where you can actually ratchet your precaution in the other direction, if those socioeconomic conditions warrant it. What we're going to go through here is a couple of animations that represent examples.

This first one is just to kind of show you how the system works, and then on the next slide, I'll talk a little bit more about the weighting aspect of it. I'm going to actually talk to her first, and then Maya, I'll ask you to click a couple of times. What this example is going to show, is how the different components of the decision tool, they can interact.

In this case, we're going to look at the overfished and overfishing status, as well as we're going to pretend that we have high model uncertainty in this case as well. I'm going to show how it increases the recommended level of precaution. Go ahead and click, I think twice on two, so you can see we start at our default.

Then where overfished and overfishing is occurring, so we're going to get more precautious here, and we move to the left. Then we also have high model uncertainty, so we shift even more to the left, which is going to make us more precautionary, potentially lowering our TAC. But now let's think about the socioeconomic effects.

Here you can see we've got high negative socioeconomic effects in our example. What this does is, it pushes us back in the other direction towards the default. You can see the two blue arrows shifted us to the left, and then because there was going to be a high negative socioeconomic effect, shifted us back to the right.

Now moving on to another example to show you the weighting. The first example is going to show you the default weighting, so this is going to be if all of the components have an equal weight to them. You can see here, we've got high management uncertainty and high model uncertainty, and the arrows have an equal length to them, because they are weighted equally. They each shift us an equal amount to the left. Here we have our high management uncertainty at that same weighting again. Now our model uncertainty, we're giving it two times the weight in the decision tool. You can see that shifts it quite a way more to the left. Now this is again, just to illustrate the effects of what the answering the questions is doing versus what the weighting is doing.

We continue to develop this. We have the Striped Bass Technical Committee, and the SES, we looked at a striped bass version of this. But it was actually through that pilot that we actually pretty significantly changed the way the process worked, which I talked about, I don't know if it was last time or two times ago.

That striped bass version was a pilot run. We learned from it, and we've modified it. After I talked to you last time, we decided we were going to give it a more rigorous implementation for tautog, which that assessment was underway, and so we thought it would be a good next phase of the Risk and Uncertainty Policy.

We're going to implement it fully for tautog, but it's still in a testing phase, so we'll still allow some flexibility, and an ability to make changes as the Board deems fit. This is the last slide, Mr. Chair. The Tautog Technical Committee, Advisory Panel and the SES, they are all providing input on the technical components.

Your first step, or the Board, we will provide input into the weighting. In other words, the relative importance of the different components of the decision tool, so we're going to make those arrows bigger or smaller with our decisions. What we're going to do is we're going to send out a survey to gather the Board input on this.

There is going to be a webinar held between this month and next month, so keep an eye out for that, to kind of give information to talk about the survey, answer any questions that people have. Then we're going to take those survey responses, and average them to produce the weightings, which we're then going to use in the decision tool for tautog.

Then once we get the whole thing created and operationalized, a draft risk and uncertainty report for each region, remember there are multiple regions for tautog. Those will be presented to the Board for review, after the assessment is complete. We're targeting the annual meeting for that. The report will include everything you need to know about the risk and uncertainty process for tautog.

That is it, Mr. Chair. I'm happy to take any questions if you want to allow a few. But again, we just wanted to reorient people as to what was going on for tautog, so that you are prepared for both the survey when you get it, and for our discussion at the annual meeting, so thanks, Mr. Chair.

CHAIR HYATT: Thank you, Jay, and yes, we do have time for questions if anybody has them. We remind people again, as you have just done, that the tool itself is expected to be fleshed out and presented at the annual meeting. I think it's safe to say that any application of that tool would be something that would be considered, probably at the winter meeting at the earliest, correct?

DR. McNAMEE: I'll look to Commission staff for help on that one. I'm not sure of the plan there, maybe Kirby can answer.

MR. KIRBY ROOTES-MURDY: Yes, thanks, Jay. I'll say it's a bit of a moving target right now. I mean in terms of what you laid out in the presentation for the survey, that holds up. But trying to wrap up the assessment updates, and then get that to the Board, as well as this other component, the decision tool report. You know there is a chance that that might be taken up by the Board again at the winter meeting. The timeline is a little fluid on when that report will be done for the Board's consideration of it.

CHAIR HYATT: Very good, so does anybody have any questions for Jay?

MS. KERNS: I have John Clark.

CHAIR HYATT: Go ahead, John.

MR. JOHN CLARK: Thank you for the presentation, Jay. Just kind of curious about the weightings, based on a survey. Are you looking for kind of the wisdom of the crowd's type of response there, where you know you're going to get, I assume you're going to send it to the entire Board to weigh in on this, and therefore there is going to be, I assume you'll get a mean value for each response? How many options will there be for the questions, and then how do you work that into a single point estimate for a weight?

DR. McNAMEE: Great question, John. I mean you've got it exactly right. That is the idea is, the survey, well it will be all of the elements that get plugged into the decision tool, and it will be judging the way the Board deems each of the elements in their scale of importance. I'm looking for the right term. I'll stick with that one.

That is exactly right, John, we'll take the responses and average them, and then we'll talk about them. We'll kind of give people an opportunity to better explain why they picked the weightings that they did, and then kind of go from there. I think you've got the process pretty well nailed, as far as what we're envisioning.

MS. KERNS: You have Dan McKiernan, and Bill, if you wouldn't mind muting while the other folks are talking, it will let us have potentially less echo.

CHAIR HYATT: Very good, will do. Go ahead, Dan.

MR. DANIEL McKIERNAN: My question has to do with, I guess do Board members need coaching on some of the details of the management, and the different management areas? For example, in New York you have a separate management unit in Long Island Sound that is shared with Connecticut, separate from the one to the south that may be shared with New Jersey.

The reliability of those data, and the attribution of those landings to the proper stock unit. I don't know if I have enough information to give you a score, as to the management uncertainty or the reliability of some of those landing's figures. I'm wondering, because these are such localized fisheries now, and I'm not sure I could even comment on what's going on for the south, in terms of each jurisdiction's ability to track some of these data, and the reliability of the data. What are your thoughts on that?

DR. McNAMEE: Thanks, Dan, it's a good question, and you've got me thinking a little bit. I think the webinar that I mentioned is partially set up to accomplish what you're getting at. I'll offer that in the end what we're trying to judge is the importance of that. For instance, you don't necessarily need to be an expert on that New Jersey/New York area, but hopefully you have a feeling about the importance of knowing landings.

If you can get a sense that, during the webinar we say, well we've got pretty high uncertainty in that area. You can make a judgment to say, I think landings are important, and if they are uncertain in that area then you can weight that element of the decision tool. It's kind of at a higher level that we're looking for. You don't' necessarily need to know the nitty gritty details, but some details probably are important to making judgments. Hopefully we can capture enough of those during that webinar to help.

MR. McKIERNAN: Thank you.

CHAIR HYATT: Jay, I'll have a quick follow up to that. It sounds like the webinar itself is critically important for getting the Board members to be looking at things consistently, kind of being on the same page. I imagine that there has either been talk or consideration that really, for providing input, the webinars would be mandatory and flexible enough to allow for accommodating people's schedules?

DR. McNAMEE: Yes. I do think it is very important. I also know how kind of fluid people's schedules are. I'm an example of that today. Yes, I'll look to maybe Kirby or Sara to have thought through the logistics of that webinar a little bit. Maybe we'll record it, and then we can be available.

You know if somebody is not able to attend live, then we'll record it and they can watch the recording, and then follow up with one of us or all of us, to kind of answer their question directly. But hopefully folks, we can set it at a time that most folks can make it. But Sara or Kirby, if you wanted to weigh in on that and bail me out here.

MS. MURRAY: No, that is exactly what we were thinking, is to have a recording. Obviously, ideally, if everyone can get on there at the same time that is great, because then if you have a question, the whole group will benefit from hearing the answer to it. But so that everyone will get the same answers, we'll record it if someone is unable to make the webinar.

CHAIR HYATT: Toni, does anybody else have their hand raised?

MS. KERNS: I have no additional hands at this time.

CHAIR HYATT: Excellent, well thank you, Jay.

DR. McNAMEE: Thank you, Mr. Chair, just a quick shout out to Kirby and Sara, for that excellent presentation. They put that together. I just wanted to make sure they get credit.

CHAIR HYATT: Very good! Excellent, thank you.

PROGRESS REPORT ON THE 2021 STOCK ASSESSMENT UPDATE

CHAIR HYATT: Now we'll move on to agenda item on Progress Report on the 2021 Stock Assessment Update, and Katie Drew, take it away.

DR. KATIE DREW: The stock assessment is proceeding well. We were able to pull together all of the 2020 data that was available. We are missing a few data points, for example, some surveys did not occur, some of the sample size in terms of ages and lengths is not where it would be during a normal year, due to the effects of COVID and the various lockdowns.

However, we do have enough information to proceed with 2020 as the terminal year. We are in the process of finalizing model runs, and finalizing the assessment report for the SAS Review, before it goes to the TC, before it goes to the Board. We are on schedule to have the assessment update completed and presented to the Board at the October meeting. I am happy to take any questions people have about progress or data limitations.

MS. KERNS: I don't see any hands at this time.

CHAIR HYATT: No hands, okay. Very good, well very quick update, Katie. Thank you very much, and we look forward to hearing what comes out of this at the annual meeting. Thank you.

CONSIDER FISHERY MANAGEMENT PLAN REVIEW AND STATE COMPLIANCE FOR THE 2020 FISHING YEAR

CHAIR HYATT: Next on the agenda is Considering the Fishery Management Plan Review and State Compliance for the 2020 Fishing Year. Kirby.

MR. ROOTES-MURDY: I've got a presentation that Maya is going to click through for me. I just want to say good afternoon to the Board, and I'll be presenting on this Tautog FMP Review. On the screen is an overview of the sections of the report I'll be reviewing briefly, status of the FMP, status of the stock, status of the fishery, compliance requirements for 2020, tagging program implementation, and then I'll take any questions.

Tautog has been managed under Amendment 1 since its approval in October, 2017. Under the Amendment each region implemented measures to achieve the regional fishing mortality target, with at least a 50 percent probability. There were no changes to the commercial or recreational size limit or possession limit from 2019 to 2020.

In terms of notable changes though, from 2019 to 2020, was the implementation of the commercial harvest tagging program, and Massachusetts and Rhode Island exceeded their commercial quotas by 1 percent and 2.5 percent respectively. In terms of status of the stock, there hasn't been a change since the previous year.

Just as a reminder, as Jason mentioned in his presentation. We are managing tautog under four regions, so there is the Massachusetts/Rhode Island Region, you've heard of that as MARI, there is the Long Island Sound Region, there is the New Jersey/New York Bight Region, and then Delaware, Maryland and Virginia as DelMarVa Region. As Katie noted, we are in the middle of the stock assessment update, and hope to have that completed later this year and presented to the Board. Between 1981 and 2020, total commercial coastwide tautog harvest, so that is recreational and commercial combined, peaked at about 22.5 million pounds in 1986. Since then, harvest has significantly declined, starting before state restrictions were implemented. Since the tautog fishery management plan was approved in 1996, landings have averaged approximately 7.5 million pounds per year.

In 2020, commercial landings and recreational harvest both decreased compared to 2019. Commercial landings account for approximately 5 percent of total coastwide harvest in 2020. On a state level, commercial landings comprise no more than 10 percent of the state's total landings. New York had the most commercial landings of tautog in 2020, it makes up about 58 percent of the coastwide total, with Massachusetts landing the second greatest amount.

As many of you are aware, tautog is predominantly taken by the recreational fishery, about 95 percent on average by weight. Coastwide anglers harvested historic highs of over 20 million pounds of tautog both in 1986 and 1992. Since then, harvest has declined, fluctuating between about 3.4 million pounds in 2018, and 11.8 million pounds in 2014.

Harvest in 2020 is estimated about 6.2 million pounds. Note that to address reduced intercept sampling caused by the COVID-19 pandemic, the 2020 harvest estimates used imputed data from previous fishing years, and may be subject to change. On a coastwide level the contribution of imputed data to the total harvest of tautog in pounds was 10 percent, and ranged from 0 to 39 percent at the state level.

What we have on the screen. This figure shows, as we've seen in previous years, most of the recreational harvest occurs in the months of September and December, so something to keep in mind when looking at this data this year, when thinking about recreational harvest going into the 2021 fishing season.

For the commercial tagging program, all states with the exception of Connecticut and New York implemented the program in 2020. In terms of participants in the fishery, you know the commercial fishery on a whole coastwide is much smaller proportion, relative to recreational harvest, as mentioned.

But even between the states that implemented the tagging program last year, Massachusetts and Rhode Island have a significantly higher number of participants in their commercial fishery, compared to New Jersey through Virginia. I'm going to get into more of the feedback that was provided regarding the tagging program from the Technical Committee, and industry members who are on the AP.

There will also be a presentation by Jason Snellbaker, the Law Enforcement Committee representative, following the FMP Review. Moving on to one of the key parts of compliance requirements for this plan. There is a biological sampling requirement, where states are to collect 200 age and length samples.

Connecticut, New Jersey, Delaware and Virginia were unable to meet that 200-age sample requirement in 2020. Most of those states reported that the issue preventing them from getting to that number was the COVID-19 pandemic, both in terms of trying to get out and sample, as well as some of the restrictions that were in place. The PRT recommended that the Board consider that nearly all of these states work to try to achieve that sampling target, and in turn were endeavoring to meet the FMP requirement in that way, in spite of the pandemic. In terms of di minimis, the criteria for it are that state landings in the most recent year of data does not exceed 10,000 pounds or 1 percent of the regional commercial landings.

Both Maryland and Delaware request de minimis status as in previous years, and meet those criteria. Today for the Board's consideration would be to accept the 2020 Tautog Fishery Management Plan Review and state compliance reports, and approve de minimis status for Delaware and Maryland. With that I'll take any questions. Thank you.

CHAIR HYATT: Thank you, Kirby. We'll open the floor to questions for Kirby in a moment, and as you see we do have a motion ready to go. I think Justin Davis was going to make that motion. But there is one item from this report I would just like to bring up before we open the floor to questions.

On Page 10, under prioritized research needs, 8.4, Management, Law Enforcement and Socioeconomic Priorities. It lists collecting data to assess illegal harvest, and the efficiency of the tagging program. It lists it as a moderate priority. I think this is fine for the 2020 fishing year report.

However, going forward, particularly given the time and effort invested by various states in the tagging program. I believe going forward, this needs to be a high priority. Furthermore, I believe the Technical Committee should be tasked with exploring options to do this research in the coming year, or to look at options for doing this research in the coming year.

It kind of reminds me of some of the work I've been involved in, in years back, in the invasive species arena, where University researchers, extension officers, places like Sea Grant, were engaged to collect that on compliance and the pet trade and nursery industry. The idea being, to collect data before valuable law enforcement time is deployed. In essence so that the Law Enforcement can be more effective, efficient and targeted, and to determine whether or not it's even in fact needed.

I don't believe we need a motion here. I think just a reflection in the proceedings, that we would like the Technical Committee to make this a high priority, and to add this to their list of tasks for the next year. I think just including it in the proceedings would be sufficient. At this point, I'll open up the floor to any questions people might have for Kirby, and if anybody has any objections to the suggestion that I just made. Toni, do we see any hands?

MS. KERNS: Not yet, Bill.

MR. ROOTES-MURDY: Hey Bill, this is Kirby. Maybe just to the point you raised. You know the Technical Committee definitely could devote some time to considering this. What you talked about was the role that maybe other state agencies could play in trying to collect some of this information, in particular Sea Grant, you know as this could be possibly pursued as a study of some type. You know from a staff standpoint, I think there might be benefit in the Board considering whether they could ask or pursue that on a state-by-state basis, as they may be best suited to look into their fresh and live markets, regarding the illegal harvest, as opposed to a coastwide approach.

CHAIR HYATT: Absolutely, Kirby, and I think my intent is just to get it out of the moderate priority to the high priority, and put it on the agenda, or on the list of things for people to start considering. But your point about it being more not coastwide, but maybe targeted to those specific areas where needed is well taken. Toni, any hands?

MS. KERNS: You have Dan McKiernan.

CHAIR HYATT: Go ahead, Dan.

MR. McKIERNAN: I guess if you could elaborate a little bit. I'm trying to understand your vision of data collection. It seems to me that in order to inspect seafood or inspect a facility, you need some authority to do that in the seafood end, especially something like live tautog. You may have to get access to like the back rooms of where fish are being stored.

I understand sort of the volunteer compliance checks on some of the issues on invasive species, but I just am a little unclear as to how this would work, you know because in Massachusetts DMF can do an administrative inspection, but it's almost exclusively done by the environmental police. Can you elaborate on what your vision is about that data collection, and how it could be done by folks other than environmental police?

CHAIR HYATT: Sure, Dan. My vision was to get this to the point where some people are considering how to go about collecting some information on compliance, particularly within the marketplace, in advance of putting all of the pressure on law enforcement to go out and do it from the start.

The example I gave had to do with rules and regulations being passed relative to the nursery trade, and organizations, not NGOs and in some groups like Sea Grant being contracted, to go out and be able to collect, go into the businesses and collecting information on the level of compliance that they encountered, collect data, compile that data, and put it into a report. Similar things I'm aware of and have been involved in that were done in the pet trade.

Now whether or not those examples can be applied to the seafood industry, I don't know. I don't know what some of the constraints might be, and I don't know what some of the opportunities to get around those constraints might also be. My intent, again, was simply to get this idea, this concept, this need elevated and into the hands of people who might be better able than I to figure out ways in which it could be done. Does that answer your question at least somewhat?

MR. McKIERNAN: It does, and I'm wondering if we should ask the Law Enforcement Committee to maybe brainstorm on that, and maybe it's like the Agency biologists that could be keeping an eye on that in some of the live tanks or something. But anyway, yes, I think this is a good topic for the enforcement folks to weigh in on as to how to get, maybe this is not just specific to tautog. How to get better observations of compliance, other than just adding to the workload of the enforcement officers. We can move on.

CHAIR HYATT: Very good, Dan, anybody else have a hand up, Toni?

MS. KERNS: No.

CHAIR HYATT: Justin Davis, you were going to make this motion?

DR. JUSTIN DAVIS: Sure, Mr. Chairman. I would be happy to do that**. I move to accept the Fishery Management Plan Review for the 2020 fishing year, State Compliance Reports and de minimis requests from Delaware and Maryland.**

MS. KERNS: You've got a second by Roy Miller.

CHAIR HYATT: Excellent, so it's moved and seconded to accept the Fishery Management Plan Review for the 2020 fishing year, state compliance reports, de minimis requests from Delaware and Maryland. Is there any opposition to this motion? If so, please raise your hand.

MS. KERNS: I have no hands raised.

CHAIR HYATT: **Excellent, so motion passes unanimously, and we can move on to the last item on the agenda**.

REVIEW THE IMPLEMENTATION OF THE COMMERCIAL TAGGING PROGRAM

CHAIR HYATT: This is to Review the Implementation of the Commercial Tagging Program. We've got three reports, a Technical Committee Report, an Advisory Panel report by Kirby, and a Law Enforcement Committee report by Jason. With that, Kirby, why don't you take it away?

MR. ROOTES-MURDY: Thank you, Chair Hyatt, let me just give Maya a second to get this up on the screen. I'll note for folks, I'll be presenting on both the Technical Committee report and Industry feedback. Our TC Chair was unavailable to be on today's meeting. I'll pause in between both reports, to make sure if people have questions that they can ask them, and we can answer them as needed.

TECHNICAL COMMITTEE REPORT

MR. ROOTES-MURDY: The first is this Technical Committee report. Just in terms of background, the Technical Committee met in early July to provide feedback on the tagging program and its implementation. That report was included in briefing materials, so hopefully all the Board members have had the opportunity to review it.

The TC members were provided questions ahead of that meeting, and during the meeting they answered them, and we pretty much had that organized on a state-by-state breakdown of how implementation has gone. The TC also developed a set of recommendations for the Board's consideration today.

What I'm going to do is next go through those state summaries briefly. Starting from south and moving north we have Virginia. Overall implementation of the tagging program has gone well. It was noted that there were some initial challenges in distributing tags, due to the COVID-19 pandemic. One of the key things that came out was that they had encountered some issues with tag accounting errors by fishermen in federal fishing reports in SAFIS, most notably that the SAFIS report wasn't allowing for tag numbers to be inputted with landings information. That was a challenge that VMRC staff raised on our call, and it was something that will be touched on later in the recommendations.

But when it comes to harvest that is coming out of Virginia, this is primarily to sell to fresh markets and not live markets. There were no reported issues with mortality, per say. I will say that we did get an anecdotal report that one harvester was trying to tag the fish in the tail, due to issues with trying to tag it in the operculum.

Moving north to Maryland and Delaware, both states reported no issues with the implementation of the tagging program. Both states have a very small commercial fishery. In Maryland there was one participant, and in Delaware they found that given their small fishery, that they are in fact going to reduce the number of tags that they ordered for this year.

Similar to Virginia, because they are primarily providing fish to the fresh market and not live, they didn't report any issues with mortality. Moving on to New Jersey. They also reported that there were not significant issues encountered. New Jersey has a limited entry permit program, which will remain at about 62 permits, even as the number of active fishermen may change year to year.

New Jersey Division of Fish and Wildlife staff indicated that they had more than enough tags, and are looking to order a small amount for 2022. Many New Jersey fishermen requested tags, in fear of losing their permit, but did not use them. They didn't report any issues with applying tags to the fish.

From what the TC member relayed, the live markets were impacted by the COVID-19 restriction, which is definitely one of the market places fish in the state go to. Whereas, the fresh market didn't report any issues. Next moving up to New York. During this call we heard from two New York DEC staff members regarding a number of challenges that they have encountered with implementation of the tagging program this year in 2021.

Most notably they have preliminary 2021 data that shows the number of harvesters has doubled, and they expect to have an increase demand for tags for their fall season. Just so the Board is aware, there was an initial 170,000 tags purchased for the 2020 season. Those are being used this year, and so far, DEC staff has been notified that 20 percent of harvesters are requesting additional tags for this year.

They have received, DEC staff that is, over 100 participants reaching out with regards to the tagging program, and expressing concerns. Many of these are full time commercial harvesters, and they catch their limit, and that is primarily with the live market. Much of the concerns focused on the applicators and issues that they were having with trying to get the tags to adhere.

For example, fishermen were getting cuts on their hands, and one report was of a fisherman having to go to the hospital, due to the severity of the cut. Harvesters were also notably reporting that they were observing mortality on tagged fish upwards of 50 percent of those fish tagged. Some of the reasons that may be contributing to this higher mortality involved the challenges of trying to tag the fish while out on the water, as well as some observed increases in water temperature in the summer. Those things in combination may be contributing to this higher level of mortality.

There were also anecdotal reports that a few harvesters like, as noted in Virginia, that had come up with tagging the fish in other parts of the body, either the caudal fin, though we are not aware of that report being substantiated. As many of you are aware, New York has a substantial live market, and given the challenges indicated with the tagging mortality, there is a lot of frustration that was expressed.

Based on their experience, many of those harvesters are advocating for a different style of tag that could cause less damage to the fish, and DEC staff indicated that they would like that to be pursued, and potentially a Floy tag may be the best alternative, in their opinion, to the current tag right now.

That was the report from New York. Moving on to Connecticut. Similar to New York, their implementation was this year. They only had a few issues. Relative to neighboring states of Rhode Island and New York, they have a much smaller fishery. When it comes to the distribution of the tags, they for 2021 had ordered 6,000 tags. They've handed out 3,000 of them, and they are planning to order another thousand for the fall.

Outside of that they reported very low mortality associated with the tagging. Moving up to Rhode Island. As noted, there is a significant increase in participation in a few of these states, Rhode Island being one of them. They saw an increase from about 250 participants annually, up to 295. Much of this seemed to center around the concern of those not participating in the fishery this year being excluded in the future.

In turn, this is presenting some challenges for the state, in terms of developing their biological metric, which as a reminder for the Board, the biological metric takes into account recent landings information to come up with an average landings amount, as well as your participants, and trying to come up with an average fish size that helps inform what the number of tags that a state needs to request, to meet their commercial fishery needs.

In terms of mortality though, associated with tagging, they didn't indicate that there was any issues or significant issues that emerged. Last, in terms of the state updates. Massachusetts has indicated that their tagging program implementation has gone well. Massachusetts moved from an open access fishery to a limited entry one. Previously there had been in the ballpark of 2,000 participants, and now it's down to about 218 license holders.

There were some noted challenges, in terms of tag application, which in that there was a learning curve for a number of harvesters, and a number of them that were experiencing issues, were not using the manufacturer applicator that goes along with the tags, purchased from National Band and Tag Company. There were also a few complaints regarding mortality associated with tagging. It's important to note that much of the landings are sold to the live market that come out of Massachusetts. We'll move on to the Technical Committee recommendations. As noted, between New York and Virginia, there was a need to address the SAFIS reporting challenge. The request from the TC is that a new field be added that allows for the tag information to be included in that. I know that ACCSP staff has been notified of this, and I'm also aware that both of those states put in requests to have that field be added as well.

Another recommendation for the Board's consideration is potentially consider additional research and trials of tag types. The TC noted that if pursued, an evaluation of tags in a variety of settings on the fish, and whether they can be tampered with once applied should be prioritized. I will note, after I get through these recommendations, just a reminder of what the previous tag selection process was, what tags were considered, for the Board as a refresher.

Then our last few Technical Committee recommendations. There was a request to consult with the Law Enforcement Committee on the enforceability of tag placement, given these anecdotal reports about tags being applied to the tail. The TC indicated that the LEC should confirm whether they've encountered any issues with tags being applied to the fish outside of the operculum, which is what the intended location is for the tags that were selected.

TC members also noted that in terms of participants for reporting out at the end of the year and state compliance reports. Only those participants that have been issued tags should be noted. There was a distinction, at least for a couple of states in their state compliance reports, as including additionally active participants, so not just those that were issued tags, but those that had landings.

While that information is helpful, in terms of how it's evaluated across states. It's important to define it as participants that were issued tags. Then in terms of 2020 fishing year information, it was noted by the TC that this year may present challenges for trying to develop biological metrics off of it, given the complications from the COVID-19 pandemic, in terms of participation and market dynamics. This may present some challenges for states, in trying to get an effective number of tags that they need for their fishery for the 2022 fishing season.

As mentioned, I thought it would be helpful, given some of the feedback from the TC on how the tags that are being used currently were selected. The timeline, going back and looking at previous files, was in October of 2015, Law Enforcement Committee Subcommittee convened to respond to public comment that was raised during, I believe it was scoping for Amendment 1 regarding illegal harvest.

In January of 2016, that subcommittee outlined objectives for what could be a commercial harvest tagging program, as well as potential tag vendors in tagging trials. Between those meetings that subcommittee outlined some key objectives that would need to be part of this tagging program, to address the potential illegal harvest that is occurring.

By May of 2016, that subcommittee had selected three tag types to test. First was a button tag, second is a strap tag, which is the current tag that the states are using, and the third was a Rototag. I'll note that Floy tags were considered, but not selected for testing. My understanding in looking at previous materials, was concerns raised about it effecting the meat, as well as that the tag type may be easily tampered with. The other important note is that both New York and Massachusetts conducted tag trials. My understanding is we have a report that I've reviewed of the New York tag trial, where they used a strap tag and recommended it. In terms of visual aids, which I think can sometimes be helpful, these were the tags that were kind of recommended for consideration by the Law Enforcement Committee.

You had the button tag here, the letter associated with this picture was from an LEC report from a number of years ago that was included in briefing materials when the Board was updated on that in 2016. The second tag is the strap tag, which is what we are currently using. The Subcommittee felt that this was the best option, as far as size and Law Enforcement attempted to adjust for tamper with the tag once it was applied, and they were not successful.

I think that inability to tamper with the tag was one of the key attributes for it being selected. Then the third kind of top choice the Subcommittee had looked at, was the Rototag. In terms of that timeline, continuing on, in summer of 2016 New York conducted that tagging trial. It was conducted in conjunction with Stonybrook University and New York DEC staff.

As I said, three tags were identified to be tested. The Research Team indicated that a National Band and Tag strap tag, which is what is currently in place, was the most appropriate. The report was completed in December, and I know it was presented to the Board in February of 2017. As noted, Massachusetts DMF staff also conducted a similar tagging trial, based off of the results from New York. With that information I'll take any questions.

CHAIR HYATT: Kirby, I'm just thinking we might want to, well questions now, but before any discussion we'll want to go through all three of these reports. Are there any questions for Kirby?

MS. KERNS: You have Adam Nowalsky, Dan McKiernan, and John Clark.

CHAIR HYATT: Hey Adam, go ahead.

MR. ADAM NOWALSKY: Assuming that certainly with COVID it limited the ability for states to do in-person work. But moving forward, did the Technical Committee talk about maybe doing some workshops or something in the states that exhibited difficulty, to help the anglers overcome the tagging problems?

We've got studies that we've done that indicated that the tag that was selected was the most appropriate. We've got the majority of the states that suggested that they had a pretty high success ratio. It would seem that perhaps if one or more states is having some specific problems, maybe rather than investing Board resources and trying to go through a new selection process, maybe there is just some work that can be done to help the fishing community directly.

MR. ROOTES-MURDY: Yes, thanks Adam for the question. You know during the TC call, they didn't go into much detail on workshops, per say. I will note that there have been educational materials, including videos that a number of states have made available to their commercial harvesters. Dan can correct me if I'm wrong on this, but I believe Massachusetts DMF did put together a video to kind of outline some best practices on applying tags.

MR. McKIERNAN: Yes, that is right Kirby, and we can share that.

MR. ROOTES-MURDY: Great, thanks.

CHAIR HYATT: Dan, I think you were up next.

MR. McKIERNAN: I have a few questions. Kirby, you had mentioned the New York experience was challenging, because fish were being tagged while on the water. In Massachusetts we allow the commercial fishermen to tag at the pier. I mean on the vessel, but before the fish is unloaded.

I don't know if New York has a different standard, or maybe they are out on a small boat that is rocking and rolling, and making the affixing of the tag kind of a dangerous process to one's hand, because it is a little tricky if you're not used to it. Are there some clarifications of what New York's requirements are for when the fish need to be tagged?

CHAIR HYATT: If there is somebody from New York, Maureen, or somebody else who might want to try to answer that.

MS. MAUREEN DAVIDSON: Hi, thanks, Bill. From what I understand, a lot of it does have to do with trying to tag the fish in rough water. I think for some of the fishermen, they would prefer to tag the fish as they come up, as opposed to putting them in the live well, and then having to tag them when they get back to dock, take them out of the live well and tag them at that time. I think they are trying to reduce handling on the fish. A lot of them are trying to tag at sea.

MR. McKIERNAN: Okay, as far as the SAFIS field for tag numbers. I know that any time that I've worked with my staff in our statistics program, who work with the ACCSP team. If I'm asking for anything novel in SAFIS, it's a really tough sell, in terms of adding new fields. I'm just curious if that is actually going to be embraced.

Because it seemed like a lot of data collection. In Massachusetts we have a 40 fish limit, so we would have to have 40 tags transcribed. I don't know, I hadn't anticipated that kind of administrative burden for the fishermen, or for the ACCSP to maintain. Is any thought being given to that?

CHAIR HYATT: Kirby, can you take a stab at that? I had kind of, given my level of knowledge, had assumed that the SAFIS tag field thing was well on its way to being done.

MR. ROOTES-MURDY: This was, as I mentioned, brought up during the TC call, and both states had reached out to SAFIS regarding making this change. I've had some preliminary, just conversations with ACCSP staff on it. I think to your point, Dan, I guess more consideration of this data collection will be needed, in terms of administrative challenges with it. Something I think we could look into, try to provide a little bit more clarity on, if this is to be included in future commercial fishing seasons, you know what it would look like, and what that input field would require staff to do.

MR. McKIERNAN: It is kind of intriguing, given the striped bass tagging that goes on among the states, to follow those fish. I'm not opposed to it.

CHAIR HYATT: The one thing I will add, at least reading from the TC recommendations, is the Technical Committee wants the SAFIS tag field available, but not mandatory. I don't know, Dan, if that makes a difference to you.

MR. McKIERNAN: Yes, that would. Then my last comment has to do with, I will remind the Board that the tag that we ultimately adopted was a slightly larger version of the tag that I think that was tested in the initial trials by the state of New York. We came up with the slightly larger tag, because we needed to inscribe more information onto the tag, to identify the state of origin, the year, and the sequential number. I don't know if that size tag is causing the issue or not, so I'll just raise that and I'll end my questions. Thank you.

CHAIR HYATT: Thank you, Dan. John Clark, I believe you are next.

MR. CLARK: I was just curious, Kirby, we didn't provide applicators to our fishermen, since our limit is only 4 tautog a day. We told them how to get the applicators, but I've seen in the presentation, and also in the report that there are fishermen that decided not to buy the applicator, and tried to apply the tag, which I thought it was almost impossible to do this tag without the applicator. But I was just curious whether you knew whether this was a problem in other states, of people using these tags without the applicator.

MR. ROOTES-MURDY: As I've said, I've got some anecdotal reports from both TC members and industry members, who I reached out to, that I'll go over in my next presentation that they have tried. That they at least attempted to do that, with pliers for example. I think a number of them, when they found that less successful, went ahead and purchased the manufacturer's applicator.

MS. KERNS: Bill, you have Pat Geer.

CHAIR HYATT: Pat, go ahead.

MR. PAT GEER: Kirby, I just want to clarify your slide that you had on Virginia. We did have at least one live harvester that claims he had mortality when he was trying to tag in the operculum, and that is why he was putting the tags in the tail. But we did have at least one live harvester.

MR. ROOTES-MURDY: Gotcha, thanks for that clarification of that.

ADVISORY PANEL REPORT

CHAIR HYATT: Very good, Kirby, are you ready to go into the AP Report?

MR. ROOTES-MURDY: Yes, we'll move on. I'll get into it a little bit more detail, but we have labeled this as an industry report, Maya can you go to the next slide, I'll explain why. Staff reached out to the Advisory Panel via e-mail, and they were polled to schedule a call in June. We had, not at a great response rate, about four or five AP members who responded to that doodle poll, and so off of that we scheduled a call. We only had one participant on that call, and they ended up providing no comment. Given that, staff reached out to the Advisory Panel again via e-mail, with just a set of questions for the AP members to answer. Written responses would be great. We got pretty poor response rate from that effort, so after that I reached out by phone to pretty much all of the AP members. I called them all up to try to get additional feedback.

What the report that was included in supplemental materials has, is feedback from four AP members, but it is important to note that their views are not representative of the group as a whole. Given that the challenge we ran into trying to get feedback from the AP, states should consider whether to change their current Advisory Panel membership in light of that.

Next are the questions that I posed to AP members, and some of the feedback from the four. First was, how has the commercial harvest tagging program gone so far? We would say this was mixed reviews. One AP member expressed frustration with when the commercial fishing season occurs in Virginia.

Of the four, a number of them raised concerns about the learning curve in trying to apply the tag, as well as some mortality that they encountered, and that mortality when tagging the fish, effected their ability to sell it to the live market. Next question was, any change in the number of commercial harvesters due to implementation?

Some industry members noted that states had seen an increase in their participation in the fishery, due to their concerns of being excluded. As noted, Massachusetts has moved to a limited entry fishery, reducing their participants. In terms of whether there were enough tags in Advisory Panel member's state. Generally, most indicated that there was. Some states either ordered more tags or distributed more later in the season, to address the rising demand.

One AP member from New Jersey indicated that the number of tags was for them a limiting factor in their landings. They indicated that they could go through many more than they were allocated, and if they were given more, they could land more fish. In terms of challenges with applying the tags, three out of the four AP members indicated there were, mostly in terms of trying to apply the tags at sea. They noted that doing so is time consuming, and that it could require additional deck hands or staff onboard to help.

Then as noted, again, there were anecdotal reports of people applying tags either in different parts of the fish, or in one instance of commercial harvester having the tag applied at a fish house after leaving the vessel. In terms of any changes in the market price compared to previous years, a number of the AP members noted that the COVID-19 pandemic definitely presented challenges to selling to the live markets. It was not a normal year in any way, with restaurants closing in many parts of the country.

In that way it is a little tough to compare this new tagging program, the impact of the tags on either price to previous years, given that confounding element. One AP member noted that dealers offered lower prices, possibly in part to many of those restaurants being closed, as mentioned, and one AP member noted competition for other live invasive species, which may have also been contributing to a lower price per pound. Then I just have two more slides. In terms of whether the tagging program has reduced or will reduce illegal harvest. Generally, the AP members indicated that illegal harvest has continued and will do so in the future, so long as there is enough of an incentive, when it comes to illegal harvest and selling to markets, so long as those markets and restaurants are willing to receive this fish. Then those individuals will continue to work outside of the legal permitted system.

They also indicated the need for more law enforcement to be on the water and in market places. In terms of any recommendations or considerations for managers, the AP member from Virginia indicated that VMRC staff should continue to engage with commercial harvesters. The AP member from Delaware was supportive of moving to an individual quota for commercial harvesters.

The AP member from Massachusetts questioned whether managers thought the program was worth the additional work. They also pointed out that mortality from tagging has affected the harvester's revenue, and that that has presented some challenges. With that I'll take any questions based off of the feedback we received from industry members.

CHAIR HYATT: Any questions for Kirby on this AP/Industry Report? Toni, any hands?

MS. KERNS: No hands.

LAW ENFORCEMENT REPORT

CHAIR HYATT: Okay, then we're going to move right on to Jason's Law Enforcement Report. Go ahead, Jason.

MR. JASON SNELLBAKER: Good afternoon to the Board and Mr. Chairman. Do we have my slides up there?

MR. ROOTES-MURDY: I'll just give Maya a minute to get them up. There you go.

MR. SNELLBAKER: Just going to provide a quick background. I'm probably going to have some duplicity here from what you've already heard. Then we'll go through the questions posed, and feedback from the Law Enforcement Committee members. October '18 saw the implementation of the tagging program was postponed until January 1st of 2020.

In the fall of 2019, all of our states received orders. By December of 2019 implementation was expected for many states starting January of 2020. Of course, as you know the COVID-19 pandemic occurred. Maryland, Rhode Island, New Jersey, Virginia all implemented the tagging program. New York and Connecticut decided to postpone implementation until 2021.

As of 2021, all states have implemented the tagging program. To the questions, how has the commercial harvest tagging program gone so far? Law Enforcement Committee replied generally successful. Some initial issues with the distribution of tags due to COVID-19 pandemic, but those issues have been addressed.

Some issues with the application of the tags, fish getting damaged in storage, and a higher mortality rate due to warmer water during some state's respective open seasons. Does your state have regulations in place? A majority of the states put regulations in place in 2020. It's also noted New Jersey did not have official regulations in place, which has presented challenges for the enforcement of the tagging program. Any change in the number of commercial tautog commercial harvesters following the implementation of the tagging program?

Yes, for a few states. Massachusetts went to a limited entry fishery from over 2,000 down to approximately 200. Also noted that 2021 is the first year for New York, and there is the chance that the number of active harvesters may increase during the fall fishery. Were there enough tags in your state in 2020? Yes, for most states.

A few states, Massachusetts, Rhode Island had to order additional tags. Challenges with applying the tags. Most indicated there wasn't significant issues with applying the tags. Some LEC members did note that there were challenges initially. Feedback as to why there were challenges included not using the recommended applicator.

Do you think the tagging program has reduced or will eventually reduce the illegal harvest sold into commercial markets? Generally, the LEC members indicated that the tagging program should reduce illegal harvest. The tagging program is in an early stage, it may take time to assess whether the illegal harvest has been reduced, and if so by how much.

What was the level of enforcement for monitoring of commercial harvesters and live fish markets for those states that have them? Generally, the Law Enforcement Committee indicated that there has not been additional patrols and monitoring with the implementation of the tagging program. One LEC member noted the issue that due to the COVID-19 pandemic, that staff capacity to monitor some of these markets was reduced.

Any recommendations or considerations for managers in continuing the tagging program? One LEC member indicated some state regulatory language leaves too much ambiguity on when fish need to be tagged, either prior to offloading from the vessel, or at the time of harvest. One Law Enforcement Committee member indicated that a different style of tag or tagging location may be helpful for fishermen. That is all I have, are there any questions?

CHAIR HYATT: Any questions for Jason?

MS. KERNS: I see no hands.

CHAIR HYATT: Okay, very good, then we're going to go into a little bit of discussion on this, but cognizant of the time, it's 2:47, we're supposed to be done at three o'clock. Maureen, you had sent me an e-mail during the course of the meeting saying that you were looking to make a motion relative to the recommendations having to do with the tagging program.

I'm going to ask you to hold that, and I'm going to suggest what at least I see as sort of a logical course of action from here, given what was provided in the pre meeting materials, and given what we've had for discussion so far. New York and Massachusetts are the two states that I'm aware of, with significant live fish markets. Based upon their experiences that they've had to date with the tagging program, they are quite divergent. New York has a disadvantage of this being their first year in the program. In the course of our discussion there were some potentially clear differences between how the Mass regulations and the practices in the Mass program versus the New York program have evolved. I'm thinking particularly about Dan's comment that Massachusetts allows for the fishermen to tag the fish at the pier, they don't have to do it at the time of capture out in rough conditions.

I'm also remembering comments made about certain aspects of training that were provided to attempt to avoid some of the mortality issues that might otherwise come up. I think that was provided by Mass. What I would ask here is that looking at the Technical Committee recommendations, relative to tagging.

One of them was to review the analysis that led up to the tagging program that is currently in place. I think Kirby did an excellent job of outlining all of that work that took place before I was ever engaged with the Commission. Then secondly, they suggested reviewing the challenges that have been reported by some portions of the fishery, specifically New York, and the potential need to evaluate alternative tags.

What I'm suggesting is, given what has come forth in the discussion today, New York and Massachusetts might collaborate a little bit, and look at this program, look at some of the experiences in Mass, and how they might be able to inform things in New York, and do that between now and the annual meeting.

Then reconsider this question, and maybe reconsider the potential need to look at a different tag types at that time, but to take no further action at this time, other than to recognize in the proceedings that New York and Massachusetts will be communicating on this issue. How does that sit with folks?

MS. KERNS: You have Dan McKiernan.

CHAIR HYATT: Dan.

MR. McKIERNAN: Yes, I would invite Rhode Island into that discussion as well, because they have a comparable quota to ours. I would also like to put on the record that Massachusetts did not make a video last year, because Rhode Island's was so good that we sent our fishermen to their website. I would definitely be interested in having that conversation, but I hope my Rhode Island counterparts would participate, because I think they also have a lot of experience with this program as well, and could be helpful.

CHAIR HYATT: Very good, Dan. I'll put you on the spot, Maureen. Are you comfortable with proceeding in that manner between now and the annual meeting?

MS. DAVIDSON: Okay, yes. We can proceed on that matter. Probably at that time we'll be in the thick of our fall/winter tautog season, and probably be able to collect more information from our commercial fishermen. But we really want to make sure that we ensure the cooperation of our fishermen, by trying to address their questions, and the needs and the issues that they are bringing us concerning tagging their tautog, especially those for the live market. At the December meeting, I hope that if we need to, we would be able to bring this again before the Board.

CHAIR HYATT: Very good, thank you, Maureen. Is there any further discussion on this topic that anybody feels needs to be had?

MR. ROOTES-MURDY: Bill, just to clarify what Maureen was saying. From a planning standpoint, as we noted earlier in this Board meeting, we'll likely have a Tautog Management Board meeting at the annual meeting in October. We don't have any meeting scheduled for December, so just want to make sure that was clear. Maybe I misheard something.

CHAIR HYATT: Yes, and I don't know whether I misspoke or elsewhere, but I wasn't implying that these conversations should take place between now and the annual meeting. Thank you, Kirby. Any further discussion on this topic? Toni, any hands?

MS. KERNS: You have Dan.

CHAIR HYATT: Dan, go ahead.

MR. McKIERNAN: Yes, to Maureen, and maybe Kirby you're going to organize this. It would be helpful to get a collection of the actual regulations that have been codified by the various jurisdictions, especially those in the conversation, so that we can take a look at that. Also, to get a better understanding of the seasonality of the fishery.

Maureen just mentioned that there is a strong fall fishery, and that is exactly when our fishery takes place. Our fishery goes September 1st until the quota is filled, which typically takes two months. It would be useful to understand the seasonality of New York's fishery as well.

MR. ROOTES-MURDY: We can pull that information together.

CHAIR HYATT: Very good. Anything else on this issue?

MS. KERNS: No additional hands.

OTHER BUSINESS/ADJOURNMENT

CHAIR HYATT: Excellent, so seeing none we'll move to the last item on the agenda, and that is other business. Is there any other business to bring before the Board? Toni, any hands?

MS. KERNS: No hands.

CHAIR HYATT: Seeing none, we are adjourned. Thank you everybody.

(Whereupon the meeting adjourned on Tuesday August 3, 2021 at 3:00 p.m.)

Atlantic States Marine Fisheries Commission

Tautog Regional Stock Assessment Update 2021

Vision: Sustainably Managing Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission

Tautog Regional Stock Assessment Update

Prepared by the
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EXECUTIVE SUMMARY

This stock assessment is an update to the existing benchmark assessment for tautog (ASMFC 2015, ASMFC 2016); the previous assessment update was completed in 2017 (ASMFC 2017). This assessment updates the accepted statistical catch-at-age model for each region with commercial and recreational fishery catch data and indices of relative abundance from fishery-independent and fishery-dependent data sources through the terminal year of 2020.

Stock status in 2020 varied by region but was generally improved from the 2016 update. In the Massachusetts-Rhode Island (MARI) region, the Long Island Sound (LIS) region, and the Delaware-Maryland-Virginia (DMV) region, the stock was not overfished and overfishing was not occurring. In the New Jersey-New York Bight (NJ-NYB) region, overfishing was not occurring, but the stock was overfished, although spawning stock biomass (SSB) had increased since the previous update and was just below the SSB threshold.

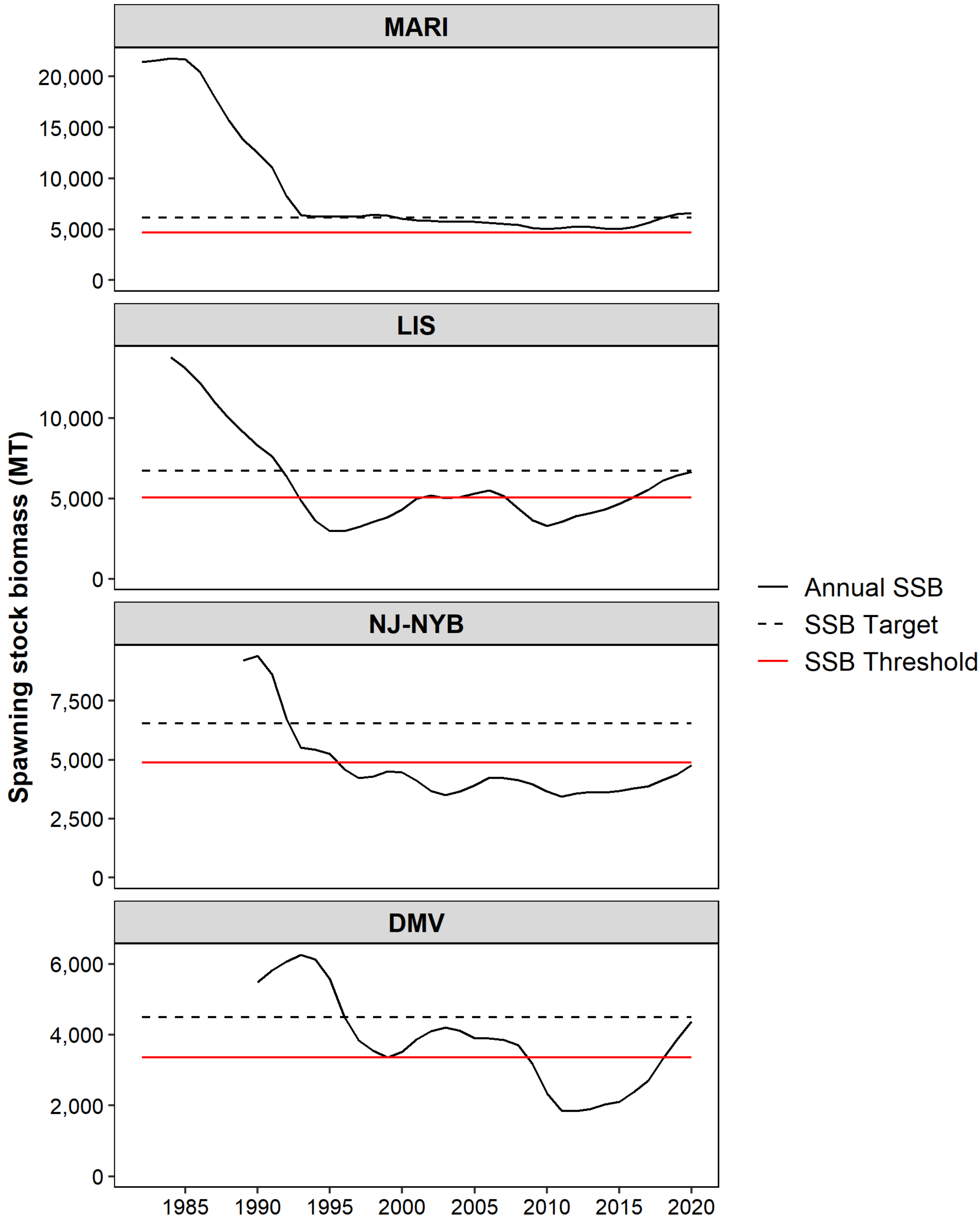
Spawning Stock Biomass				
Region	Target	Threshold	2020	Status
MARI	4,578 mt	3,434 mt	6,579 mt	Not overfished
LIS	6,725 mt	5,044 mt	6,665 mt	Not overfished
NJ-NYB	6,552 mt	4,890 mt	4,782 mt	Overfished
DMV	4,488 mt	3,355 mt	4,382 mt	Not overfished

Fishing Mortality				
Region	Target	Threshold	2020	Status
MARI	0.28	0.49	0.23	Not overfishing
LIS	0.26	0.38	0.30	Not overfishing
NJ-NYB	0.19	0.30	0.26	Not overfishing
DMV	0.17	0.27	0.06	Not overfishing

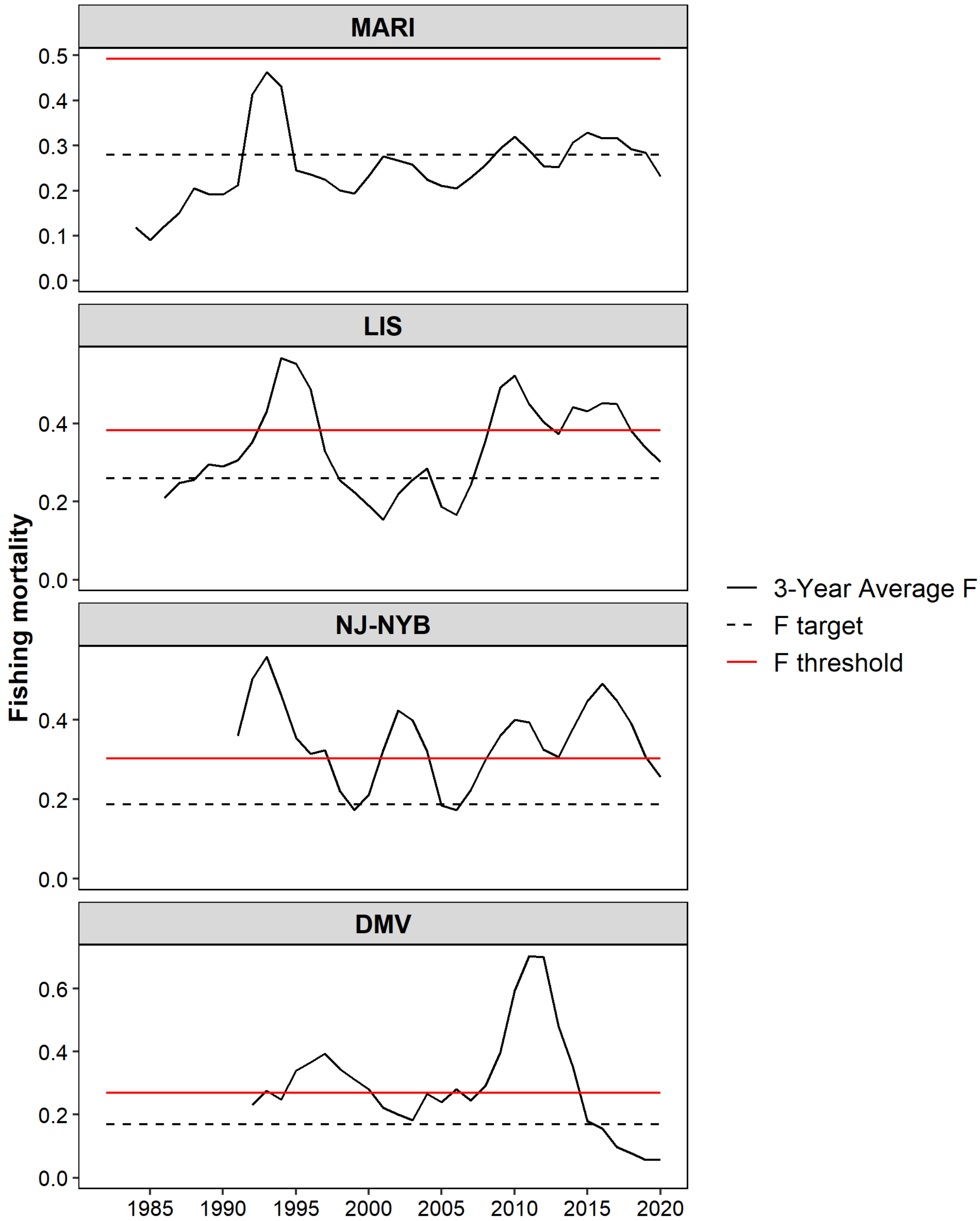
This update included the new time-series of calibrated recreational data from the Marine Recreational Information Program (MRIP). For all regions, the calibrated MRIP estimates of recreational removals was higher across the entire time series than the uncalibrated estimates. For the MARI region, the calibrated estimates averaged 163% higher than the uncalibrated estimates over the time series. For the LIS region, the calibrated estimates averaged 143% higher than the uncalibrated estimates over the time series. For the NJ-NYB region, the calibrated estimates averaged 133% higher than the uncalibrated estimates over the entire time series. For the DMV region, the calibrated estimates averaged 138% higher than the uncalibrated estimates over the entire time series. Like many species, the differences were greater in more recent years. However, for tautog, all regions also saw significantly higher estimates of calibrated catch early in the time series.

The new MRIP estimates resulted in higher estimates of SSB and recruitment in all regions, but had less of an impact on fishing mortality (*F*). Stock status has changed in 3 of the 4 regions since the last assessment update: LIS and DMV are no longer overfished or experiencing overfishing, and NJ-NYB is still overfished but not experiencing overfishing. This appears to be related to reductions in *F* and increases in SSB in the most recent few years, as opposed to an artifact of the new MRIP numbers. Regional stock status in 2015 was the same in the 2021 update as it was in the 2016 update.

All regions showed retrospective patterns in *F* and SSB, with MARI, LIS, and NJ-NYB overestimating *F* and underestimating SSB, while the pattern was reversed in the DMV region. The terminal year values of *F* and SSB were still within the confidence intervals of the model estimates and stock status did not change if the retrospective bias was corrected for, so a retrospective adjustment was not performed. However, the SAS highlighted this as a source of uncertainty in the assessment and recommended that this issue be addressed during the next benchmark.



Spawning stock biomass plotted with the SSB target and threshold by region for the 2021 tautog assessment update.



Three-year average fishing mortality rate plotted with the *F* target and threshold by region for the 2021 tautog assessment update.

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Tautog Stock Assessment Update
MASSACHUSETTS-RHODE ISLAND REGION
2021

Executive Summary

A catch-at-age model was used to estimate population size and fishing mortality rates during 1982-2020 for the Massachusetts-Rhode Island (MARI) management area. This model did not make structural changes or modifications to the estimation process relative to the 2015 benchmark. In general the only modification was the additional years of data, although historical catch-at-age and removals were updated using newly calibrated MRIP data. Biological reference points for the population were calculated using spawning potential ratio (SPR)-based methods. The comparison of the most recent three year averaged (2018-2020) fishing mortality rate (0.23) to the fishing mortality threshold reference point of 0.49 indicated that the MARI population was not experiencing overfishing. The 2020 spawning stock biomass (6,568 mt) was estimated to be above the spawning stock biomass threshold reference point of 4,335 mt, indicating that the population was not overfished. Model diagnostics indicated some residual patterns, especially in age composition data, as well as moderate retrospective trends. However, these patterns were not deemed substantial enough to compromise use of the model results for management purposes.

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 for commercial and recreational removals was extended from the previous assessment update (ASMFC 2017) through 2020, along with the associated age compositions from both sources. Total commercial landings in weight (mt) from 1982-2020 were retrieved from the ACCSP. Total recreational landings (weight) and releases for the same years were retrieved by querying MRIP estimates. Commercial and recreational harvest data were simply converted from landed pounds to mt for use in the model. Recreational releases (i.e., B2 catch) presented more of a challenge because these estimates are only available in numbers. Total estimated releases were converted to estimated releases-at-length using a combination of American Littoral Society (ALS) volunteer angler discard length data and MRIP headboat discard data (i.e., Type 9). Length frequencies were converted to age frequencies using annual age-length keys, which were developed using data from biological sampling programs. Finally, estimated discarded age frequencies were converted to total weight using observed weight-at-age matrices from biological sampling programs; age-specific totals were summed to derive the total estimated annual discards in weight. These totals were multiplied by the assumed discard mortality rate of 2.5% to derive an estimate for dead discards.

Commercial and recreational catch proportions-at-age depended on the observed size frequency distributions and annual age-length keys, which were calculated using data from biological sampling. Observed recreational landings size composition (Type A) were taken from the MRIP size frequency data. Both unobserved recreational landings (Type B1) and commercial landings were assumed to share the same size composition as the Type A data (commercial size regulations are currently consistent with the recreational limit).

This assessment update used the newly calibrated estimates of recreational removals from MRIP. The calibrated estimates of recreational removals (harvest and dead releases) were consistently higher across the entire time series, averaging about 163% higher than the uncalibrated estimates (Figure 1).

The tautog fishery in the MARI region is predominantly recreational (Table 1, Figure 2). Recreational removals comprised 97% of total removals by weight in the region in 1982 with an average of 91.8% for the time series. Total recreational removals were high but variable at the beginning of the time series, averaging about 1.5 million fish from 1982–1992. Recreational removals declined significantly after that, averaging about 425,000 fish from 1993–2013. Recreational removals from 2018–2020, after the implementation of Amendment 1 to the Tautog FMP, have averaged about 521,000 fish.

Commercial landings showed a similar trend, averaging 221 mt from 1982–1993 before declining rapidly to lower but relatively stable numbers through 2020 (Table 1, Figure 2). Commercial landings averaged 59 mt from 1994–2017, and 52 mt from 2018–2020, under Amendment 1.

The calibrated MRIP length frequencies, together with annual age-length keys developed from biological sampling programs, were used to calculate the age composition of the recreational harvest and used as a proxy for the age composition of the commercial harvest. Data from the MRIP at-sea headboat observer program and the ALS volunteer tagging program were used to calculate the age composition of the recreational release mortality. Ages 4-7 made up the majority of the total removals over the time series (each over 10%; MARI Appendix 1).

The Tautog TC developed a fishery dependent catch-per-unit-effort index of abundance from MRIP recreational survey data, using the same “logical species guilds” from the benchmark assessment to identify tautog trips for the effort component. Only non-imputed intercepts were used to calculate average catch rate – and thus the index – for 2020. The MRIP CPUE index was high and somewhat variable at the beginning of the series before declining through the mid-1990s to lower stable levels throughout the 2000s (Figure 3). 2019 and 2020 showed an uptick in the index.

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.

The set of fishery-independent indices available in the MARI region consists of the Massachusetts Trawl Survey, the Rhode Island Trawl Survey, and the Rhode Island Seine Survey (Table 2, Figure 3). Age composition information was available for the MA and RI trawl surveys and is shown in Appendix 1. For all indices, statistical model-based standardization of the survey data using generalized linear models was conducted to account for factors that affect tautog catchability.

The MA coastal trawl survey is typically performed in the spring and autumn utilizing a stratified random design. Only the results of the spring survey were used for this assessment. The survey was not conducted in 2020 due to COVID-19 restrictions. The index peaked at the beginning of the time series and was highest in the late 1980s; it declined through the 1990s and remains at low, stable levels (Figure 3).

The RI trawl survey has two components, a seasonal survey with a random stratified design which began in 1979, and a monthly fixed station survey which began in 1990 that is conducted monthly throughout the year. For the tautog stock assessment only the fall segment of the RI trawl survey was used, consistent with the benchmark assessment. The RI trawl survey was conducted as usual in 2020. Like the MADMF trawl survey, the RI trawl survey peaked in the mid- to late 1980s and then declined. There was a small increase in the early 2000s, but the index declined again after that and remains low and stable (Figure 3).

The RI seine survey has operated from 1986 to the present, with a consistent standardized methodology starting in 1988. It is a fixed site survey that takes place throughout the extent of Narragansett Bay Rhode Island. The survey was conducted as usual in 2020. The index was highest during the early 2000s and the late 1980s, and in recent years has been increasing since 2010 with a peak of 13.75 fish/seine in 2019 (Figure 3).

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.

There were no significant changes to life history information or model structure from the benchmark stock assessment (Table 3).

The update uses data from 1982 – 2020. Natural mortality was fixed at 0.16 across all ages and years, maturity in each year was set at 0 for age 1 and age 2, 0.8 for age 3 and all fish age 4 and older were considered fully mature. All fish aged 12 and greater were grouped together for the assessment (i.e., these fish were represented in the plus group). Release mortality for all age classes in all years remained at 2.5%. Annual weight-at-age was the average weight for each age class, weighted by the abundance-at-size within each age class – in other words changes in size-at-age would be reflected in the annual average weight-at-age matrix.

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.

The ASAP (Age Structured Assessment Program) model from the NOAA Fisheries Toolbox was used to estimate population fishing mortality, abundance, recruitment trends and other parameters and states. The primary model used in this assessment was an update of the 2015 benchmark assessment that used data through 2020; the major difference was the use of recalibrated MRIP data. A bridge model was produced for comparison using the newly calibrated data but with a terminal year of 2015 to align with the terminal year of the 2016 update. Further sensitivity runs included (1) exclusion of MA trawl survey; (2) exclusion of RI trawl survey; (3) exclusion of RI seine survey; (4) exclusion of MRIP index; (5) alternate MRIP index using imputed 2020 data; and (6) survey CVs unadjusted for optimizing diagnostic root mean standard errors (RMSE). Retrospective runs (seven peels) were produced for the base model to address coherence in annual estimates.

The stock assessment model was able to successfully estimate fishing mortality and spawning stock biomass for the MARI tautog population through 2020. The final maximum gradient, a measure indicating the stability of the model that should be close to zero, was 0.00086. There were residual patterns evident in diagnostic plots, especially for age compositions associated with abundance indices as well as catch (see MARI Appendix 1); however, these patterns were not deemed substantial enough to compromise use of the model results for management purposes. The model estimates tracked the general pattern of observations in the MA and RI trawl surveys as well as the MRIP CPUE annual indices, but did not closely follow observations for the RI seine survey.

A bridge model was run to isolate the impact on the assessment estimates of updating MRIP removals using calibrated data from the effect of adding additional years of data. The bridge run did not make any additional adjustments to the model structure; the new MRIP AB1 landed weight and B2 numbers converted to dead discard weight as well as updated catch-at-age proportions were inserted into the model files in place of the catch-at-age and landings that were used in the 2016 update assessment. The new MRIP estimates approximately doubled estimates of SSB and recruitment (Figure 4 and Figure 5). The update assessment did not change the overall scale of fishing mortality (Figure 6) because the model estimated a larger population size to account for the larger removals. The calibrated MRIP data did result in a spike in fishing mortality during 1992 that was not consistent with the 2016 update. In addition, the final *F* estimate for 2015 was approximately double that estimated during the 2016 update, but adding 2016-2020 data lowered the estimate of *F* for 2015. This was consistent with the retrospective pattern noted for the base run of the current update.

Retrospective errors were evident for *F* (Mohn's rho = 0.37), SSB (Mohn's rho = -0.10) and recruitment (Mohn's rho = -0.16). Fishing mortality estimates tended to be overestimated relative to the terminal year run and be revised down with additional years of data (Figure 7) while SSB estimates (Figure 8) tended to be underestimated and revised up with additional years of data. Recruitment revisions (Figure 9) were mixed. The retrospective bias was still within the confidence intervals of the terminal year estimates of *F* and SSB, so a retrospective adjustment was not conducted (MARI Appendix 2 Figure A2.1). The source of retrospective patterns was unknown. Retrospective runs on sensitivity analyses did not indicate that tension among survey indices was a source of retrospective patterns.

There were no obvious trends in fishing mortality over the time series – in general it ranged between 0.07 and 0.37, save for a spike to 0.77 during 1992 (Table 4, Figure 10). Estimated spawning stock biomass (Figure 10) generally reflected the trend in removals (Figure 2) and in the MA and RI trawl indices and MRIP CPUE index (Figure 3) with the highest estimates occurring early in the time series during the 1980s followed by a substantial decline to lower levels where the stock has generally remained since the early 1990s (Table 4, Figure 10). The estimates suggest a small increase in spawner biomass since 2016. The model estimated recruitment has remained generally stable throughout the time series (Table 4, Figure 5), without the dramatic fluctuations that characterize some fish populations. The highest estimated recruitment occurred in 1982 during the period of highest spawner biomass, but the second highest recruitment event occurred in 2015 during a period of relatively low biomass.

Six sensitivity runs were produced to examine the dependence of the model results on the four survey indices, the 2020 MRIP data imputation methods, and survey index CVs that were unadjusted to correct for RMSE (MARI Appendix 2 Figures A2.2 and A2.3). No sensitivity run substantially changed the general trends in fishing mortality or SSB over the time series. The largest average percent difference in *F* was 14% and occurred when the MA trawl survey was removed; however, the largest median difference was only 2% and occurred when the MRIP index was removed. The largest percent differences in SSB occurred when the MA trawl survey and MRIP index were removed, both causing estimates averaging 7% larger than the base model. The largest median percent difference occurred when the 2020 imputed data were used, causing estimates that were 7% lower than the base model.

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

The target and threshold levels for fishing mortality were calculated using spawning potential ratio (SPR) reference points. The previous assessment update recommended use of maximum sustainable yield (MSY) reference points, but ultimately SPR reference points were used for management purposes. The updated target fishing mortality reference point for 2021, F40%, was 0.28 and the threshold level, F30%, was 0.49, the same values as estimated for the 2016 update (Table 5). The three-year average (i.e., 2018-2020) Fishing Mortality was estimated to be 0.23. Since the three-year average fishing mortality was below the target and threshold, the model did not indicate that overfishing was occurring (Table 6, Figure 10).

Target and threshold SSB reference points were calculated by determining equilibrium SSB when assuming fishing at the target or threshold fishing mortality levels and assuming historical recruitment patterns as well as terminal year selectivity, maturity and weight-at-age. These calculations were conducted using the AgePro program from the NOAA Fisheries Toolbox. The SSB threshold was 4,335 mt and the SSB target was 5,763 mt, higher than the estimates from the 2016 update (Table 5). Estimated 2020 SBB was 6,568 mt. Since the estimated spawner biomass was above both the target and the threshold, the model indicated that the stock was not overfished (Table 6, Figure 10).

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

Short term projections were implemented to estimate the probability of overfishing or the stock being overfished during 2022-2025. Projections assumed a harvest level equal to the average annual removals during 2018-2020 (941 mt). Stock life history information and selectivity patterns were assumed equal to the terminal model year (i.e., the current patterns persisted throughout the projection period). During each projection instance, recruitment was drawn randomly from the empirical distribution of recruitments previously estimated by the ASAP model. Under these assumptions, the short term projections showed a 100% probability of being at or below the F target in 3 years and showed a 100% probability of being at or above the SSB threshold in 3 years (Table 7, Figure 11).

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.

Fishery-dependent high priorities from the last benchmark assessment focused on biological sampling. A need for expanded sampling of commercial catch, continuation of collecting age structures, increasing catch and discard lengths from commercial and recreational fisheries, and an increase in MRIP sampling to improve recreational catch estimates.

The MARI region has continued to collect age structures since the benchmark, and has on the recommendation of the TC begun collecting paired samples of opercula and pelvic spines (RI) or otoliths (MA). One difficulty with collecting opercula or otoliths from the commercial fishery is the presence of the live market and the whole fish market. If the pelvic spine is deemed an appropriate structure by the aging committee, use of spines as the primary age structure collected should allow for increased samples. This is a diversion from the benchmark which suggested taking paired otolith samples to compare to opercula. While RI (and MA) did sample both opercula and otoliths, the presence of the live and whole fish market is driving the need for a non-lethal and non-mutilating method of collecting age structures. In addition, the assessment process identified differences in length-at-age between Massachusetts and Rhode Island. These differences may be naturally occurring or the result of differences in ageing techniques. This should be pursued and the source of the disparity identified if possible.

Additional improvements to MRIP sampling for tautog should be made. While percent standard error (PSEs) are reasonable for state level landings, improvements of PSEs by mode through additional sampling would greatly increase the understanding of the fishery, especially as tautog is a recreational heavy fishery.

Fishery-independent priorities included conducting a workshop and pilot studies to design a multi-state fishery survey, to establish standardized multi-state surveys to monitor tautog abundance and to develop young of the year (YOY) indices, and to enhance age structure collection for smaller fish.

The RI seine survey is used as the MARI YOY index and has been ongoing since 1988.

Since the benchmark, both RI and MA have sampled fish smaller than 20cm for age/length. Sample sizes continue to be small at this size and sampling should continue to be a priority to improve the age-length key.

List of Appendices

MARI Appendix 1: ASAPplots output of the base model
MARI Appendix 2: Retrospective adjustments and sensitivity runs

References

Atlantic States Marine Fisheries Commission. 2015. Tautog benchmark stock assessment. Arlington, VA.

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Tables

Table 1. Total removals in metric tons by sector for the MARI region.

Year	Recreational Harvest	Recreational Release Mortalities	Commercial Harvest
1982	2,700.6	2.4	70.6
1983	1,714.1	10.6	90.8
1984	1,761.8	17.9	182.7
1985	603.4	5.9	211.6
1986	4,363.9	21.5	239.9
1987	1,834.5	13.3	304.1
1988	2,905.9	23.0	274.9
1989	1,523.2	8.6	257.1
1990	1,792.2	13.7	226.9
1991	2,502.6	20.3	329.3
1992	4,624.0	12.4	295.8
1993	1,109.0	7.9	164.2
1994	579.8	14.5	76.1
1995	507.1	14.0	59.1
1996	771.0	20.9	44.2
1997	441.9	12.5	47.1
1998	415.7	12.2	50.6
1999	1,033.1	34.8	46.1
2000	903.2	14.0	63.4
2001	655.3	20.0	63.7
2002	788.3	37.6	89.8
2003	868.9	30.0	63.9
2004	818.2	20.1	56.6
2005	1,052.1	29.3	64.5
2006	732.2	28.0	88.4
2007	650.6	26.4	72.2
2008	732.8	22.6	55.3
2009	855.3	34.9	47.9
2010	1,106.9	27.4	54.1
2011	513.7	41.2	47.7
2012	868.9	42.7	53.5
2013	1,571.0	67.6	56.1
2014	1,198.2	104.1	52.9
2015	973.6	72.7	49.4
2016	729.1	55.3	49.3
2017	1,580.3	107.1	54.1
2018	623.8	100.7	51.0
2019	965.8	118.3	51.5
2020	701.3	158.5	52.6

Table 2. Indices used in the ASAP model for the MARI region

Index Name	Index Metric	Design	Time of Year	Years	Ages
MRIP CPUE	Total catch per angler-trip	Stratified Random	Mar-Dec	1982-2020	2+
Massachusetts Trawl Survey	Mean number per tow	Stratified Random	Spring and Fall	1982-2019	2+
Rhode Island Fall Trawl Survey	Mean number per tow	Stratified Random	September - November	1982 - 2020	2+
Rhode Island Narragansett Bay Seine	Mean number per haul	Fixed	June - October	1988-2020	YOY

Table 3. Model structure and life history information used in the MARI stock assessment

	Value(s)
Years in Model	1982-2020
Age Plus Group	12+
Fleets	1 (Rec and Commercial)
Recreational Release Mortality Rate	2.5%
Fraction of year before SSB clculation	0.42
Number of selectivity blocks	3
Selectivity periods	1982-1996, 1997-2006, 2007-2020
Selectivity type	Single logistic

	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	12
Proportion mature-at-age	0	0	0.8	1	1	1	1	1	1	1	1	1
Natural mortality	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

Table 4. Spawning stock biomass, recruitment, annual F, and 3-year average *F* estimates for the MARI region.

Year	Spawning stock biomass (mt)	Recruitment (millions of age-1 fish)	Annual *F*	3-year Average *F*
1982	21,417	3.43	0.15	-
1983	21,557	2.52	0.10	-
1984	21,744	1.91	0.09	0.11
1985	21,683	1.71	0.07	0.09
1986	20,430	1.89	0.20	0.12
1987	18,024	1.91	0.18	0.15
1988	15,697	2.13	0.22	0.20
1989	13,766	1.73	0.16	0.19
1990	12,534	1.65	0.18	0.19
1991	11,048	1.73	0.28	0.21
1992	8,246	1.75	0.75	0.40
1993	6,376	1.65	0.32	0.45
1994	6,214	1.70	0.19	0.42
1995	6,308	1.65	0.20	0.24
1996	6,236	1.41	0.29	0.23
1997	6,229	1.45	0.16	0.22
1998	6,426	1.66	0.14	0.20
1999	6,346	1.86	0.28	0.19
2000	6,026	1.58	0.28	0.23
2001	5,880	1.28	0.27	0.27
2002	5,825	1.32	0.25	0.26
2003	5,733	1.38	0.25	0.26
2004	5,709	1.41	0.17	0.22
2005	5,724	1.62	0.21	0.21
2006	5,610	1.40	0.23	0.20
2007	5,535	1.36	0.24	0.23
2008	5,409	1.83	0.29	0.25
2009	5,155	1.55	0.34	0.29
2010	5,035	1.30	0.31	0.31
2011	5,148	1.42	0.20	0.28
2012	5,290	1.76	0.23	0.25
2013	5,226	1.66	0.31	0.24
2014	5,075	2.10	0.36	0.30
2015	5,016	2.80	0.29	0.32
2016	5,240	2.25	0.27	0.31
2017	5,652	1.44	0.36	0.31
2018	6,140	1.28	0.22	0.28
2019	6,502	1.67	0.25	0.28
2020	6,568	1.41	0.21	0.23

Table 5. SSB and *F* reference points from 2016 and 2021 updates for the MARI region

	SSB		*F*	
	Target	Threshold	Target	Threshold
2016 Update	2,684	2,004	0.28	0.49
2021 Update	5,763	4,335	0.28	0.49

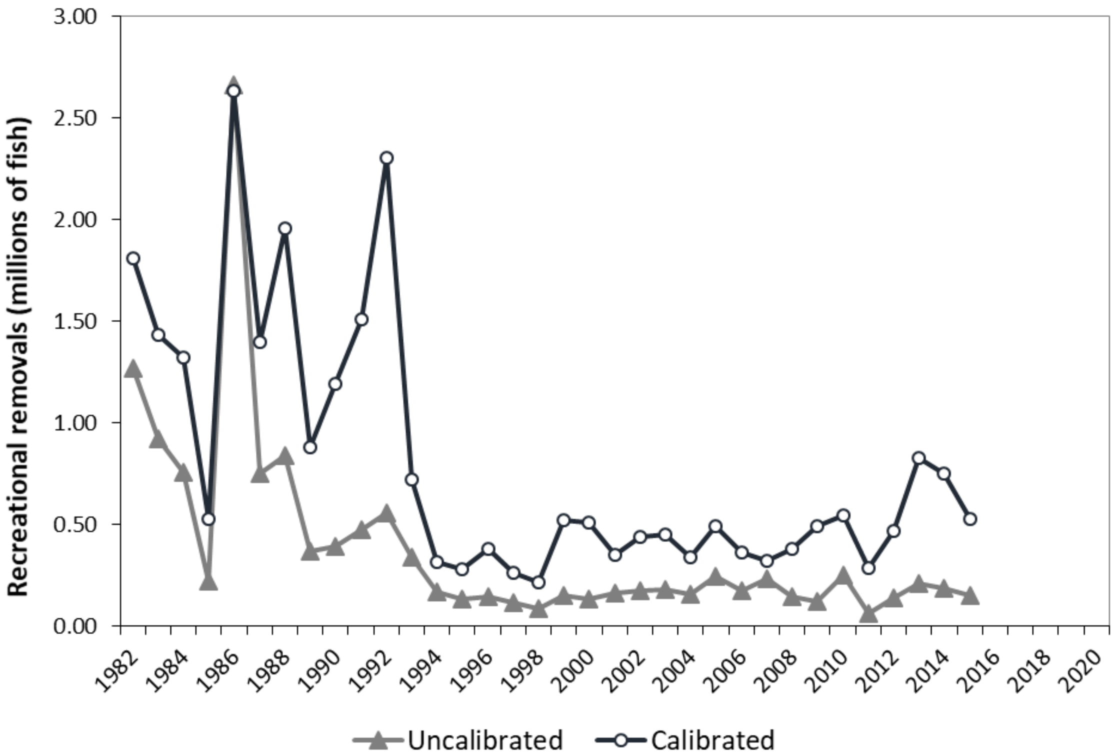
Table 6. Stock status for the MARI region.

	SSB		*F*	
	Target	Threshold	Target	Threshold
Reference Points	5,763	4,335	0.28	0.49
2020 Value	6,568		0.23	
2020 Status	Not Overfished		Overfishing not Occurring	

Table 7. Short-term projection results for the MARI region using status quo removals.

Landings (mt) for 2022-2025	Probability of being at or below *F* Target in 3 years	Probability of being at or above SSB threshold in 3 years
Status quo (2018-2020 average)	100%	100%

Figures



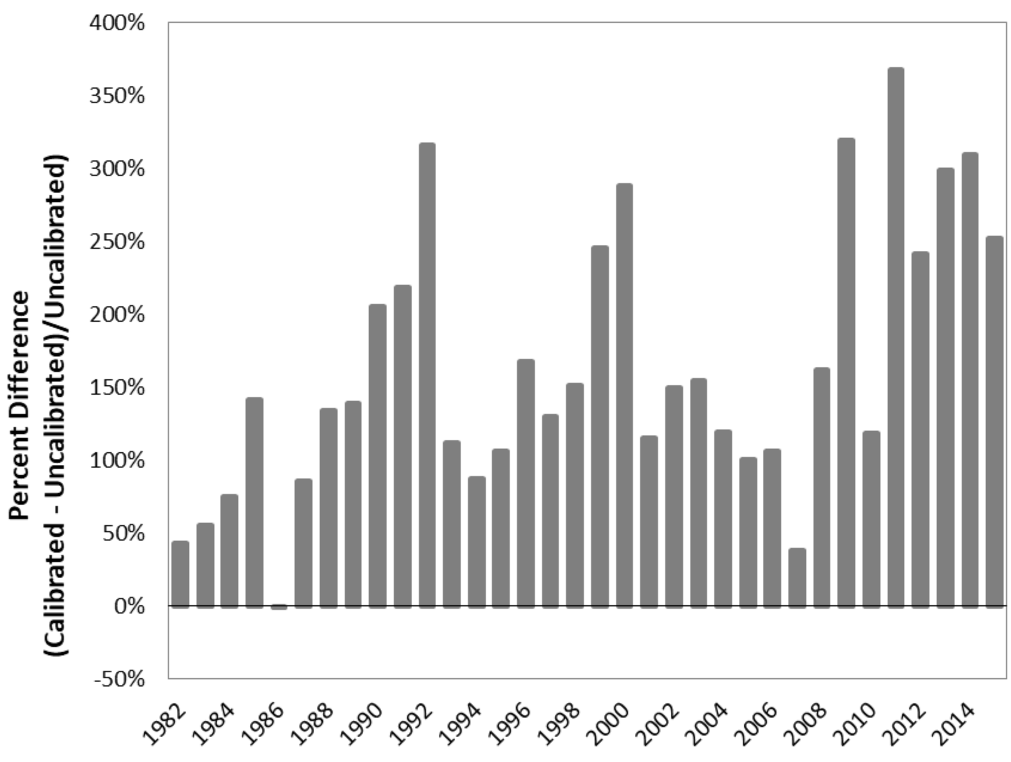


Figure 1. Comparison of calibrated and uncalibrated recreational removals (harvest + dead releases) in numbers of fish (top) and percent difference (bottom) for the MARI region.

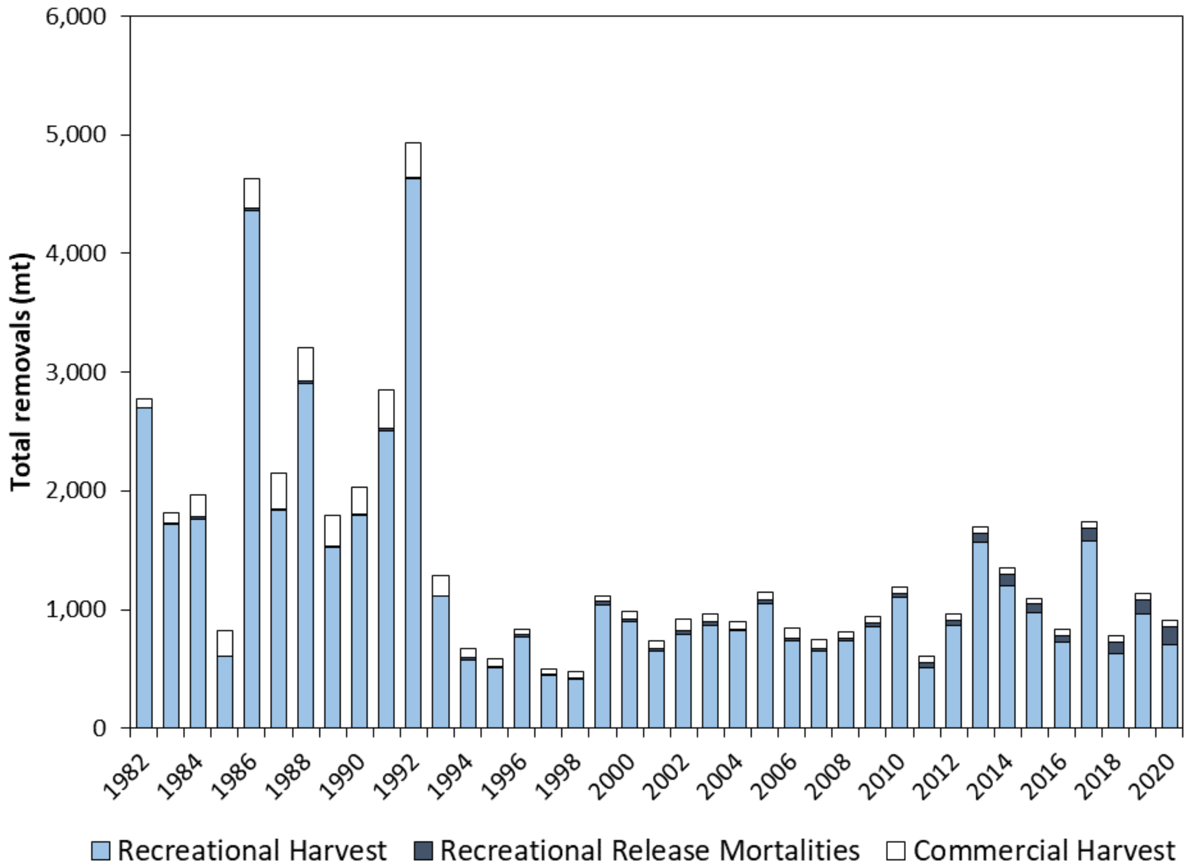


Figure 2. Total removals by sector for the MARI region.

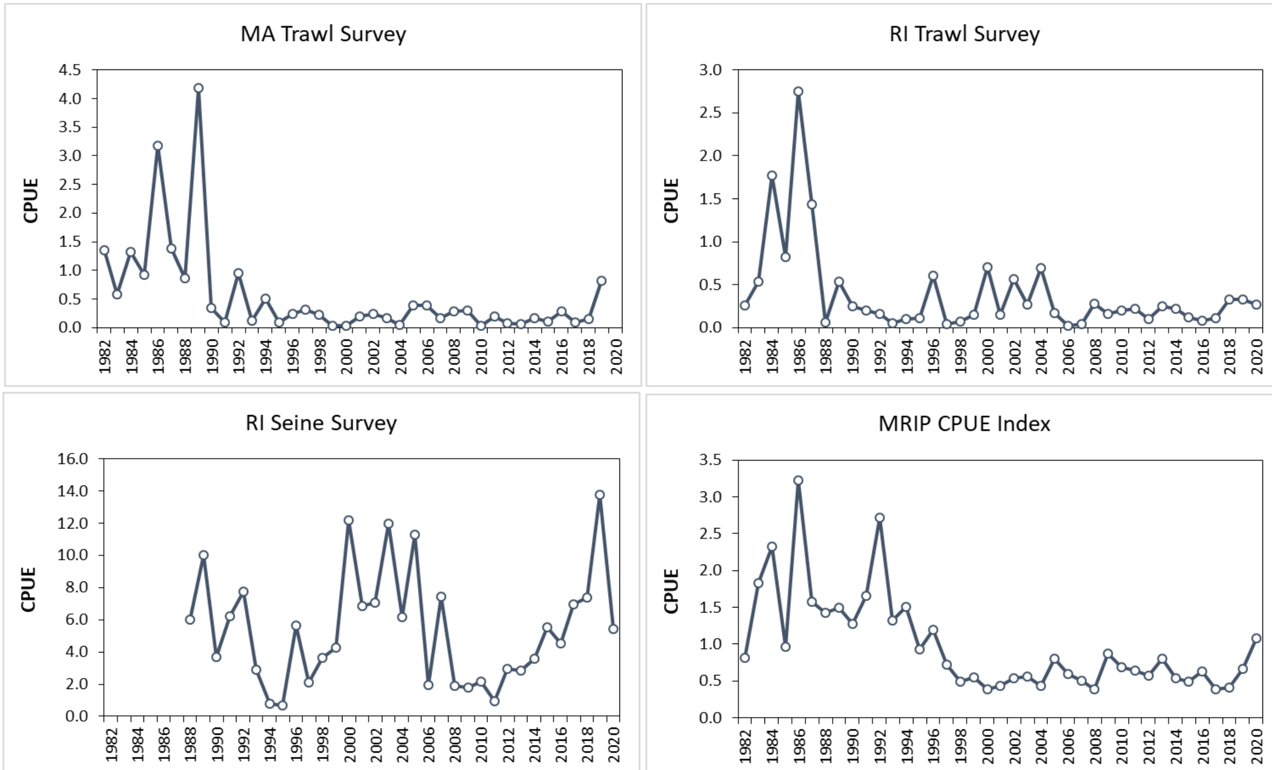


Figure 3. Indices of abundance used in the ASAP model for the MARI region.

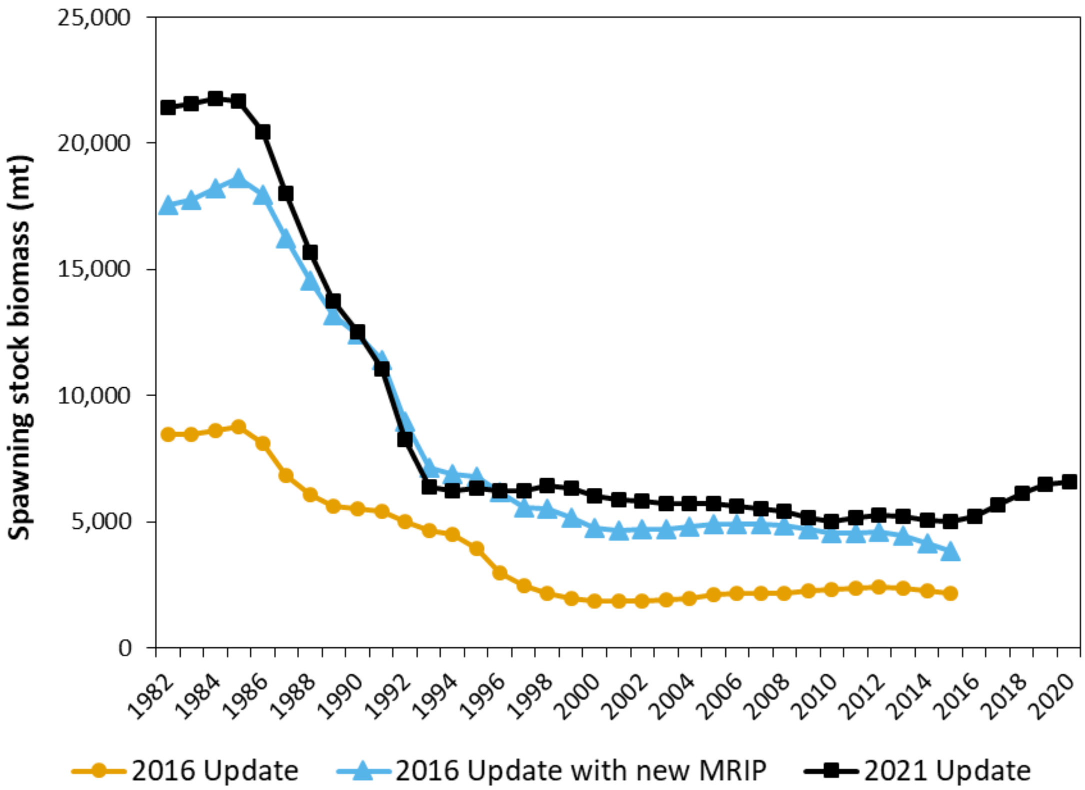


Figure 4. Estimates of spawning stock biomass for the MARI region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

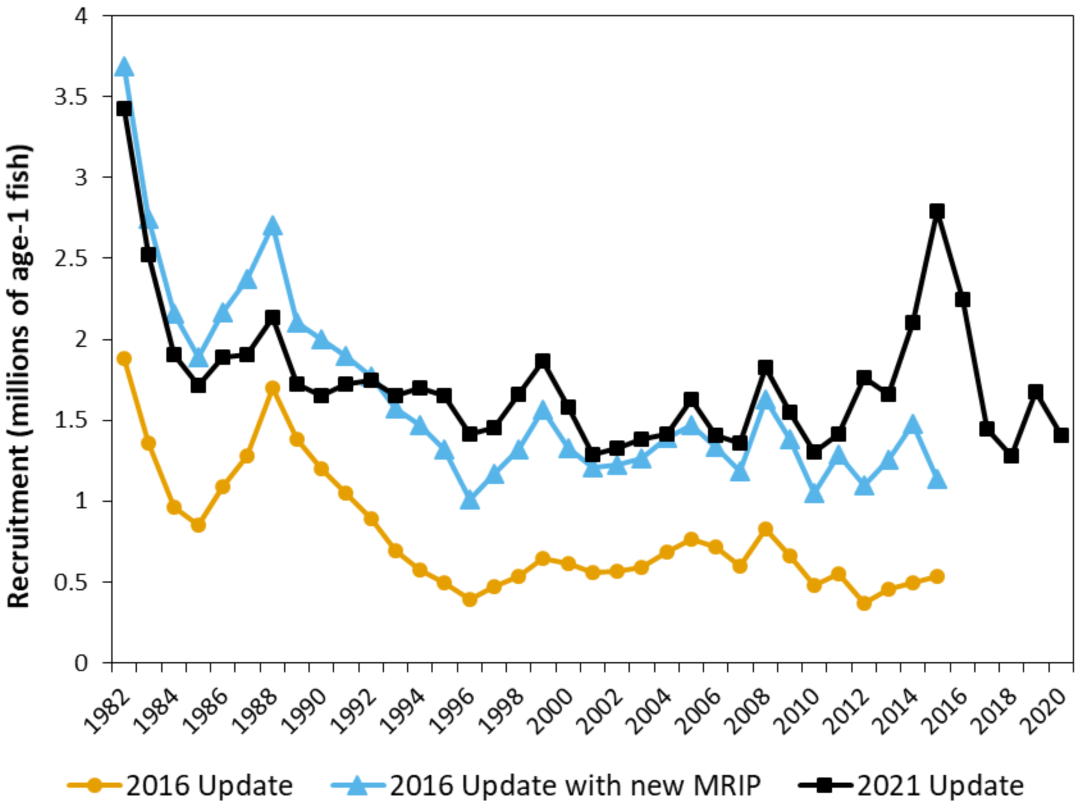


Figure 5. Estimates of recruitment for the MARI region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

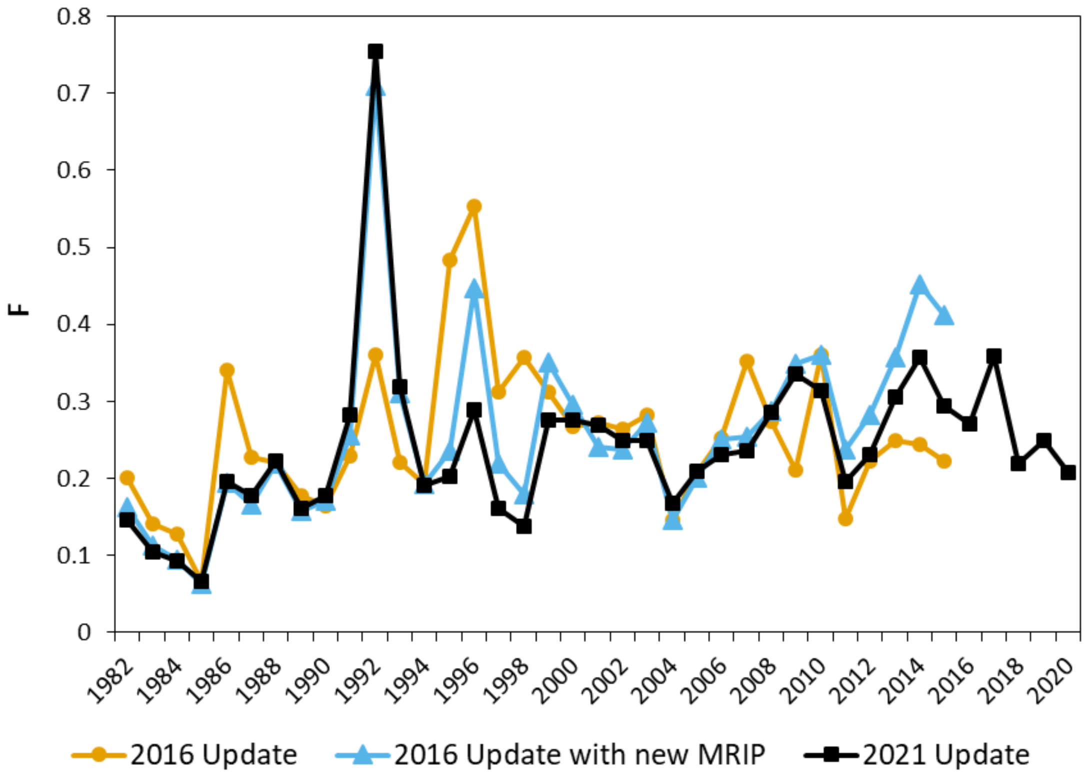
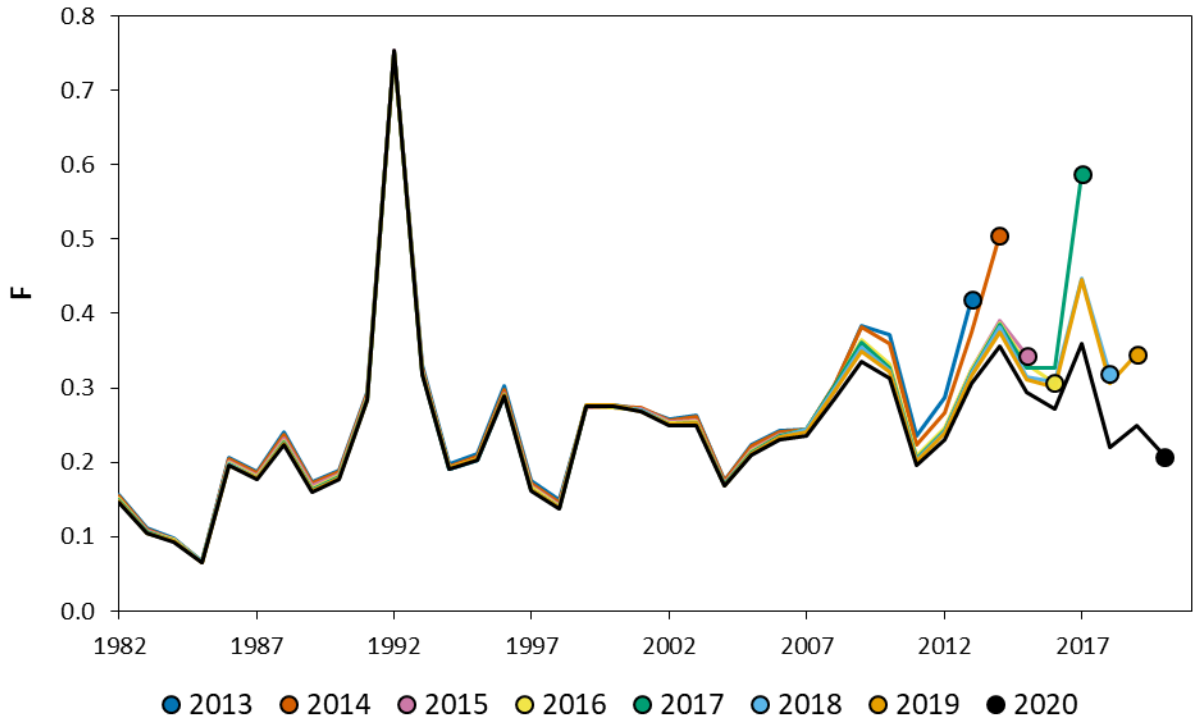


Figure 6. Estimates of the annual full *F* for the MARI region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.



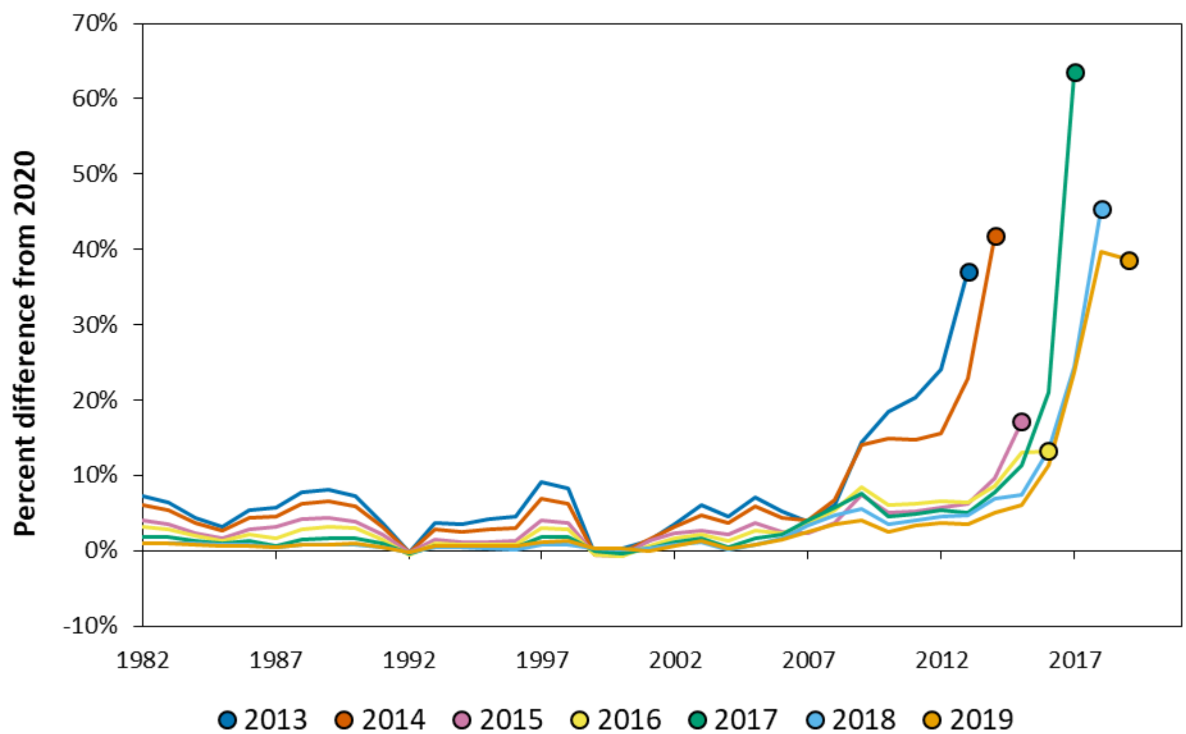
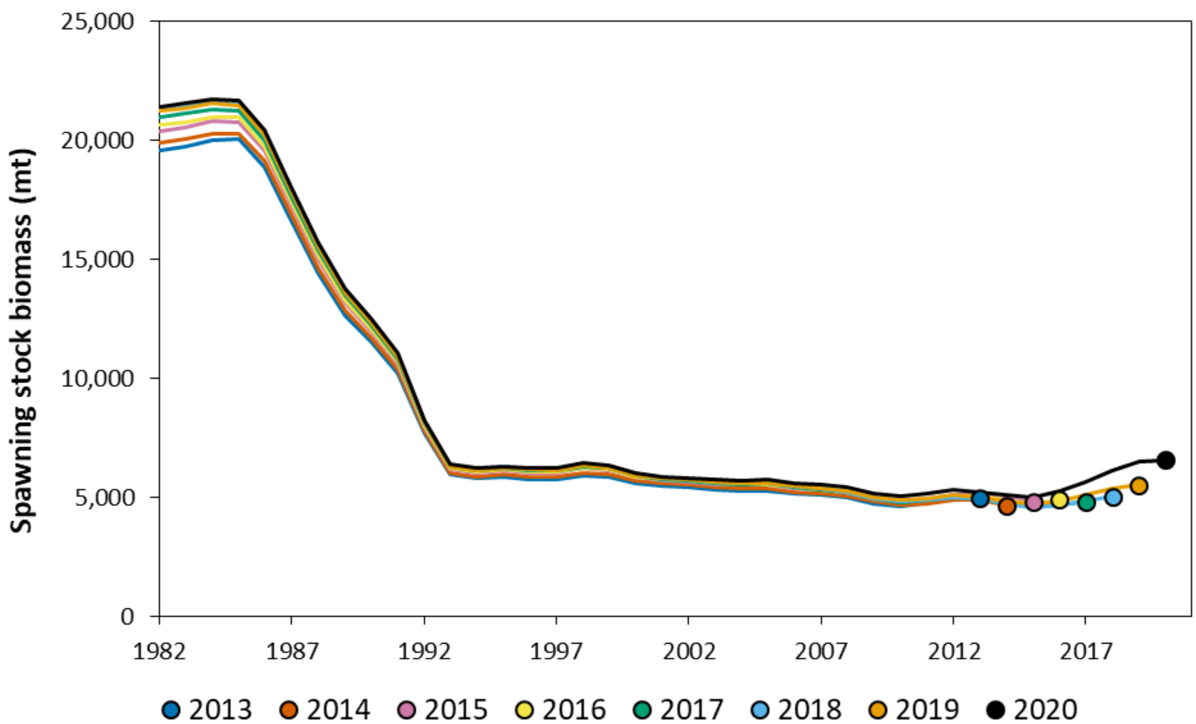


Figure 7. Retrospective analysis for annual *F* for the MARI region in absolute numbers (top) and percent difference (bottom).



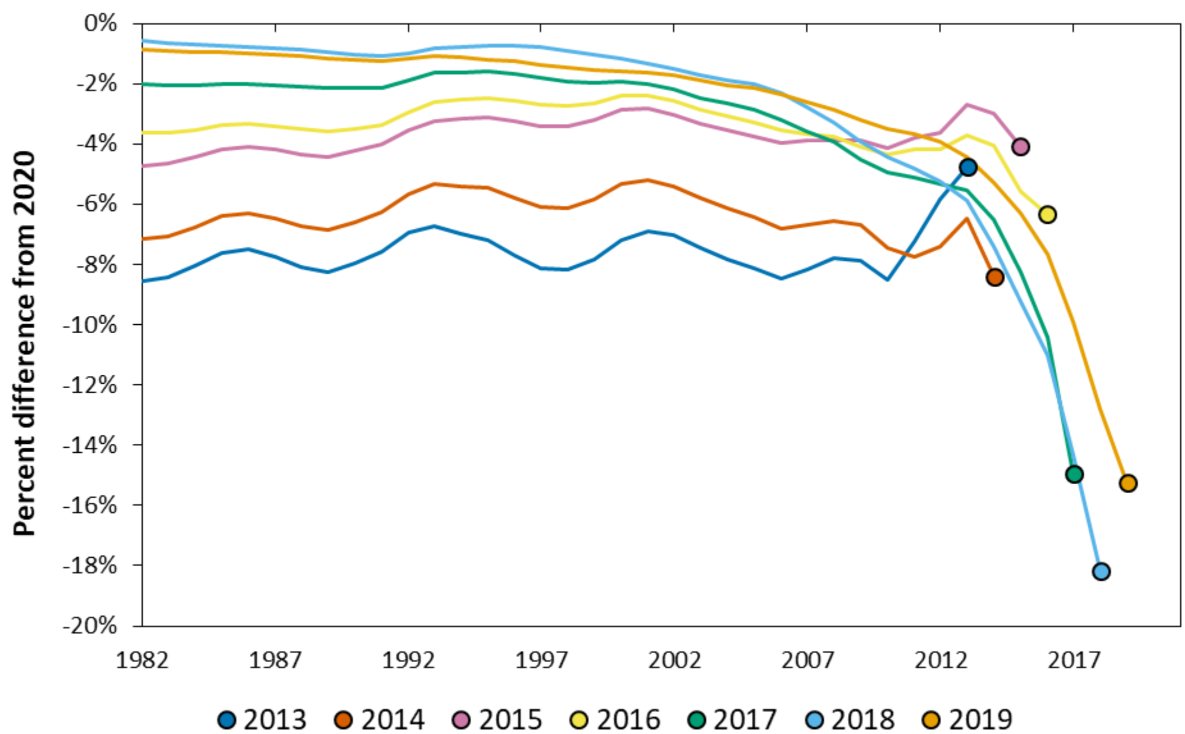


Figure 8. Retrospective analysis for SSB for the MARI region in absolute numbers (top) and percent difference (bottom).

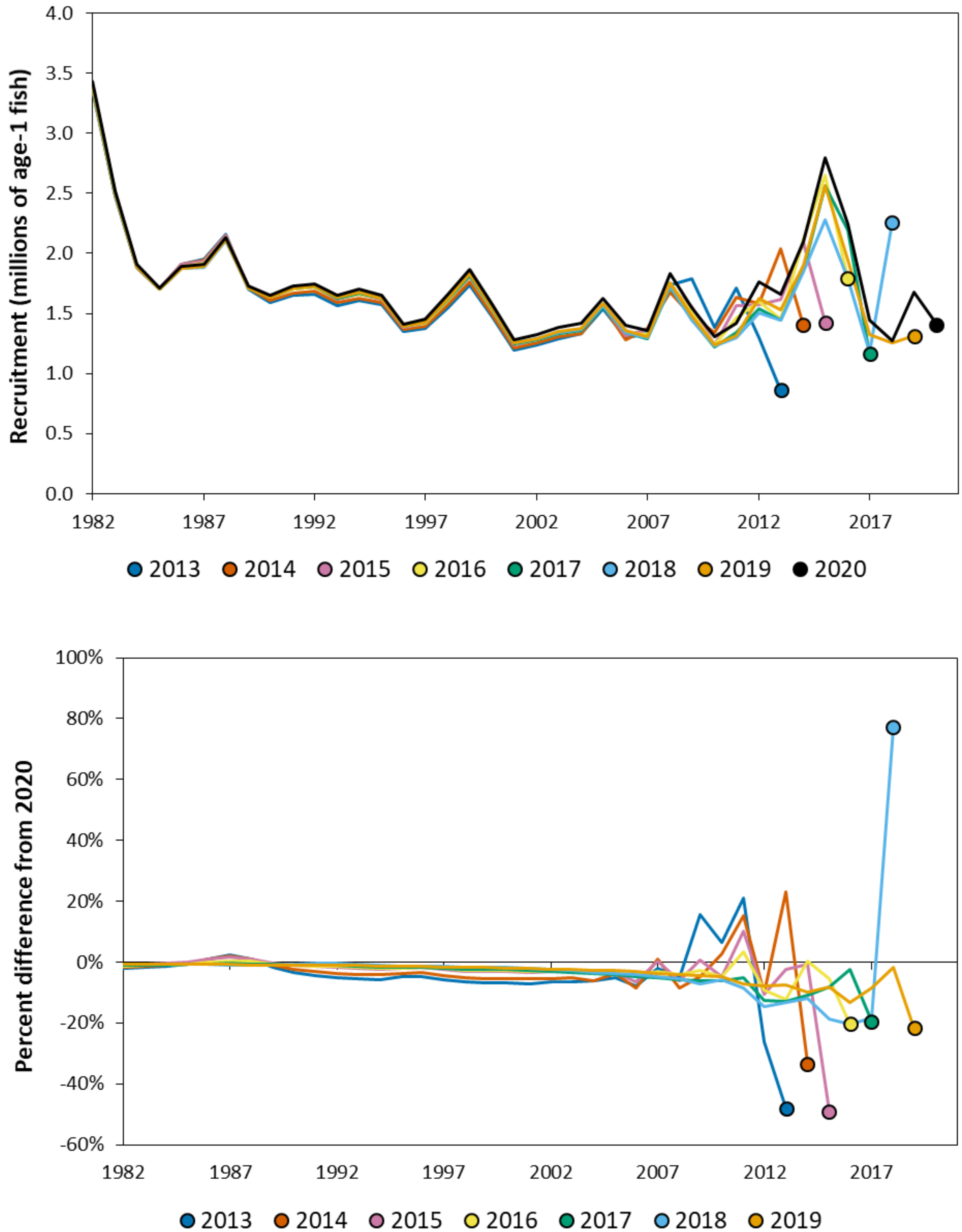
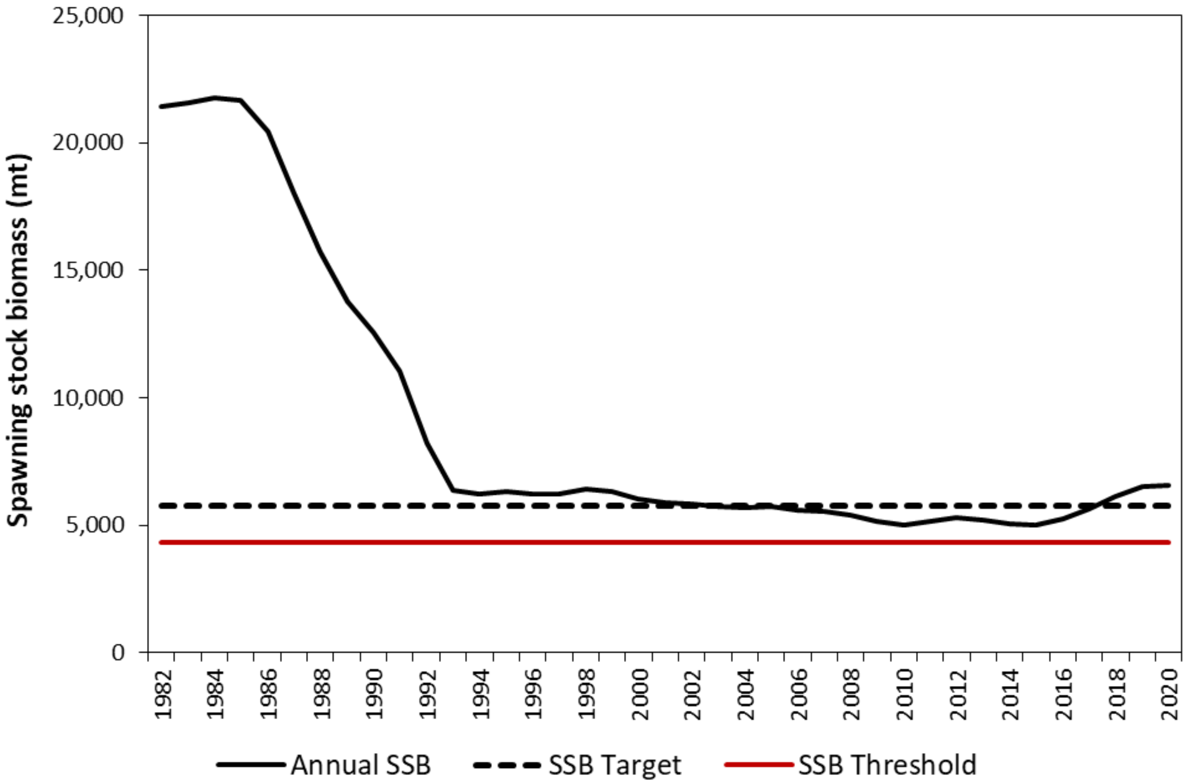


Figure 9. Retrospective analysis for recruitment for the MARI region in absolute numbers (top) and percent difference (bottom).



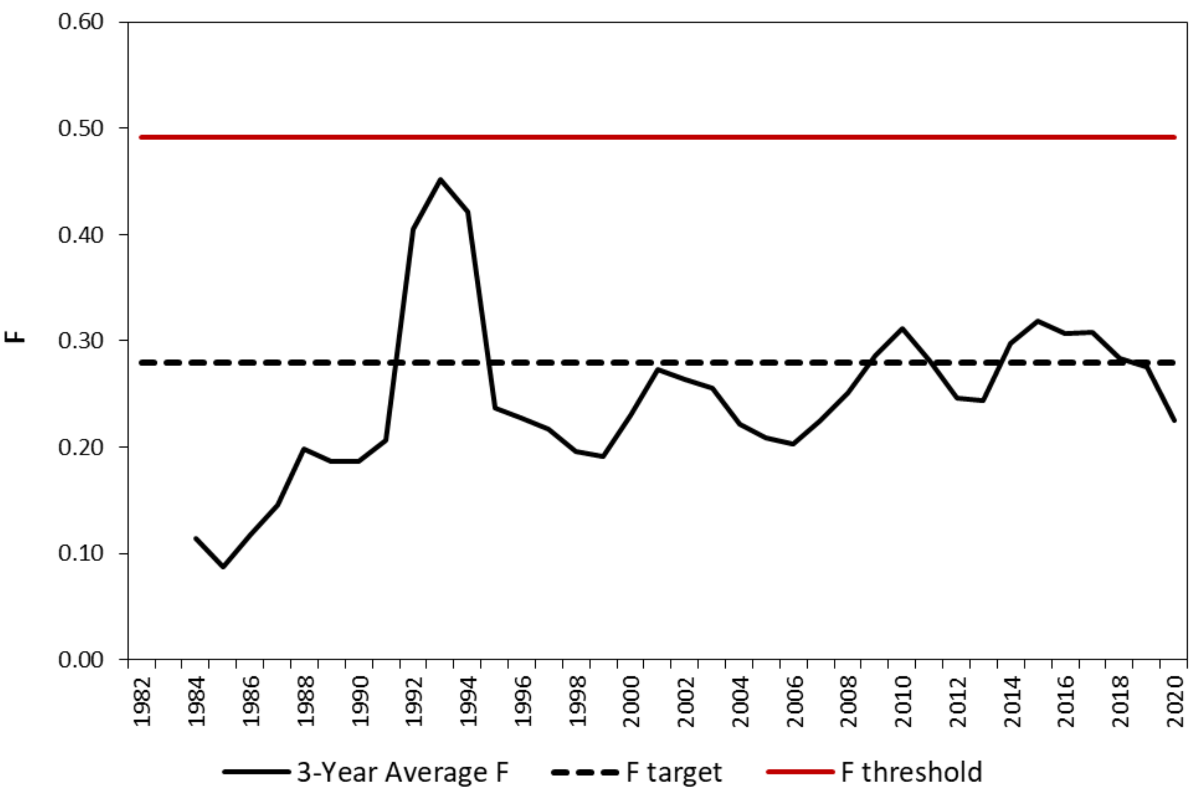


Figure 10. Annual SSB plotted with SSB target and threshold (top) and 3-year average *F* plotted with *F* target and threshold (bottom) for the MARI region.

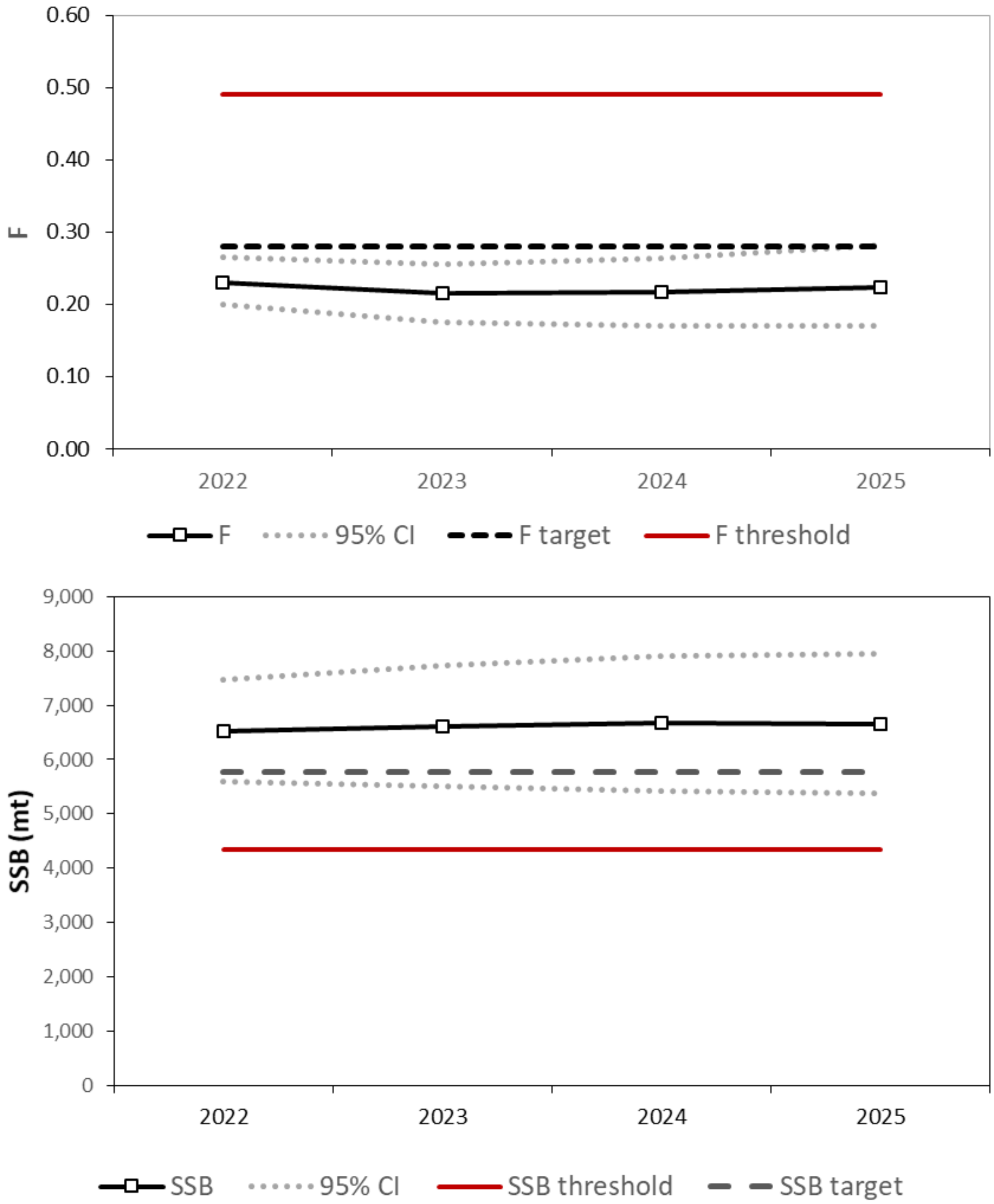


Figure 11. Status quo harvest projections for the MARI region showing the trajectory of annual *F* (top) and SSB (bottom) with their target and threshold reference points. Dotted grey lines indicate the 95% confidence intervals of the estimates.

Tautog Stock Assessment Update
LONG ISLAND SOUND REGION
2021

Executive Summary

The 2020 Long Island Sound (LIS) tautog stock assessment update used the Age Structured Assessment Program (ASAP) version 3.0.17, available through the Northeast Fishery Science Center (NEFSC) National Fishery Toolbox (NFT) which is a “data rich,” forward projecting statistical catch at age program to assess tautog populations. The model incorporated annual harvest estimates, adult fishery-independent and fishery-dependent biomass, available age structure, size-at-age, and juvenile abundance indices. The ASAP model assumed a single fleet with four selectivity periods based on management time blocks. The assessment update used the calibrated MRIP data, a departure from the previous update. As the annual harvest estimates increased by an average of 143% between the uncalibrated and calibrated MRIP, a bridge model was evaluated. The bridge model covered the same time period (1984–2015) as the previous update but used the newly calibrated MRIP data. There was no status change in the terminal year between the previous update and the bridge model. As there were fewer MRIP samples in 2020 (due to the COVID-19 pandemic) a base model was conducted for the region using the MRIP CPUE index developed from non-imputed MRIP data. A sensitivity analysis was also conducted for the model using imputed MRIP data in the MRIP CPUE to evaluate model sensitivity to input data. Stock status in the terminal year was consistent between both base and sensitivity models. Additionally, stock status in 2015 for the base and sensitivity models were consistent with the previous update. The current update indicated that the stock is not overfished and not experiencing overfishing. This is a change from the stock status in 2015, when the stock was overfished and overfishing was occurring. Short-term projections (five years) were conducted to evaluate the risk to the stock for maintaining status quo management. While there is little risk that the stock will be overfished in the near future, the stock is still at risk for overfishing with the current level of removals, so precaution should be taken in management decisions.

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 for commercial and recreational removals was extended from the previous assessment update (ASMFC 2017) through 2020, along with the associated age compositions from both sources.

This assessment update used the new, calibrated estimates of recreational removals from the Marine Recreational Information Program (MRIP). The calibrated estimates of recreational removals (harvest and dead discards) were consistently higher across the entire time series, averaging about 143% higher than the uncalibrated estimates (Figure 12).

The tautog fishery in the LIS region is predominantly recreational (Table 8, Figure 13). Recreational removals make up 95% of total removals by weight in the region. Total recreational removals were high but variable at the beginning of the time series, averaging about 1,306,630 fish from 1984–1991. Recreational removals declined significantly after that, averaging about 561,343 fish from 1992–2020. Recreational removals from 2018–2020, after the implementation of Amendment 1 to the Tautog FMP, averaged about 742,624 fish.

Commercial landings peaked in the mid-to late 1980s, averaging 125 mt per year from 1986–1990 before declining to a series low of 8.9 mt in 1999 (Table 8, Figure 13). Commercial landings increased since then, averaging 58 mt from 2018–2020, under Amendment 1.

The calibrated MRIP length frequencies were used to calculate the age composition of the recreational harvest and were also used as a proxy for the length composition of the commercial harvest. Data from the MRIP at-sea headboat observer program, the Connecticut Volunteer Angler Survey, and the American Littoral Society (ALS) volunteer tagging program were used to calculate the age composition of the recreational release mortality. Ages 5–7 made up the majority of the total removals over the time series (LIS Appendix 1).

The Tautog TC developed a fishery dependent index of abundance from MRIP recreational survey data, using the same "logical species guilds" from the benchmark assessment to identify tautog trips. Only non-imputed intercepts were used to calculate the index for 2020. The MRIP CPUE index was high and somewhat variable at the beginning of the series before declining through the mid-1990s to lower, stable, levels throughout the 2000s (Figure 14). In recent years, the index has been somewhat higher but more variable, with upticks in 2014, 2019, and 2020.

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.

The fishery independent indices from the LIS consist of the Connecticut Long Island Sound Trawl Survey, the New York Peconic Bay Trawl Survey, and the New York YOY Seine Survey (Table 9). Age composition information was available for the CT LIST survey and is shown in LIS Appendix 1. For all indices, statistical model-based standardization of the survey data was conducted to account for factors that affect tautog catchability.

The CT LIST survey is conducted in the spring and fall utilizing a stratified random design and was used to develop an index of age-1+ abundance for tautog. The survey was not conducted in 2020 due to COVID-19 restrictions; this survey is the source of CT's age and length samples for tautog, so as a result, the age-length key for the LIS region did not include CT data for 2020. The index was highest at the beginning of the time series and declined through the mid-1990s; it rebounded somewhat during the late 1990s and early 2000s and then remained at low, stable levels; the index was higher than in the early 2000s in three of the last four years (Figure 14).

New York YOY Seine Survey operated from 1984 to the present, with a consistent standardized methodology starting in 1987. It is a fixed site survey that is conducted in three separate embayments on Long Island; the data were subset to bays on the north side of Long Island for the LIS region. It was used to develop a YOY index of recruitment for tautog. New York YOY Seine Survey was conducted in 2020 but the start was delayed due to COVID-19 restrictions. The index was variable with periods of higher recruitment including the early 1990s and the early 2000s; in recent years the index has been lower (Figure 14).

NYDEC Peconic Bay trawl survey operated from 1987 to the present, with a consistent standardized methodology starting in 1991. Sixteen stations are randomly sampled from May to October and target age-1 individuals. The survey was not conducted in 2005, 2006, and 2008. The index is highly variable with a few periods of higher recruitment including the late 1980s and the mid-2010s (Figure 14).

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.

Life history parameters were the same as used in the peer-reviewed benchmark stock assessment (Table 10).

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.

The 1984–2015 assessment, the bridge model, was updated with the new MRIP estimates to isolate the effects of the MRIP changes from the effects of adding additional years of data to the model. Spawning stock biomass was higher in the bridge model than the previous assessment (Figure 15). While SSB was similar for most years between the bridge model and the current update, there is a recent divergence as the current update estimated higher SSB in the 2010s. Overall, recruitment estimates were larger in the bridge model than the previous update and even larger in the current update (Figure 16). Fishing mortality was similar between the bridge model and the previous update, except in the terminal year (Figure 17). Overall, *F* was similar among the current update, the bridge model, and the previous update, although F was higher in the early 1990s and early 2000s. According to the bridge model, there was no status change from the previous update: LIS was overfished and in overfishing in 2015 (LIS Appendix 2 Table A2.1 and Table A2.2). The consistency between the previous update and the bridge model indicates that the mean increase of 143% in the calibrated MRIP data (Figure 12) did not impact stock status.

The current update was conducted using calibrated MRIP data. There were a few changes in how these data were prepared for the model input from the previous assessment. New York did not code “area C” in 2016 for the MRIP observations, so there was no LIS-specific catch estimates. Harvest and discards for 2016 LIS in NY were estimated by applying the mean proportion of LIS-specific harvest from 2013–2017 to the 2016 NY data. The New York headboat survey program ended in 2015 which was a loss of an important data source for both catch and release length observations. As such, there were only 6 NY length and age fishery dependent samples (harvest only) after 2015 and all of these were in 2019.

The other departures from the previous update were due to the COVID-19 pandemic. These included: no MIRP type-9 sampling in 2020, no LISTS in 2020, and fewer MRIP intercepts in 2020. As there were no MRIP type-9 data from 2020, all 2020 discard lengths were from the CT Volunteer Angler Survey and the data from the American Littoral Society tagging program. Due to the nature of these surveys, all fish lower than the minimum size of 16 inches were considered to be "released" fish. There was no abundance survey for fish older than 1 year in 2020 as the LISTS was not conducted. As there were fewer MRIP intercepts in 2020, two models were evaluated. The base model used the MRIP index developed only with non-imputed 2020 data and a sensitivity model used the MRIP index that included imputed 2020 data. There was no difference in stock status between the base model and the sensitivity model (LIS Appendix 2 Table A2.1 and Table A2.2).

Retrospective analysis was run from 2013–2020. While there was a strong retrospective pattern, the bias was generally conservative. Fishing mortality was overestimated in all but one year (Figure 18) and SSB was underestimated in all but two years (Figure 19). Recruitment was overestimated in 3 of 7 years (Figure 20). In the case of recruitment overestimation, two of the years were overestimated by less than 13%. In the other year recruitment was overestimated by 72%. For fishing mortality and SSB, the retrospective adjustment was within the 95% confidence intervals, so no adjustment was needed (LIS Appendix 2 Figure A2.1).

Spawning stock biomass was highest at the beginning of the time-series and declined steadily to a low in 1995, during a period when the stock was experiencing high *F* (Table 11, Figure 21). As *F* declined, the stock recovered somewhat in the early 2000s. The recovery was interrupted by increasing *F* and a decline in SSB in the late 2000, but decreasing *F* and strong recruitment events over the last 10 years resulted in an increasing trend in SSB in recent years (Table 11, Figure 21).

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

The updated SSB reference points for the LIS region were higher than the values from the 2016 assessment as a result of the scale change from the MRIP calibration, but the *F* reference points were more similar (Table 12).

The ASAP model runs indicated overfishing was not occurring in Long Island Sound in 2020 relative to MSY reference points. Both the point estimate of F_{2020} = 0.34 and the 3-year average value of F_{3yr} = 0.30 were below the *F* threshold value of 0.38 (Table 13, Figure 21).

The ASAP model runs indicated the tautog stock was not overfished in Long Island Sound relative to MSY reference points. SSB in 2020 was 6,665 mt, above the $SSB_{75\%MSY}$ threshold of 5,044 mt but below the SSB_{MSY} target of 6,725 mt (Table 13, Figure 21).

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

Short term projections in AgePro were used to predict the impact of status quo management on the population. Overall, the stock is not at risk for becoming overfished in the near future, but is at risk for overfishing to occur. The short term projection using the F_{Target} estimate resulted in only a 3% probability of being at or below F_{Target} in the terminal year (Table 14, Figure 22). A projection using $F_{Threshold}$ resulted in a 27% probability of being above $F_{Threshold}$. These projections showed a 97% probability of being at or above $SSB_{Threshold}$ in 2025 but only a 66% probability of being at SSB_{Target}. These results were quite similar to the sensitivity analysis using the imputed MRIP CPUE.

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 from the previous update should be an area of prioritization. Increased fishery dependent biological sampling (length and age for both harvest and released fish) would greatly benefit the stock assessment process and improve management.

For the next benchmark assessment, utilizing a modeled age-length key (Gerritsen et al. 2006) could help to avoid borrowing age-length data from other years and regions, this approach was recently implemented to evaluate the impact of harvest slot limits on tautog in the LIS region (Kasper et al. 2020). Additionally, modeling the harvest and discard at length distributions, rather than using the actual harvest and discard length observations, would help to manage the small sample size for such observations.

List of Appendices

Appendix 1: ASAPplots output of the base model
Appendix 2: Retrospective adjustment and sensitivity runs

References

ASMFC. 2017. Atlantic States Marine Fisheries Commission 2016 Tautog Stock Assessment Update. Atlantic States Marine Fisheries Commission.

Gerritsen, H. D., D. McGrath, and C. Lordan. 2006. A simple method for comparing age–length keys reveals significant regional differences within a single stock of haddock (*Melanogrammus aeglefinus)*. ICES Journal of Marine Science 63:1096–1100.

Kasper, J. M., J. Brust, A. Caskenette, J. McNamee, J. C. Vokoun, and E. T. Schultz. 2020. Using Harvest Slot Limits to Promote Stock Recovery and Broaden Age Structure in Marine Recreational Fisheries: A Case Study. North American Journal of Fisheries Management 40:1451–1471.

Tables

Table 8. Total removals in metric tons by sector for the LIS region.

Year	Recreational Harvest	Recreational Release Mortalities	Commercial Harvest
1984	1,413.1	3.0	
1985	2,389.6	6.3	
1986	2,179.7	3.2	129.4
1987	2,483.9	5.9	159.1
1988	1,779.0	6.0	116.9
1989	1,794.0	5.7	140.4
1990	1,518.5	7.8	77.9
1991	1,373.1	8.8	76.2
1992	1,195.2	6.3	74.4
1993	1,254.6	5.1	60.0
1994	837.0	5.9	33.5
1995	472.1	4.4	11.1
1996	252.1	3.3	51.5
1997	262.3	3.5	31.9
1998	381.5	9.7	26.0
1999	508.0	8.0	8.9
2000	154.3	2.5	9.1
2001	151.5	4.8	15.6
2002	1,625.2	19.9	20.4
2003	735.5	9.5	31.9
2004	717.9	10.1	40.8
2005	370.7	5.5	33.6
2006	885.2	13.8	39.3
2007	1,695.5	25.9	54.6
2008	1,371.7	15.5	37.5
2009	1,371.2	14.8	21.5
2010	1,003.7	13.7	25.2
2011	340.7	12.2	33.1
2012	1,224.8	67.6	25.4
2013	972.4	55.2	31.8
2014	1,053.6	93.8	39.6
2015	1,356.3	88.3	29.7
2016	1,519.1	85.3	33.3
2017	833.0	81.5	47.9
2018	303.2	61.1	38.8
2019	1,550.5	99.2	76.3
2020	1,120.4	96.2	58.0

Table 9. Indices used in the ASAP model for the LIS region.

Index Name	Index Metric	Design	Time of Year	Years	Ages
MRIP CPUE	Total catch per angler-trip	Stratified Random	Mar-Dec	1984-2020	2+
Connecticut LIS Trawl Survey	Mean number per tow	Stratified Random	April-June	1984-2019	2+
New York Peconic Bay Trawl Survey	Mean number per tow	Stratified Random	May-October	1985, 1987-1994, 1996-2009, 2011-2020	1
New York YOY Seine Survey	Mean number per haul	Fixed	July-Nov	1987-2004, 2007, 2009-2020	YOY

Table 10. Model structure and life history information used in the stock assessment for the LIS region.

	Value(s)
Years in Model	1984-2020
Age Plus Group	12+
Fleets	1 (Rec and Commercial)
Recreational Release Mortality Rate	2.5%
Fraction of year before SSB clculation	0.42
Number of selectivity blocks	4
Selectivity periods	1984-1986, 1987-1994, 1995-2011, and 2012-2020
Selectivity type	Single logistic

	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	12+
Proportion mature-at-age	0	0	0.8	1	1	1	1	1	1	1	1	1
Natural mortality	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Table 11. Spawning stock biomass, recruitment, annual *F*, and 3-year average *F* estimates for the LIS region.

Year	Spawning stock biomass (mt)	Recruitment (millions of age-1 fish)	Annual *F*	3-year Average *F*
1984	13,786	2.83	0.17	
1985	13,092	2.16	0.23	
1986	12,198	3.14	0.23	0.21
1987	11,006	2.54	0.28	0.25
1988	10,004	2.71	0.26	0.26
1989	9,116	1.60	0.34	0.29
1990	8,301	1.56	0.27	0.29
1991	7,608	1.55	0.31	0.31
1992	6,386	1.25	0.48	0.35
1993	4,859	1.12	0.51	0.43
1994	3,614	1.23	0.72	0.57
1995	2,973	1.45	0.44	0.55
1996	2,978	1.24	0.31	0.49
1997	3,219	1.43	0.24	0.33
1998	3,547	1.79	0.21	0.25
1999	3,830	1.84	0.22	0.22
2000	4,319	1.46	0.14	0.19
2001	4,992	1.32	0.11	0.15
2002	5,193	1.41	0.41	0.22
2003	5,016	1.63	0.25	0.26
2004	5,086	1.22	0.19	0.28
2005	5,322	1.28	0.12	0.19
2006	5,520	1.09	0.18	0.17
2007	5,167	1.28	0.42	0.24
2008	4,372	1.89	0.46	0.35
2009	3,635	1.66	0.59	0.49
2010	3,303	1.60	0.52	0.52
2011	3,548	1.69	0.24	0.45
2012	3,912	1.82	0.45	0.40
2013	4,107	2.52	0.43	0.37
2014	4,325	2.68	0.45	0.44
2015	4,670	2.65	0.42	0.43
2016	5,087	2.05	0.49	0.45
2017	5,538	1.12	0.44	0.45
2018	6,128	3.38	0.21	0.38
2019	6,431	2.80	0.36	0.34
2020	6,665	1.58	0.34	0.30

Table 12. SSB and *F* reference points from 2016 and 2021 updates for the LIS region.

	SSB		*F*	
	Target	**Threshold**	**Target**	**Threshold**
2016 Update	2,865	2,148	0.28	0.49
2021 Update	6,725	5,044	0.26	0.38

Table 13. Stock status for the LIS region.

	SSB		*F*	
	Target	**Threshold**	**Target**	**Threshold**
Reference Points	6,725	5,044	0.26	0.38
2020 Estimate	6,413		0.3	
2020 Status	Not Overfished		Overfishing not Occurring	

Table 14. Short-term projection results for the LIS region using status quo removals.

Landings (mt) for 2021-2025	Probability of being at or below *F* Target in 3 years	Probability of being at or above SSB threshold in 3 years
Status quo (2018-2020 average)	3%	97%

Figures

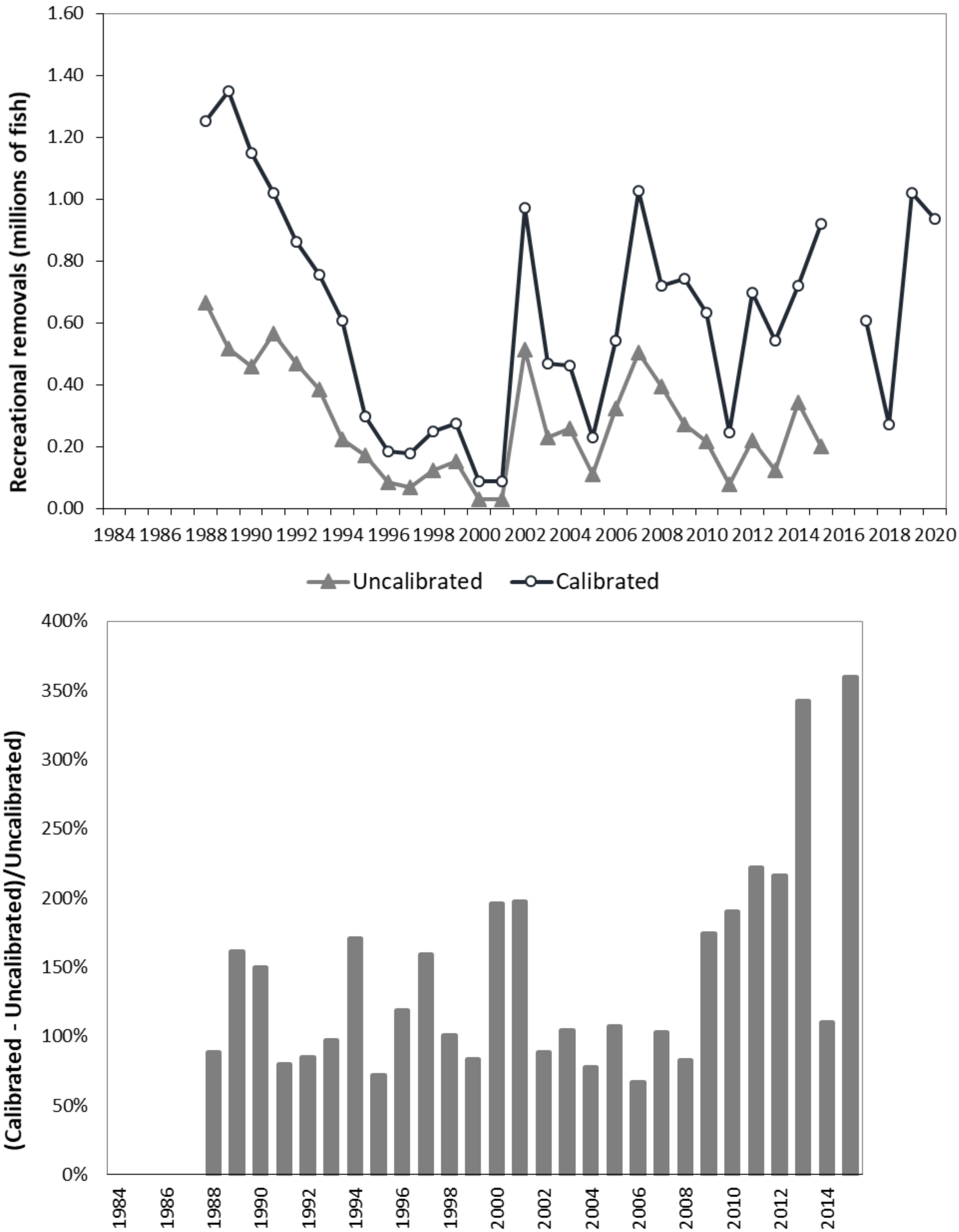


Figure 12. Comparison of calibrated and uncalibrated recreational removals (harvest + dead releases) in numbers of fish (top) and percent difference (bottom) for the LIS region.

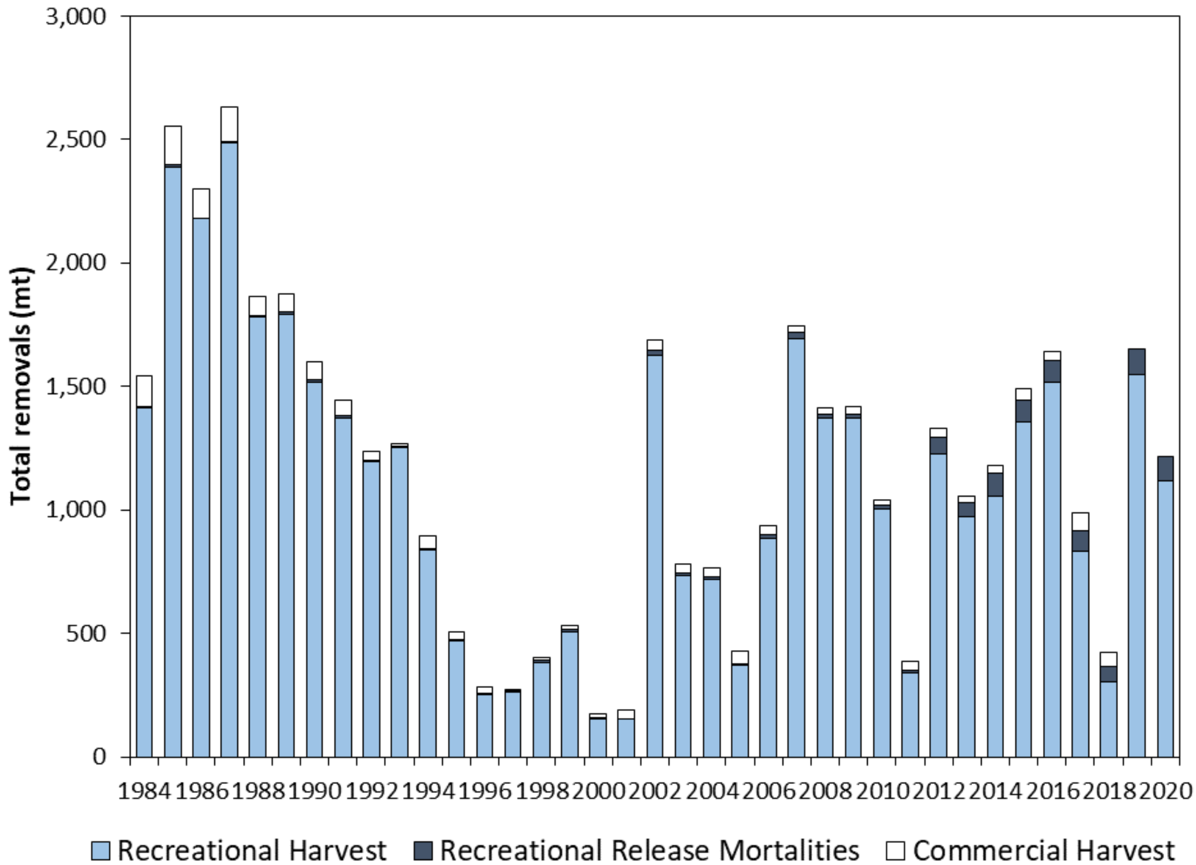


Figure 13. Total removals by sector for the LIS region.

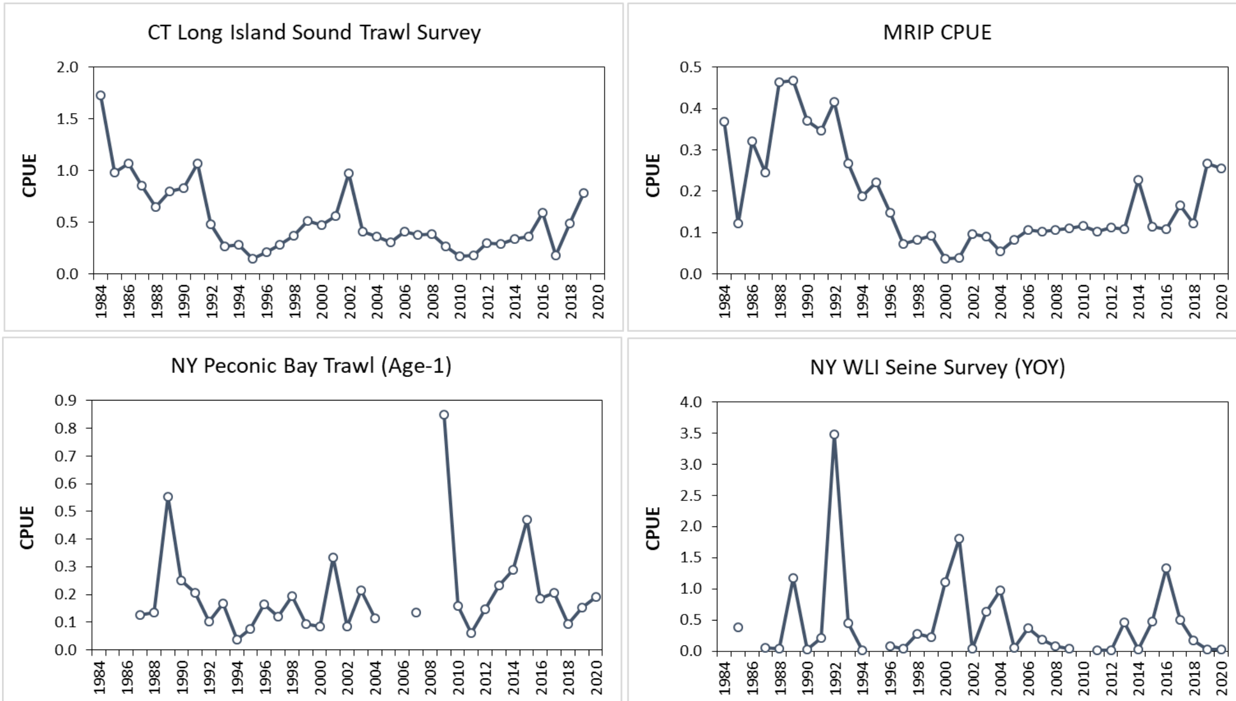


Figure 14. Indices of abundance used in the ASAP model for the LIS region.

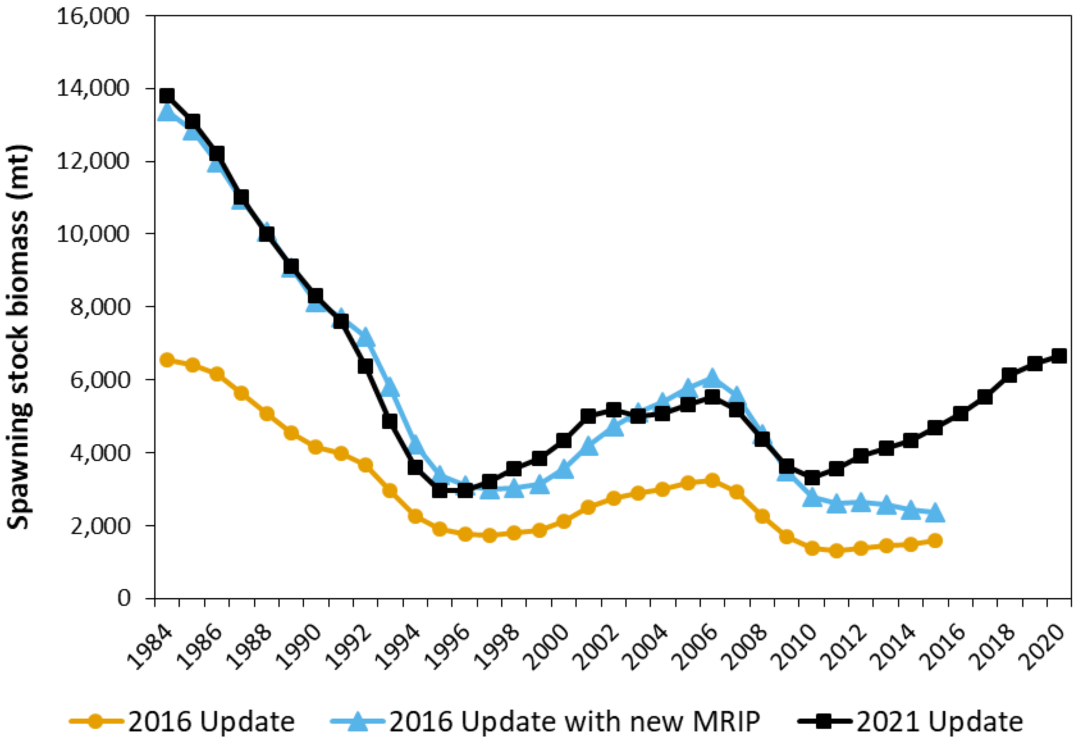


Figure 15. Estimates of spawning stock biomass for LIS region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

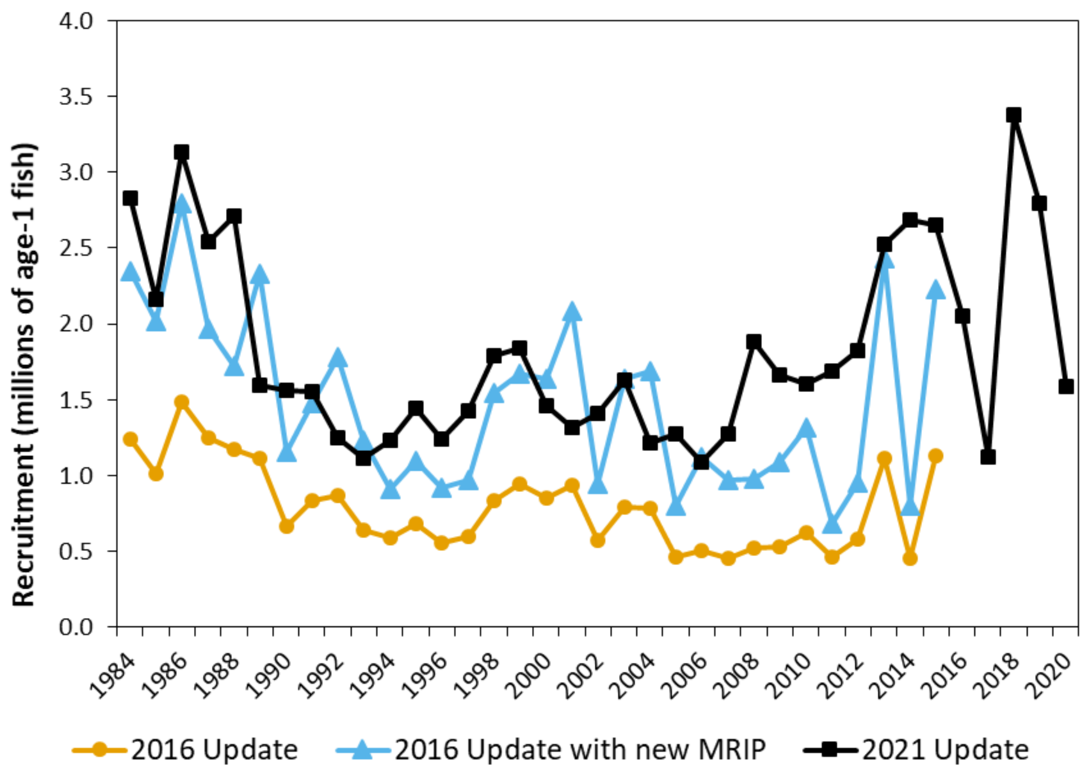


Figure 16. Estimates of recruitment for the LIS region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

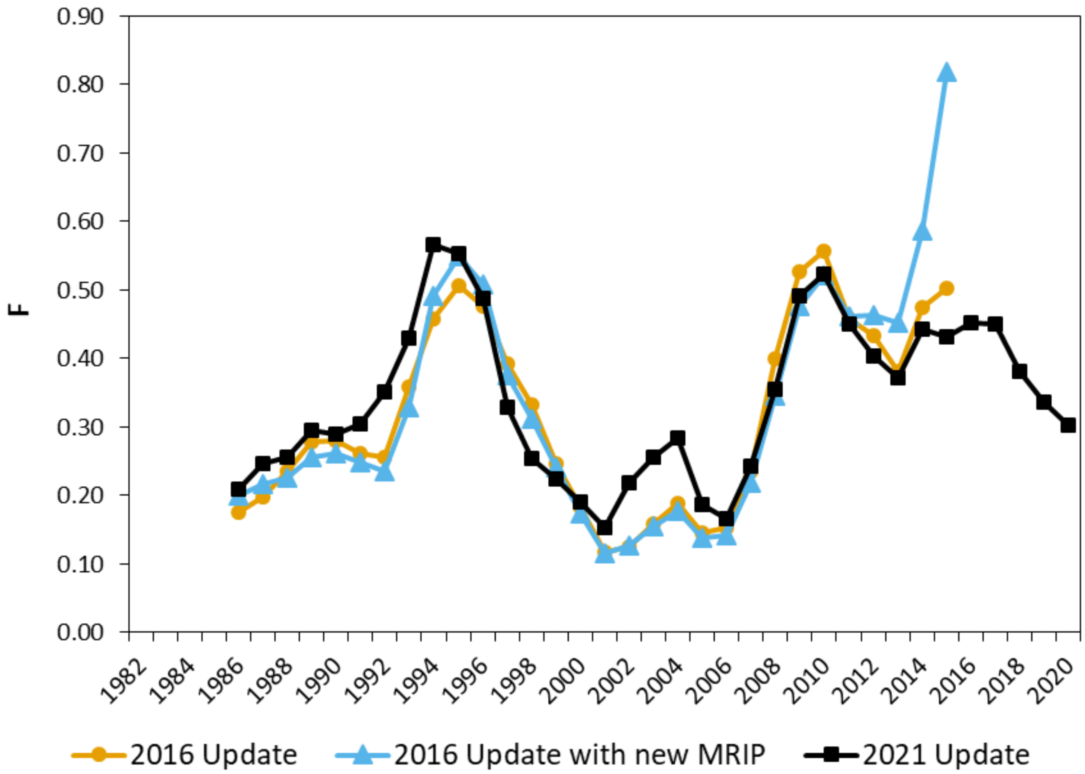
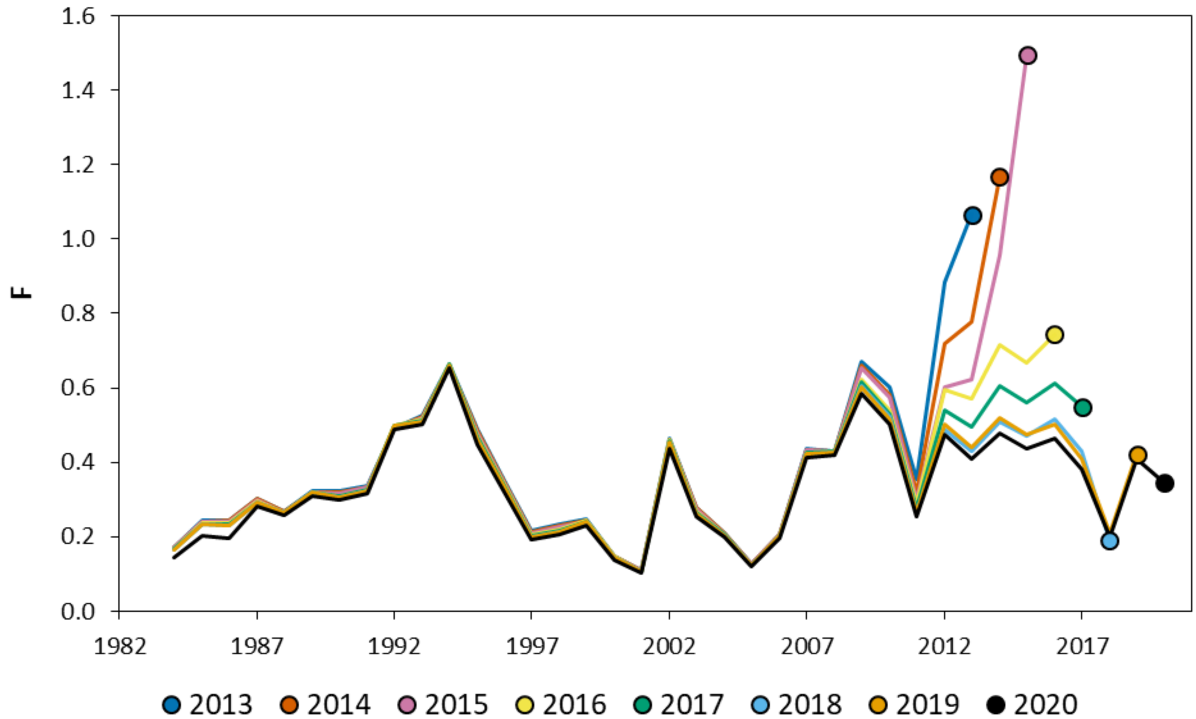


Figure 17. Estimates of the annual full *F* for the LIS region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.



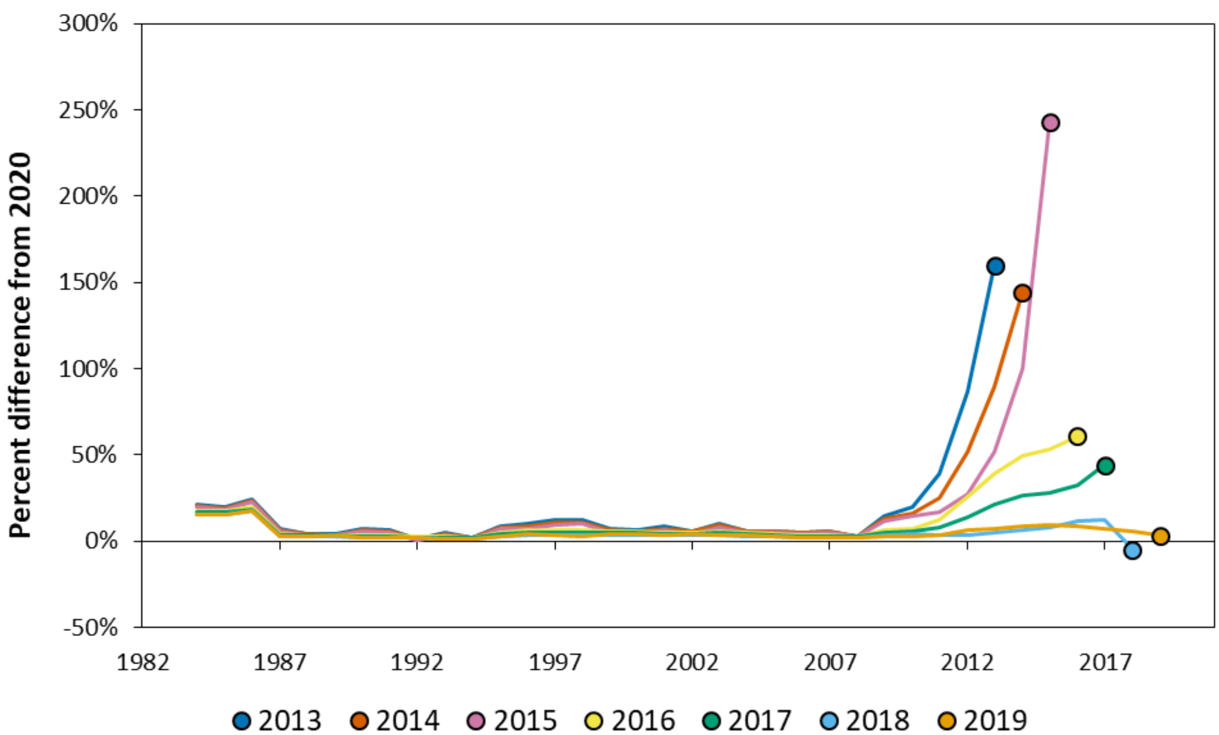


Figure 18. Retrospective analysis for annual *F* from the LIS region in absolute numbers (top) and percent difference (bottom).

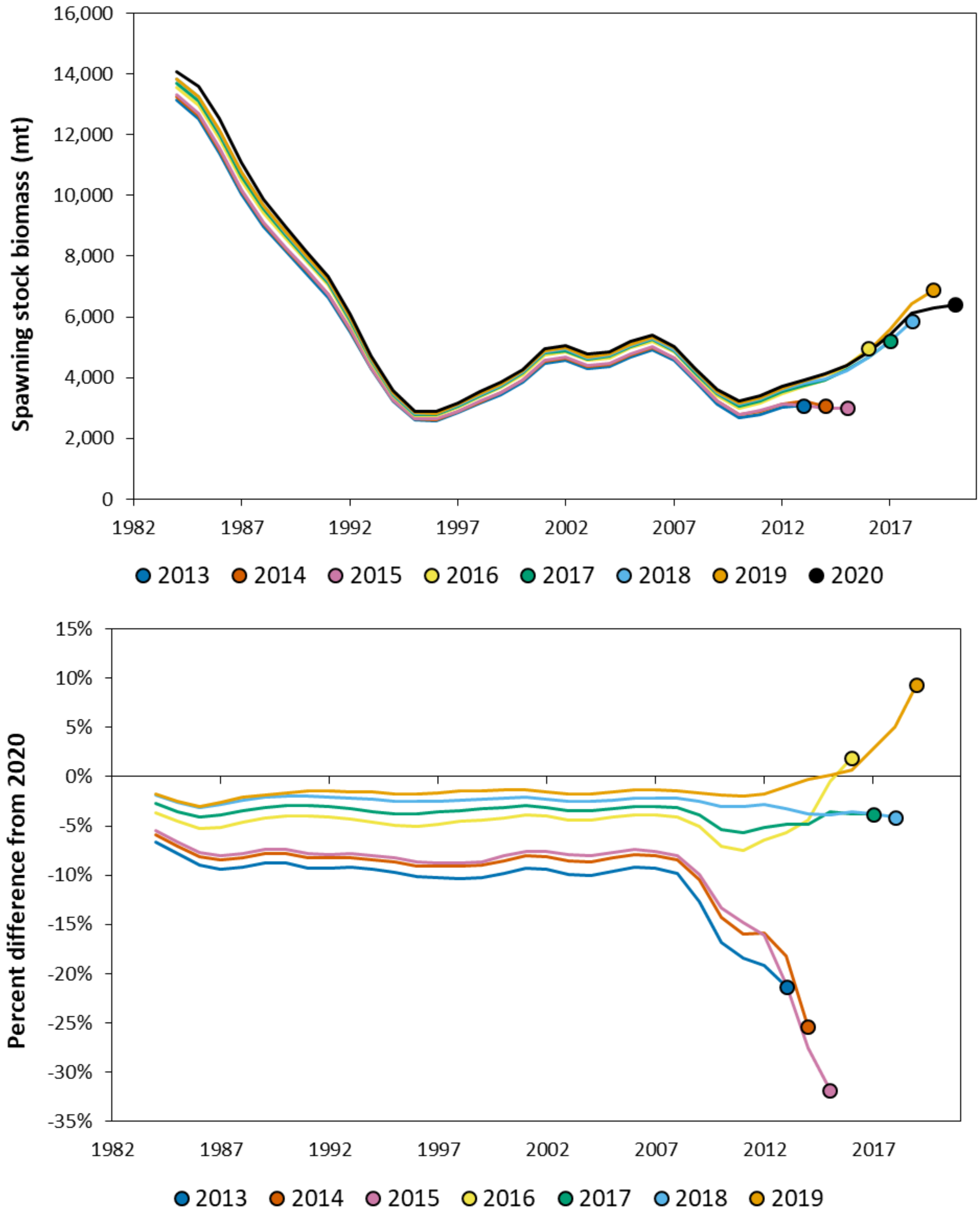
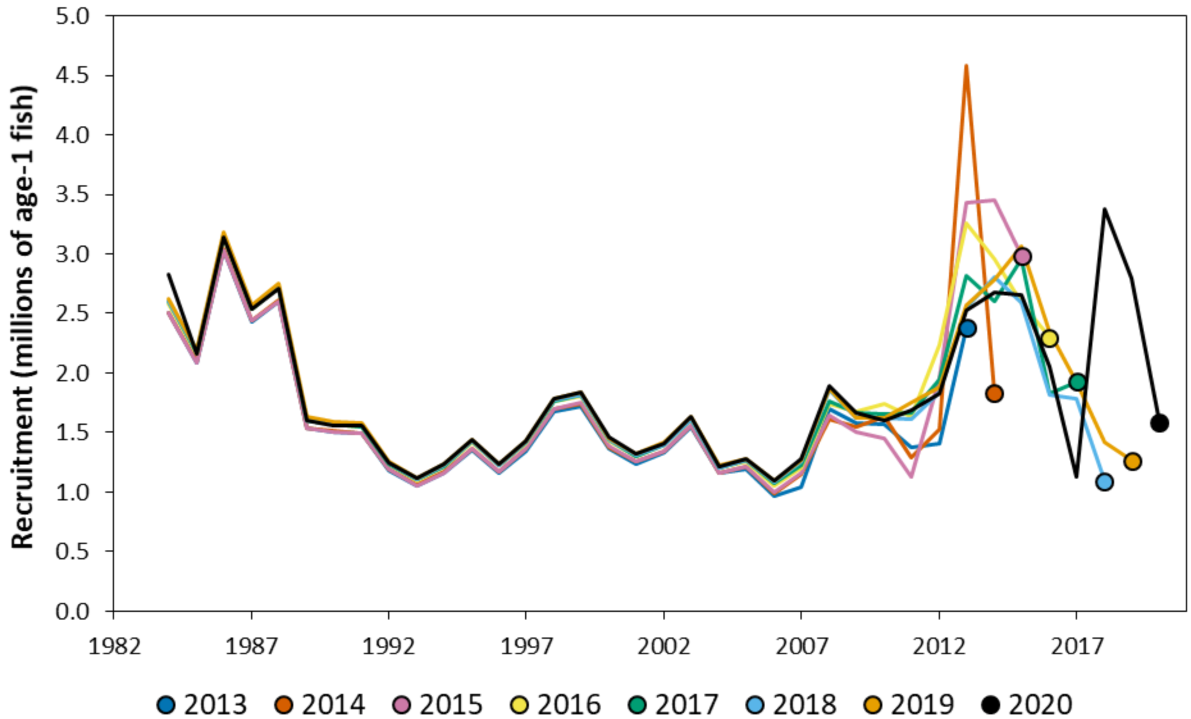


Figure 19. Retrospective analysis for annual SSB from the LIS region in absolute numbers (top) and percent difference (bottom).



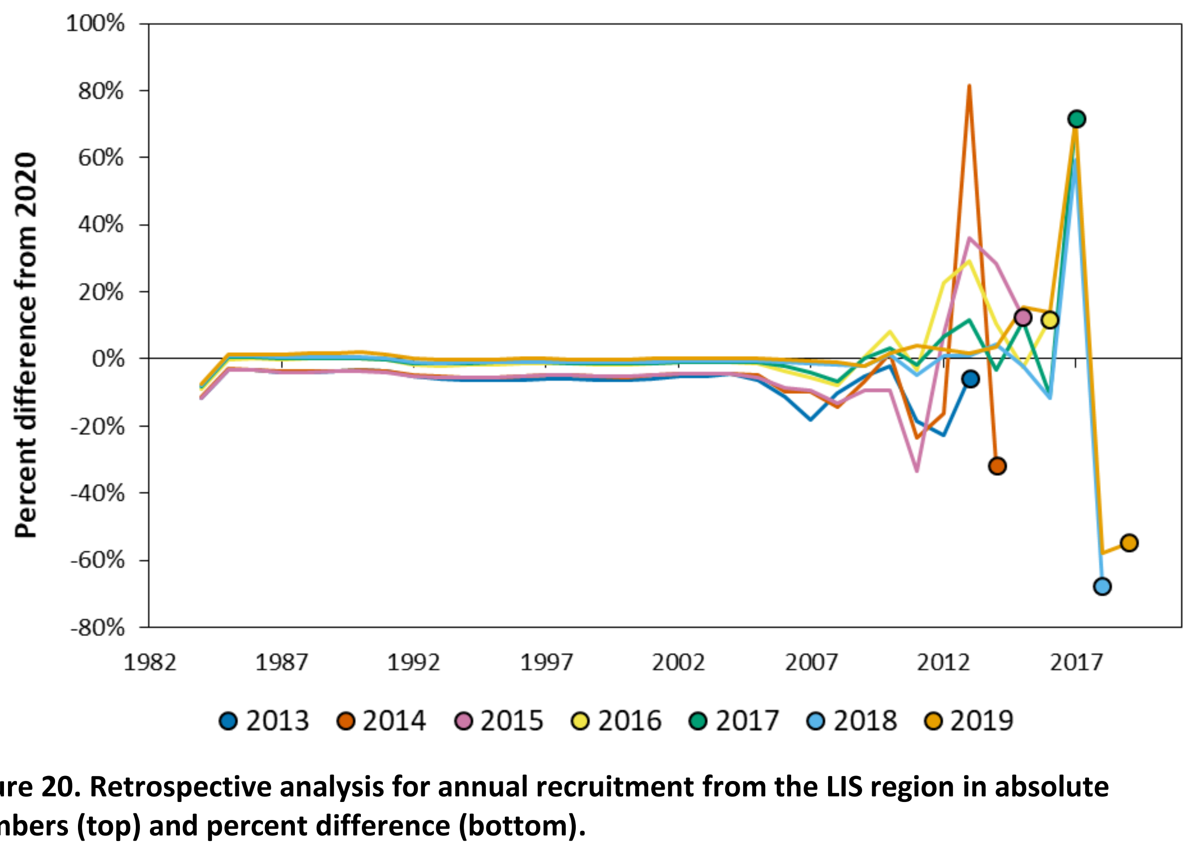


Figure 20. Retrospective analysis for annual recruitment from the LIS region in absolute numbers (top) and percent difference (bottom).

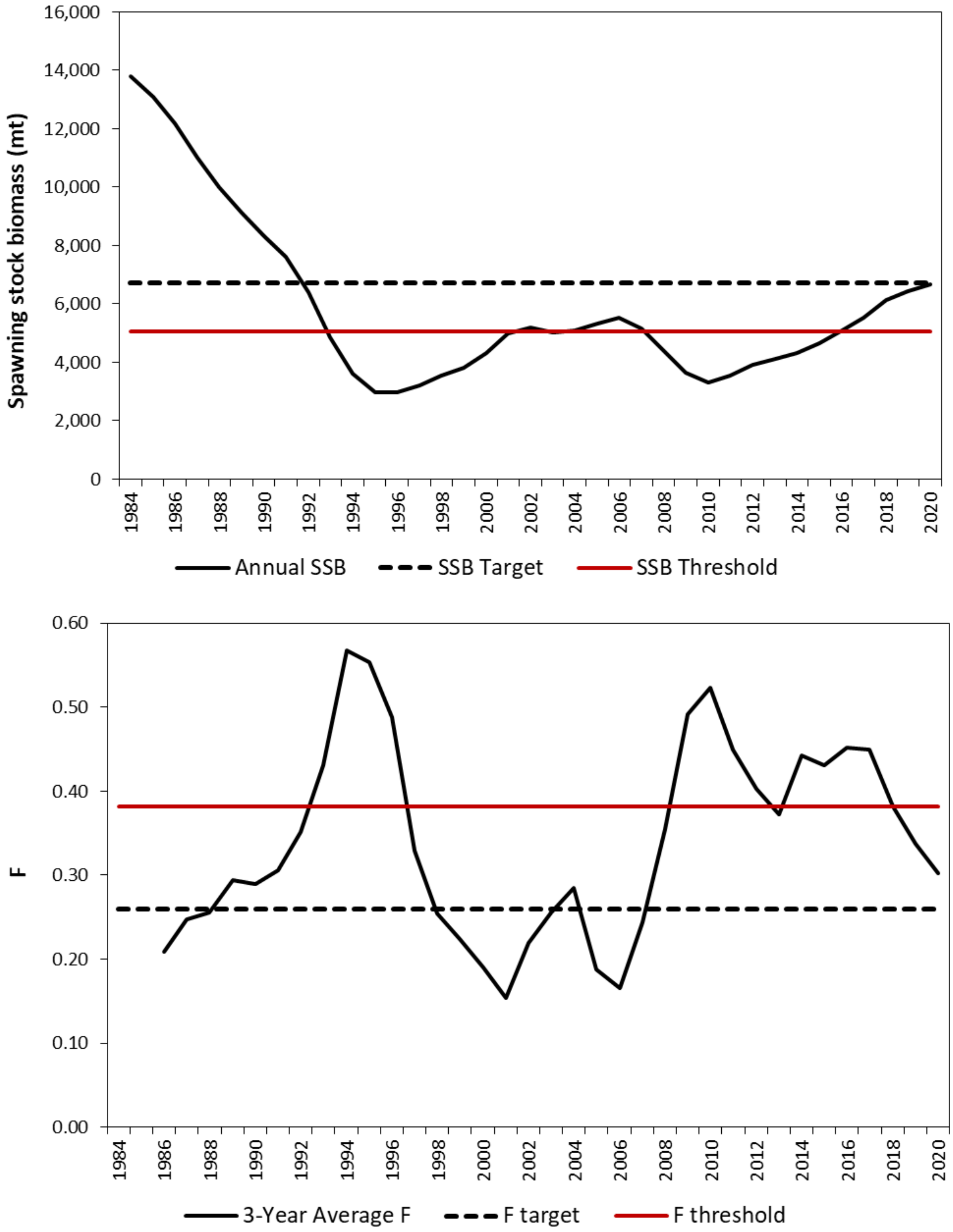


Figure 21. Annual SSB plotted with SSB target and threshold (top) and 3-year average *F* plotted with *F* target and threshold (bottom) for the LIS region.

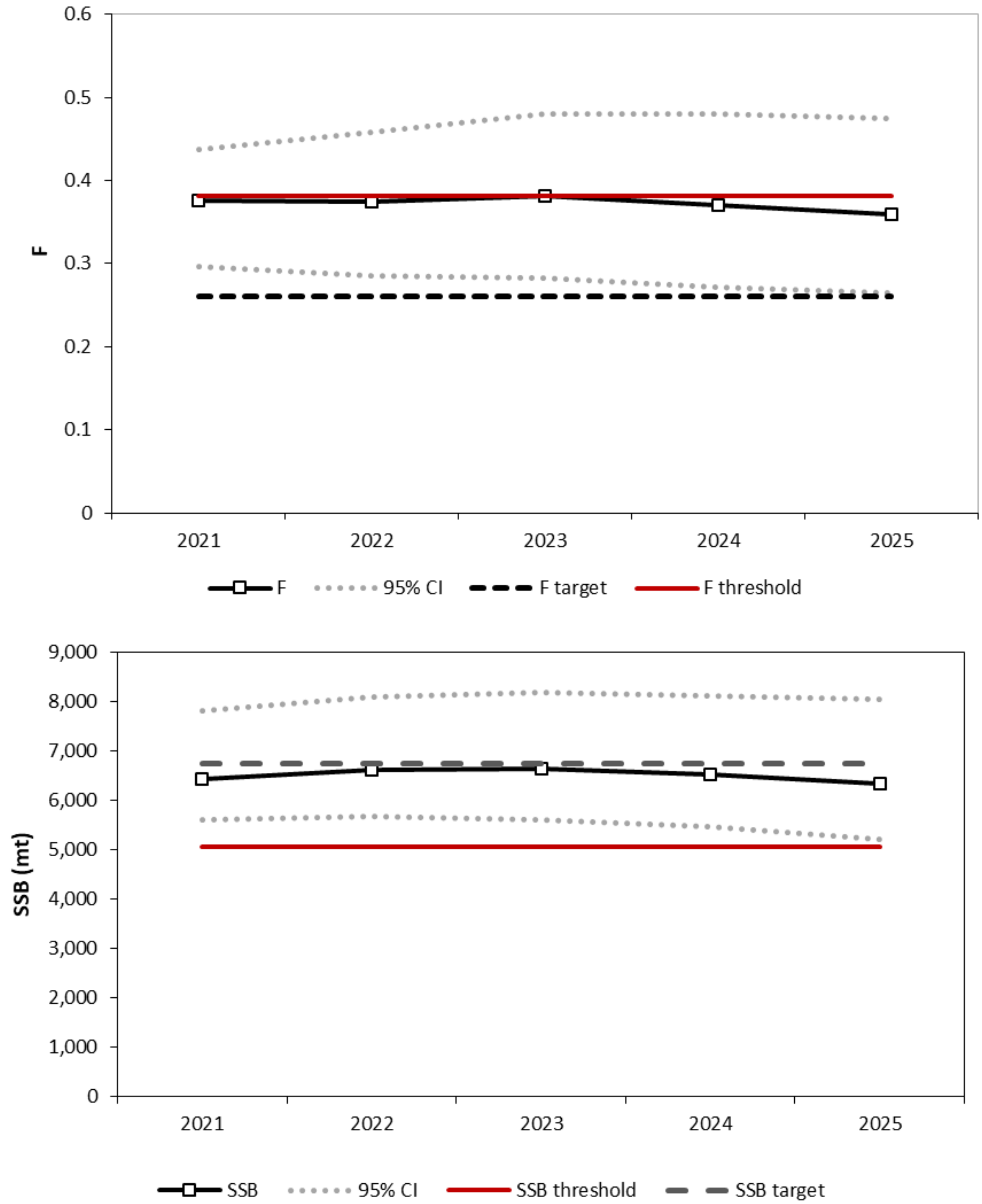


Figure 22. Status quo harvest projections for the LIS region showing the trajectory of annual *F* (top) and SSB (bottom) with their target and threshold reference points. Dotted grey lines indicate the 95% confidence intervals of the estimates.

Tautog Stock Assessment Update
NEW JERSEY-NEW YORK BIGHT REGION
2021

Executive Summary

This stock assessment is an update to the existing benchmark assessment for tautog (ASMFC 2015, ASMFC 2016); the previous assessment update was completed in 2017 (ASMFC 2017). This assessment updates the accepted statistical catch-at-age model with commercial and recreational fishery catch data and indices of relative abundance from fishery-independent and fishery-dependent data sources through the terminal year of 2020.

In the New Jersey-New York Bight (NJ-NYB) region, the stock was overfished, but overfishing was not occurring. The stock has shown an increasing trend since the last assessment update, with Spawning stock biomass (SSB) now just below the threshold in 2020.

This update includes the new time-series of calibrated recreational data from the Marine Recreational Information Program (MRIP). For the NJ-NYB region, the calibrated estimates averaged 133% higher than the uncalibrated estimates over the entire time series. The new MRIP estimates resulted in higher estimates of SSB and recruitment, but had less of an impact on *F*. Stock status has changed in this region since the last assessment update: NJ-NYB is still overfished but not experiencing overfishing. This appears to be related to reductions in *F* and increases in SSB in the most recent few years, as opposed to an artifact of the new MRIP numbers.

Short term projections using the average landings from the last three years resulted in a 15% probability of being at or below target F in 2025 and a 53% probability of being at or above SSB threshold in 2025.

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 for commercial and recreational removals was extended from the previous assessment update (ASMFC 2017) through 2020, along with the associated age compositions from both sources.

This assessment update used the new, calibrated estimates of recreational removals from MRIP. The calibrated estimates of recreational removals (harvest and dead releases) were consistently higher across the entire time series, averaging about 133% higher than the uncalibrated estimates (Figure 23).

The tautog fishery in the NJ-NYB region is predominantly recreational (Table 15, Figure 24). Recreational removals make up 96% of total removals by weight in the region. Total recreational removals were high but variable at the beginning of the time series, averaging about 2.8 million fish from 1983-1992. Recreational removals declined significantly after that, averaging about 800,000 fish from 1993-2017. Recreational removals from 2018–2020, after the implementation of Amendment 1 to the Tautog FMP, have averaged about 565,000 fish.

Commercial landings averaged 89 mt per year through the mid-1990s before quickly declining through the late 1990s, averaging 46 mt from 2000 to 2017 (Table 15, Figure 24). Commercial landings averaged 53 mt from 2018–2020, under Amendment 1.

The calibrated MRIP length frequencies were used to calculate the age composition of the recreational harvest and used as a proxy for the length composition of the commercial harvest. Data from the MRIP at-sea headboat observer program, the New Jersey Volunteer Angler Survey, and the American Littoral Society (ALS) volunteer tagging program were used to develop the age composition of the recreational release mortality. Ages 4-7 made up the majority of the total removals over the time series (NJ-NYB Appendix 1).

The Tautog TC developed a fishery dependent index of abundance from MRIP recreational survey data, using the same "logical species guilds" from the benchmark assessment to identify tautog trips (Table 16). Only non-imputed intercepts were used to calculate the index for 2020. The MRIP CPUE increased at the beginning of the series, peaking in the early 1990s before declining to lower but somewhat variable levels from the late 1990s to the present (Figure 25).

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.

Fishery-independent indices from the NJ-NYB region consisted of the NJ Ocean Trawl Survey and the New York Western Long Island Seine Survey (Table 16, Figure 25). Age composition information was available for the NJ Ocean Trawl survey and is shown in NJ-NYB Appendix 1. For all indices, statistical model-based standardization of the survey data was conducted to account for factors that affect tautog catchability.

The NJ ocean trawl survey, which began in 1989, is conducted 5 times annually from January through October utilizing a stratified random design and is used in the assessment as an index of age-1+ tautog abundance. The survey was not conducted in 2020 due to COVID-19 restrictions. The index was variable but indicated a period of high abundance at the beginning of the time series, declined through the late 1990s, then recovered to moderate abundance between 2000 and 2010. The index has been variable since 2010 showing early declines in 2011-2012, a moderate recovery from 2013 to 2016, then declining again in 2017 and remaining low through 2019 (Figure 25).

The NY WLI seine survey has operated from 1984 to the present, with a consistent standardized methodology starting in 1987. It is a fixed site survey that is conducted in three separate embayments on Long Island; the data were subset to Jamaica Bay on the south side of Long Island for the NJ-NYB region. The WLI seine index captures mainly age- 0 fish, so was lagged forward one year and treated as an age-1 index. It was used to develop a YOY index of recruitment for tautog. The NY WLI seine survey was conducted in 2020 but the start was delayed due to COVID-19 restrictions. The index was variable with periodic years of higher recruitment including the early 1990s and the early 2000s; recent years from 2012 to 2018 showed time-series highs before declining sharply in 2019 and 2020 (Figure 25).

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.

Life history information used in this update continued using the same values as those utilized in the benchmark assessment (Table 17). Natural mortality was set at 0.15. The age plus group included ages 12 and over. The start year was set at 1989 with the terminal year of 2020 which adds 5 additional years of data since the last assessment. The maturity schedule remained the same as the benchmark with 0 for ages 1 and 2, 0.8 for age 3, and 1 for ages 4 through 12 plus. One additional selectivity block was incorporated in this update to reflect the changes in seasons and bag limits for the years 2018 through 2020, resulting in a total of 5 selectivity blocks utilized for this assessment (Table 17).

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.

Comparison runs were made for *F*, SSB and recruitment using the original 2016 assessment estimates and a continuity bridge run through 2015 using the calibrated MRIP values to isolate the effect of the MRIP calibration from the effect of adding more years of data. Comparison runs for SSB showed a marked increase in scale for the models using the calibrated MRIP values (continuity and the 2021 update) over the 2016 assessment run, yet all 3 show a similar pattern with an upward trend in the latest years (Figure 26). Comparison model runs for recruitment show a similar difference in scale as seen for SSB (Figure 27). However, both the 2016 update and the continuity runs show a spike upward for 2013 to 2014 which is absent in the 2021 update. The upward spike may be an artifact of the way the ASAP model estimates recruits since the 2021 update shows a sharp upward spike in 2018 which is within the 2-year window from the terminal year as seen for the models with 2015 as the terminal year. Both the 2016 update and continuity run estimates for *F* were higher than the 2016 update early in the time series from 1995 to 1996 and again in 2014 (Figure 28). The 2016 assessment *F* values diverged upward from the other 2 runs in 2007 and 2008 and spiked sharply upward during the years 2010 through 2012, Otherwise all 3 runs seemed to track closely with each other, and all their 2015 *F* estimates were in fairly close agreement.

Retrospective analyses peeling back 7 years from 2020 through 2013 for F and SSB showed discernible patterns. Previous year estimates overestimated *F* by a range of 9% to just over 100% (Figure 29), while SSB was shown to have been underestimated in the previous 3 years by a range 5% to 15% (Figure 30). The Mohn's rho adjusted estimates for *F* (0.22) and SSB (3,614 mt) fell within the 95% CI of 0.08-0.39 for the current *F* estimate of 0.24 and within the 95% CI of 2,989 mt-6,575 mt for the current SSB estimate of 4,782 mt (NJ-NYB Appendix 2 Figure A2.1), so a retrospective adjustment was not conducted. The retrospective analysis for recruitment showed much greater variability than those for *F* and SSB but seemed to show a general pattern of overestimating recruits in most years by a range of 3% to 88% (Figure 31). Recruits in 2020 were estimated to number about 1.4 million fish (standard deviation of about 765,000).

Sensitivity runs included individually dropping each survey index and utilizing the MRIP index calculated with imputed values for 2020. The sensitivity runs generally show most model estimates of SSB and *F* tracking closely with the 2021 update through most of the time series through 2015. The model without the NJ Ocean Trawl Survey showed consistently lower SSB estimates through 2007 and then yielded higher values from 2010 through 2018 before nearly matching the 2021 update estimate in 2019. The other 3 models diverged from the 2021 update after 2015 with the model minus the MRIP index showing sharply higher SSB estimates from 2018 through 2020. The model without the NY WLI Seine Survey and the model using the imputed MRIP index showed lower estimates than the 2021 update after 2015, however the model with the imputed MRIP index follows the upward trend seen in the other model runs. The model without the NY WLI Seine index shows a slight dip in the terminal year. The sensitivity runs showed only slight differences from the 2021 update run for F estimates, with the model minus the NJ Ocean Trawl Survey index showing the most divergence with slightly higher F estimates early in the time series during the 1990s, and then slightly underestimating F since 2009 (NJ-NYB Appendix 2 Figures A2.2).

For recruitment, the sensitivity runs show all model runs tracking closely through the time series through 2012 then the model without the NY WLI Seine index and the model without the MRIP index diverge in opposite directions (NJ-NYB Appendix 2 Figure A2.4). The model without the NY WLI Seine drops below the 2021 update while the model without the MRIP index tracks a higher recruitment through 2018. However, all the models estimated terminal year values that are within 0.4 million of each other. The models without the MRIP, NJ Ocean Trawl and with the imputed MRIP indices all show a dip from 2019 to 2020 while the model without the NY WLI Seine index shows an increase in the final year which is reflected in the slight increase seen in the 2021 update run.

Overall, the sensitivity runs seem to indicate that none of the indices has a significant impact on the *F* estimates, but both the NY WLI and MRIP indices seem to influence the SSB and recruitment estimates in opposite directions: the NY WLIS index impacting the SSB and recruitment in an upward direction while the MRIP index appears to have a dampening effect on those values (NJ-NYB Appendix 2 Figures A2.2-A2.4).

Overall, spawning stock biomass in the NJ-NYB region has declined since the beginning of the time series; there were brief periods of increasing SSB as F declined, but as F increased again, those increases would reverse (Table 18, Figure 32). SSB reached a low in 2011 but has been increasing since then. The 3-year average of F has been highly variable over time, with alternating periods of being above and below the F threshold; F has been declining since 2016 (Table 18, Figure 32)

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

Biological reference points were scaled up for spawning stock biomass and decreased for fishing mortality due in part to the increased values from the calibration of MRIP landings. The SSB target and threshold values increased from those in the 2016 update to a target SSB of 6,552 mt and threshold SSB of 4,890 mt (Table 19). Target and threshold *F* decreased from those in 2016 to target F of 0.19 and threshold *F* of 0.30 (Table 19). The 2020 estimated SSB of 4,782 mt is below the threshold, and the stock remains in the overfished status as it was in the 2016 assessment (Table 20, Figure 32). The 2020 3-year average for *F* of 0.26 is below the threshold value thereby changing the overfishing status of the 2016 assessment to the 2020 status of not overfishing (Table 20, Figure 32).

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

Short term projections for the years 2021-2025 were run using the status quo landings from the average of the total removals from 2018 through 2020 (840 mt). The short term projection using the target *F* estimate resulted in a 15% probability of being at or below target *F* in the terminal year (Table 21, Figure 33), and a 63% probability of being at or below threshold *F*. These projections showed a 53% probability of being at or above SSB threshold in 2025 but only a 12% probability of being at target SSB (Table 21, Figure 33). The 2016 projection of 93% probability of being below threshold *F* in 2020 seemed to be met with the current estimate of *F* below the threshold. The 2020 SSB estimate just missed meeting current SSB threshold estimates bearing out the 85% probability of being at or above the SSB threshold for 2020 in the 2016 projection.

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.

MRIP sampling sites have been increased for 2021 and 2022 which should result in increased sampling opportunities for recording tautog catches.

In 2016, New Jersey began conducting a ventless trap survey within and around 3 artificial reef sites off the central New Jersey coast. The trap gear is more appropriate for structure-oriented species such as tautog, and the data from this survey may potentially be useful for the next benchmark assessment if the time-series meets the minimum requirement of 10 years.
The commercial tagging program was implemented in 2020, and New Jersey's commercial fishing sector has generally been supportive. While the program has too recently been implemented to gauge its results, it is hoped the illegal market for tautog was reduced with this measure. The ability to quantify the number of fish commercially harvested will augment the current weight-only data from this fishery and increase the accuracy of its removals estimates.

List of Appendices

NJ-NYB Appendix 1: ASAPplots output of the base model
NJ-NYB Appendix 2: Retrospective adjustments and sensitivity runs

References

Atlantic States Marine Fisheries Commission. 2015. Tautog benchmark stock assessment. Arlington, VA.

Atlantic States Marine Fisheries Commission. 2016. Tautog regional stock assessment: Long Island Sound and New Jersey-New York Bight. Arlington, VA.

Atlantic States Marine Fisheries Commission. 2017. 2016 Tautog Stock Assessment Update. Arlington, VA. 143 pp.

Tables

Table 15. Total removals in metric tons by sector for the NJ-NY Bight region.

Year	Recreational Harvest	Recreational Release Mortalities	Commercial Harvest
1982	1,162.4	6.8	67.2
1983	1,579.3	13.3	45.6
1984	1,581.0	4.7	58.8
1985	2,798.7	16.7	56.9
1986	2,550.7	10.7	54.8
1987	3,404.6	39.0	58.4
1988	1,895.5	24.1	89.6
1989	1,826.0	19.9	57.9
1990	1,895.6	23.1	86.6
1991	2,767.4	66.5	93.2
1992	2,932.7	53.7	84.8
1993	1,481.2	43.3	89.2
1994	439.9	18.0	92.2
1995	1,616.0	30.3	64.1
1996	1,322.2	37.0	50.7
1997	871.9	39.1	30.9
1998	64.5	14.3	31.5
1999	769.5	77.1	26.5
2000	1,978.2	42.2	30.9
2001	1,313.3	32.6	50.3
2002	1,552.1	71.0	35.9
2003	534.4	30.2	49.5
2004	412.1	27.1	49.5
2005	170.3	10.6	47.4
2006	847.3	28.7	52.2
2007	1,087.5	62.3	58.0
2008	814.7	43.7	57.3
2009	1,241.1	48.6	34.6
2010	1,172.3	53.5	57.4
2011	762.4	49.0	66.8
2012	370.3	18.1	39.9
2013	1,277.8	134.0	52.8
2014	2,609.5	64.3	46.4
2015	820.4	75.2	47.7
2016	1,352.4	189.3	66.2
2017	868.5	82.7	64.1
2018	578.7	17.6	50.0
2019	900.9	84.6	66.3
2020	643.4	147.0	32.1

Table 16. Indices used in the ASAP model for the NJ-NYB region.

Index Name	Index Metric	Design	Time of Year	Years	Ages
NY DEC Western Long Island Seine Survey	Mean number per haul	Fixed	May-Oct	1984-2020	YOY
NJ DEP Ocean Trawl Survey	Mean number per tow	Stratified Random	Jan-Oct	1989-2019	1+
MRIP CPUE	Total catch per angler-trip	Stratified Random	Mar-Dec	1981-2020	1+

Table 17. Model structure and life history information used in the stock assessment.

	Value(s)
Years in Model	1989-2020
Age Plus Group	12+
Fleets	1 (Rec and Commercial)
Recreational Release Mortality Rate	2.5%
Fraction of year before SSB clculation	0.42
Number of selectivity blocks	5
Selectivity periods	1989-1996, 1997- 2006, 2007-2011, 2012-2017, and 2018-2020
Selectivity type	Single logistic

	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	12+
Proportion mature-at-age	0	0	0.8	1	1	1	1	1	1	1	1	1
Natural mortality	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Table 18. Spawning stock biomass, recruitment, annual *F*, and 3-year average *F* estimates for the NJ-NY Bight region.

Year	Spawning stock biomass (mt)	Recruitment (millions of age-1 fish)	Annual *F*	3-year Average *F*
1989	9,206	3.91	0.29	
1990	9,408	3.54	0.30	
1991	8,633	3.44	0.49	0.36
1992	6,738	2.58	0.72	0.50
1993	5,517	2.04	0.47	0.56
1994	5,428	1.62	0.20	0.46
1995	5,262	1.40	0.39	0.35
1996	4,599	1.25	0.35	0.31
1997	4,230	1.38	0.23	0.32
1998	4,293	1.85	0.09	0.22
1999	4,502	1.52	0.20	0.17
2000	4,457	1.46	0.35	0.21
2001	4,124	1.52	0.42	0.32
2002	3,683	1.38	0.51	0.42
2003	3,511	1.41	0.27	0.40
2004	3,649	1.85	0.18	0.32
2005	3,921	1.91	0.10	0.18
2006	4,241	1.91	0.24	0.17
2007	4,232	1.88	0.33	0.22
2008	4,133	1.86	0.32	0.30
2009	3,963	1.42	0.42	0.36
2010	3,665	1.57	0.45	0.40
2011	3,442	1.56	0.31	0.39
2012	3,565	2.19	0.22	0.32
2013	3,645	2.10	0.40	0.31
2014	3,615	2.20	0.52	0.38
2015	3,674	2.05	0.42	0.44
2016	3,779	1.92	0.53	0.49
2017	3,867	1.60	0.39	0.45
2018	4,150	2.46	0.25	0.39
2019	4,373	1.35	0.28	0.31
2020	4,782	1.41	0.23	0.26

Table 19. Comparison of spawning stock biomass and fishing mortality reference points from 2016 and 2021 updates for the NJ-NYB region.

	SSB		*F*	
	Target	Threshold	Target	Threshold
2016 Update	3,154	2,351	0.20	0.34
2021 Update	6,552	4,890	0.19	0.30

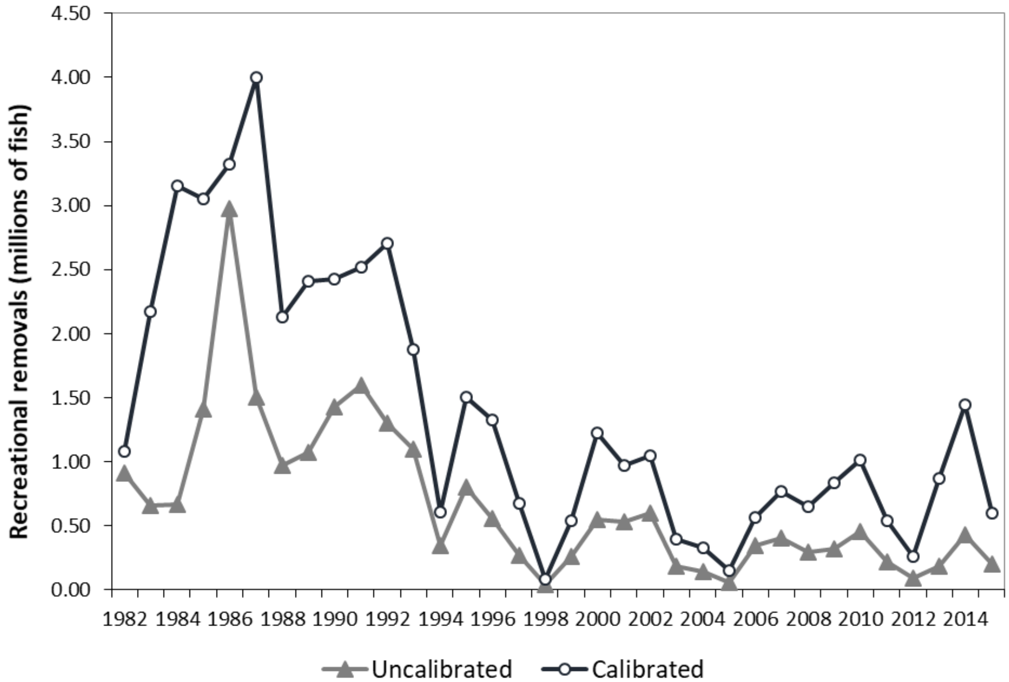
Table 20. Stock status for the NJ-NYB region.

	SSB		*F*	
	Target	Threshold	Target	Threshold
Reference Points	6,552	4,890	0.19	0.30
2020 Estimate	4,782		0.26	
2020 Status	Overfished		Not Overfishing	

Table 21. Short-term projections for the NJ-NYB region using status quo landings

Landings (mt) for 2021-2025	Probability of being at or below *F* Target in 5 years	Probability of being at or above SSB threshold in 5 years
Status quo (2018-2020 average)	15%	53%

Figures



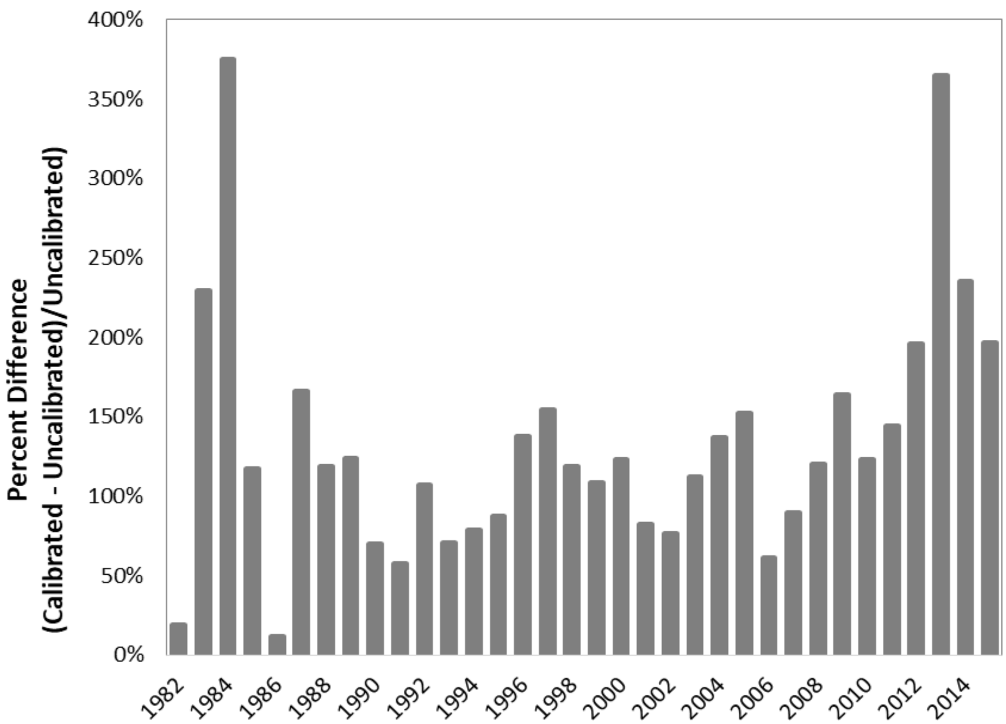


Figure 23. Comparison of calibrated and uncalibrated recreational removals (harvest + release mortalities) in numbers of fish (top) and percent difference (bottom) for the NJ-NY Bight region.

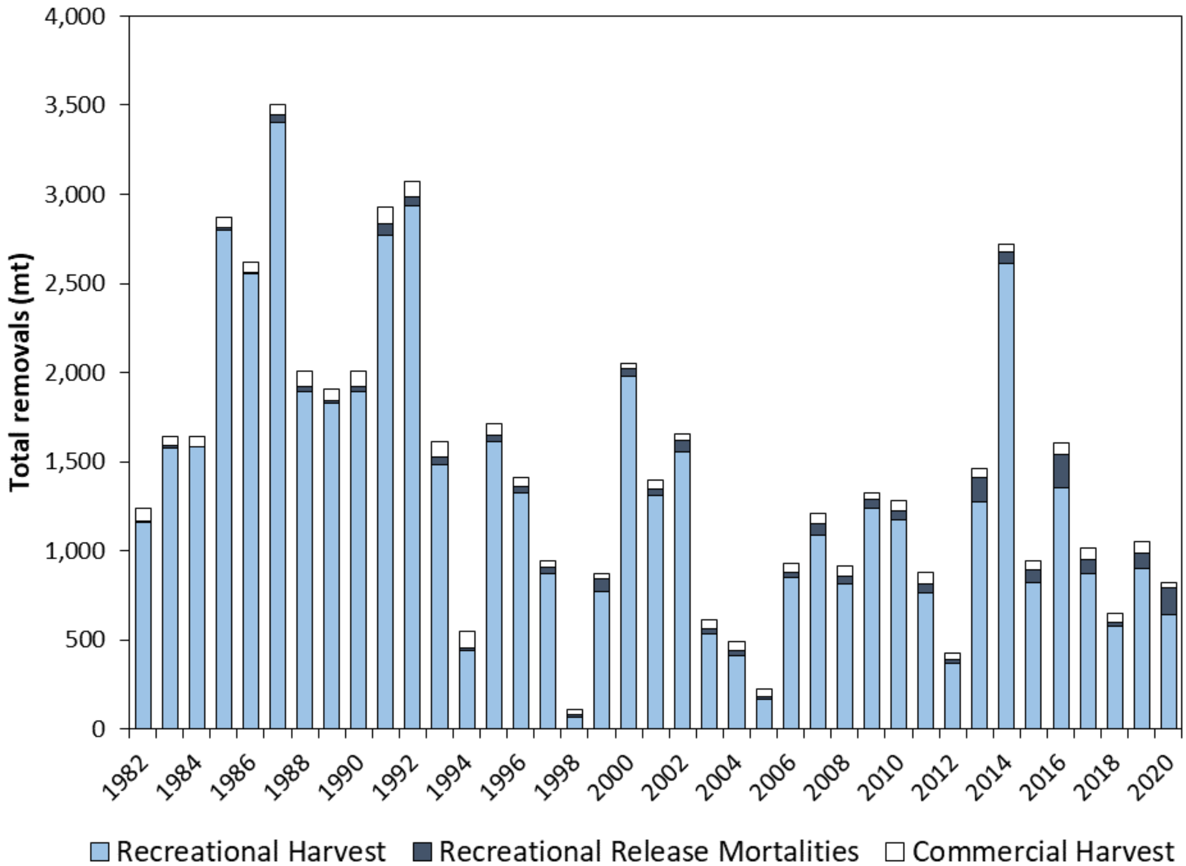
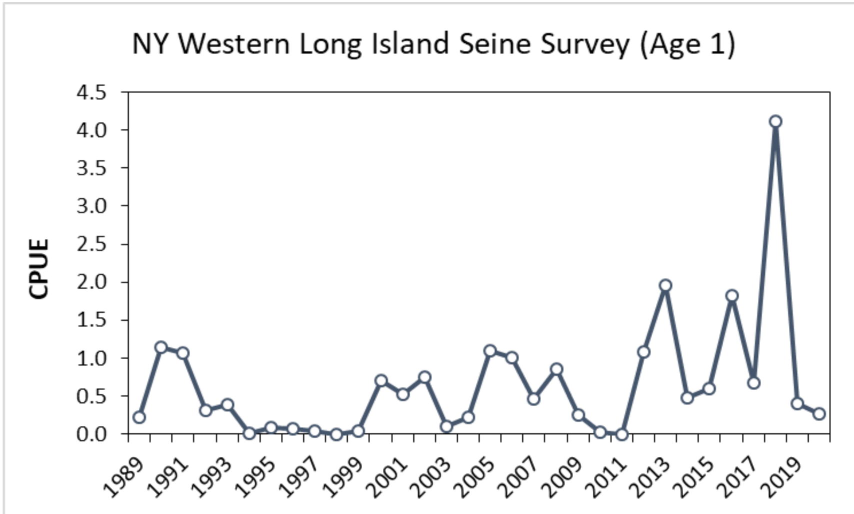
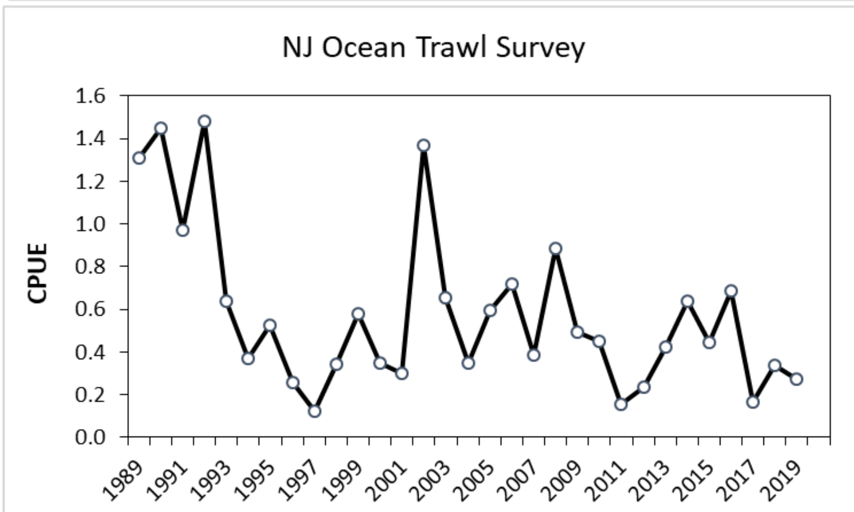


Figure 24. Total removals by sector for NJ-NY Bight region.





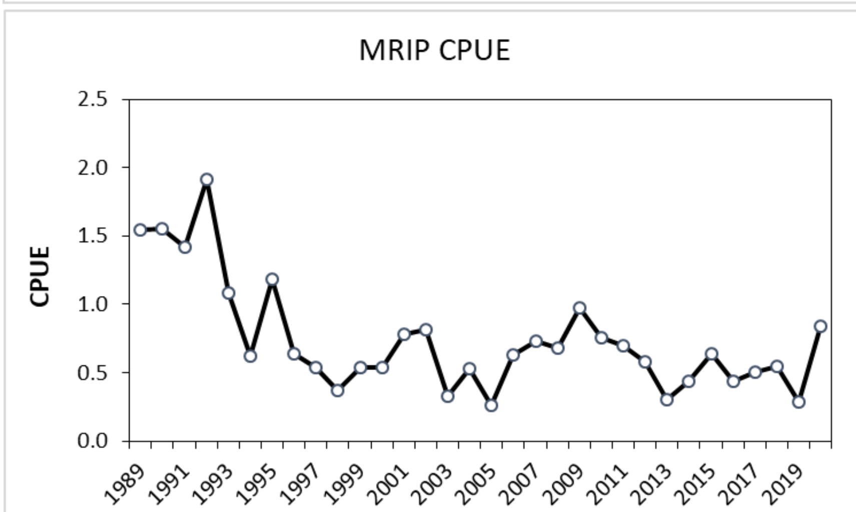


Figure 25. Indices of abundance used for the NJ-NY Bight region.

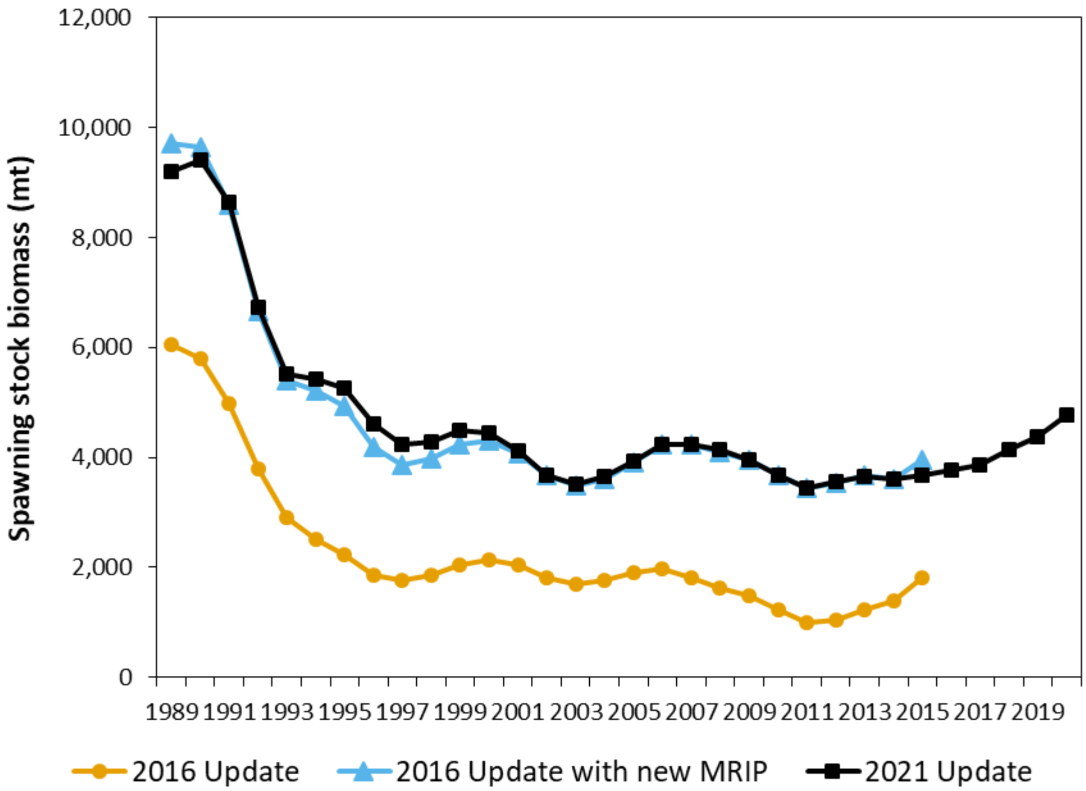


Figure 26. Estimates of spawning stock biomass for the NJ-NYB region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

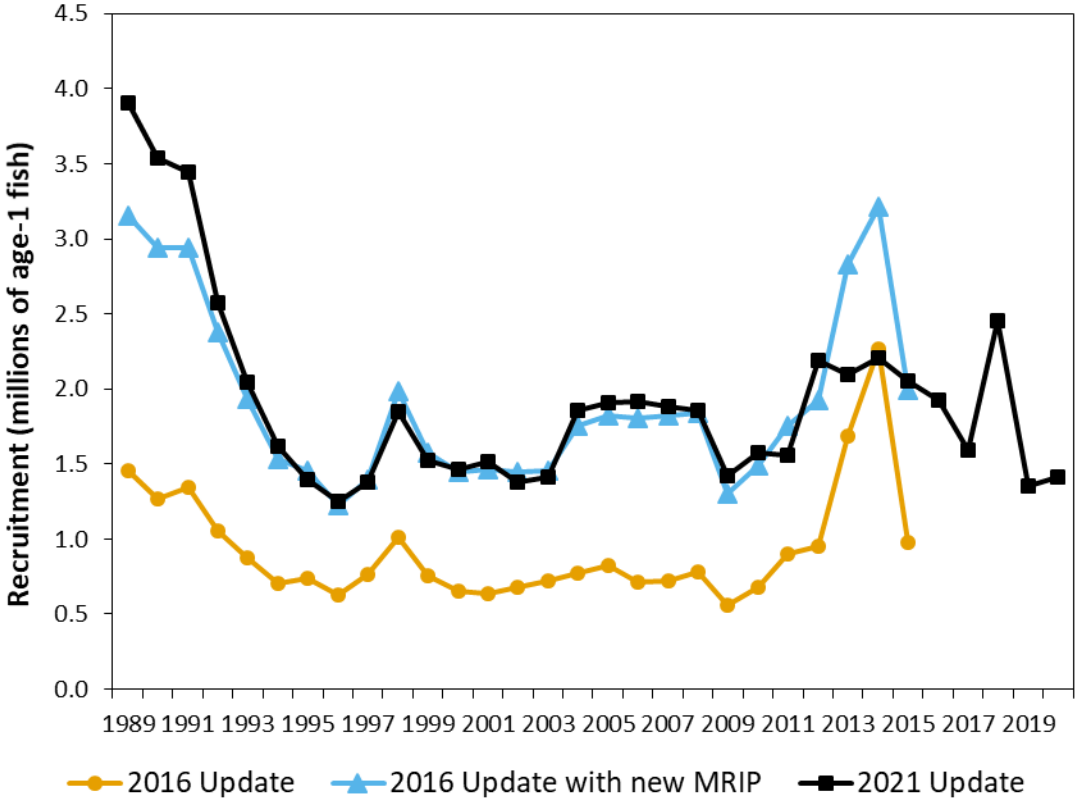


Figure 27. Estimates of recruitment for the NJ-NYB region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

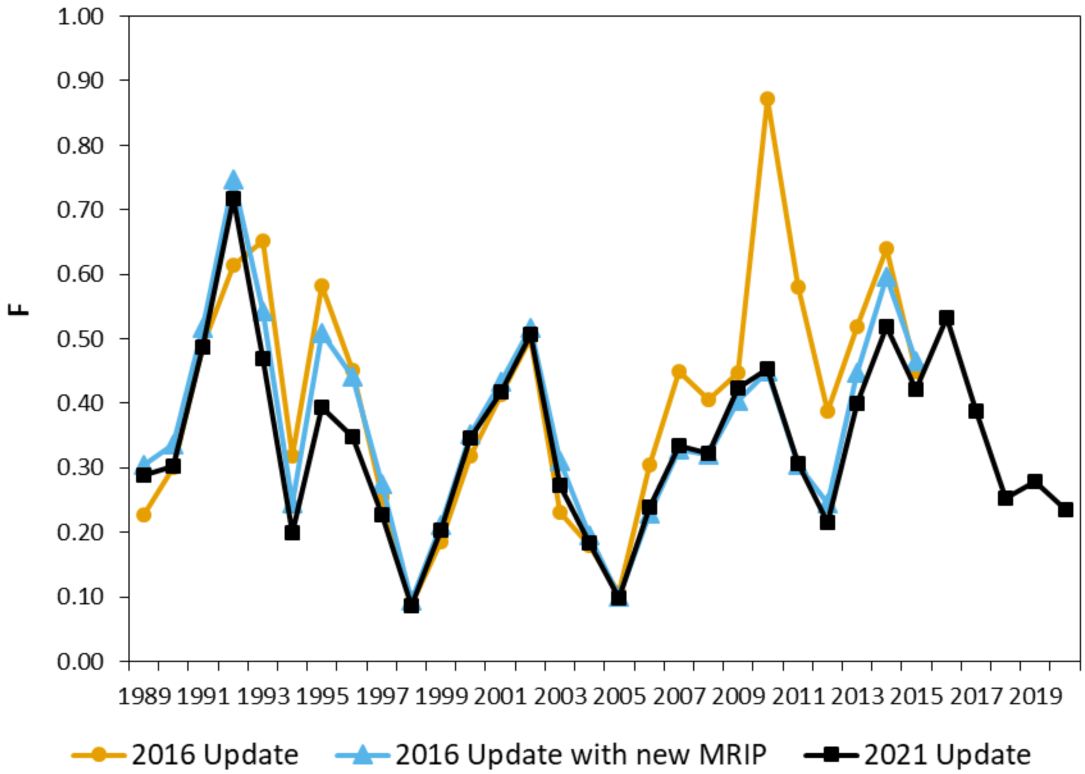
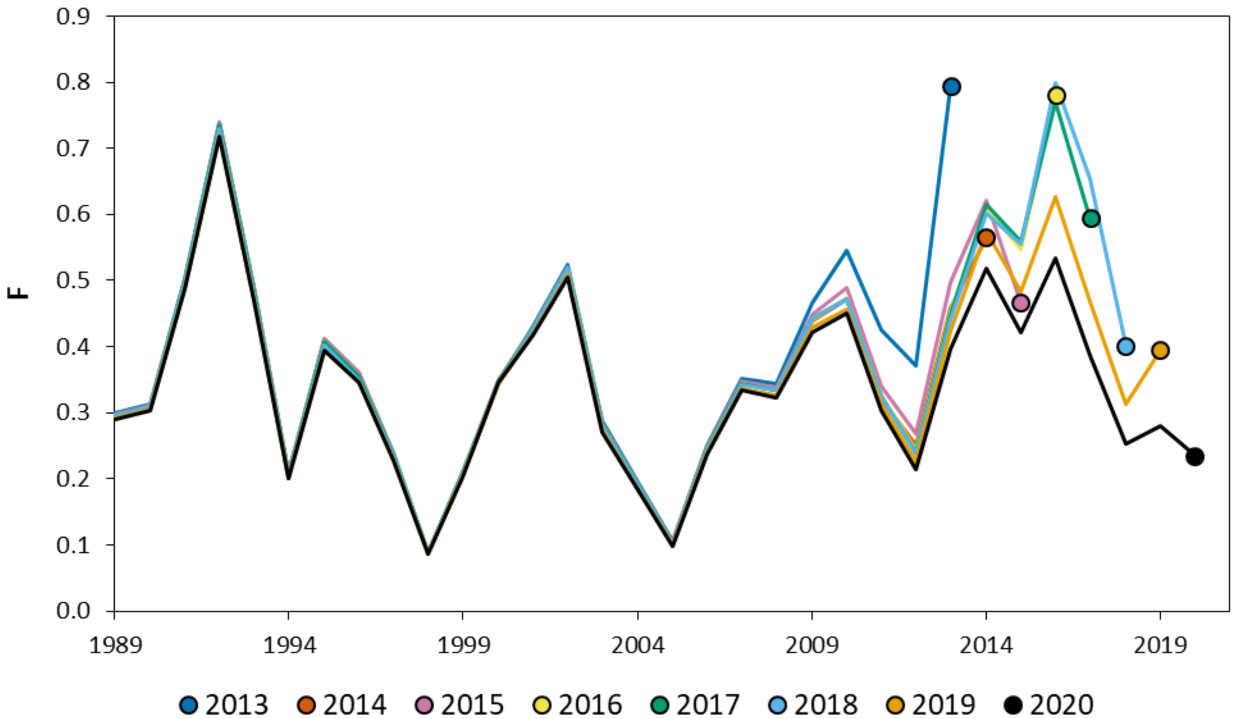


Figure 28. Estimates of the annual full *F* for NJ-NYB region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.



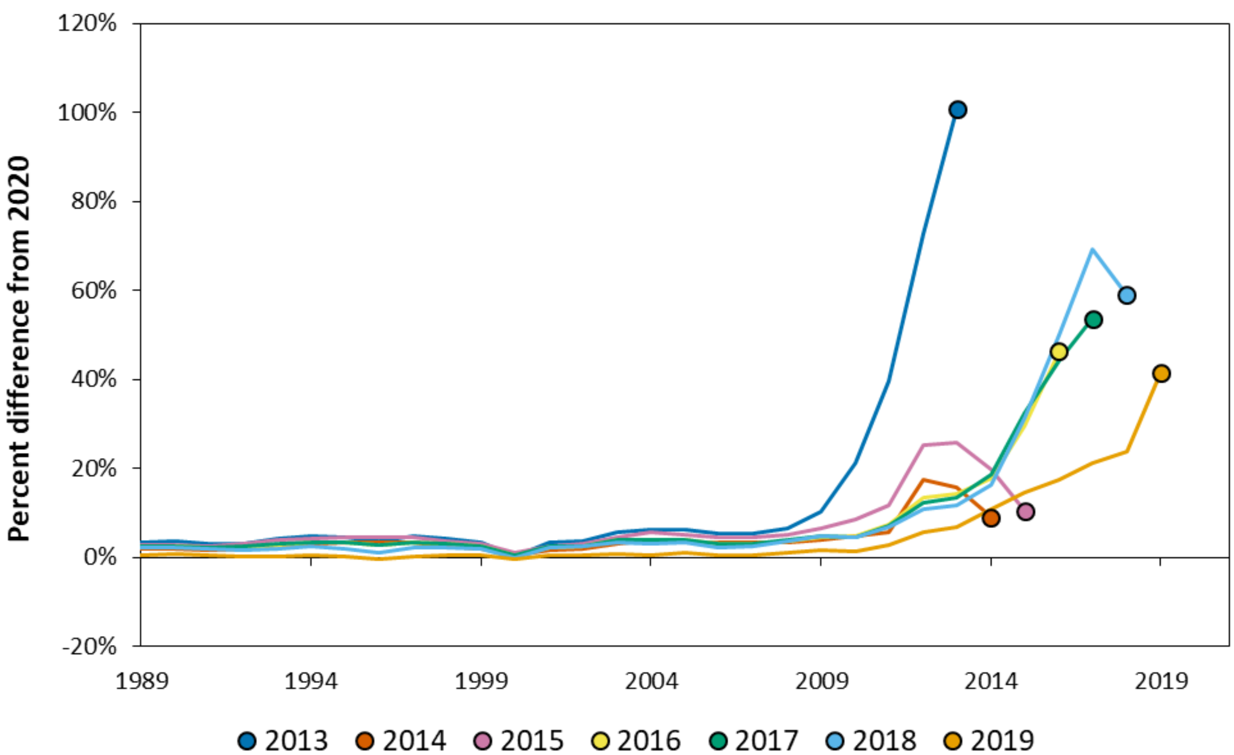


Figure 29. Retrospective analysis for annual *F* from the NJ-NYB region in absolute numbers (top) and percent difference (bottom).

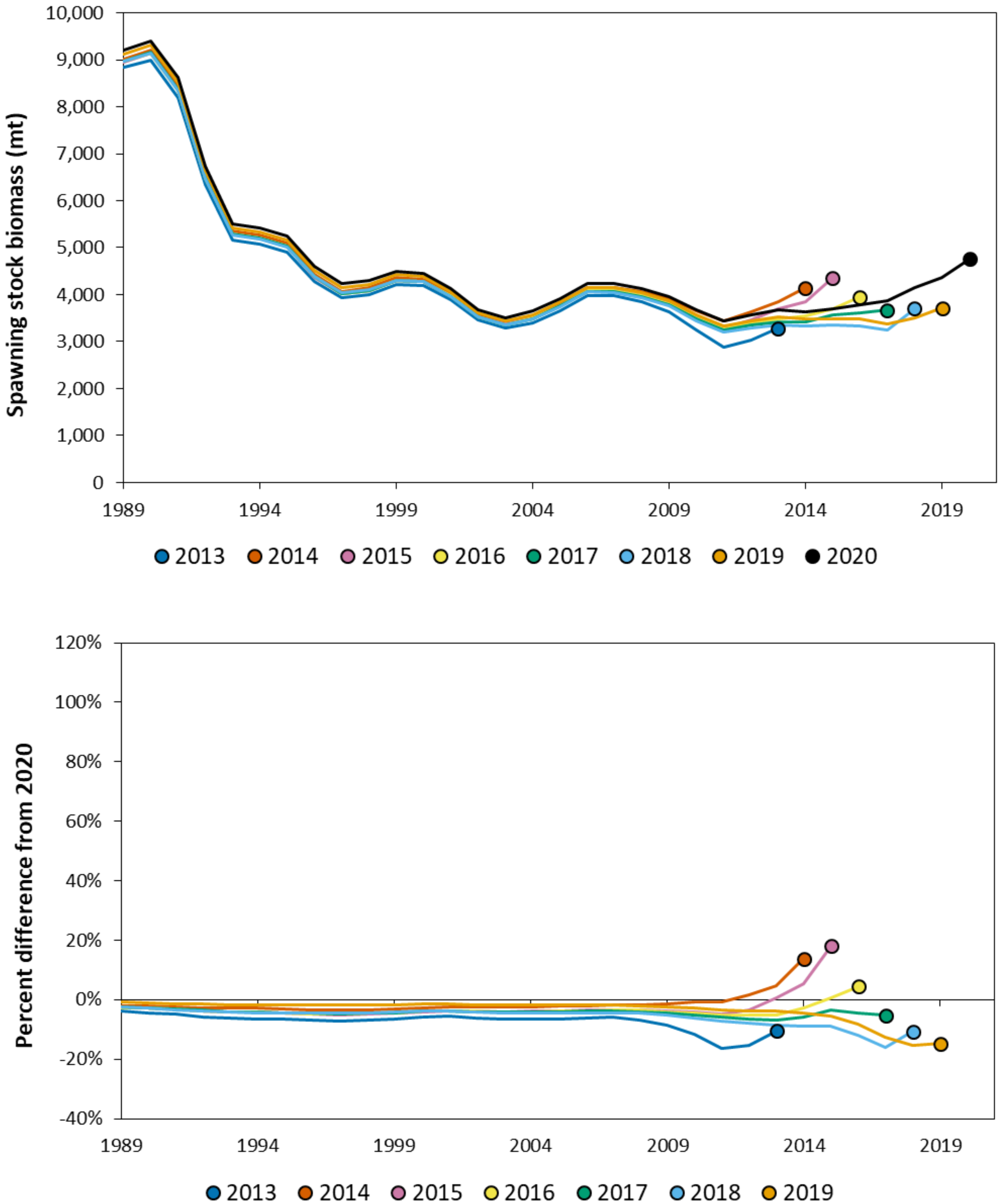


Figure 30. Retrospective analysis for annual SSB from the NJ-NYB region in absolute numbers (top) and percent difference (bottom).

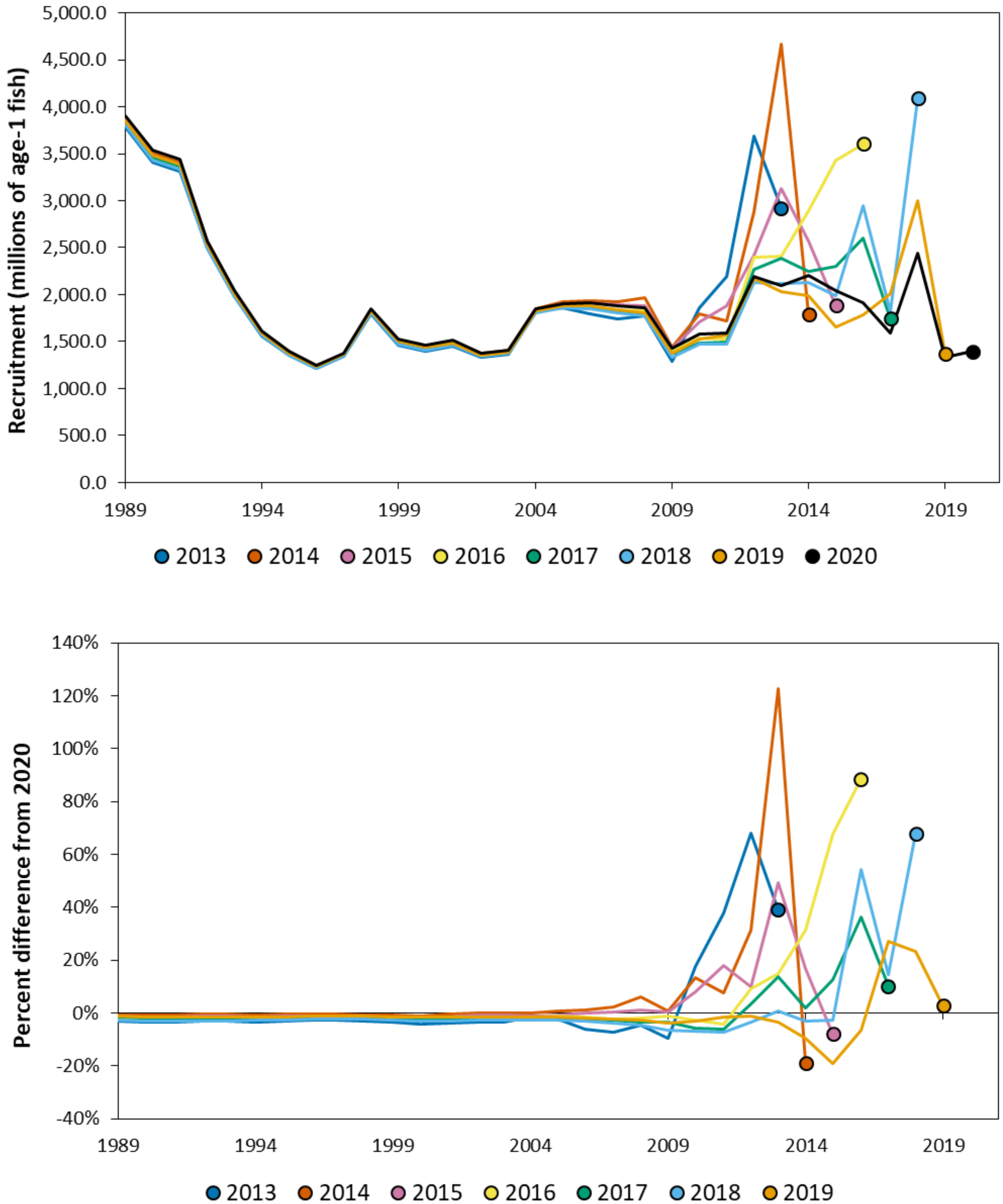


Figure 31. Retrospective analysis for annual recruitment from the NJ-NYB region in absolute numbers (top) and percent difference (bottom).

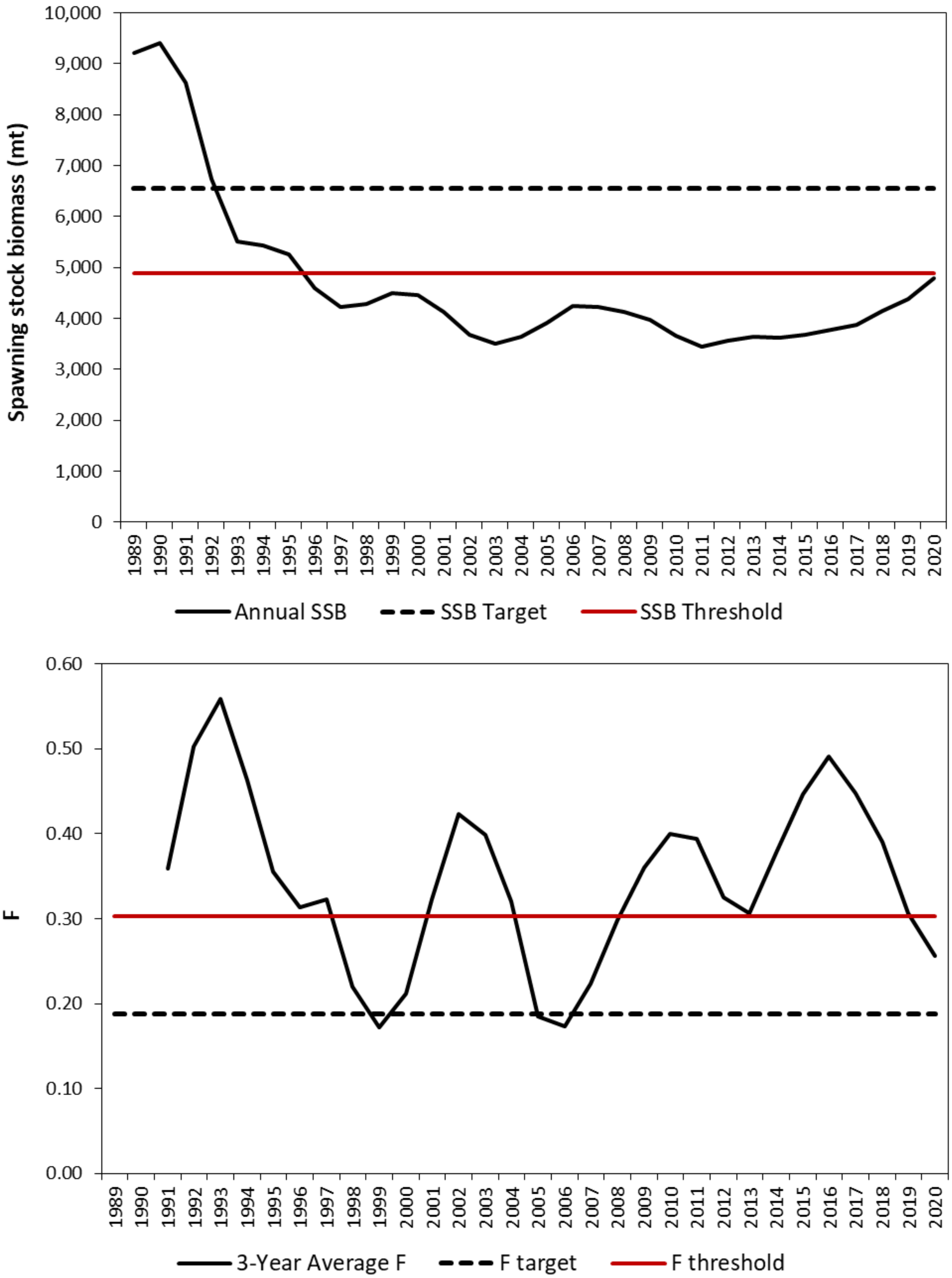


Figure 32. Annual SSB plotted with SSB target and threshold (top) and 3-year average *F* plotted with *F* target and threshold (bottom) for the NJ-NYB region.

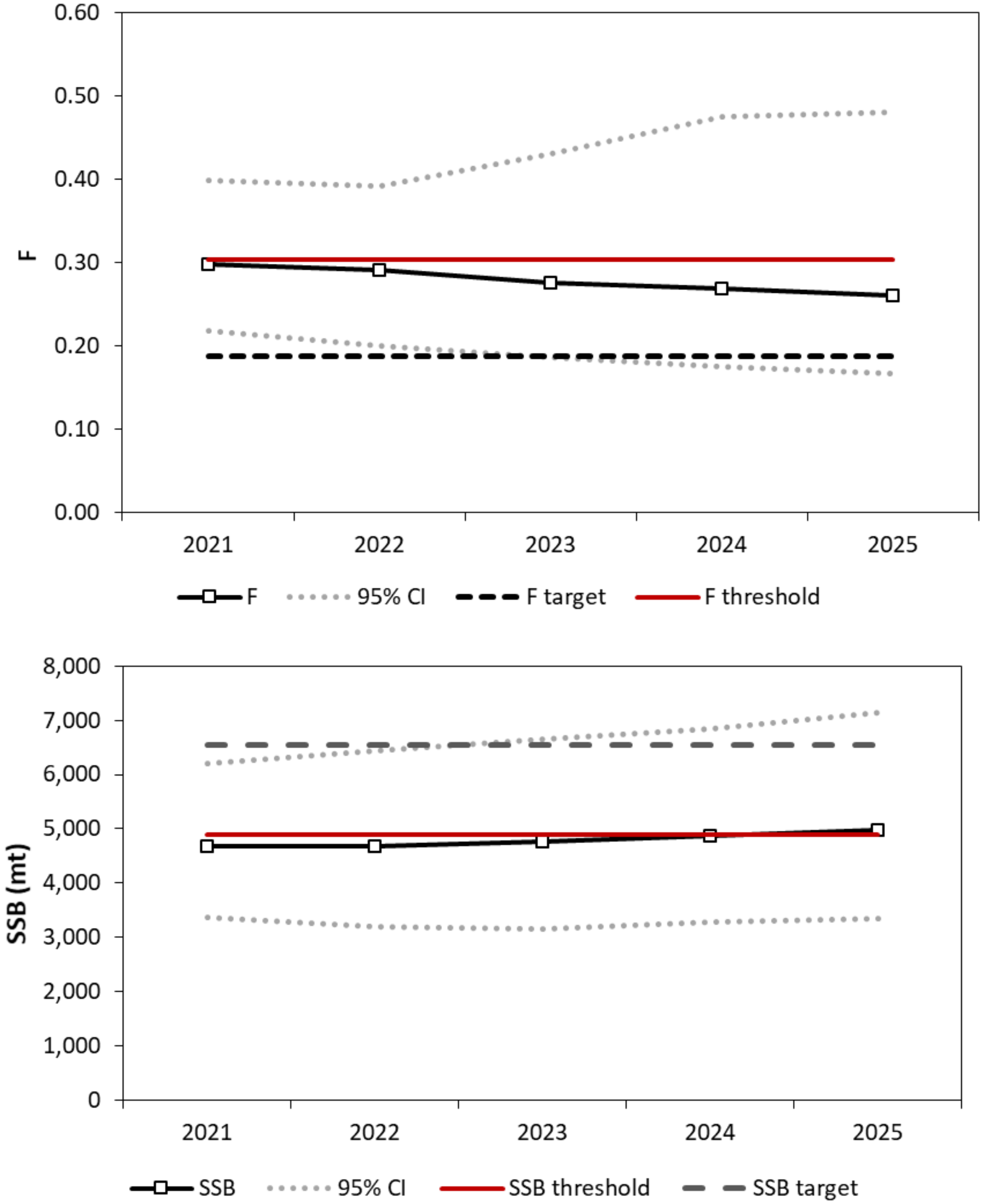


Figure 33. Status quo harvest projections for the NJ-NY Bight region showing the trajectory of annual *F* (top) and SSB (bottom) with their target and threshold reference points. Dotted grey lines indicate the 95% confidence intervals of the estimates.

Tautog Stock Assessment Update
DELAWARE-MARYLAND-VIRGINIA REGION
2021

Executive Summary
This stock assessment is an update to the existing benchmark assessment for tautog (ASMFC 2015, ASMFC 2016); the previous assessment update was completed in 2017 (ASMFC 2017). This assessment updates the accepted statistical catch-at-age model with commercial and recreational fishery catch data and indices of relative abundance from fishery-independent and fishery-dependent data sources through the terminal year of 2020.

In the Delaware-Maryland-Virginia (DMV) region, the stock was not overfished and overfishing was not occurring in 2020.

This update includes the new time-series of calibrated recreational data from the Marine Recreational Information Program (MRIP). For the DMV region, the calibrated estimates were on average 138% higher than the uncalibrated estimates over the entire time series. The new MRIP estimates resulted in higher estimates of SSB and recruitment, but had less of an impact on *F*. Stock status has changed in this region since the last assessment update: the DMV region is no longer overfished or experiencing overfishing. This appears to be related to reductions in *F* and increases in SSB in the most recent few years, as opposed to an artifact of the new MRIP numbers.

Short term projections using the average landings from the last three years found that the probability of the fully-recruited *F* being at or below the F target is expected to be 100% in 2025 and for every year of the projections. The probability of SSB being at or above SSB threshold is also equal to 100% in 2025 and for every year of the projection.

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.
Recreational landings were obtained from the NMFS MRIP data collection program. In 2018 MRIP changed the method of estimating fishing effort by introducing mail-based fishing effort survey (FES) and eliminating Coastal Household Telephone Survey (CHTS). This change resulted in significant increases in the estimates of the recreational harvest and discards, with calibrated estimates of removals averaging 138% higher than uncalibrated estimates (Figure 34).

Recreational harvest (A+B1) of tautog for DMV region in 1982 - 2020 varied between 35 thousand and 1.1 million of fish, with the overall declining trend through time (Table 22, Figure 35). There is an overall declining trend in recreational harvest, most likely a reflection of the protective regulatory measures (minimum size increase, bag size reduction and seasonal closures) instituted to reduce fishing mortality. Average recreational harvest for the most recent five year period (2016-2020) was 80.9 thousand fish, while the estimated harvest in 2018 was the lowest on record – 35.4 thousand fish.

Estimated recreational releases have varied from 15.6 thousand fish in 1984 to 2.55 million fish in 2010. Assuming 2.5% release mortality rate, dead releases varied from 391 to 63.75 thousand fish (Table 22, Figure 35). There was a general increasing trend for recreational releases through time. However, release mortality losses generally were very small relative to the harvest, thus the total recreational losses (A+B1+B2) are only slightly above the recreational harvest (A+B1) as reflected in Figure 35.

Due to low number of intercepted fishing trips that had tautog in recent decade, annual estimates of recreational landings and discards in MD and VA had low precision; Proportional Standard Error (PSE) values exceeded 50% in about half of the most recent years PSEs were mostly below 50% in Delaware.

Commercial landings reported by each state (DE, MD, and VA) were updated through 2020 and combined to derive region specific landings. Historically commercial landings peaked at 31.4 thousand pounds (14.2 mt) in 1997 and were in continuous decline ever since (Table 22, Figure 35). Average commercial landings for 2016 - 2020 were 4,363 pounds (1.98 mt). Data on commercial discards were not available, but discards are believed to be minimal. Therefore, estimates of dead discards were not generated.

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.

There are no fishery independent indices available for the DMV region. The only index of relative abundance used in the 2013 benchmark assessment and 2016 assessment update was catch per trip derived from MRIP data (Table 23). Total catch per trip was modeled with GLM method using a suite of potentially important covariates (year, state, wave, and mode) with an effort offset based on angler hours for the trip. The MRIP based index was updated through 2020. The MRIP index in 2016-2020 reverted a declining trend and was relatively stable in recent years (Figure 36).

Biological sampling for tautog is conducted by each state on annual basis with the goal to collect at least 200 samples per year for each state. Samples for length, weight, sex and age are taken mostly by intercepting the catch of recreational fishermen. However, some samples were taken from commercial fishery as well. Annual age length keys were constructed by combining paired length - age samples from all three states. Age length keys were constructed for years 2016 - 2020 to update age information since 2016 assessment update that had a 2015 terminal year. On average, 462 samples of age and size samples per years were used to construct annual ALKs for 2016 - 2020, covering 22 - 78 cm size range and ages 2 - 28.

Length frequency of the recreational harvest was characterized using length frequency of the data collected by MRIP for each state. State specific MRIP annual harvest estimates were applied to corresponding length frequency of the recreational harvest (A+B1) to obtain harvest in numbers by size. Size frequency of discards (B2) was characterized by combining the MRIP Type 9 and ALS raw data on the size of released fish by state. State specific data were pooled to obtain regional estimate of total harvest (A+B1) and discards.

Due to low or absent commercial fishery size sampling, size frequency of recreational harvest was used to describe commercial catch at size. State-specific recreational harvest, dead releases, and commercial harvest in numbers of fish by size were combined into a total regional estimate and converted into catch at age using regional year-specific age-length keys.

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 structure and life history parameters used in the assessment for DMV region are presented in Table 24. Natural mortality was assumed to be a constant value for all ages M=0.16 as estimated in the 2015 benchmark assessment. Tautog were considered to be immature through age 2, 78% mature at age 3, 97% mature at age 4 and 100% mature at age 5. Sex ratio was assumed to be 50:50 and no sexual dimorphism in growth was considered.

ASAP model was run from 1990 to 2020 based on the catch at age and MRIP index data representing ages 1 - 12, where age 12 was treated as a plus group. Removals were modeled as a single fleet that included total removals in weight and numbers-at-age from recreational harvest, recreational release mortality, and commercial catch. Selectivity of the fleet was described by a single logistic curve. Four selectivity blocks were used: 1982-1996, 1997- 2006, 2007-2011 and 20012 - 2020. The number of selectivity blocks and their definition was similar to the 2016 assessment updated, except that the fourth block was extended through 2020. Breaks were chosen based on implementation of fishery regulations. Adult indices were fit to index-at-age data assuming a single logistic selectivity curve and constant catchability. No YOY indices are available for DMV region.

All likelihood components weights (lambda values) were retained from the 2015 benchmark assessment and 2016 assessment update. Annual CVs on total catch were set equal to the weighted mean of state specific MRIP PSE values, while index CVs were based on the GLM-standardized CVs and adjusted upwards to bring their RMSE values close to one. The input effective sample size (ESS) was set equal to the number of tautog trips intercepted by the MRIP. ESS values were further adjusted during second model run using ASAP’s estimates of stage 2 multipliers for multinomials.

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.

The previous assessment update completed in 2016 was based on the ASAP model run from 1990 to 2015. To evaluate the effect of new estimates, a bridge run was completed with new MRIP removals estimates for 1990 – 2015 using the same model inputs as in 2016 assessment update, with the exception of the total catch and the catch-at-age matrix, which was modified according to the new MRIP estimates. As expected, higher estimates of recreational catch from recalibrated MRIP survey resulted in higher estimates of numbers at age, recruitment, total and spawning biomass (Figure 37 and Figure 38; DMV Appendix 1). New fishing mortality estimates were slightly lower than in 2016 assessment update for the first half of the time series, and then switched to being slightly higher than in 2016 assessment for the second half of the time series (Figure 39). However, the trend in both cases was very similar (Figure 39). The overall scale of estimated fishing mortality has not changed. The assessment model inputs were further updated through 2020 and model was run with the inputs and parameters as described in TOR3.

Retrospective analyses were performed by shortening the data time series by one year at a time and comparing the results to the output of the model with full time series (1990-2020). The analysis was completed for time series ending in 2014 (a seven-year peel).

As in the 2015 benchmark assessment and 2016 assessment update, the DMV region showed a strong retrospective pattern, consistently underestimating *F* (16% or less, Figure 40) and overestimating SSB (120% in 2014, about 40% in 2015-2017, Figure 41). Retrospective bias in *F* and SSB in this assessment update appears to be smaller than estimated before in 2015. Bias in recruitment was not unidirectional; both over and underestimation have occurred. The level of bias ranged from 10 to 115% (Figure 42). The estimates of recruitment, *F* and SSB produced by different runs converged when going back in time. Terminal year estimates of SSB and *F* were still within the confidence intervals of the model estimates when corrected for retrospective bias (DMV Appendix 2 Figure A2.1), so a retrospective adjustment was not performed.

A limited number of sensitivity runs were conducted to examine the effects of input data and model configuration on model performance and results.

The base model results were insensitive to changes in starting values of model parameters (initial numbers at age, steepness, selectivity, catchability, etc). The model was converging on the same parameters estimates, within a range of initial starting values, indicating stability of model solution. Fixing steepness parameter at 1, thus assuming no stock recruitment relationship, had very little effect on the final model results.

Unlike other regions, no sensitivity runs were completed to explore the effect of the specific index of abundance and the effect of imputed data on MRIP index and model results. There is only one index available for the region (MRIP CPUE), therefore removal of the index was not possible. The MRIP survey schedule was not significantly affected by the COVID pandemic in 2020 in this region. Consequently, MRIP index calculated using imputed data was nearly identical to the one that used only collected information. The index based on the imputed data was consistently higher by 3-4% relative to index based on non - imputed information. Hence, comparison was not needed as it would produce identical results.

The most influential parameters to the model were coefficients of variation (CVs) of the index of abundance and catch. Smaller values of CV force the model to fit predicted values of index or total catch closer to the observed and vice versa. To investigate the role of the precision of the estimate of index (MRIP CV), the model was run with the range of estimates of CVs (beginning with the original estimates and following with the CVs increased two, three, four and five fold), resulting in five different CV vectors. Results indicated that overall model fit (objective function value) improves with the increase in CV index and the RMSE approaches desired value of 1 when CVs are inflated lose 4.5 times, the overall differences in terminal values of SSB and in particular, *F* were insignificant (DMV Appendix 2 Figure A2.2). However, there are more substantial differences between SSB and *F* values in earlier part of time series, but the overall trend in SSB and *F* persisted (Figure 10).

The 2016 assessment update applied a 1.3 inflation factor to the catch CV to account for some unreported catch. A comparison of model runs with the catch CV as estimated by MRIP versus the inflated CV option demonstrated no appreciable change in estimated *F* or SSB (DMV Appendix 2 Figure A2.3). Overall, the model estimates appear to be stable and not sensitive to changes explored in various sensitivity runs.

As in the benchmark and 2016 assessments, there was a high peak in fishing mortality in 2010-2012 caused by high recreational harvest estimates for these years. Fishing mortality has been continuously declining since then, likely due to a series management actions, designed to reduce removals. Fishing mortality has been below the target since 2015 (Table 25, Figure 43). The terminal year (2020) *F* was estimated at 0.09, while the three-year average for 2018 – 2020 was estimated as 0.06 (Table 25).

Spawning stock biomass went through two stages of decline during 1990-2010 (Table 25, Figure 5). SSB has been increasing since 2012, following reductions in removals, crossed the SSB threshold in 2018 and nearly approached the SSB target in the terminal year 2020 (Table 25, Figure 5). Total abundance declined from a stable level of about 5 million fish in 1998 - 2008 period to the lowest level of 2.9 million fish in 2013. Total abundance was increasing since 2013 and reached the level of early 2000s by 2020 (5.1 million).

Except for the single spike at the beginning of the time series, recruitment appears to have been relatively stable, varying within the range of 0.5-1.5 million fish with an average near 1 million fish (Table 25, Figure 38). No outstanding year classes were noted aside of the 1990 year class (age-1 in 1991 on Figure 38). Overall, recruitment has exhibited low variability and lack of sharp inter-annual changes.

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

Overfishing status was evaluated based on average *F* from 2018-2020. Annual estimates of *F* are highly variable due to the annual variability in estimated catch due to the imprecision of the MRIP estimates. Therefore, the assessment update employed the three-year running average to evaluate overfishing status to smooth out the inter-annual variability in *F* and allow management to respond to genuine trends. Overfished status is determined by SSB in the terminal year of the assessment (2020). Estimates of SSB are more stable, so the terminal year estimate is considered to be appropriate to determine overfished status.

Stock-recruitment relationship for the DMV region was considered to be unreliable by the 2013 benchmark assessment. Therefore, SPR-based reference points were used for *F* reference points. Specifically, F40% was selected as a target reference point and F30% as a threshold. To calculate corresponding target and threshold level of SSB, the projection model AGEPRO was used to project the population forward in time under constant fishing mortality ($F_{30\%SPR}$ and $F_{40\%SPR}$) with recruitment drawn from the model estimated time-series of observed recruitment to develop an estimate of the long-term equilibrium SSB associated with those fishing mortality reference points.

The 2021 update resulted in slightly different values of *F* reference points $F_{40\%SPR}$ = 0.17, and $F_{threshold}$ = 0.27 (Table 26). These slight changes are a result of re-estimation of age specific selectivity for the latest selectivity block (2012-2020). The three-year average *F* from 2018-2020 was 0.09, below both the target and the threshold, indicating overfishing is not occurring (Table 27, Figure 43).

New estimates for SSB target and threshold were higher than estimated during the benchmark, at 4,488 and 3,355 mt, respectively (Table 26). Terminal year SSB estimate was 4,382 mt, slightly below the target but above the threshold (Table 27, Figure 43). According to the probability distribution of SSB estimates based on the MCMC analysis, there is 99% chance that SSB in 2020 was above $SSB_{threshold}$, indicating the stock is not overfished.

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

Short term (2021-2025) projection scenario to determine status of the stock and trends in SSB and *F* assuming constant harvest level equal to the recent three year average (2018-2020) was completed using AgePro (v. 4.2, NOAA Fisheries Toolbox) model. Biological parameters (maturity, M, weights at age) for the projection model were the same used in the ASAP population model, with the exception that projection catch weights at age were set equal to the average catch weight at age in the most recent selectivity block. Recruitment for the projected years was drawn from the vector of recruitment values estimated by ASAP model in 2021 assessment update. Fishery selectivity at age was set equal to the one estimated by ASAP for the most recent selectivity period. Harvest for the projected period was assumed equal to the most recent three-year average harvest.

If the constant catch of 155.47 mt is maintained during 2021-2025 (status quo scenario), the probability of the fully-recruited *F* being at or below the F target is expected to be 100% within each year of the projection. The probability of SSB being at or above SSB threshold is also equal to 100 % (Table 28, Figure 44). Fishing mortality is projected to be low (0.03 to 0.04), while SSB is projected to grow and exceed the target in 2021 (Figure 44).

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.

Developing a fishery independent index for tautog in the DMV is a high priority research recommendation. Since the last benchmark, MD DNR has started a seagrass survey that has the potential to serve as a YOY index for tautog. The SAS recommends that this survey be continued and considered for use in the next benchmark.

List of Appendices

DMV Appendix 1: ASAPplots output of the base model
DMV Appendix 2: Retrospective adjustments and sensitivity runs

References

Atlantic States Marine Fisheries Commission. 2015. Tautog benchmark stock assessment. Arlington, VA.

Atlantic States Marine Fisheries Commission. 2016. Tautog regional stock assessment: Long Island Sound and New Jersey-New York Bight. Arlington, VA.

Atlantic States Marine Fisheries Commission. 2017. 2016 Tautog Stock Assessment Update. Arlington, VA. 143 pp.

Tables

Table 22. Total removals in metric tons by sector for the DMV region.

Year	Recreational Harvest	Recreational Release Mortalities	Commercial Harvest
1982	1,110.8	0.8	
1983	1,266.9	4.5	
1984	1,158.6	0.4	
1985	927.9	9.5	3.0
1986	1,093.1	3.6	2.3
1987	1,068.5	3.5	3.4
1988	665.1	3.4	4.3
1989	1,758.8	7.5	5.5
1990	532.1	9.5	4.3
1991	1,126.8	14.5	4.3
1992	652.9	13.5	4.3
1993	1,429.3	21.5	3.1
1994	1,249.3	16.5	6.1
1995	1,662.0	21.1	14.1
1996	1,373.5	10.9	13.8
1997	717.8	13.1	14.2
1998	771.9	24.7	10.0
1999	677.5	27.0	12.5
2000	496.7	27.4	8.5
2001	261.9	17.2	8.4
2002	669.1	22.8	12.7
2003	449.8	20.3	8.4
2004	1,010.9	36.7	9.7
2005	539.4	29.2	5.5
2006	709.2	30.8	7.0
2007	676.7	30.6	6.6
2008	709.8	43.4	7.3
2009	999.9	39.1	6.8
2010	1,193.9	47.1	4.2
2011	532.7	18.7	8.1
2012	297.2	7.3	7.4
2013	226.3	16.1	6.8
2014	387.6	23.2	5.0
2015	111.4	23.0	4.6
2016	138.8	15.9	3.6
2017	113.9	29.7	2.7
2018	50.0	15.8	1.0
2019	85.3	13.2	1.2
2020	244.2	10.7	1.3

Table 23. Indices used in the ASAP model for the DMV region.

Index Name	Index Metric	Design	Time of Year	Years	Ages
MRIP CPUE	Total catch per angler-trip	Stratified Random	Mar-Dec	1982-2020	1+

Table 24. Model structure and life history information used in the stock assessment.

	Value(s)
Years in Model	1982-2020
Age Plus Group	12+
Fleets	1 (Rec and Commercial)
Recreational Release Mortality Rate	2.5%
Fraction of year before SSB calculation	0.42
Number of selectivity blocks	4
selectivity periods	1982-1996, 1997- 2006, 2007-2011 and 20013-2020
Selectivity type	Single logistic

	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	12+
Proportion mature-at-age	0	0	0.8	1	1	1	1	1	1	1	1	1
Natural mortality	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

Table 25. Spawning stock biomass in metric tons, recruitment (millions of age-1 fish), annual Fishing Mortality (*F*), and 3-year average *F* estimates for the DMV region.

Year	Spawning stock biomass (mt)	Recruitment (millions of age-1 fish)	Annual *F*	3-year Average *F*
1990	5,473	2.05	0.21	
1991	5,806	2.26	0.31	
1992	6,049	1.83	0.18	0.23
1993	6,251	1.36	0.34	0.28
1994	6,118	0.96	0.23	0.25
1995	5,566	0.86	0.45	0.34
1996	4,506	0.93	0.42	0.37
1997	3,837	1.01	0.31	0.39
1998	3,539	1.46	0.30	0.34
1999	3,347	1.23	0.32	0.31
2000	3,507	1.17	0.22	0.28
2001	3,866	1.20	0.12	0.22
2002	4,098	1.08	0.26	0.20
2003	4,204	0.96	0.17	0.18
2004	4,108	1.14	0.37	0.27
2005	3,900	1.29	0.18	0.24
2006	3,894	1.10	0.29	0.28
2007	3,854	1.06	0.25	0.24
2008	3,706	1.02	0.32	0.29
2009	3,168	0.91	0.60	0.39
2010	2,344	1.19	0.83	0.58
2011	1,839	0.71	0.65	0.70
2012	1,802	0.64	0.61	0.70
2013	1,880	0.52	0.20	0.49
2014	2,008	0.83	0.27	0.36
2015	2,081	0.89	0.09	0.19
2016	2,361	1.37	0.12	0.16
2017	2,680	1.05	0.09	0.10
2018	3,297	1.26	0.03	0.08
2019	3,868	0.97	0.05	0.06
2020	4,396	1.08	0.09	0.06

Table 26. SSB and *F* reference points from 2016 and 2021 updates for the DMV region.

	SSB		*F*	
	Target	Threshold	Target	Threshold
2016 Update	1,919 mt	1,447 mt	0.16	0.24
2021 Update	4,488 mt	3,355 mt	0.17	0.27

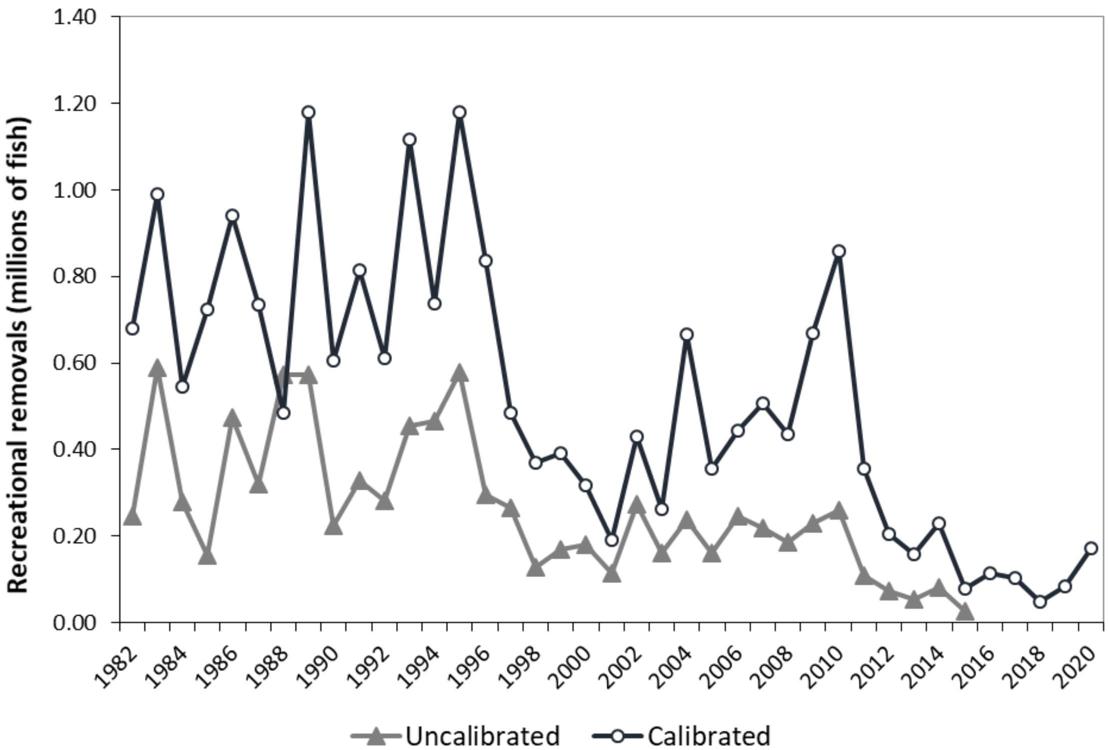
Table 27. Stock status for the DMV region.

	SSB		*F*	
	Target	Threshold	Target	Threshold
Reference Points	4,488 mt	3,355 mt	0.17	0.27
2020 Estimate	4,396 mt		0.06	
2020 Status	Not Overfished		Not Overfishing	

Table 28. Projection results for the DMV region.

Landings (mt) for 2021-2023	Probability of being at or below *F* Target in 3 years	Probability of being at or above SSB threshold in 3 years
Status quo (2018-2020 average)	100%	100%

Figures



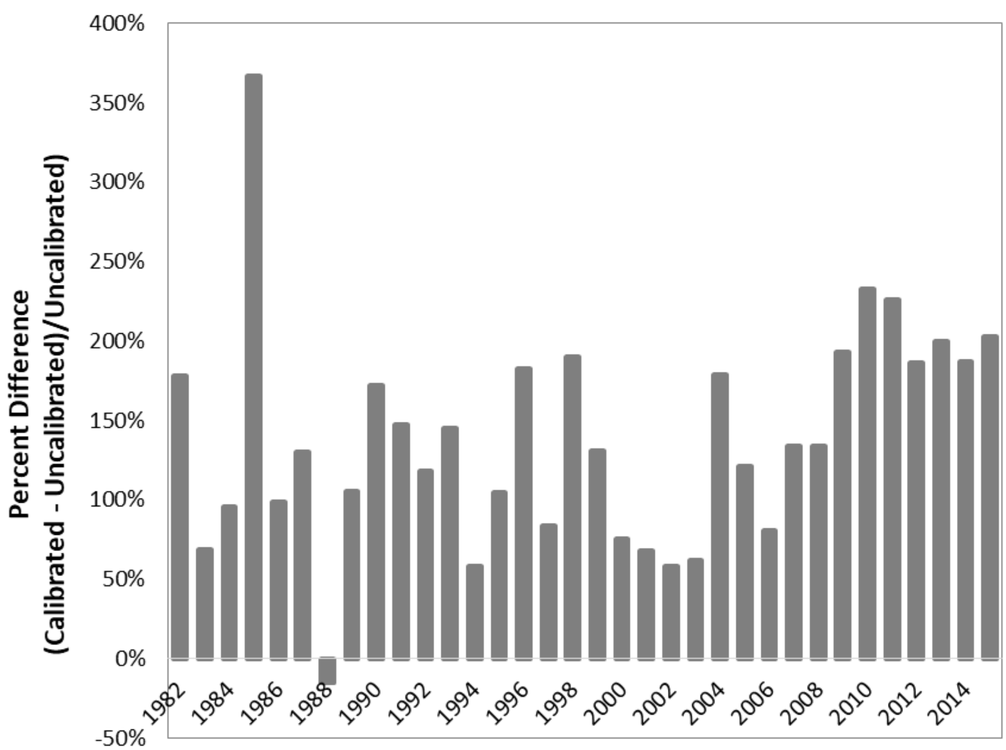


Figure 34. Comparison of calibrated and uncalibrated recreational removals (harvest + release mortalities) in numbers of fish (top) and percent difference (bottom) for the DMV region.

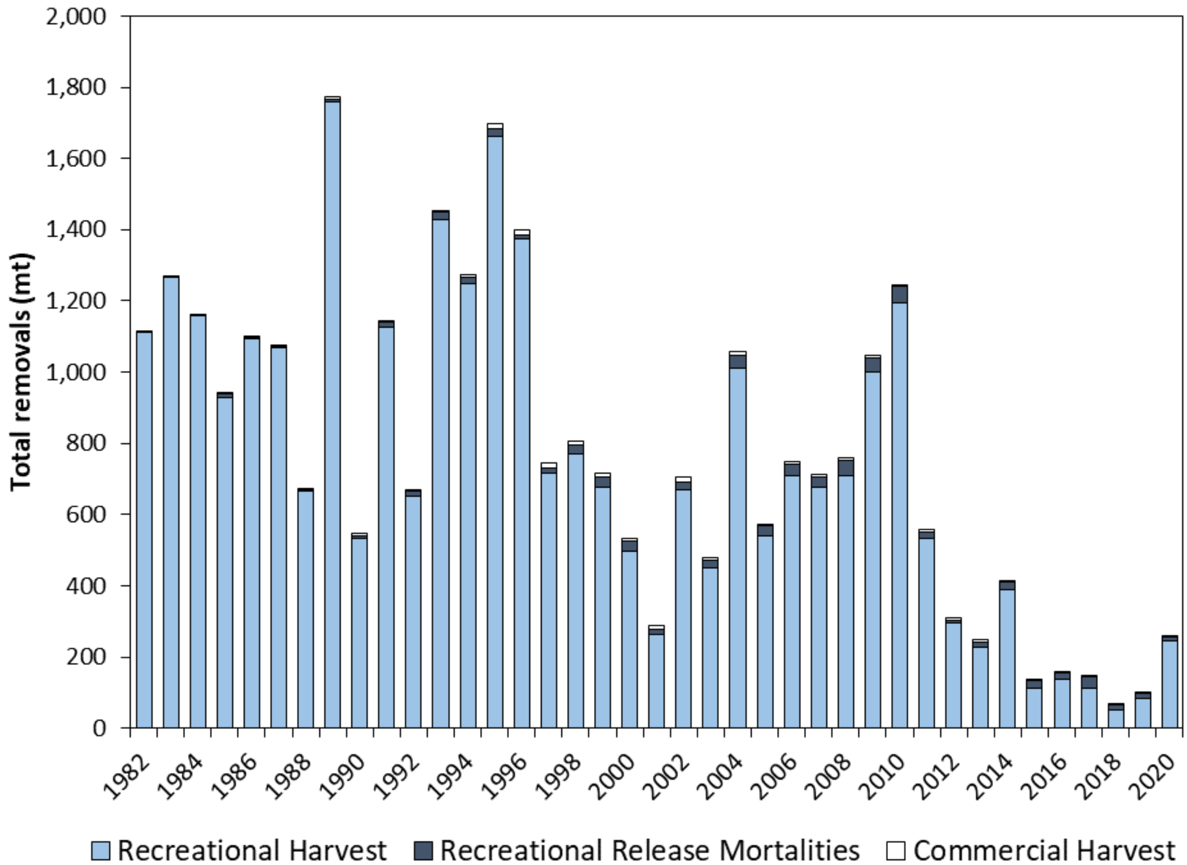


Figure 35. Total removals by sector for the DMV region.

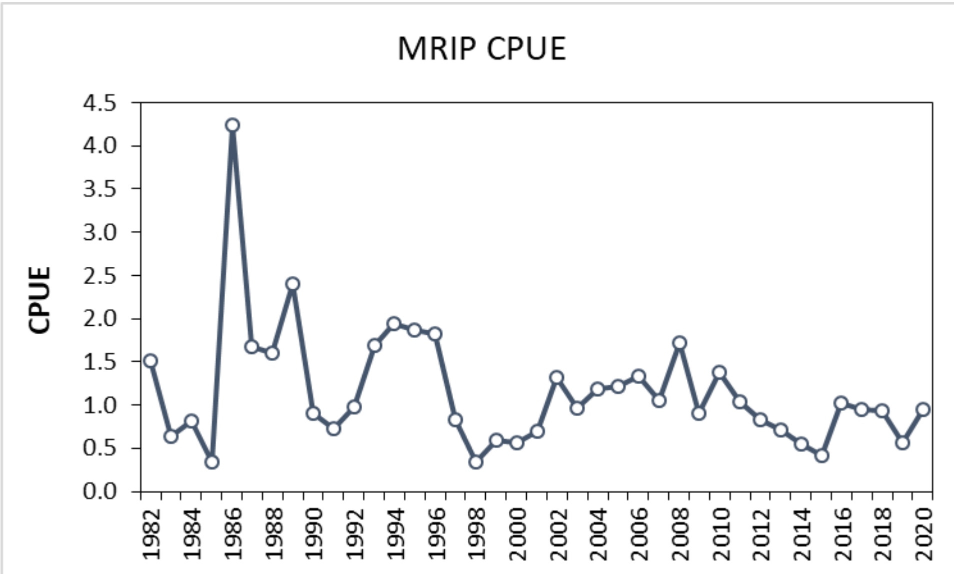


Figure 36. Indices of abundance used for the DMV region.

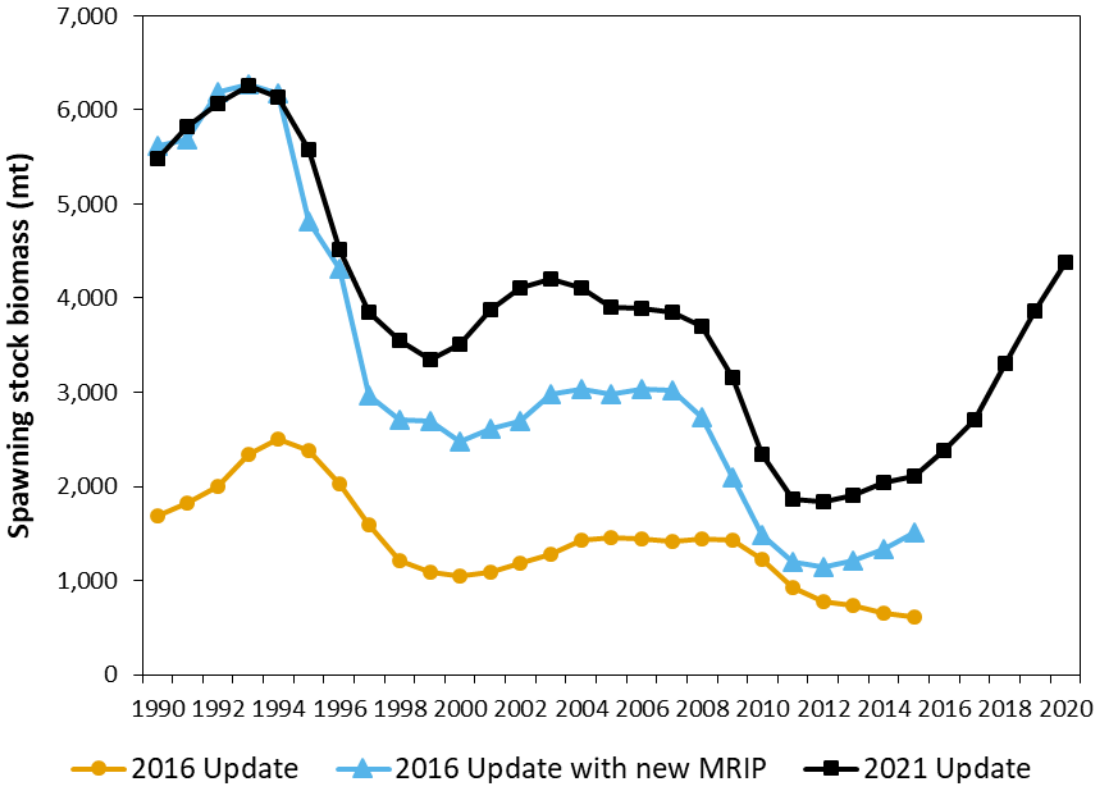


Figure 37. Estimates of spawning stock biomass for the DMV region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

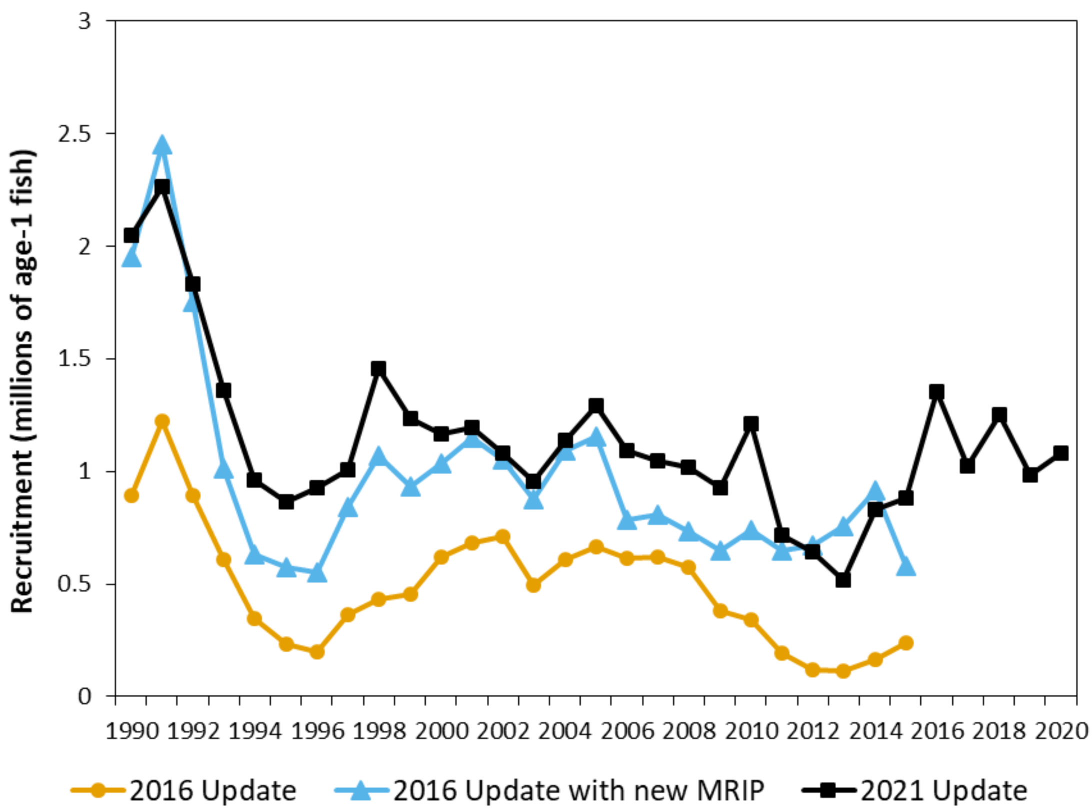


Figure 38. Estimates of recruitment for the DMV region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

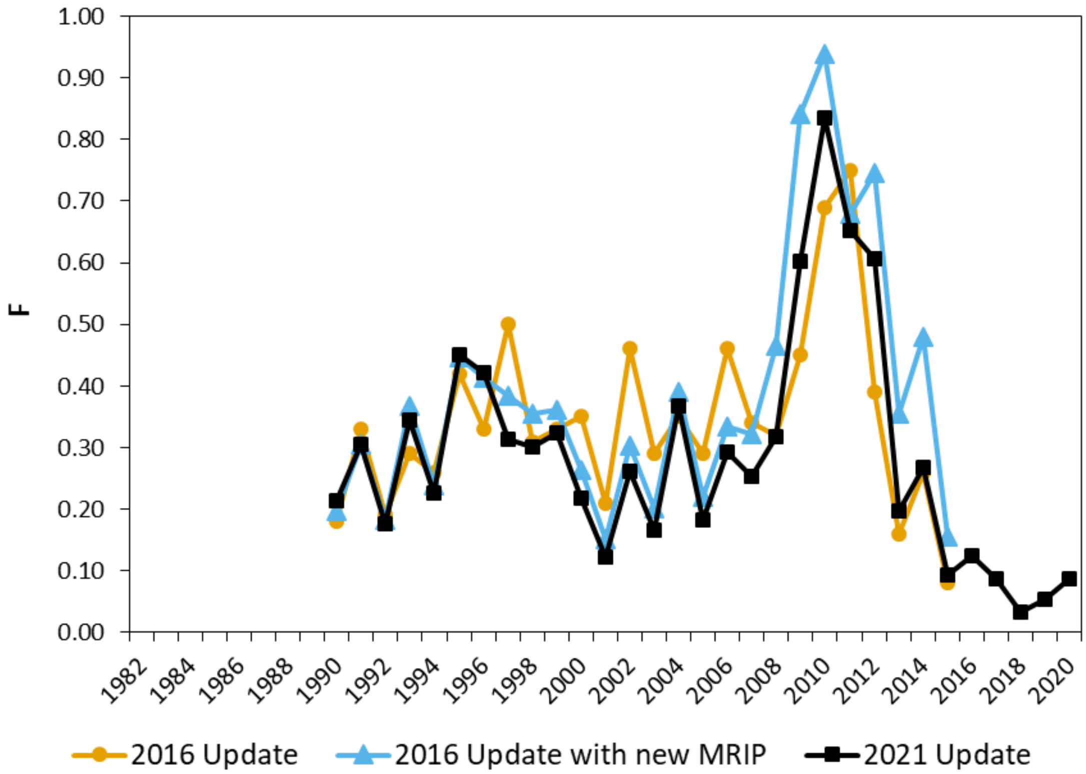


Figure 39. Estimates of the annual full F for the DMV region from the 2016 update, the 2016 model using the calibrated MRIP data, and the 2021 update.

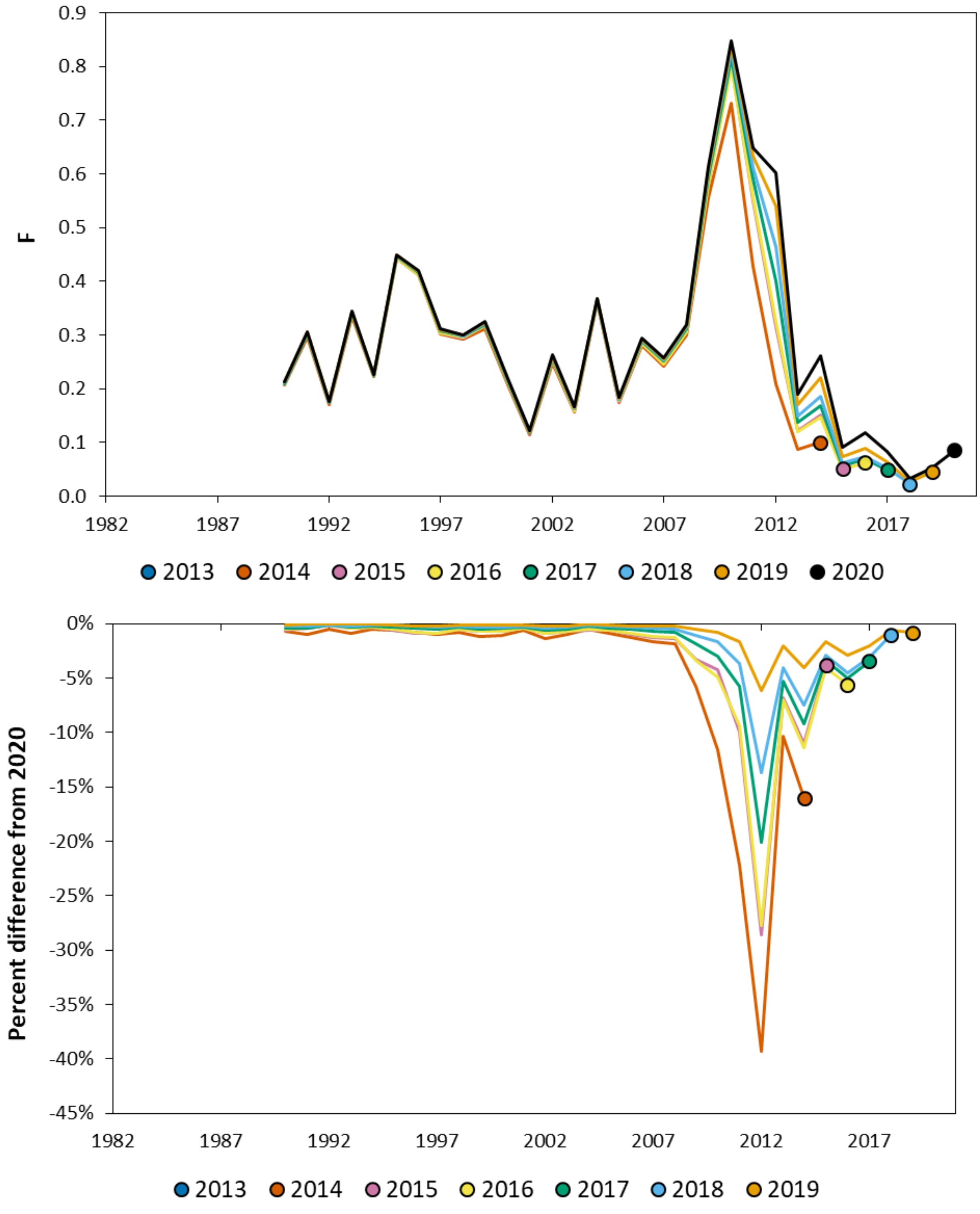


Figure 40. Retrospective analysis for annual *F* in absolute numbers (top) and percent difference (bottom) for the DMV region.

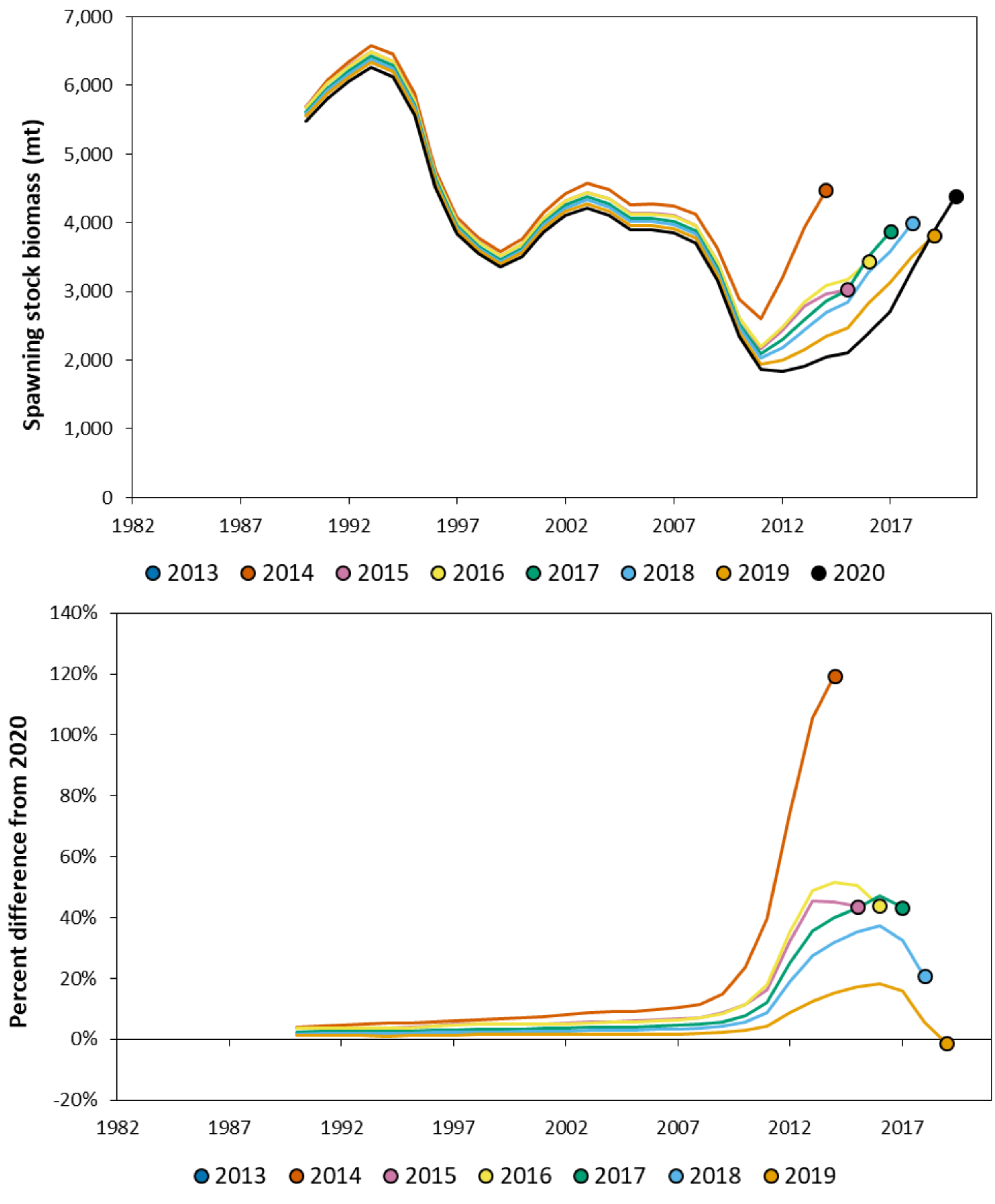


Figure 41. Retrospective analysis for SSB in absolute numbers (top) and percent difference (bottom) for the DMV region.

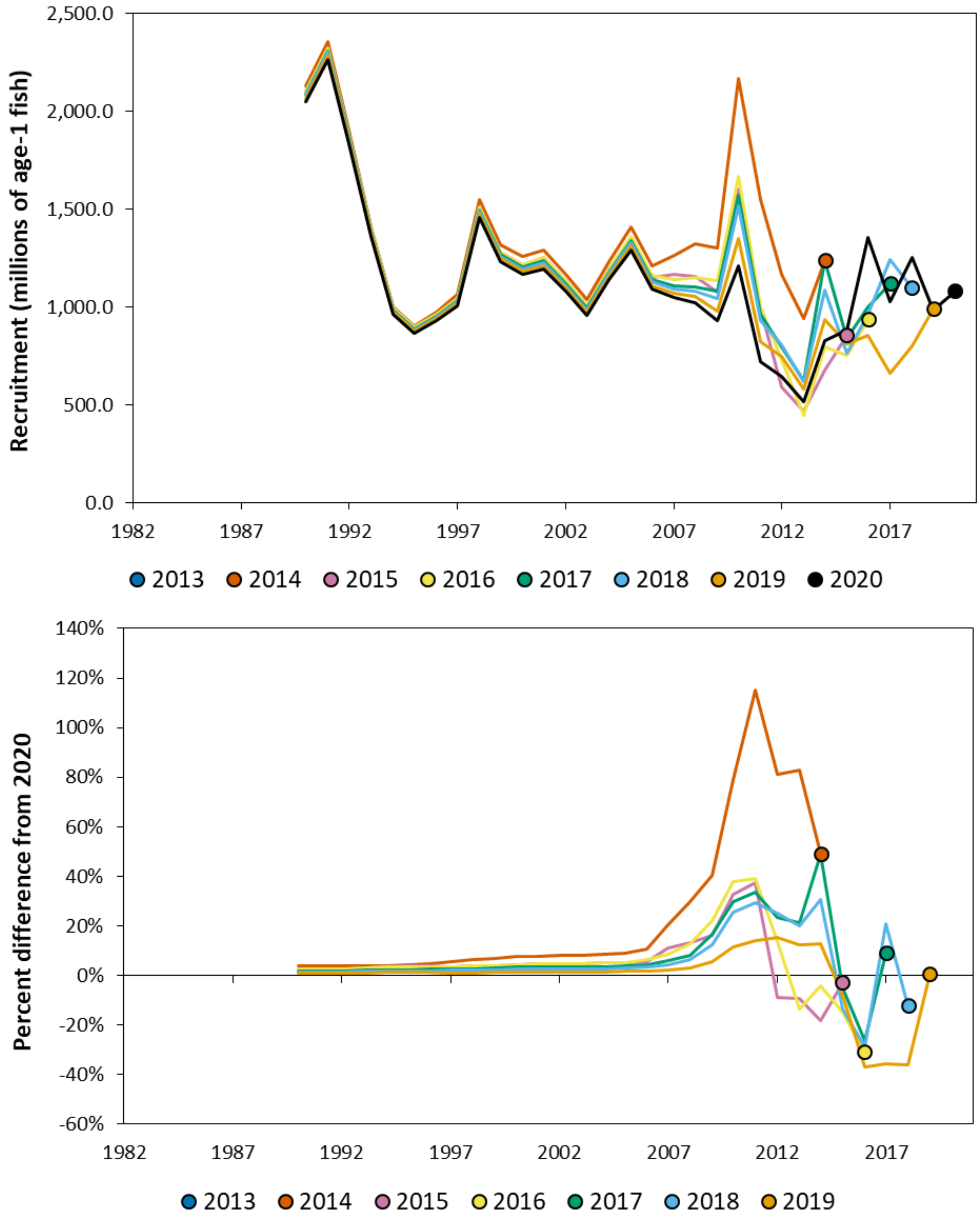
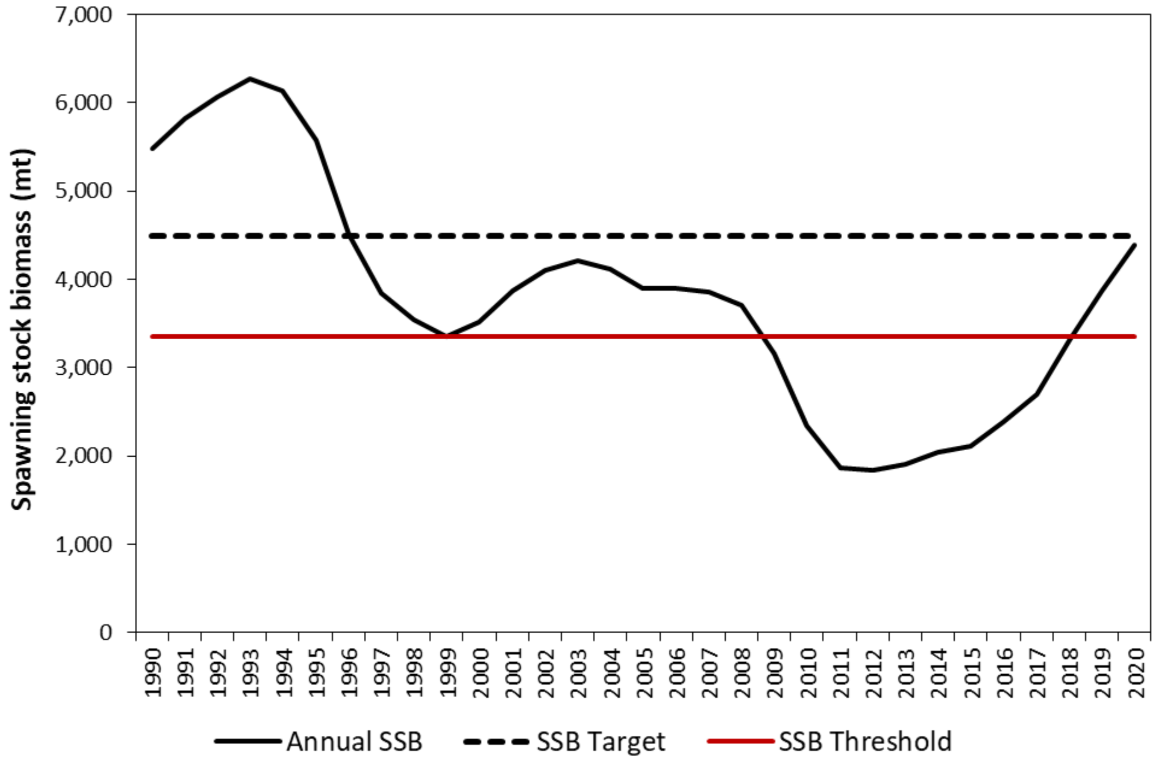


Figure 42. Retrospective analysis for recruitment in absolute numbers (top) and percent difference (bottom) for the DMV region.



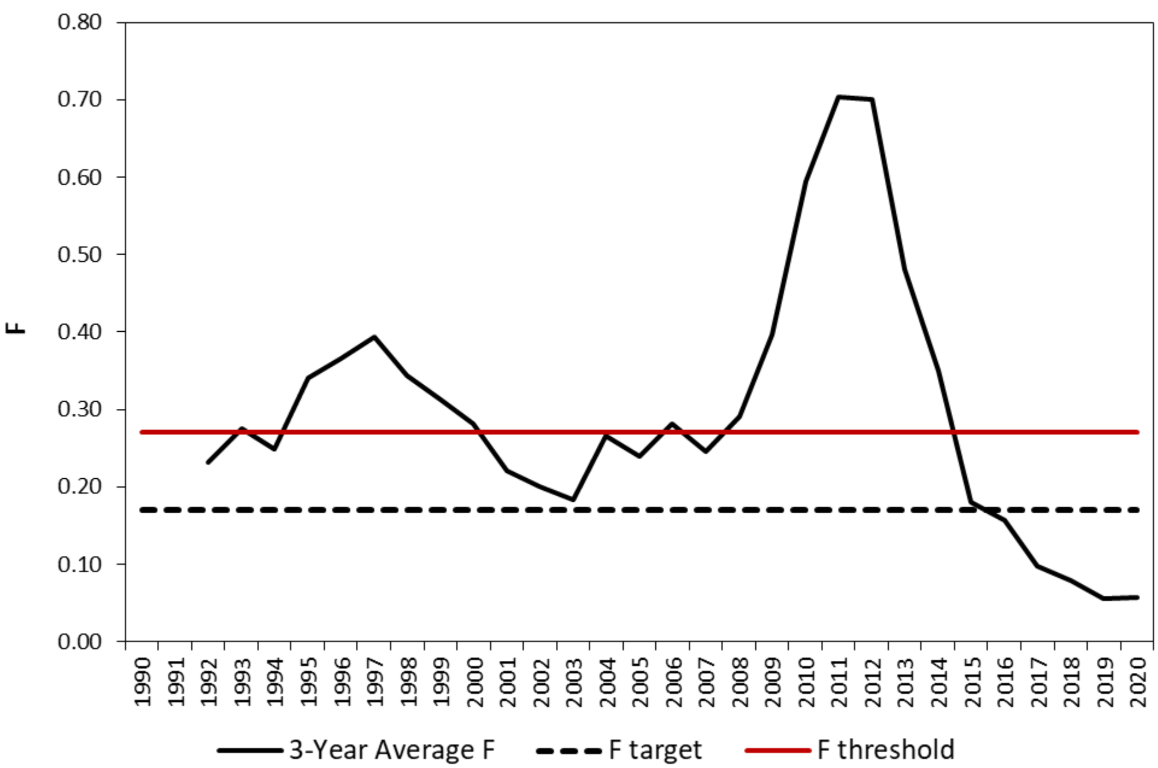


Figure 43. Annual SSB plotted with SSB target and threshold (top) and 3-year average *F* plotted with F target and threshold (bottom) for the DMV region.

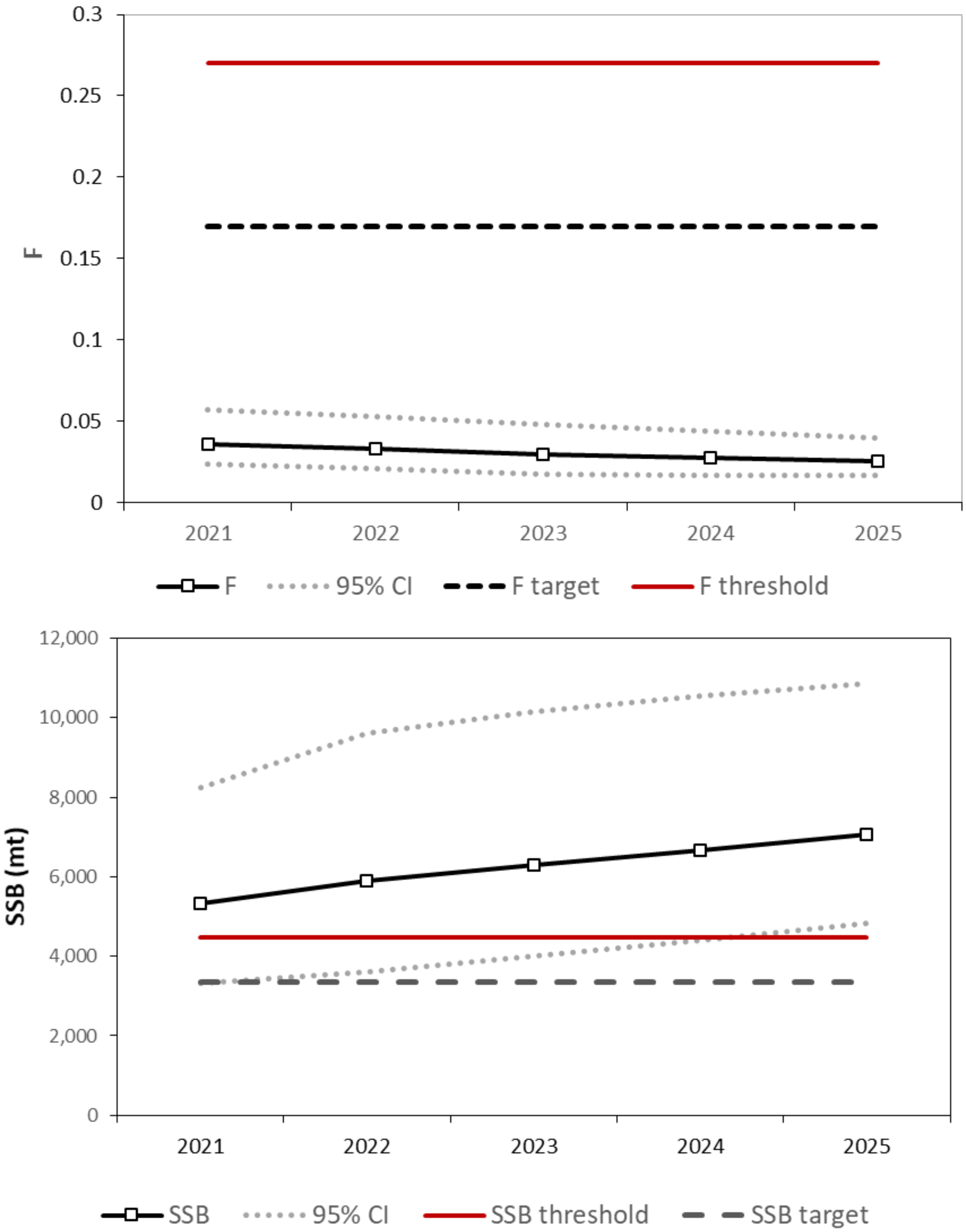


Figure 44. Status quo harvest projections for the DMV region showing the trajectory of annual *F* (top) and SSB (bottom) with their target and threshold reference points. Dotted grey lines indicate the 95% confidence intervals of the estimates.

Tautog Stock Assessment Update

REGIONAL APPENDICES

Tautog Stock Assessment Update
MARI Region 2021

Appendix 1: ASAP Input, Diagnostic, and Results Plots for the Base Run

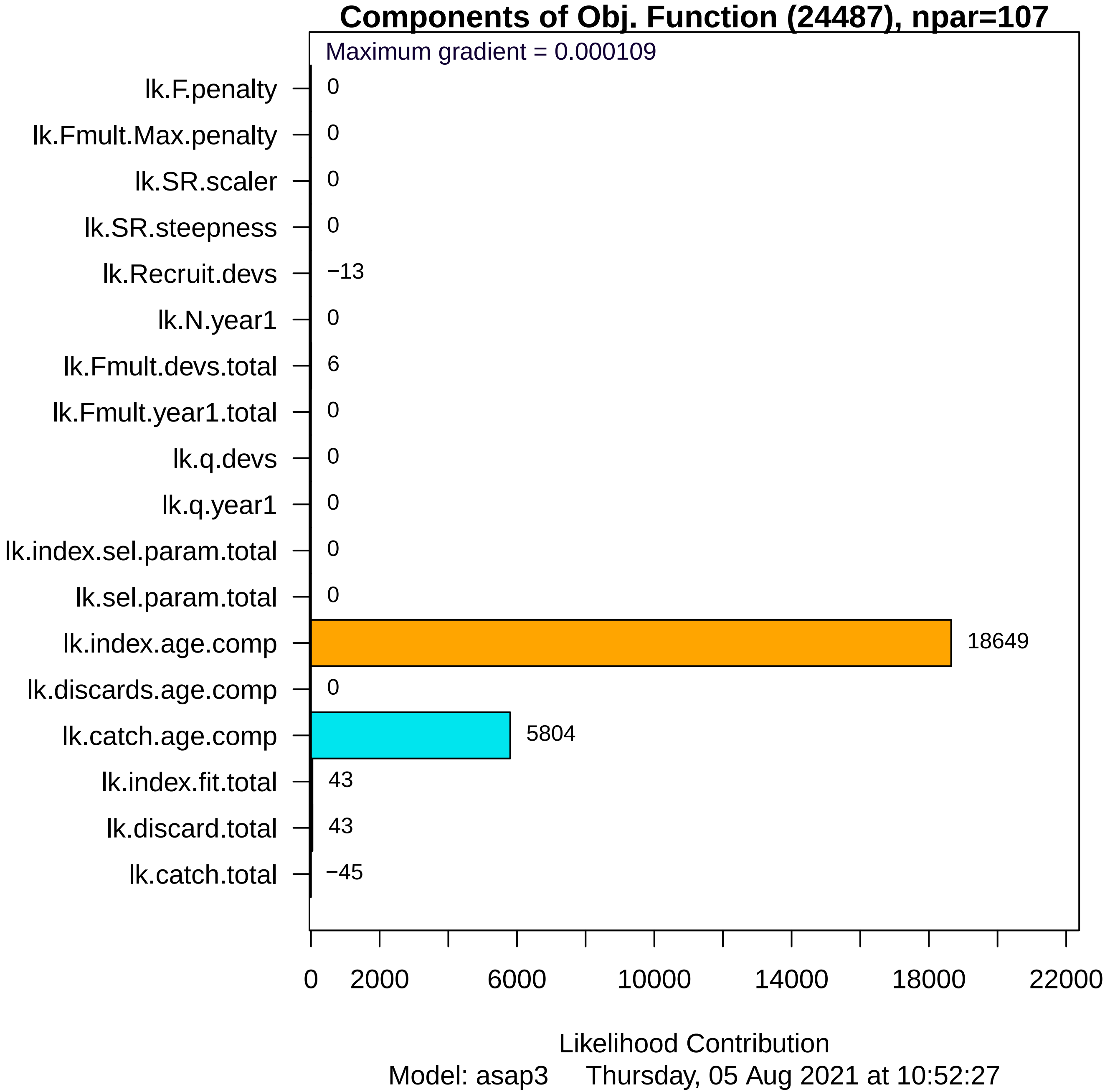
File = asap3.dat

ASAP3 run on Thursday, 05 Aug 2021 at 10:52:27

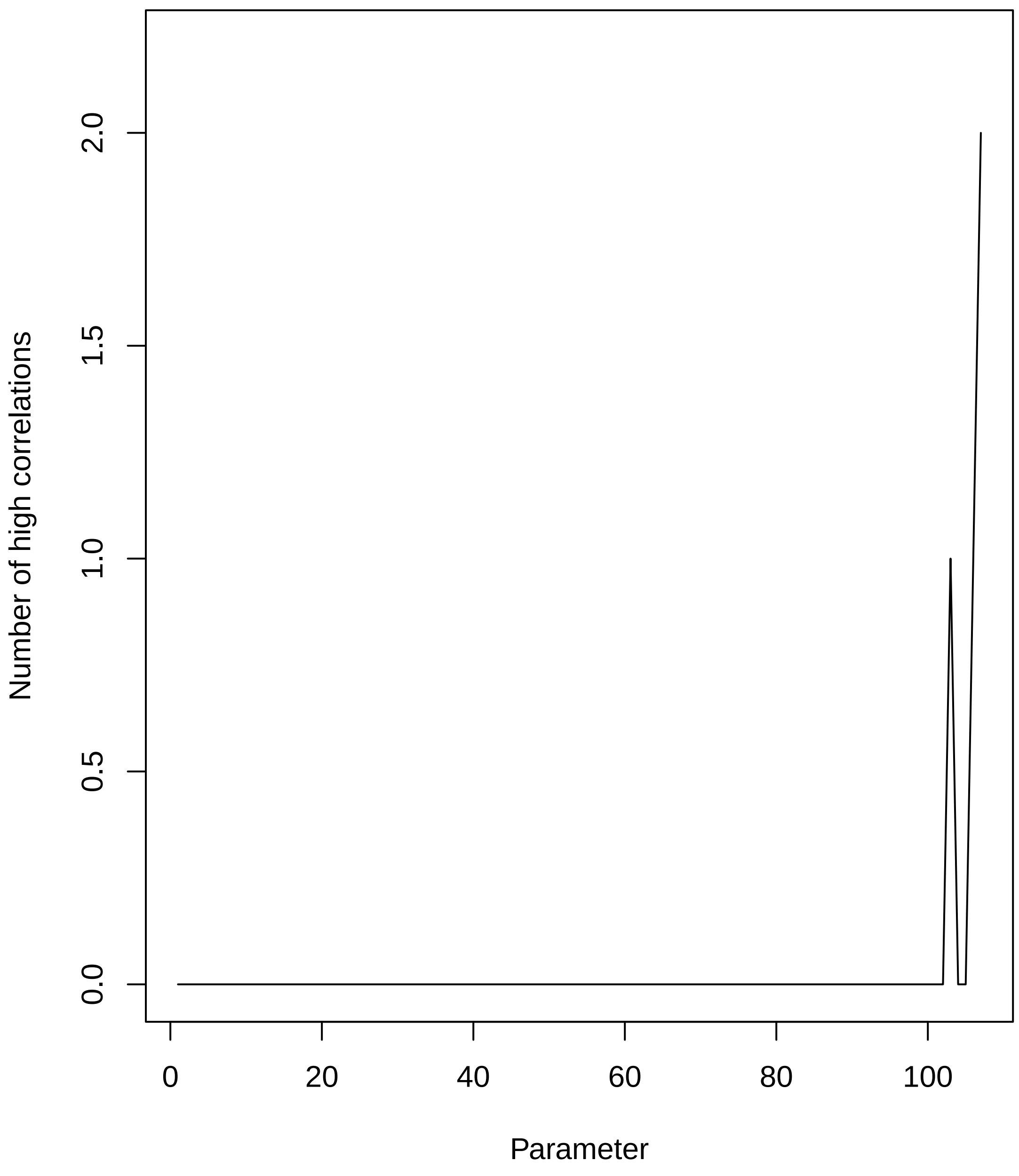
dir = .

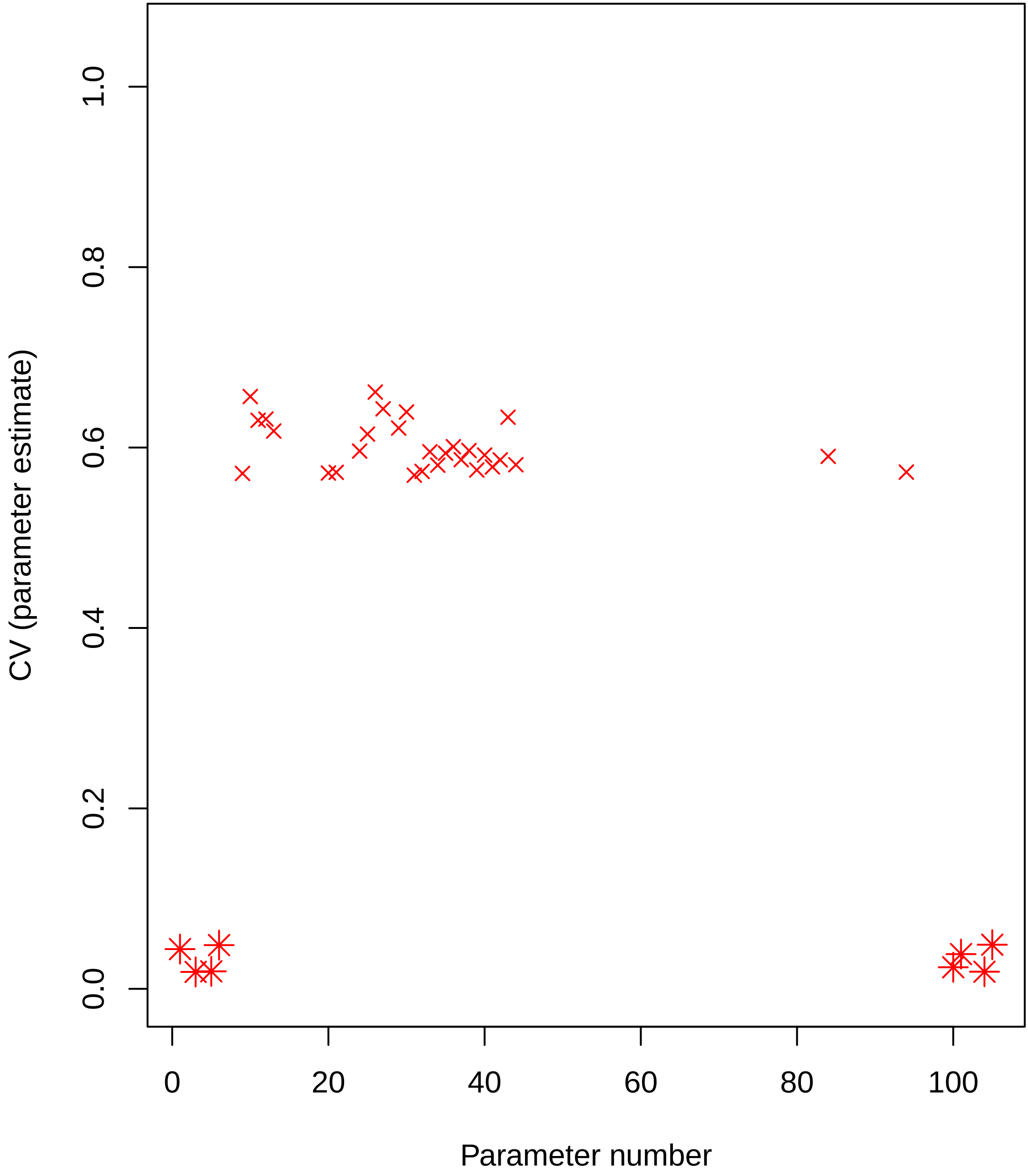
ASAPplots version = 0.2.18

npar = 107, maximum gradient = 0.000108525



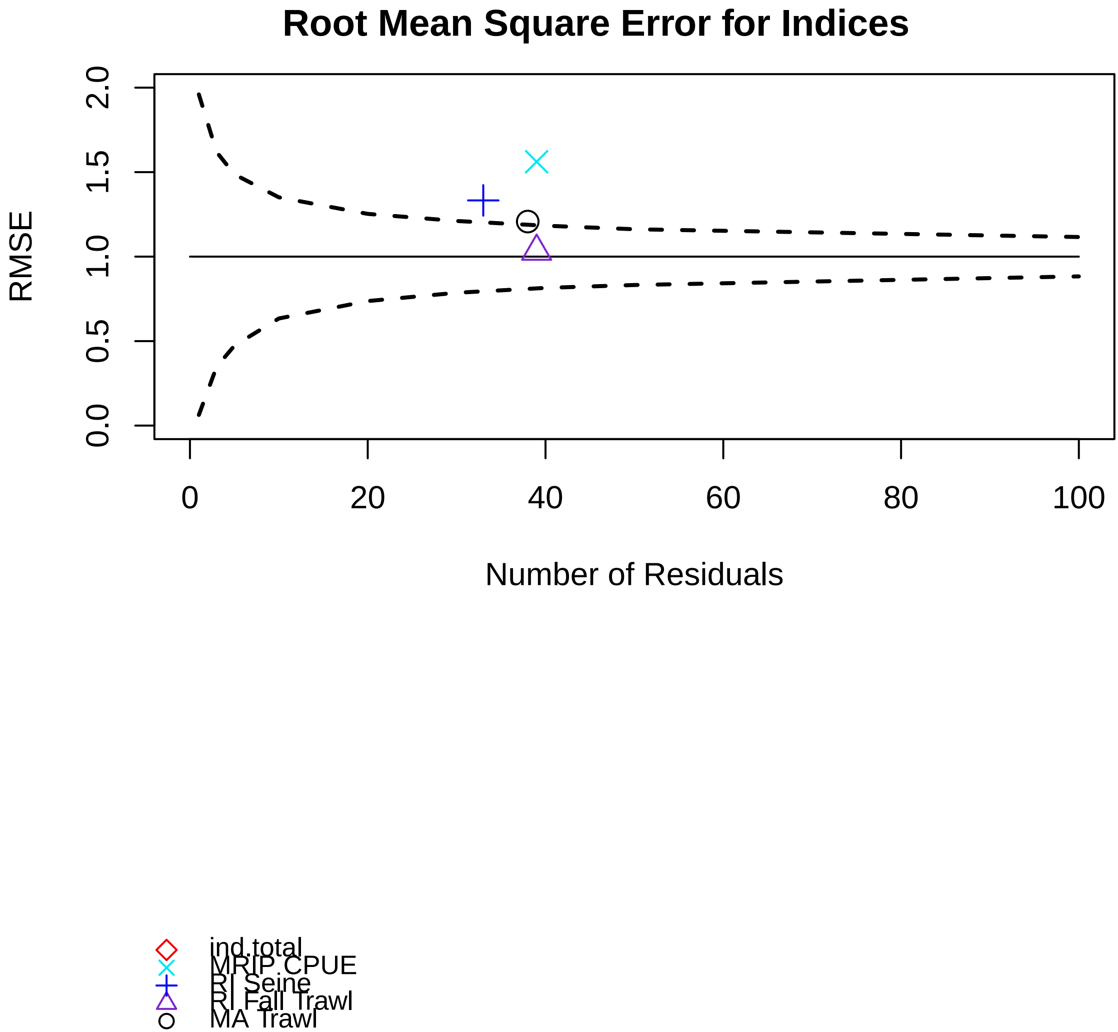
Components of Obj. Function (24487), npar=107
Maximum gradient = 0.000109
lk.F.penalty
lk.Fmult.Max.penalty
lk.SR.scaler
lk.SR.steepness
lk.Recruit.devs
lk.N.year1
lk.Fmult.devs.total
lk.Fmult.year1.total
lk.q.devs
lk.q.year1
lk.index.sel.param.total
lk.sel.param.total
lk.index.age.comp
lk.discards.age.comp
lk.catch.age.comp
lk.index.fit.total
lk.discard.total
lk.catch.total
0
0
0
0
−13
0
6
0
0
0
0
0
18649
0
5804
43
43
−45
0
2000
6000
10000
14000
18000
22000
Likelihood Contribution
Model: asap3 Thursday, 05 Aug 2021 at 10:52:27

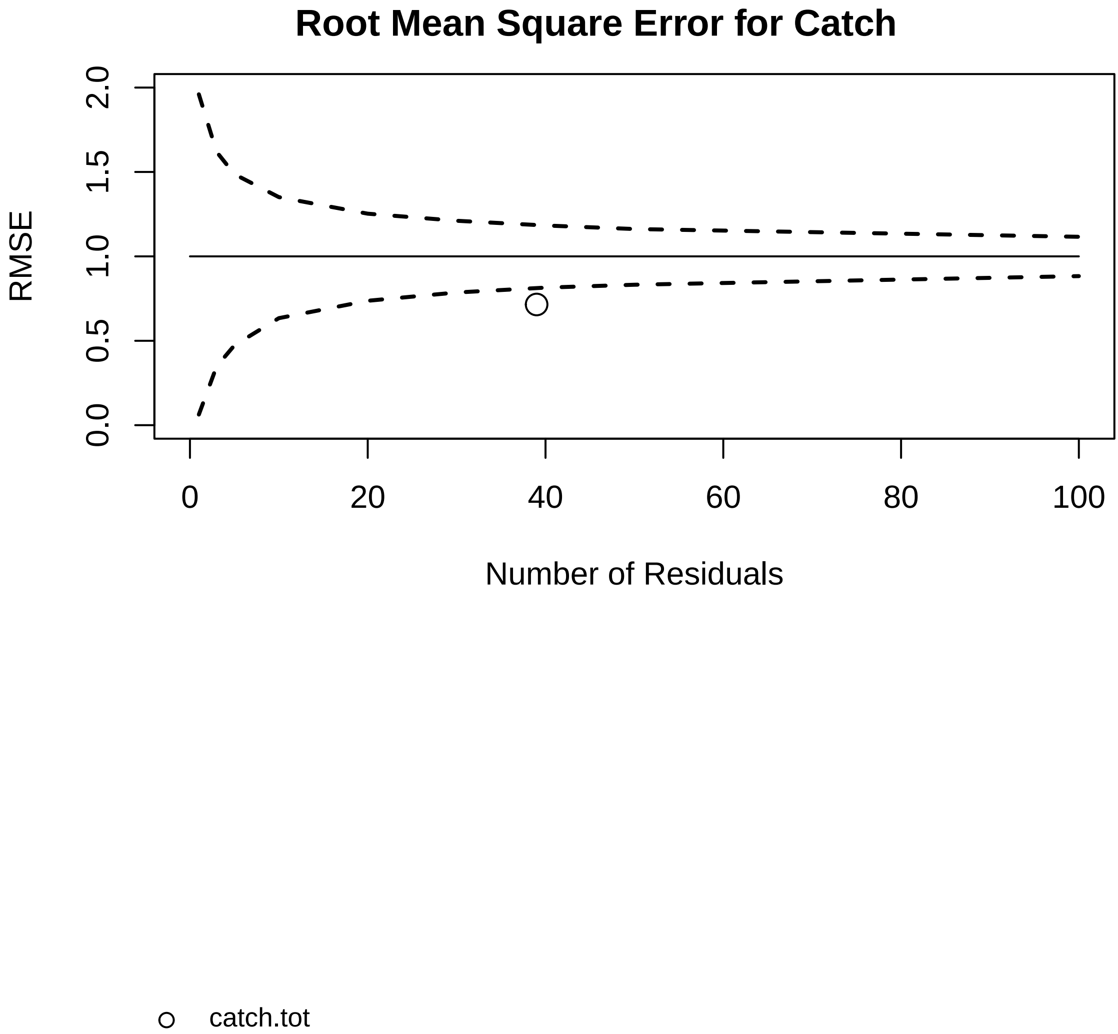

Number of high correlations
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Parameter

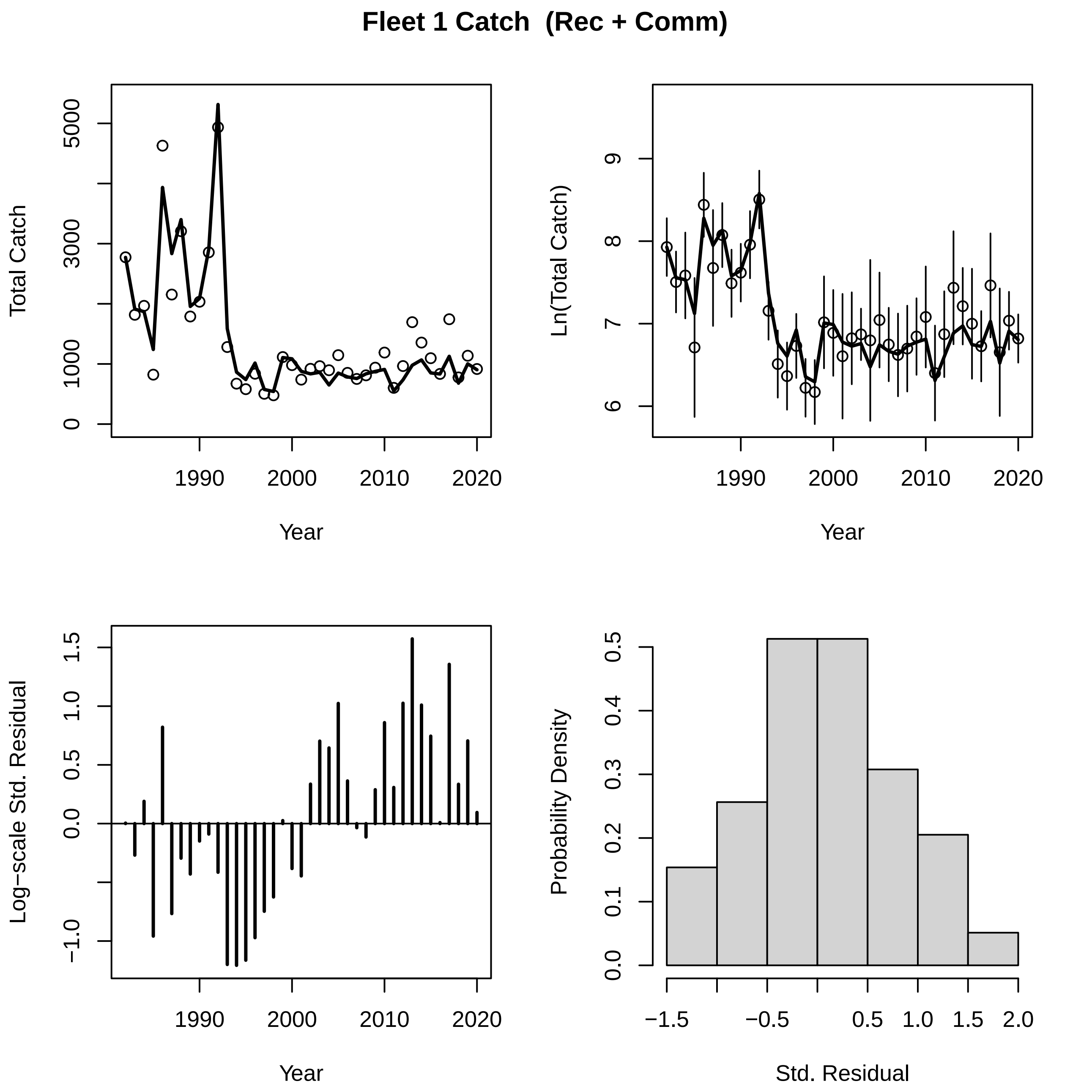

CV (parameter estimate)
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Parameter number

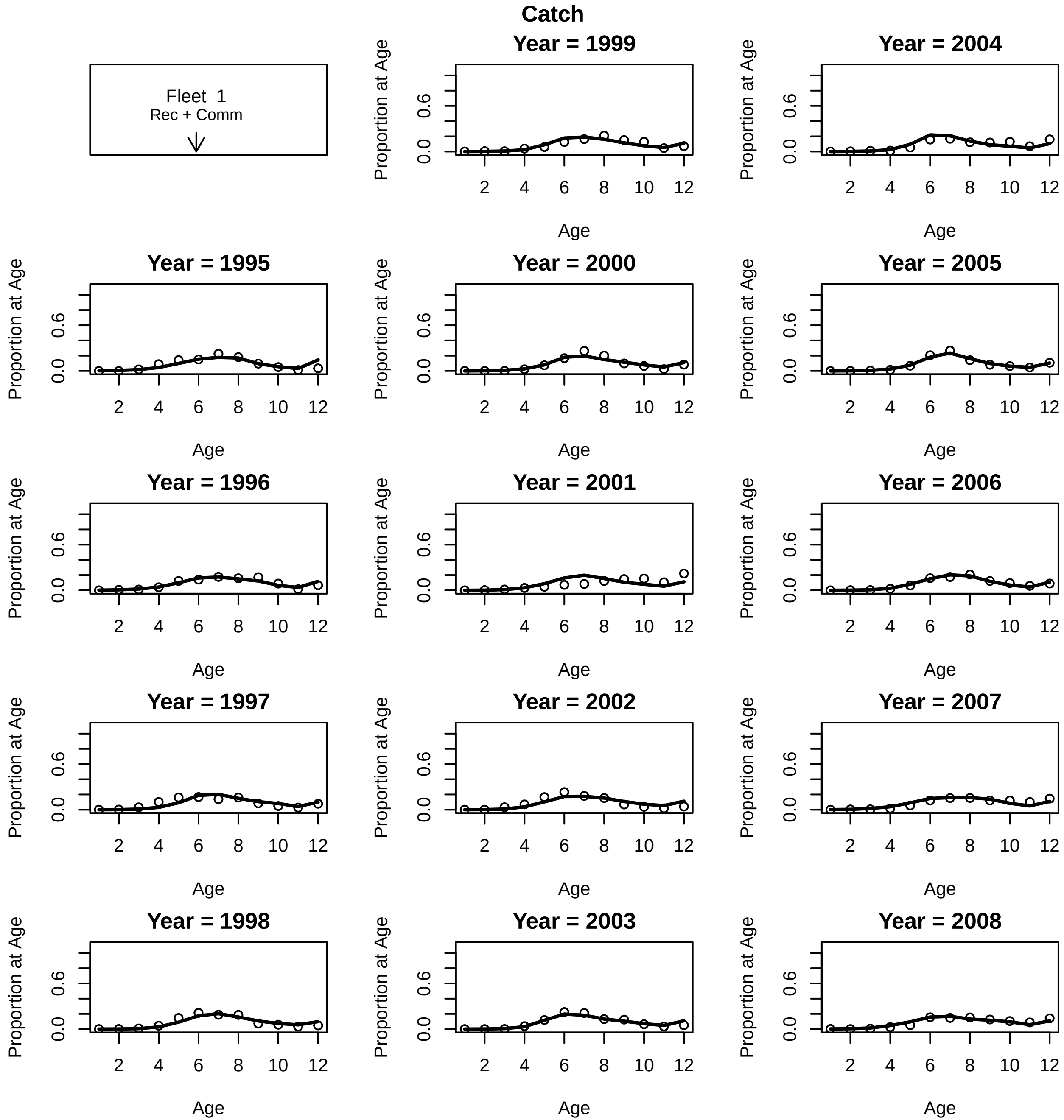
Root Mean Square Error computed from Standardized Residuals

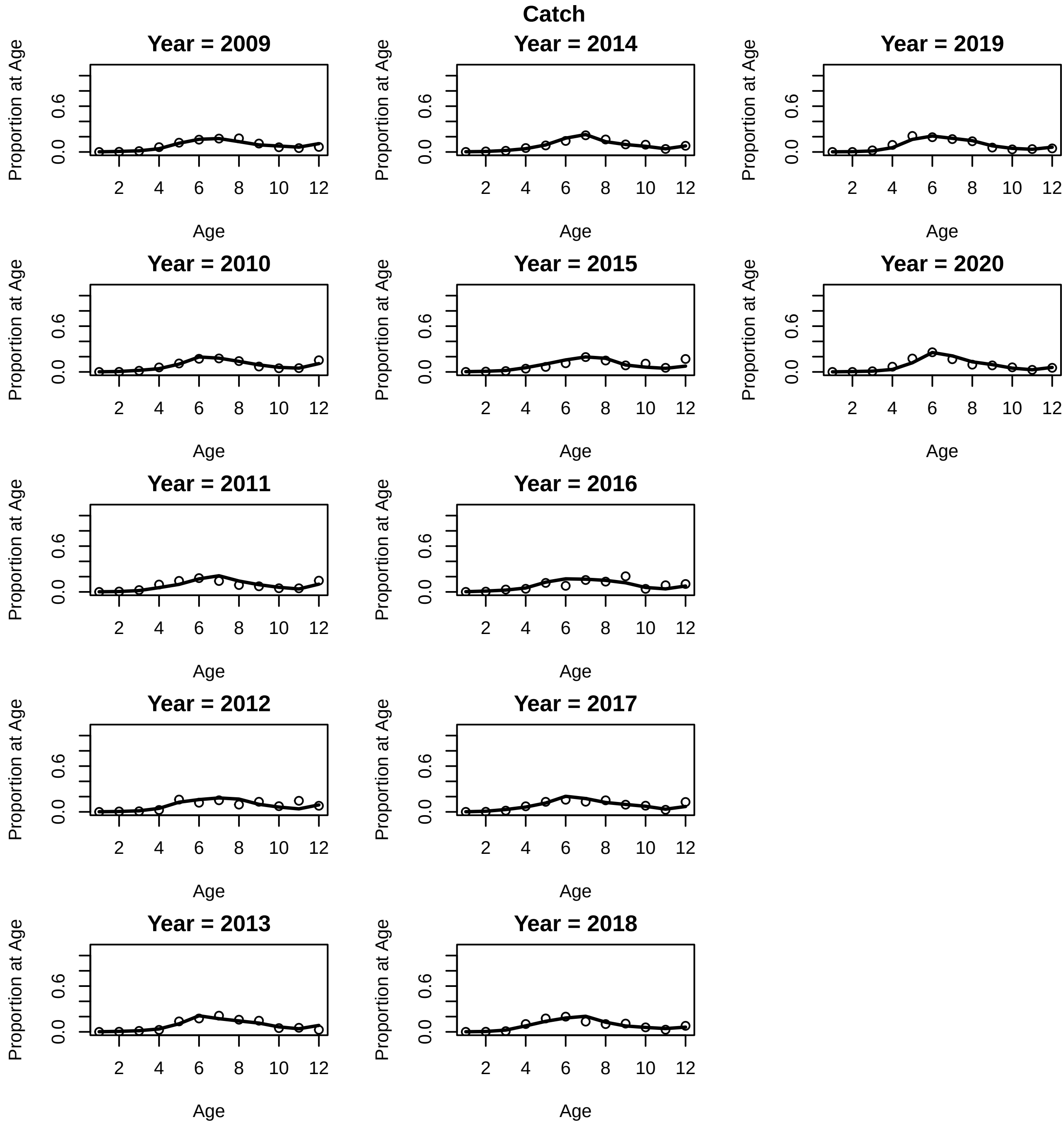
Component	# resids	RMSE
catch.tot	39	0.715
discard.tot	0	0
ind01	38	1.21
ind02	39	1.03
ind03	33	1.33
ind04	39	1.56
ind.total	149	1.3
N.year1	0	0
Fmult.year1	0	0
Fmult.devs.total	38	0.821
recruit.devs	39	0.402
fleet.sel.params	0	0
index.sel.params	0	0
q.year1	0	0
q.devs	0	0
SR.steepness	0	0
SR.scaler	0	0

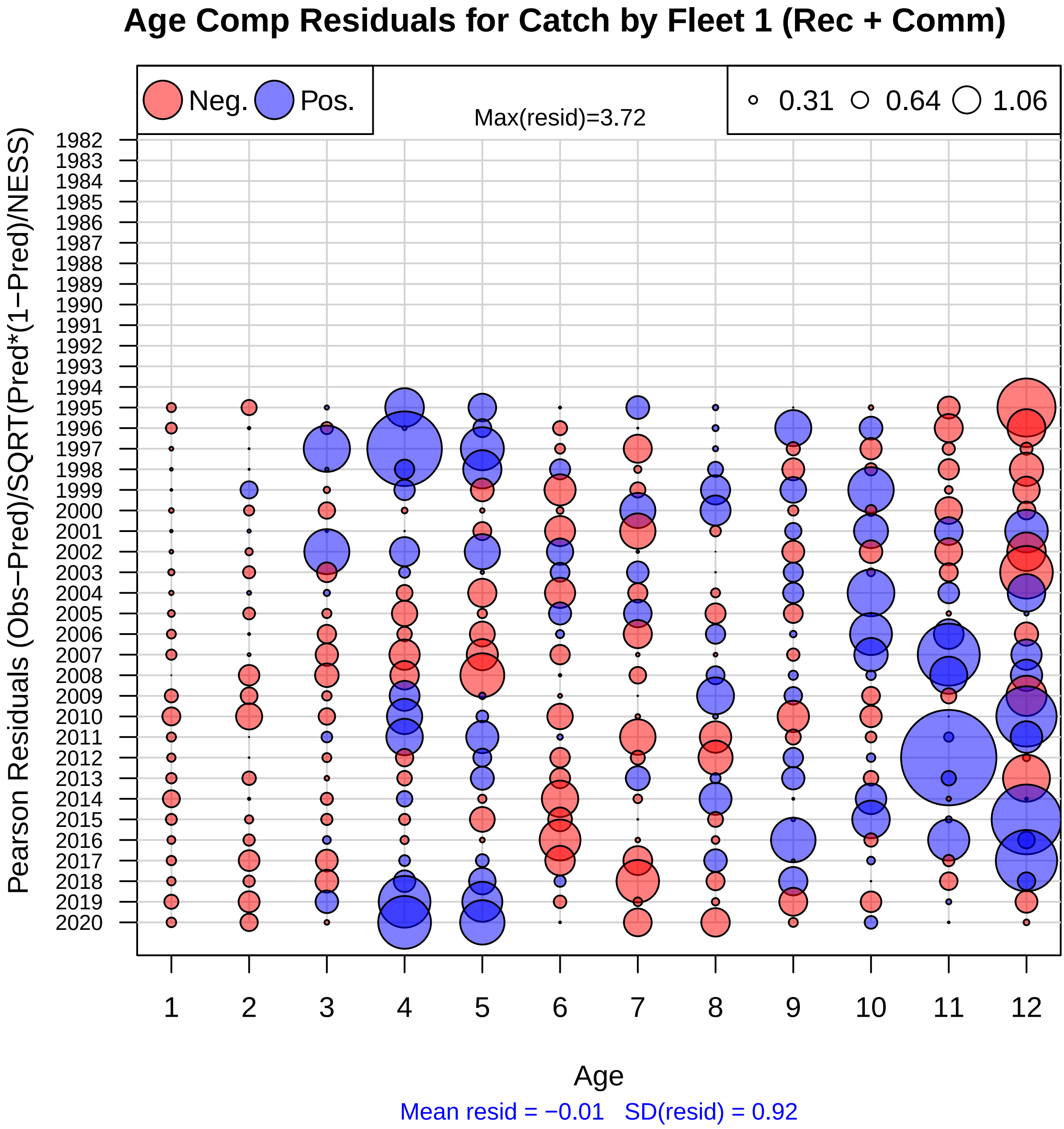

Root Mean Square Error for Indices
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
ind.total
MRIP.CPUE
RI Seine
RI Fall Trawl
MA Trawl

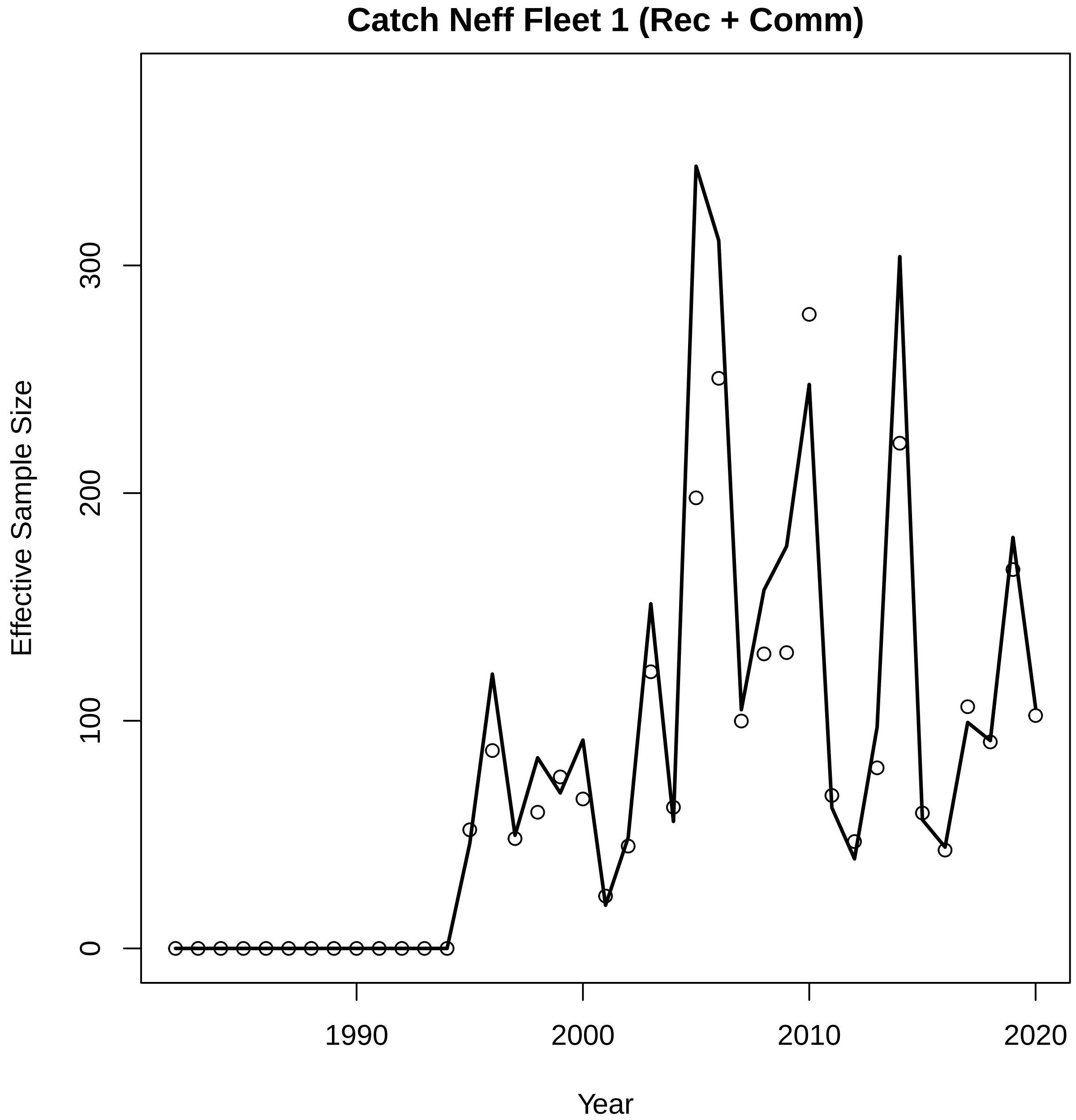

Root Mean Square Error for Catch
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
catch.tot


Fleet 1 Catch (Rec + Comm)
Total Catch
0
1000
3000
5000
1990
2000
2010
2020
Year
Ln(Total Catch)
6
7
8
9
1990
2000
2010
2020
Year
Log−scale Std. Residual
−1.0
0.0
0.5
1.0
1.5
1990
2000
2010
2020
Year
Probability Density
0.0
0.1
0.2
0.3
0.4
0.5
−1.5
−0.5
0.5
1.0
1.5
2.0
Std. Residual

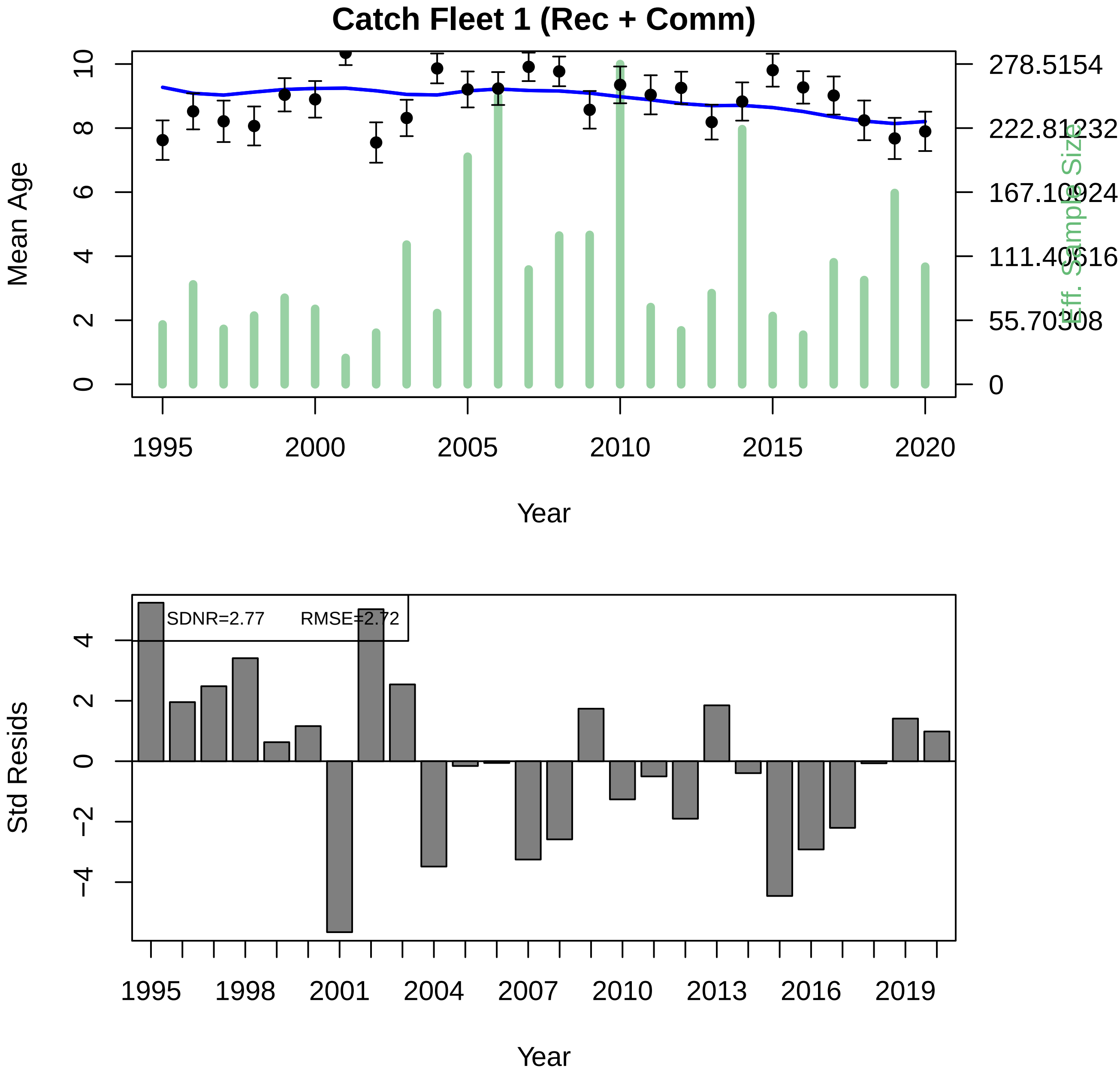

Catch
Fleet 1
Rec + Comm
Year = 1995
Year = 1996
Year = 1997
Year = 1998
Year = 1999
Year = 2000
Year = 2001
Year = 2002
Year = 2003
Year = 2004
Year = 2005
Year = 2006
Year = 2007
Year = 2008
Proportion at Age
Age


Catch
Year = 2009
Year = 2014
Year = 2019
Year = 2010
Year = 2015
Year = 2020
Year = 2011
Year = 2016
Year = 2012
Year = 2017
Year = 2013
Year = 2018
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age

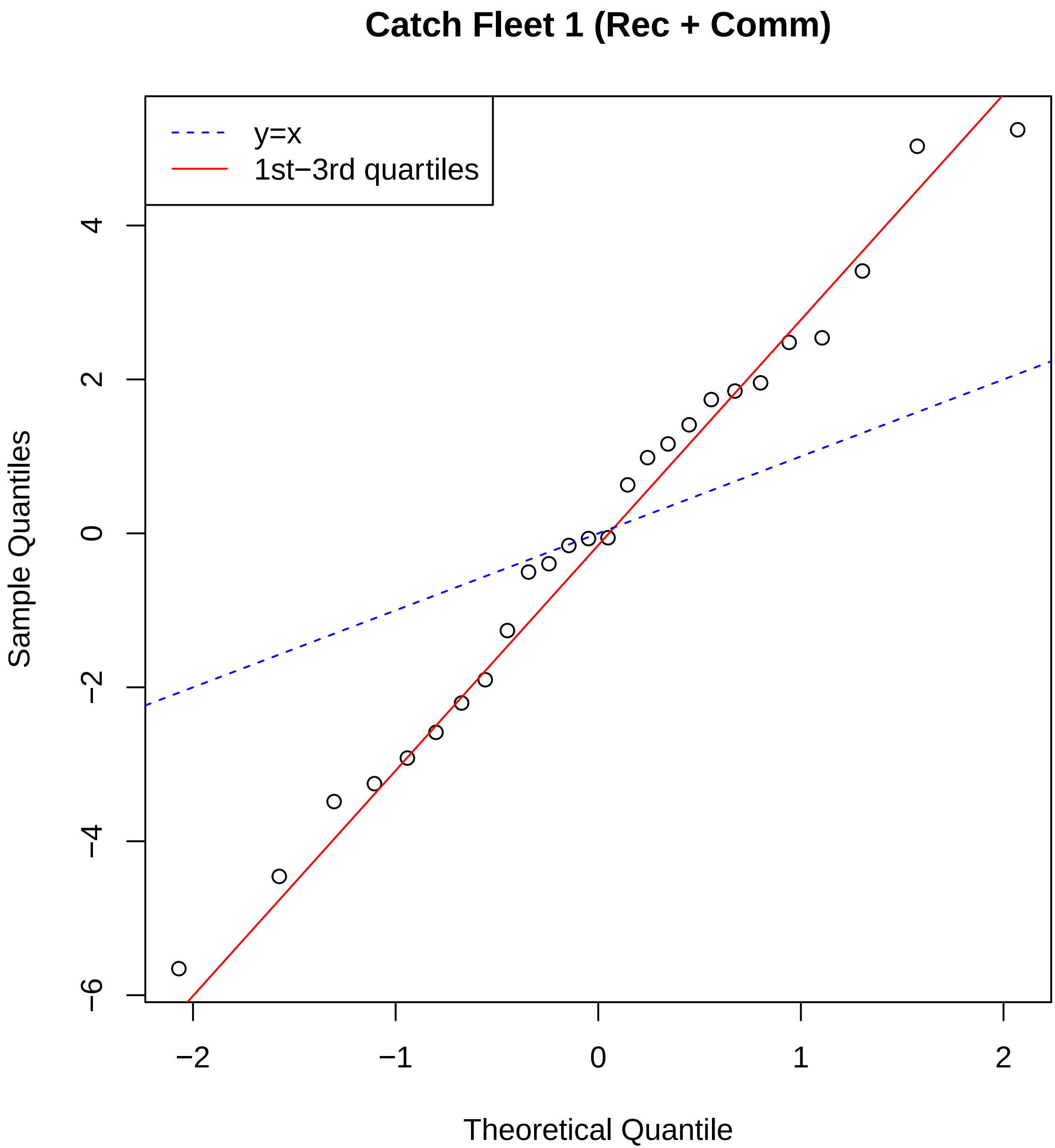

Age Comp Residuals for Catch by Fleet 1 (Rec + Comm)
Neg.
Pos.
Max(resid)=3.72
0.31
0.64
1.06
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.01   SD(resid) = 0.92



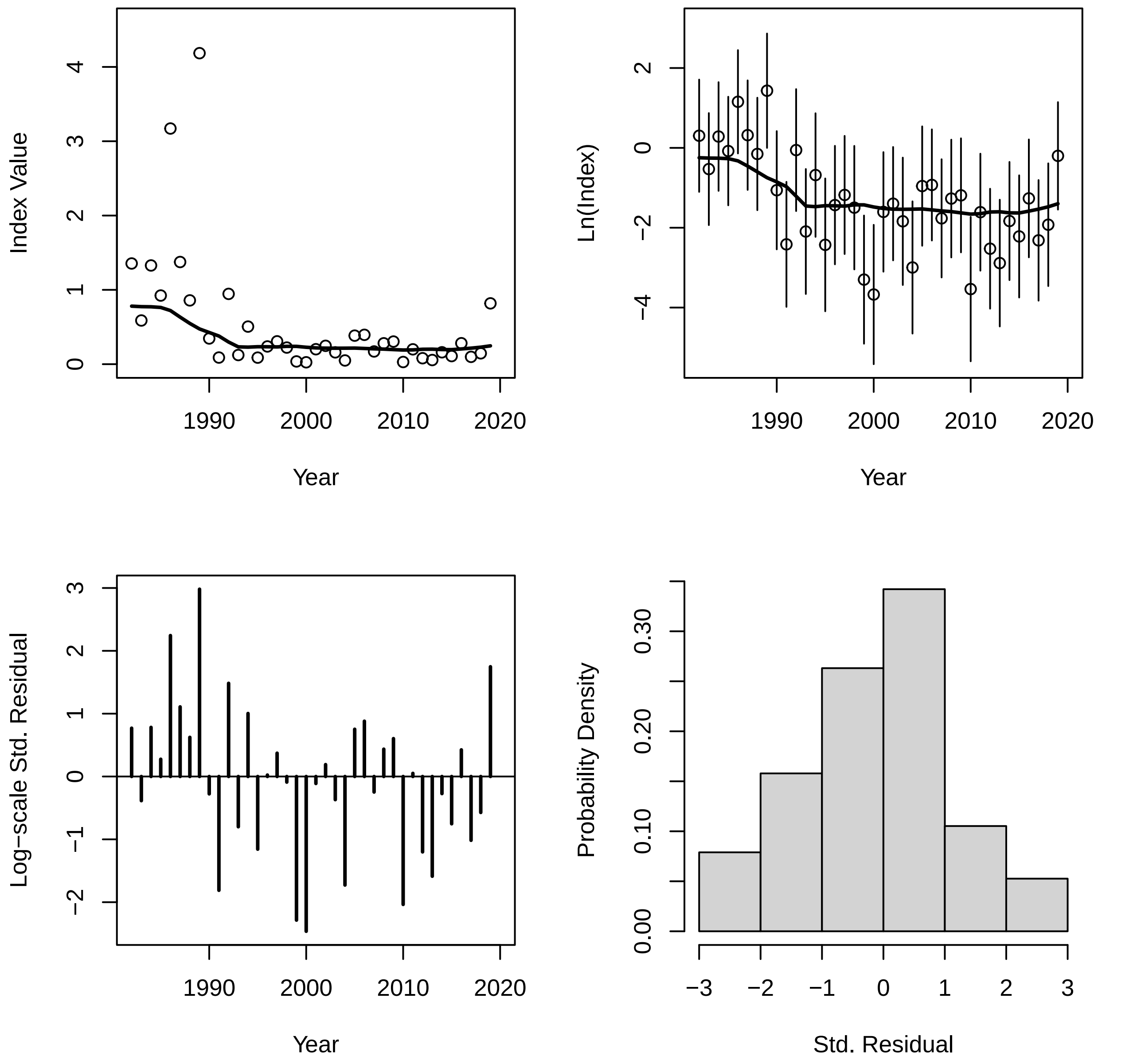
Catch Neff Fleet 1 (Rec + Comm)
Effective Sample Size
0
100
200
300
1990
2000
2010
2020
Year

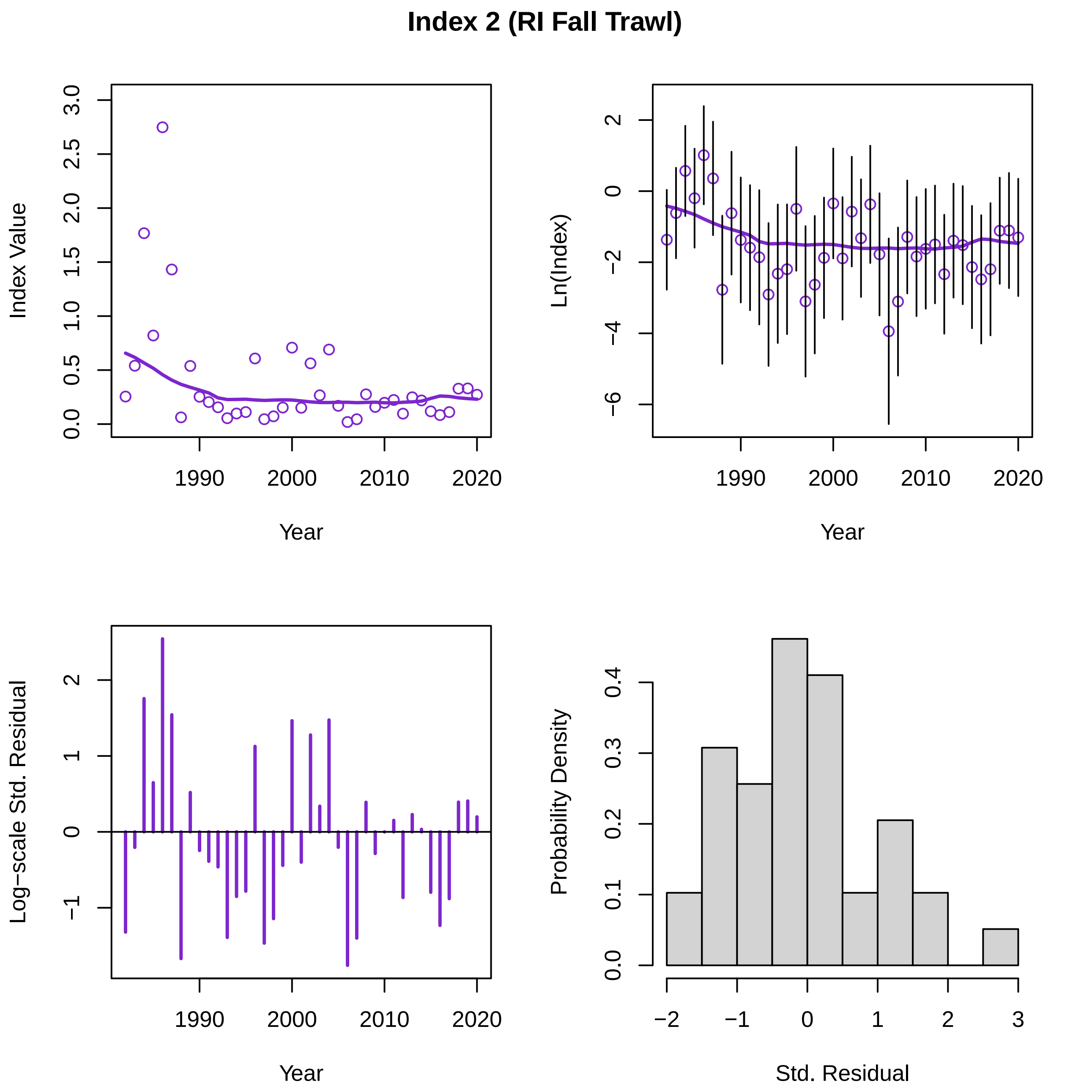


Catch Fleet 1 (Rec + Comm)
Mean Age
Eff. Sample Size
0
2
4
6
8
10
0
55.70308
111.40616
167.10924
222.81232
278.5154
1995
2000
2005
2010
2015
2020
Year
SDNR=2.77
RMSE=2.72
Std Resids
−4
−2
0
2
4
1995
1998
2001
2004
2007
2010
2013
2016
2019
Year

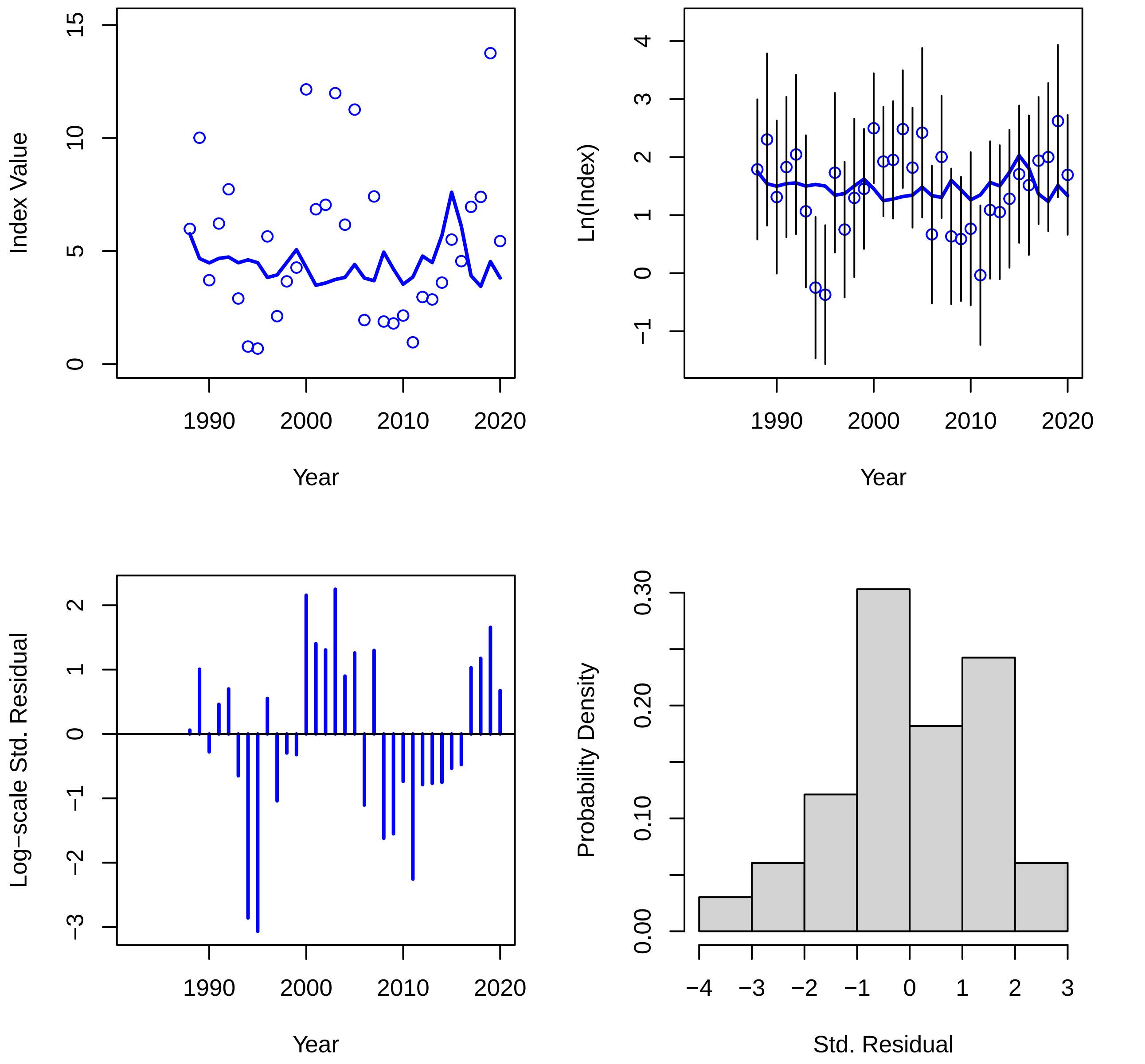

Catch Fleet 1 (Rec + Comm)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−6
−4
−2
0
2
4
−2
−1
0
1
2

Index 1 (MA Trawl)

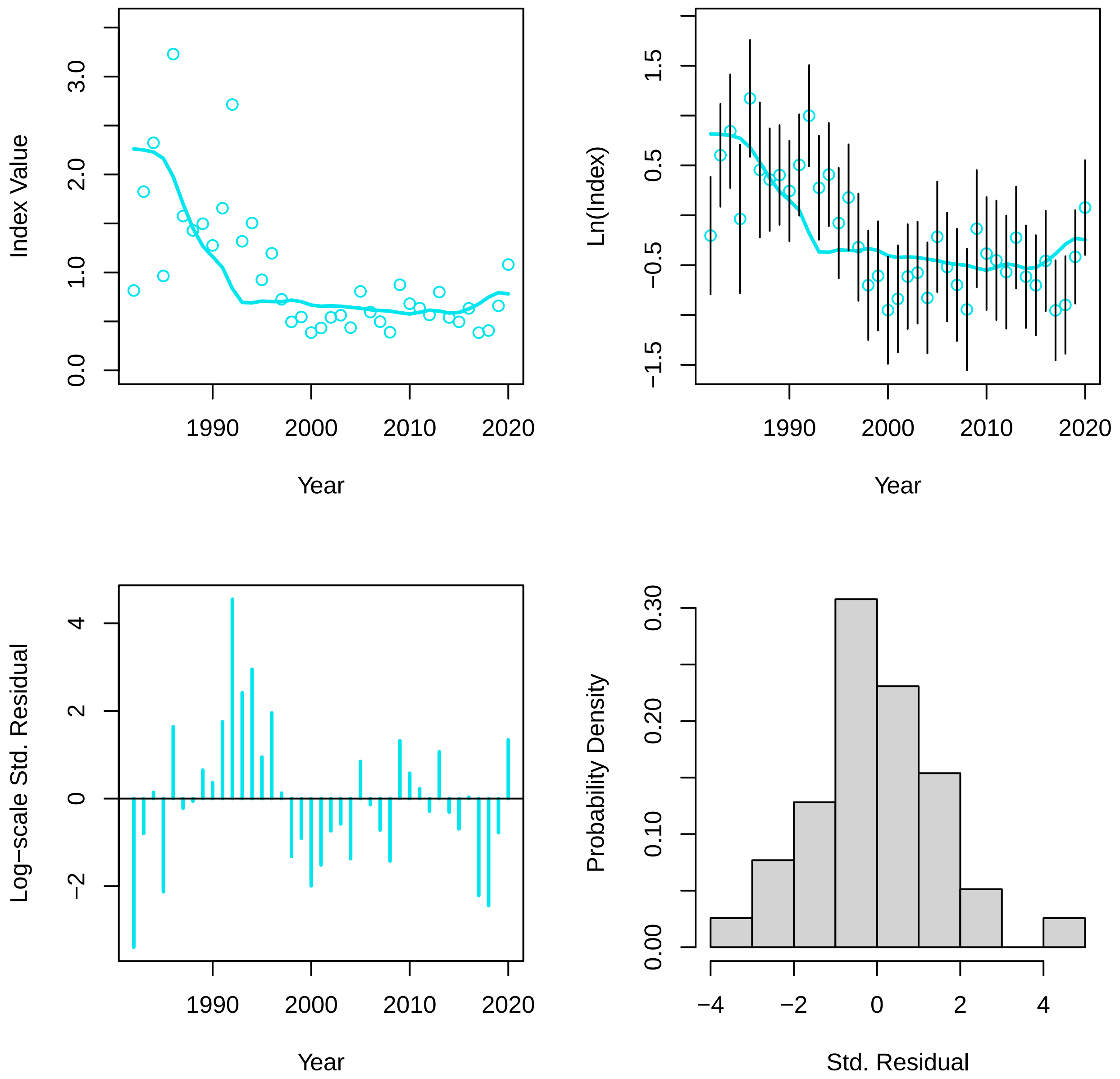


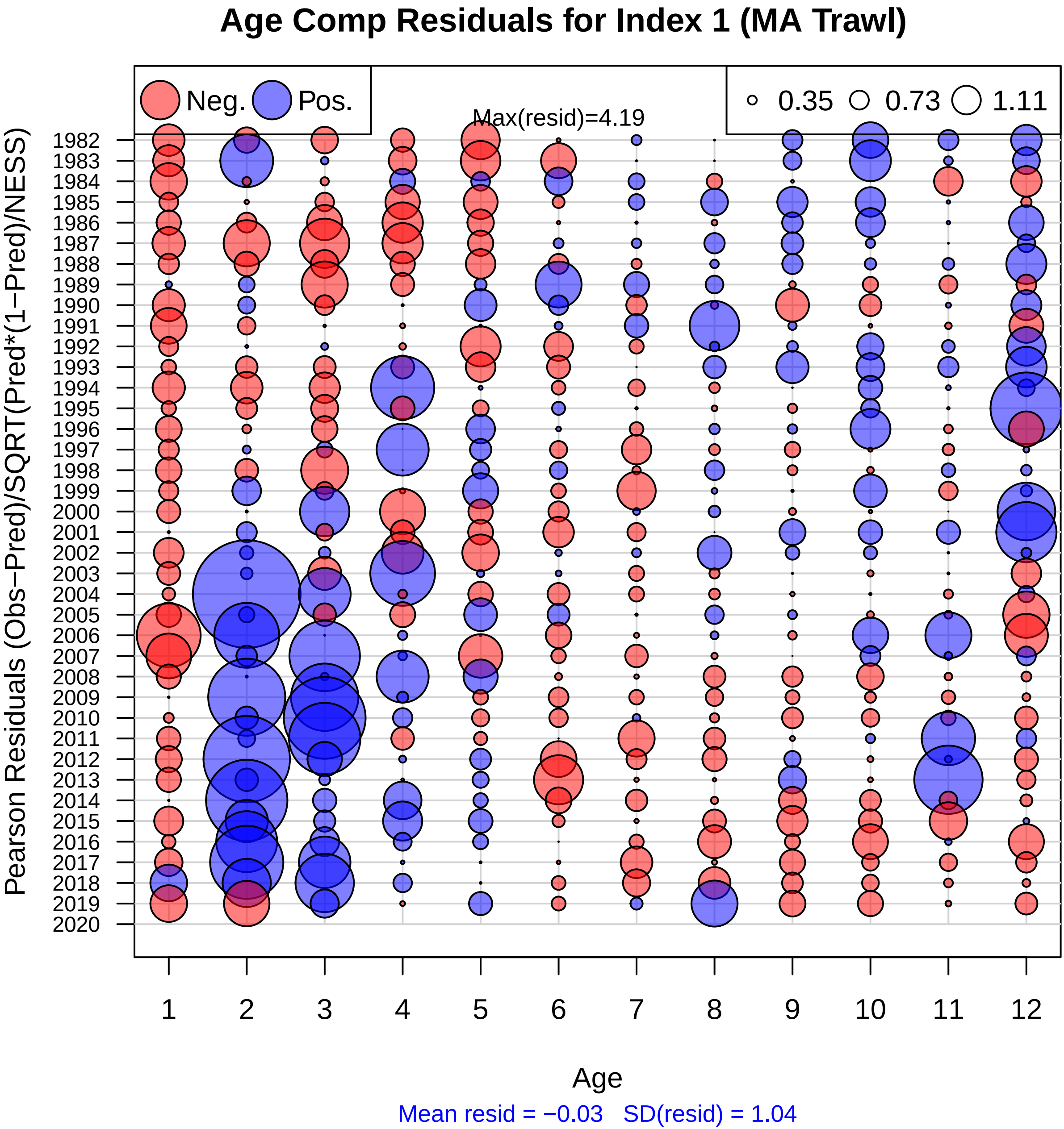

Index 2 (RI Fall Trawl)
Index Value
Year
Ln(Index)
Year
Log−scale Std. Residual
Year
Probability Density
Std. Residual

Index 3 (RI Seine)

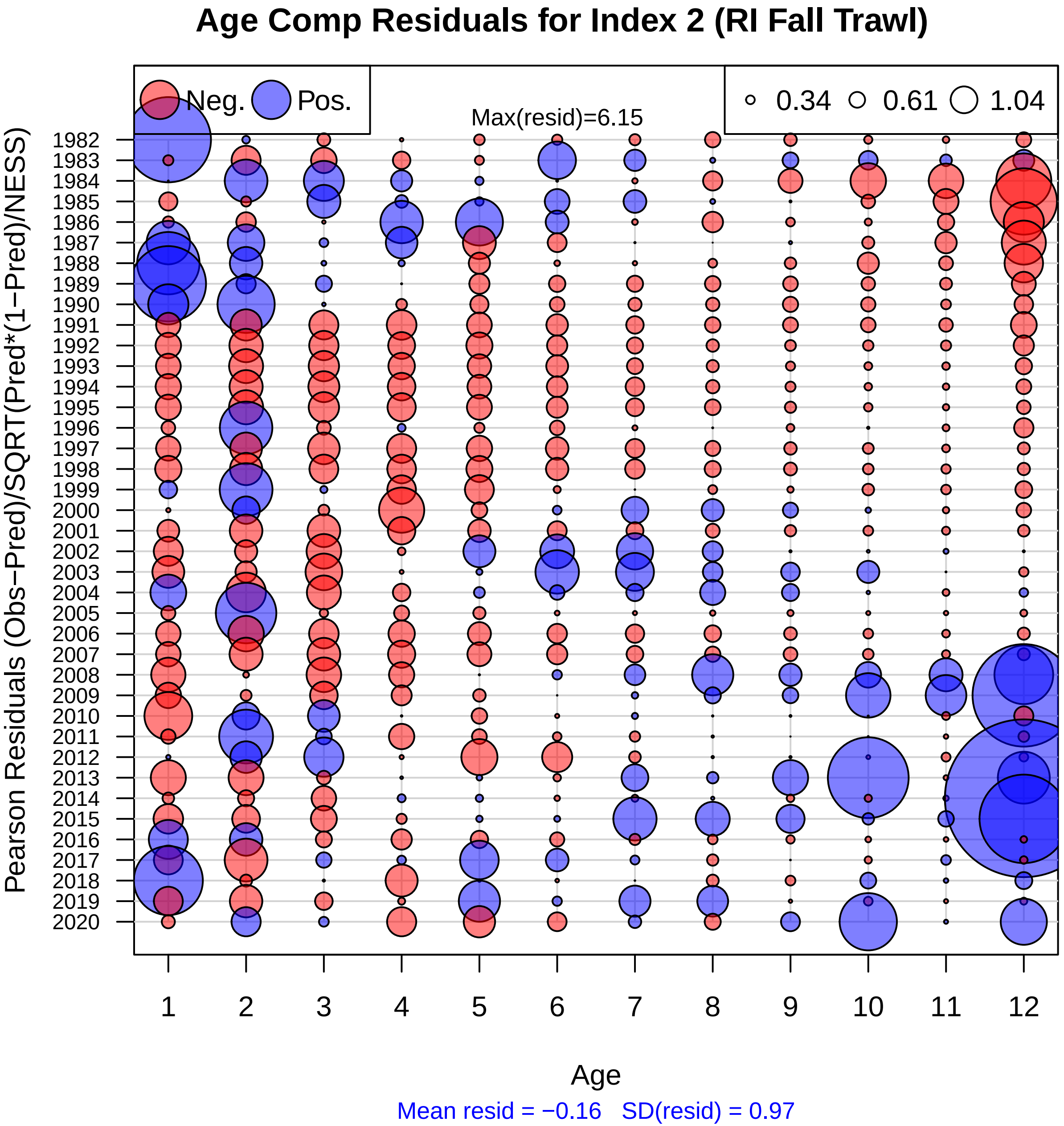


Index 4 (MRIP CPUE)

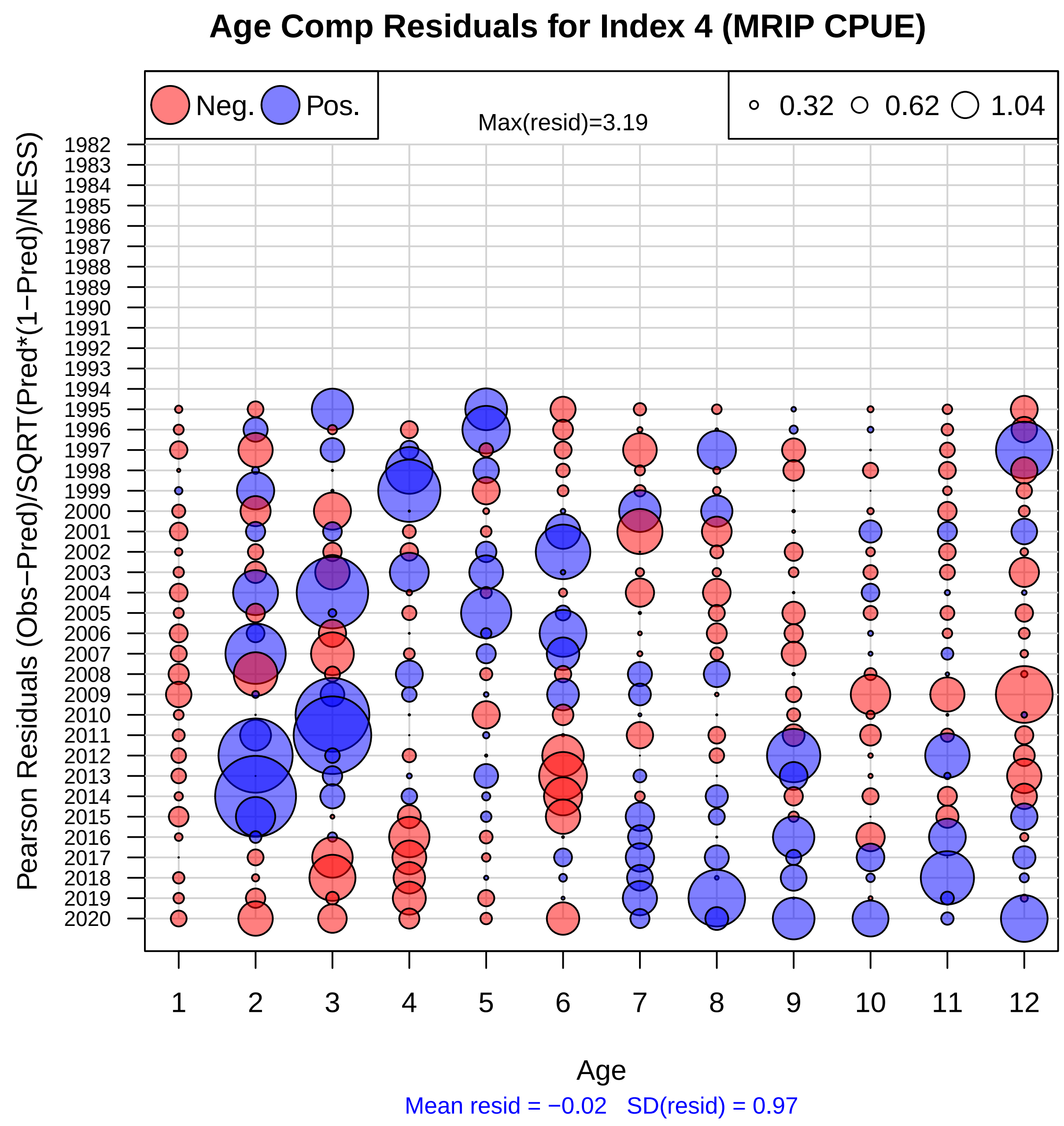




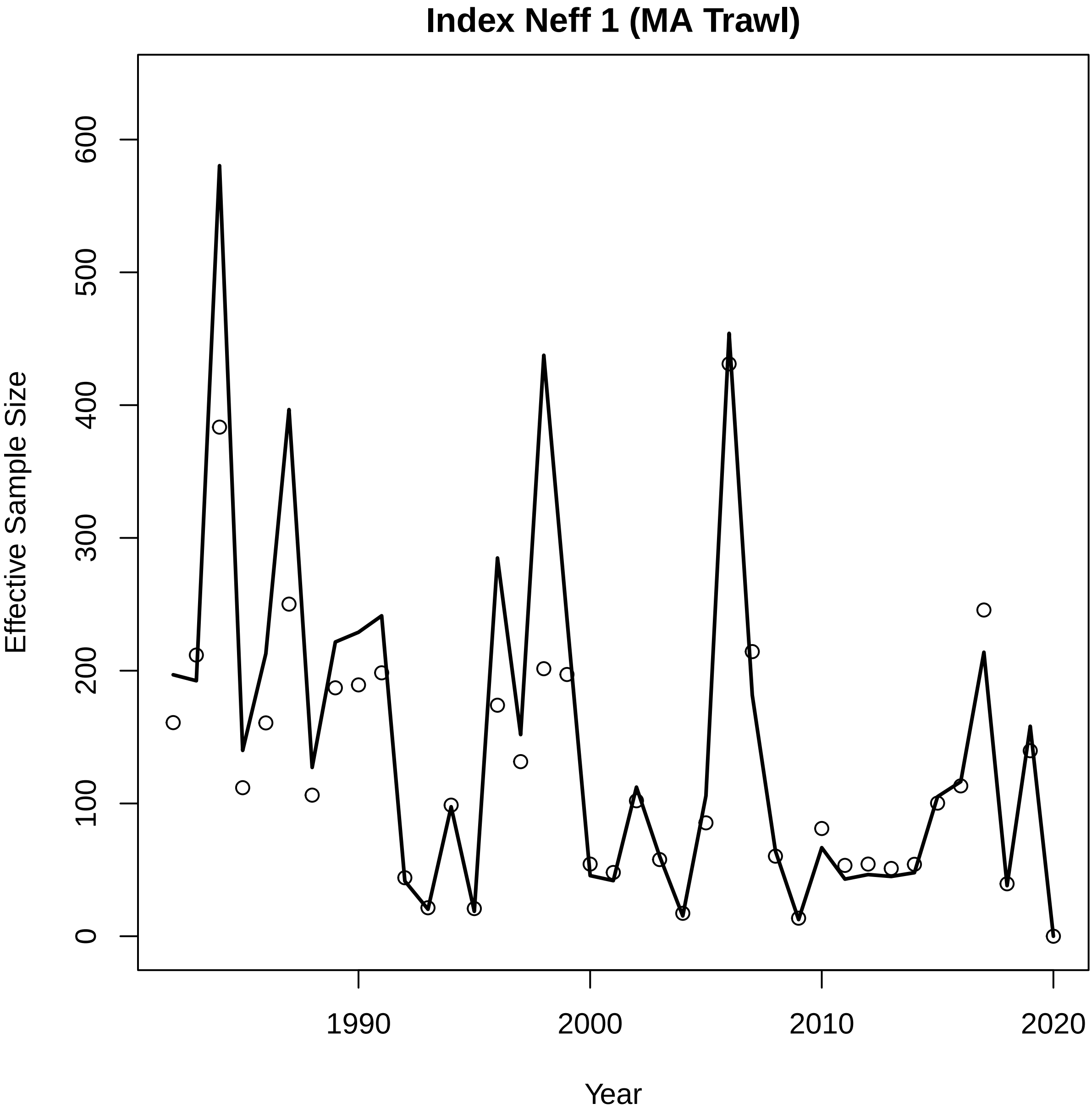
Age Comp Residuals for Index 1 (MA Trawl)
Neg.
Pos.
0.35
0.73
1.11
Max(resid)=4.19
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.03   SD(resid) = 1.04



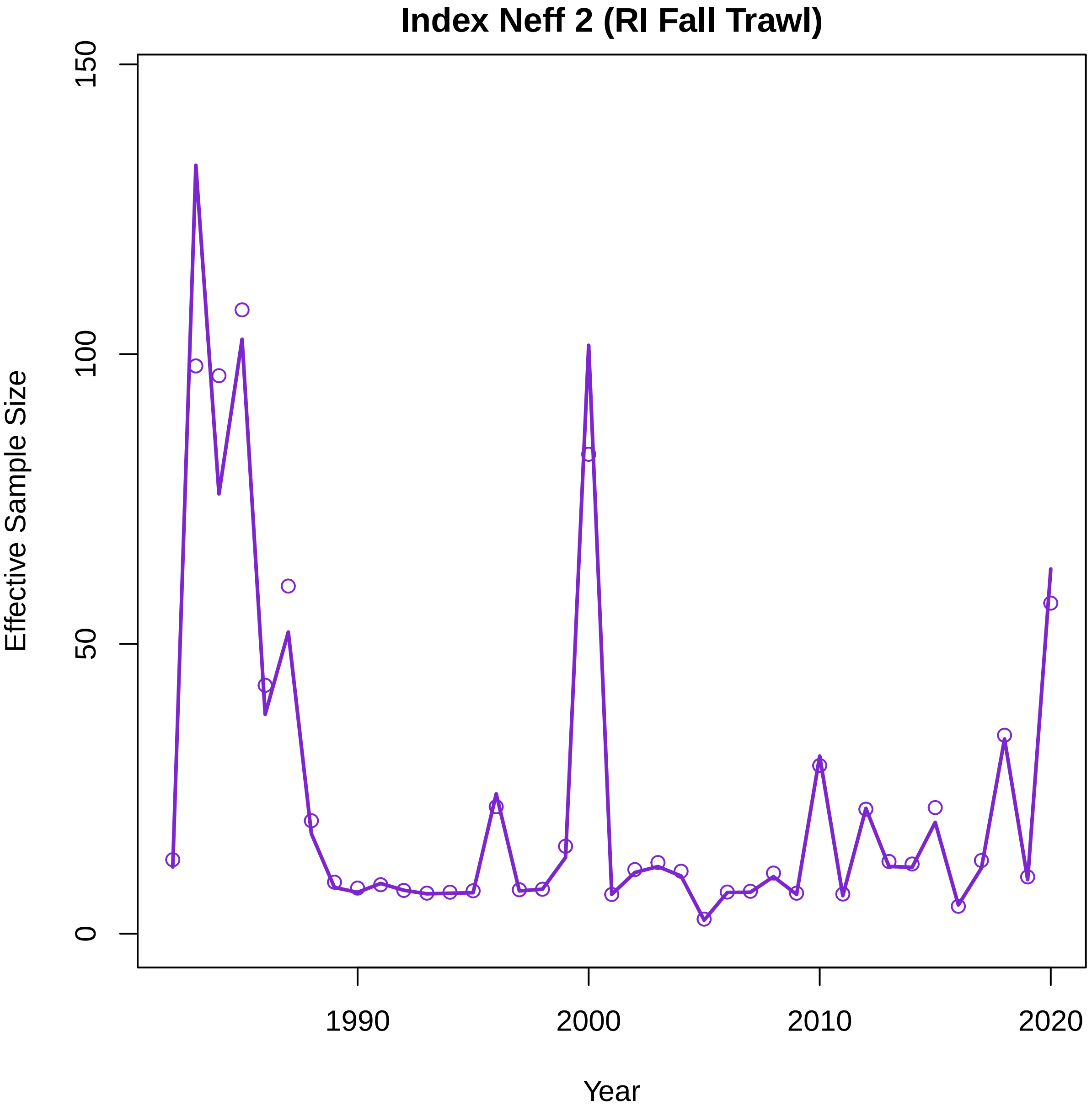
Age Comp Residuals for Index 2 (RI Fall Trawl)
Neg.
Pos.
0.34
0.61
1.04
Max(resid)=6.15
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.16   SD(resid) = 0.97



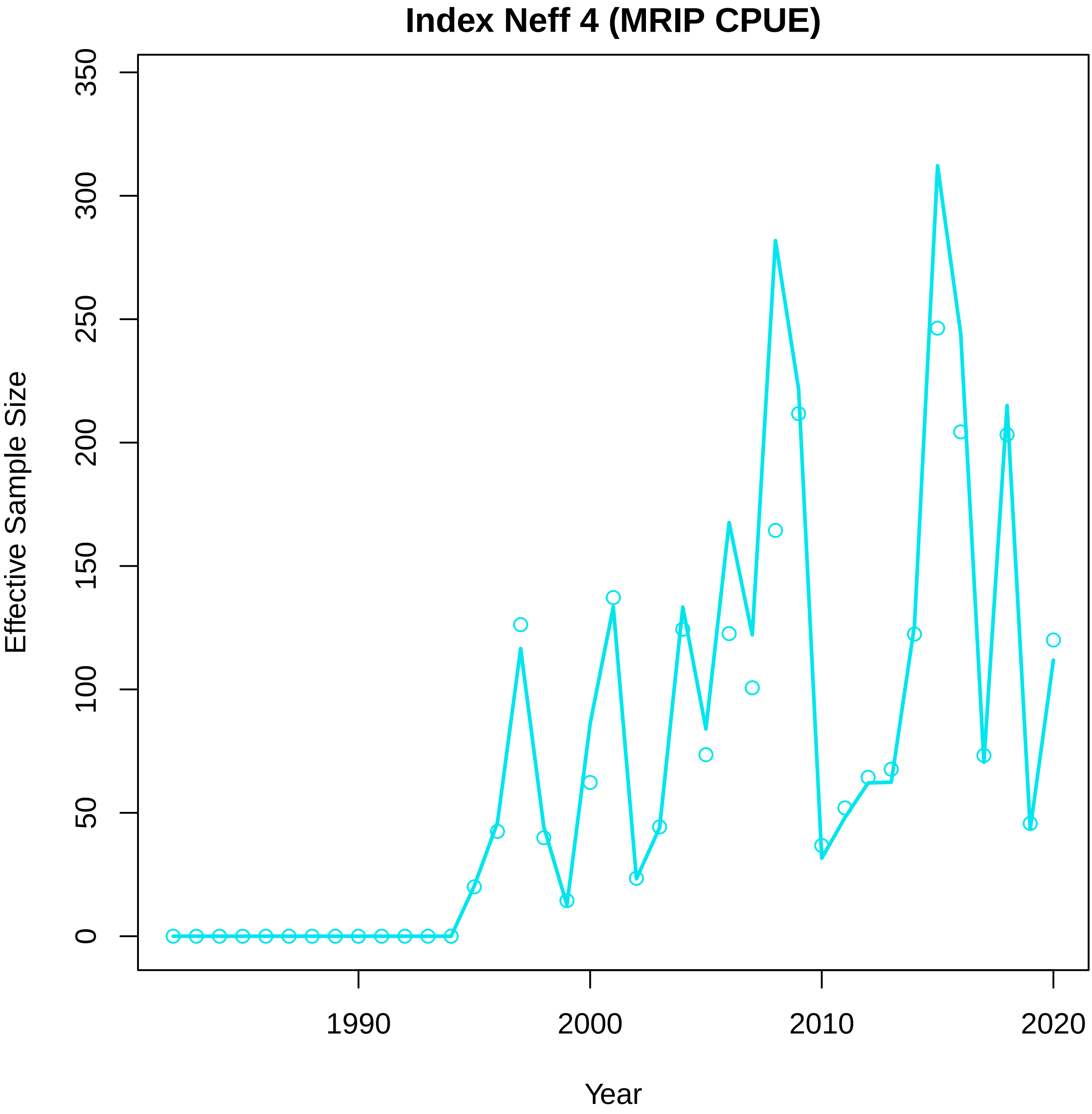
Age Comp Residuals for Index 4 (MRIP CPUE)
Neg.
Pos.
Max(resid)=3.19
0.32
0.62
1.04
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.02   SD(resid) = 0.97

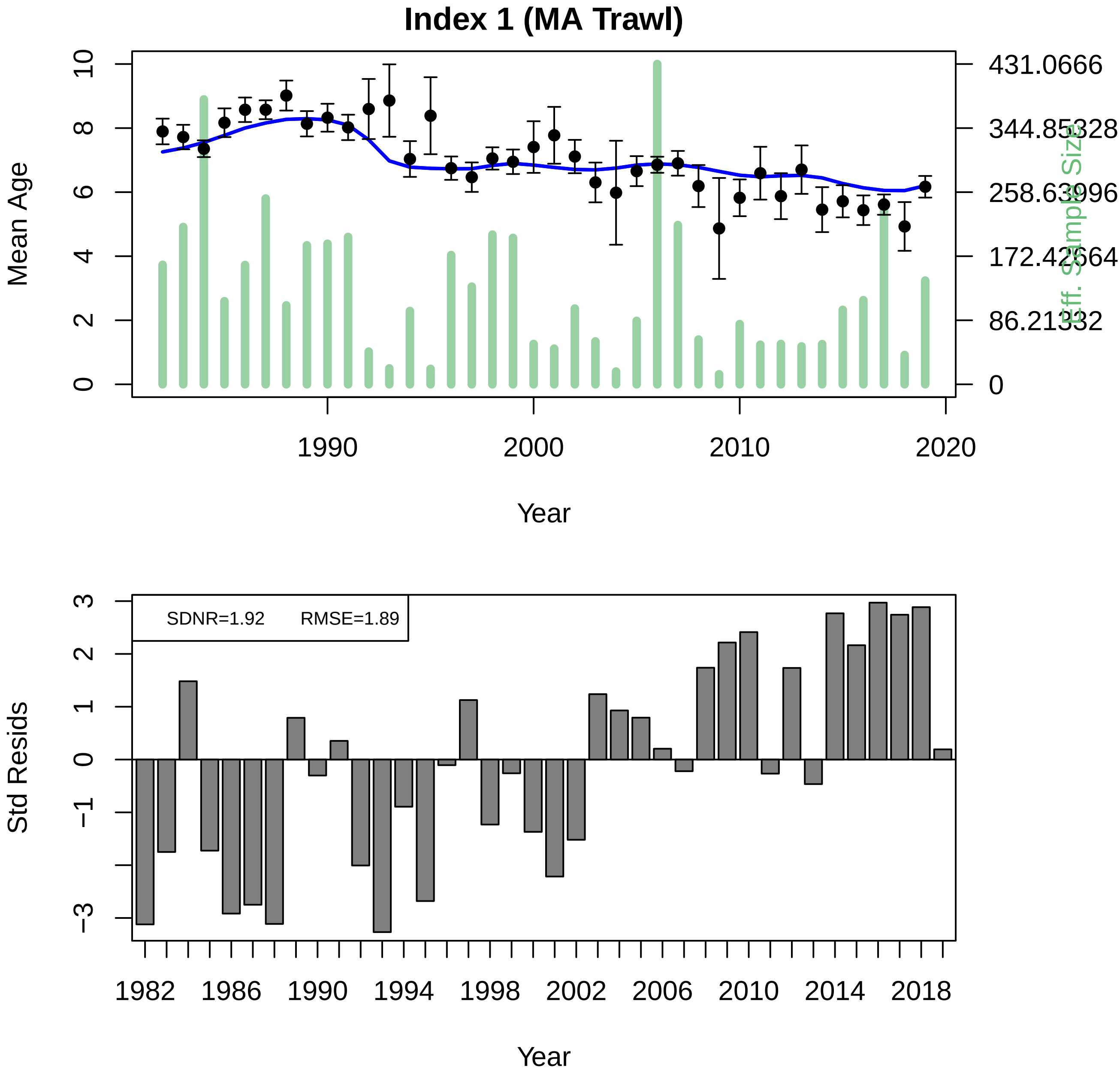


Index Neff 1 (MA Trawl)
Effective Sample Size
Year
0
100
200
300
400
500
600
1990
2000
2010
2020

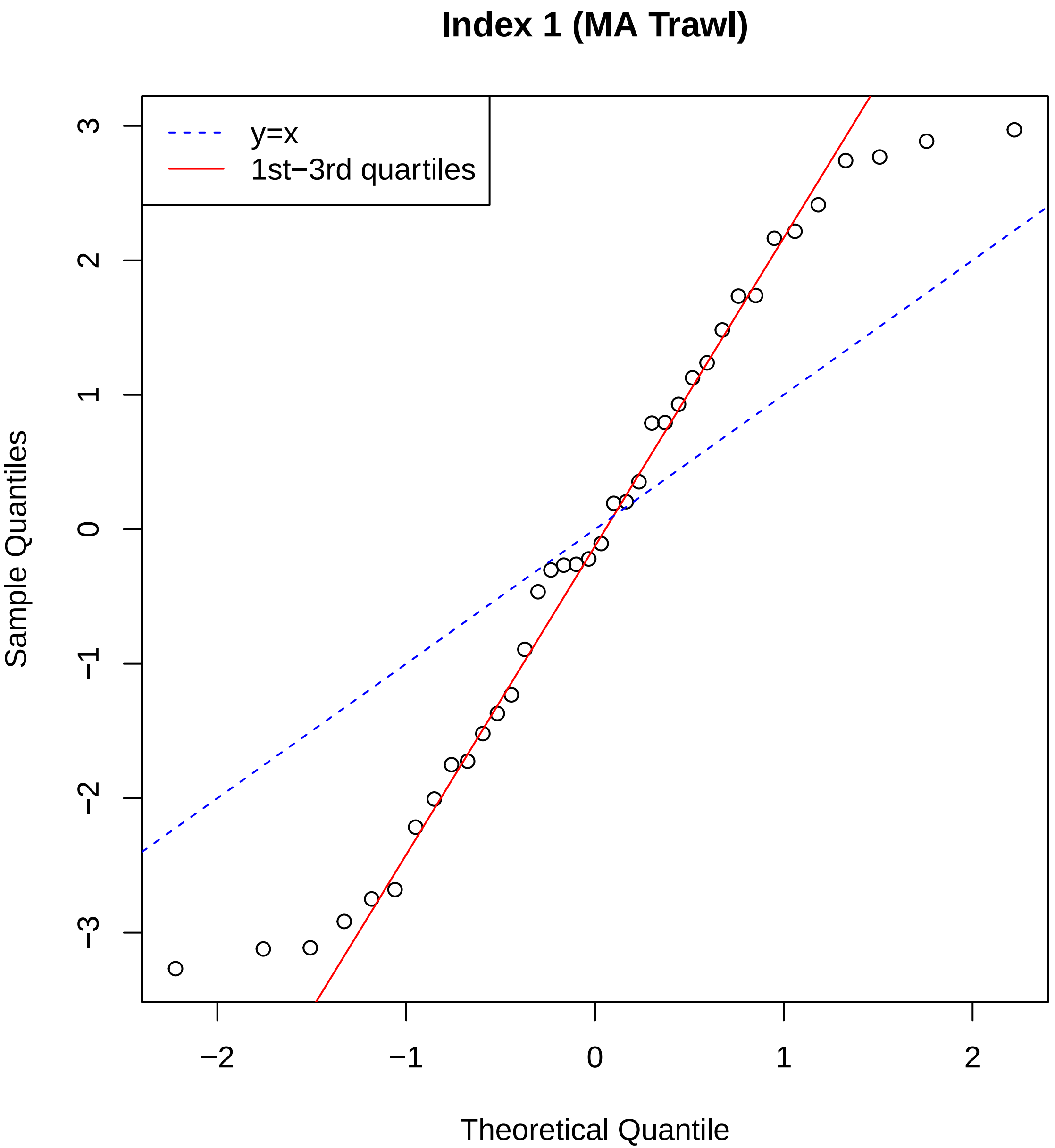


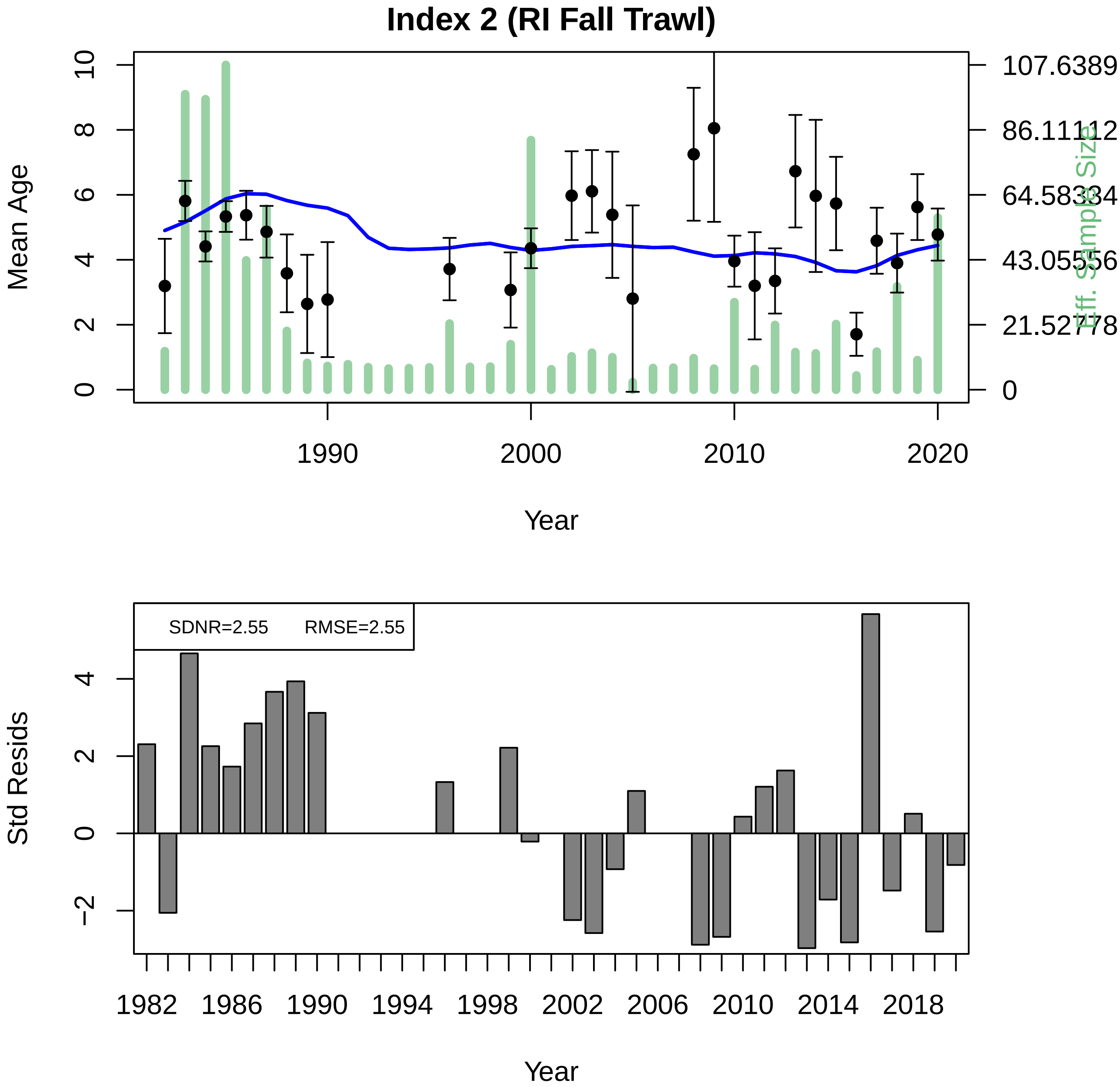
Index Neff 2 (RI Fall Trawl)
Effective Sample Size
0
50
100
150
1990
2000
2010
2020
Year

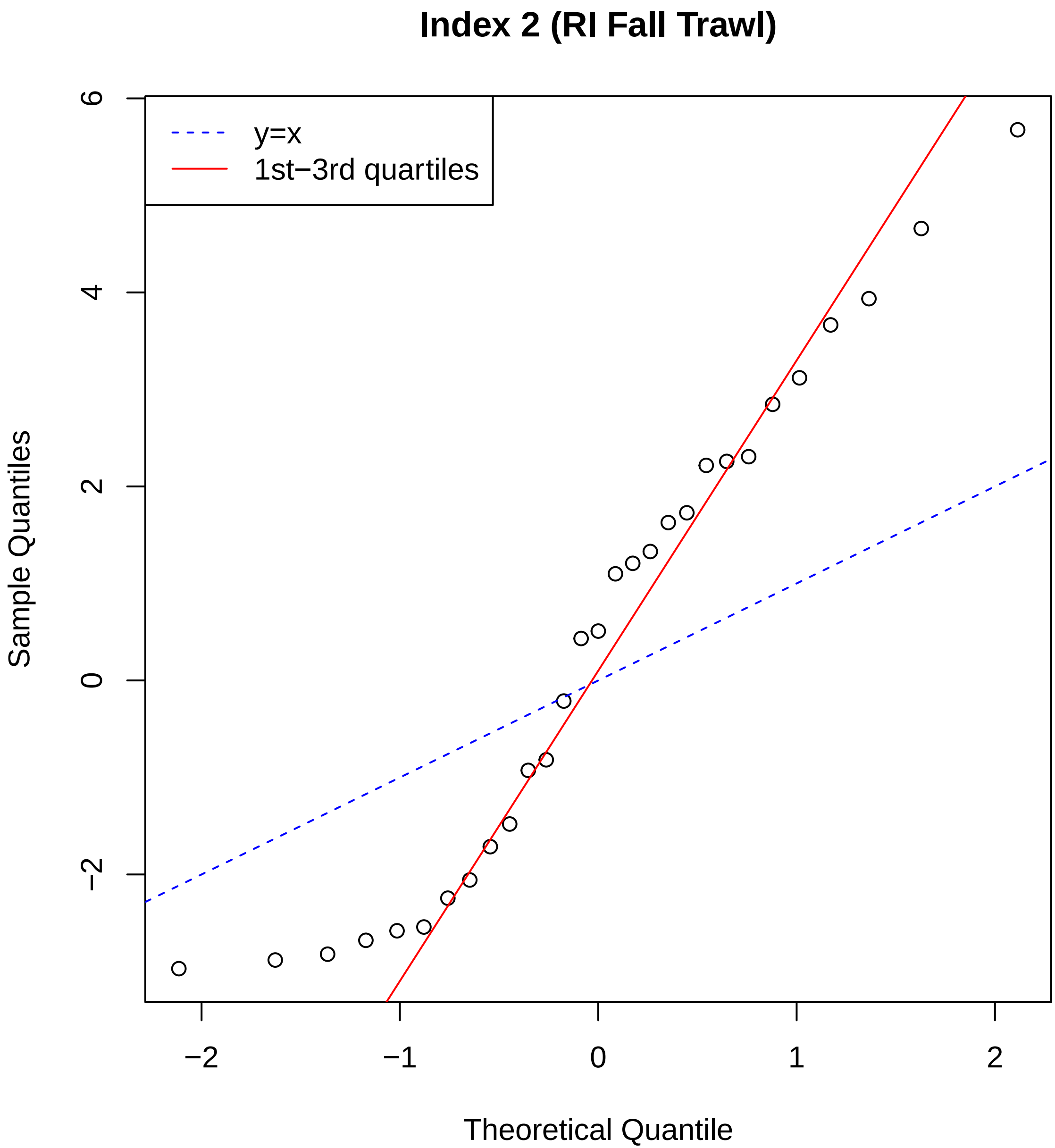

Index Neff 4 (MRIP CPUE)
Effective Sample Size
Year
0
50
100
150
200
250
300
350
1990
2000
2010
2020



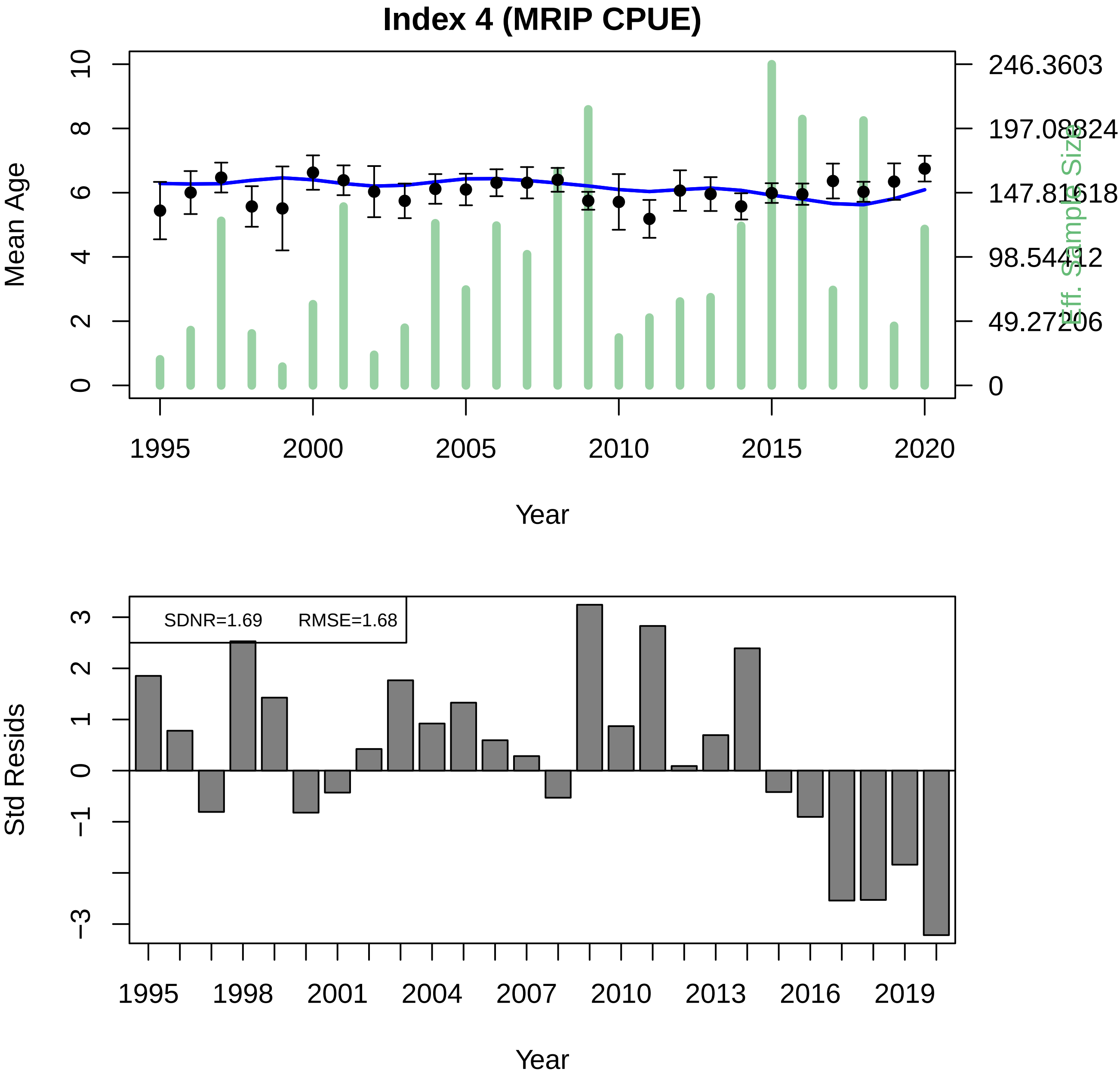
Index 1 (MA Trawl)
Mean Age
Eff. Sample Size
Year
Std Resids
SDNR=1.92
RMSE=1.89
Year


Index 1 (MA Trawl)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
3
2
1
0
−1
−2
−3
−2
−1
0
1
2

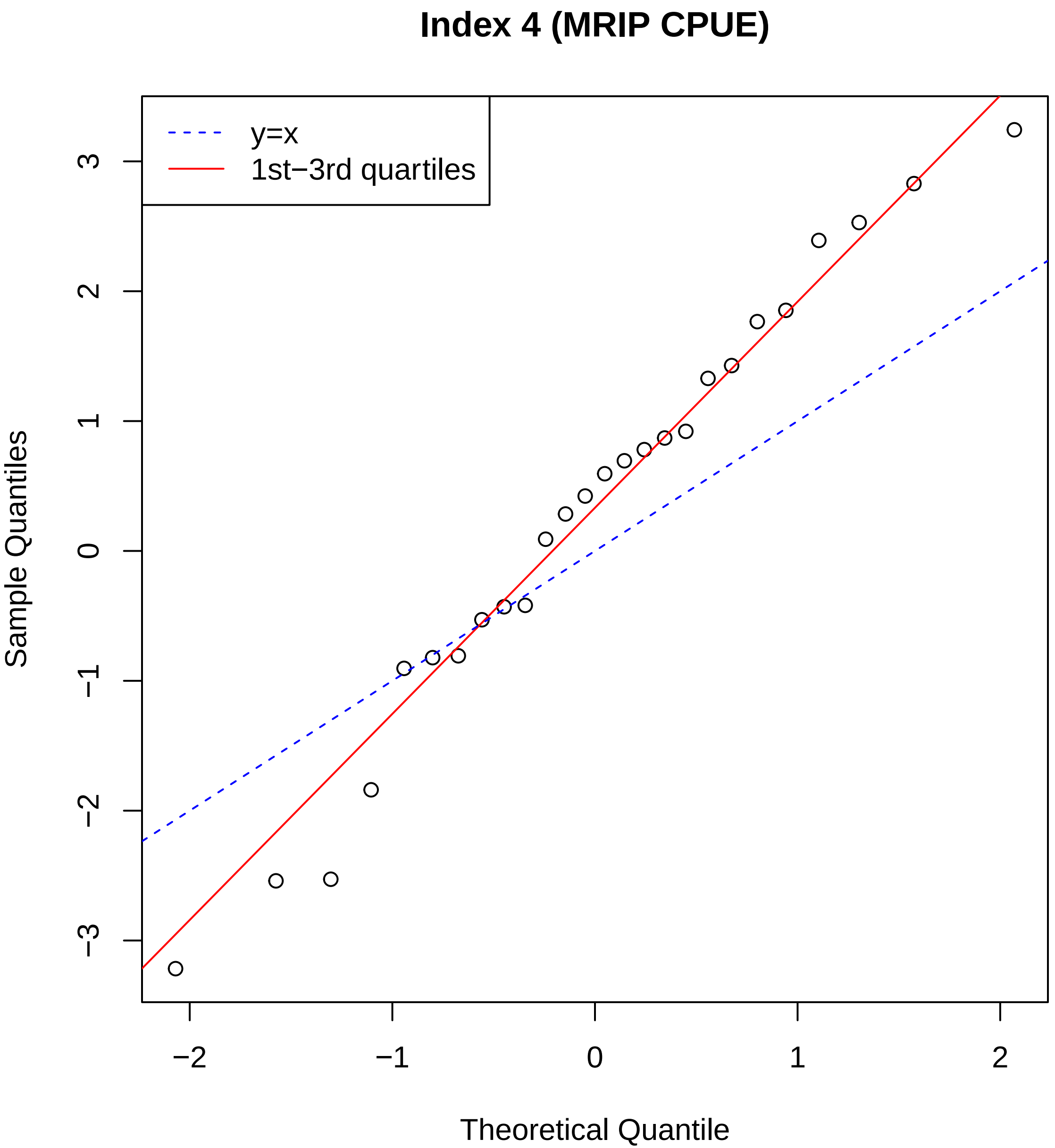

Index 2 (RI Fall Trawl)
Mean Age
Eff. Sample Size
107.6389
86.11112
64.58334
43.05556
21.52778
0
10
8
6
4
2
1990
2000
2010
2020
Year
SDNR=2.55
RMSE=2.55
Std Resids
4
2
0
−2
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year



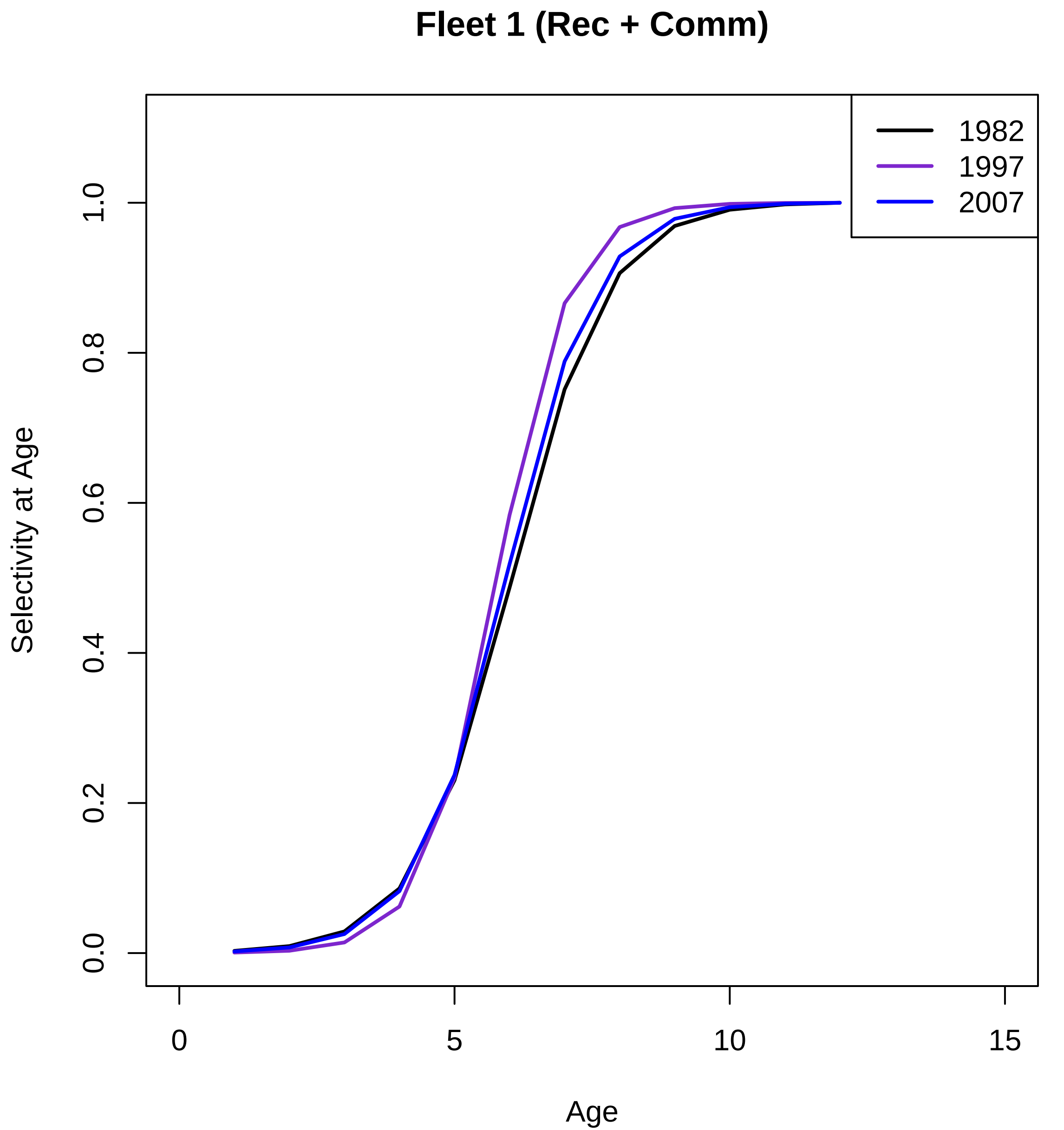
Index 2 (RI Fall Trawl)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
6
4
2
0
−2
−2
−1
0
1
2

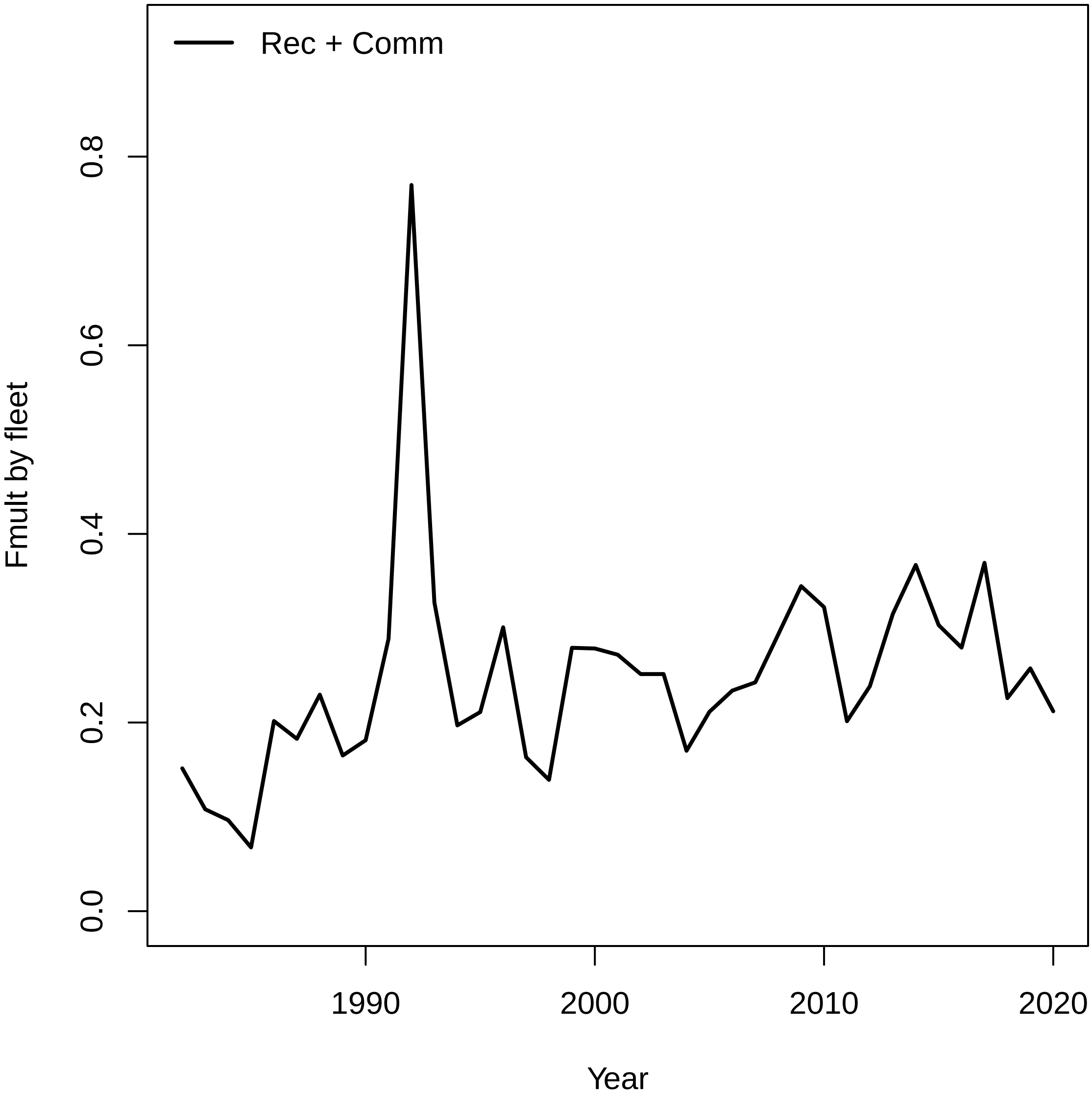


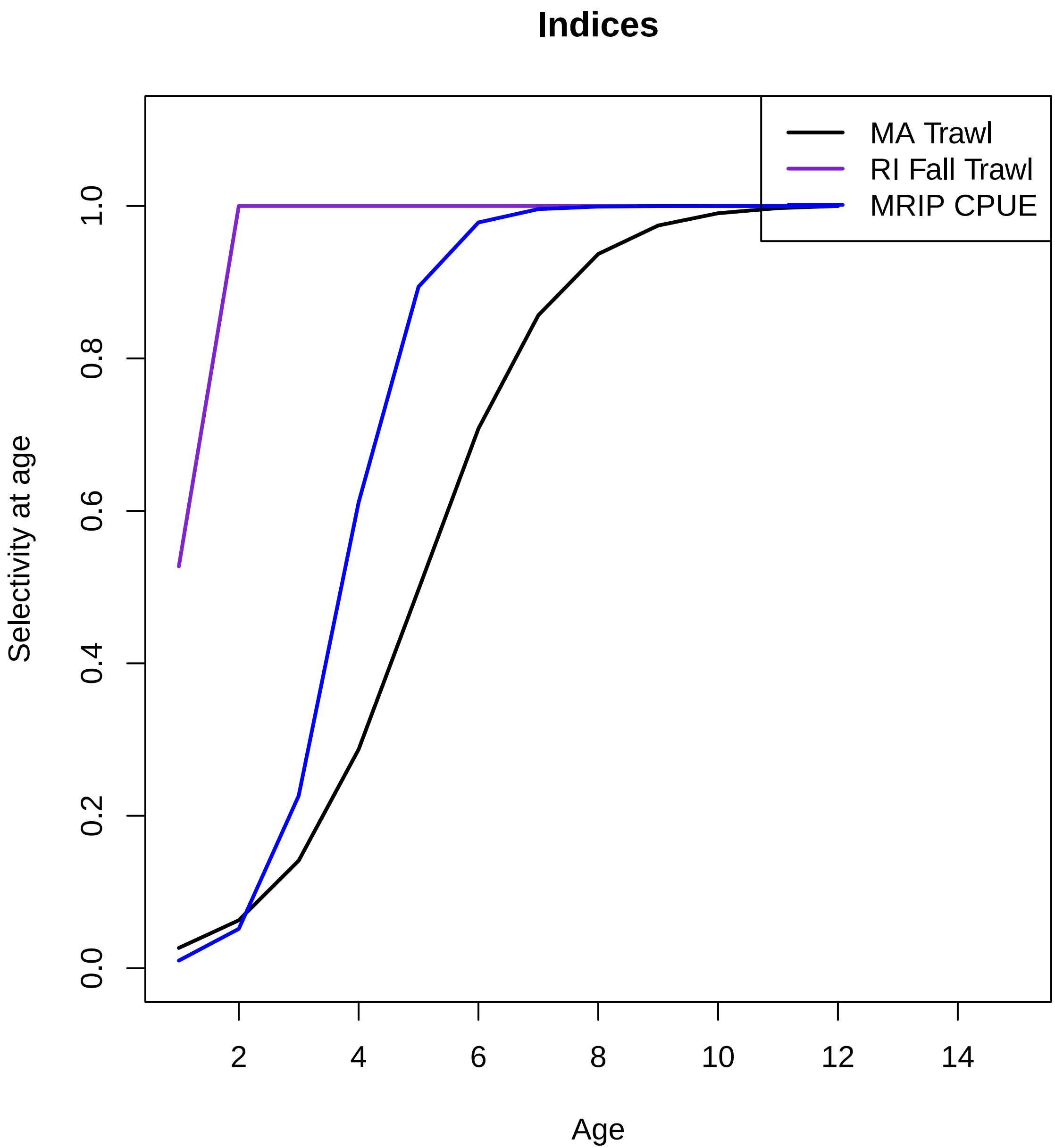
Index 4 (MRIP CPUE)
Mean Age
Eff. Sample Size
246.3603
197.08824
147.81618
98.54412
49.27206
Year
SDNR=1.69
RMSE=1.68
Std Resids
Year

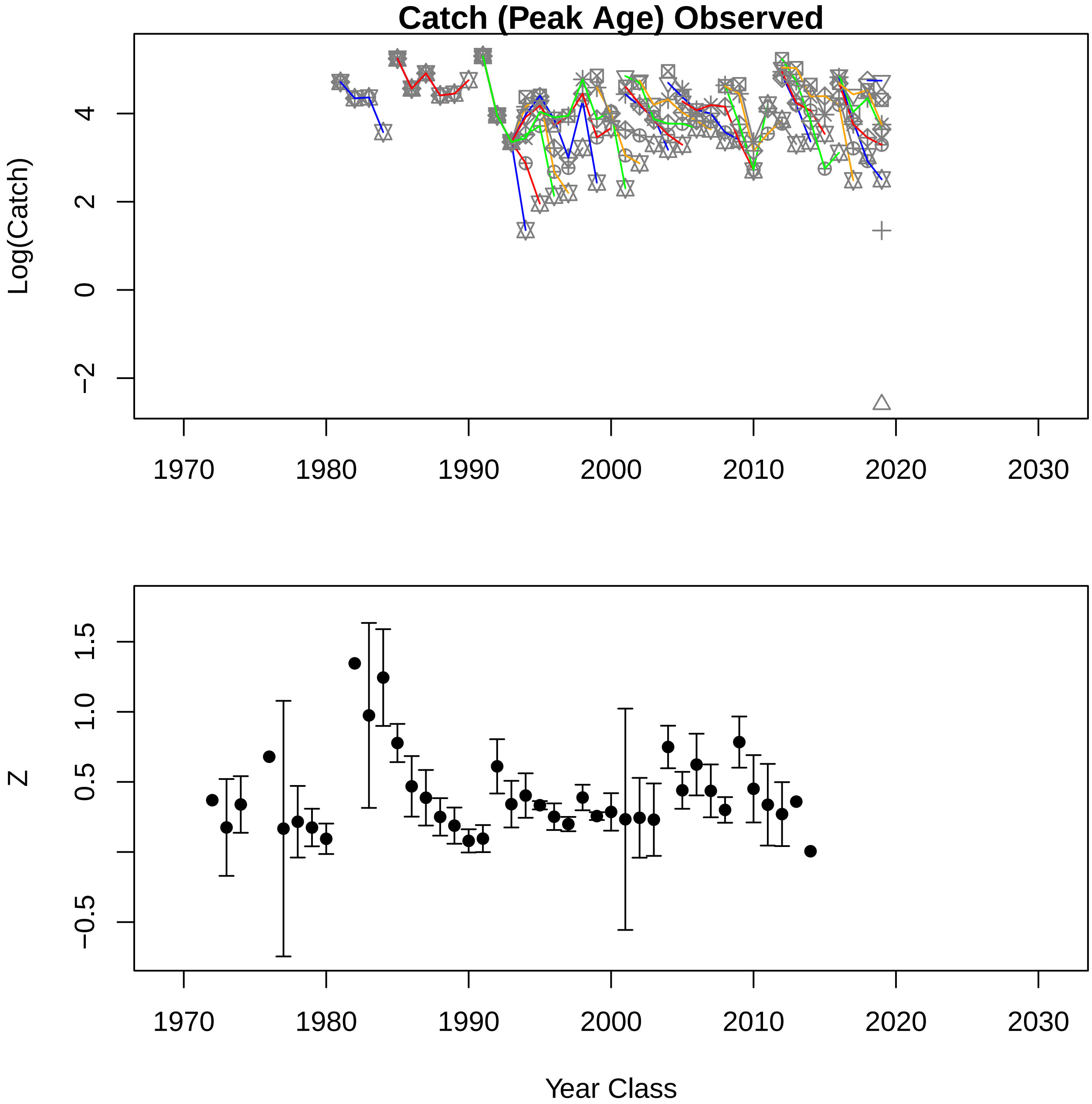


Index 4 (MRIP CPUE)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
3
2
1
0
−1
−2
−3
−2
−1
0
1
2

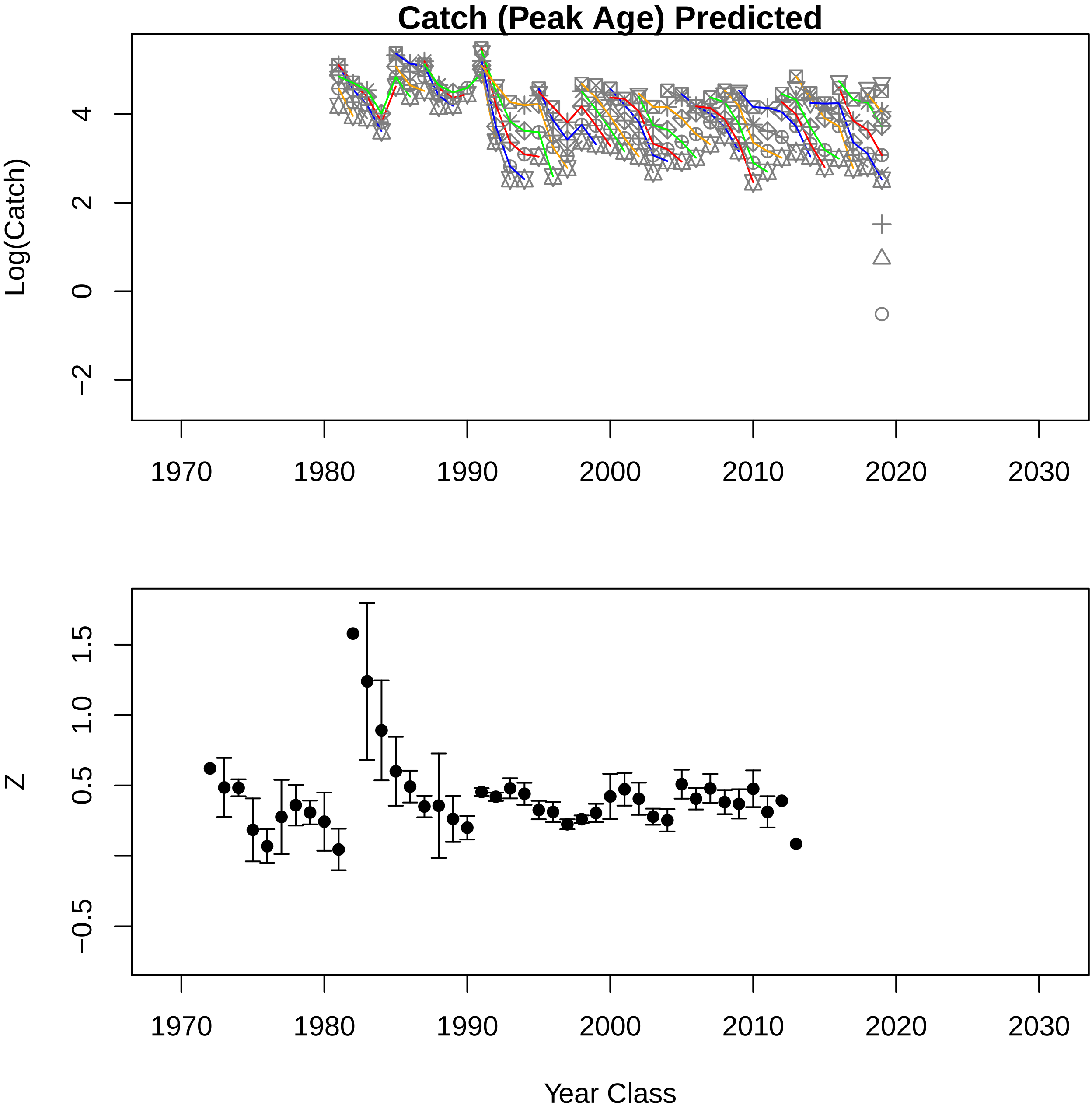

Fleet 1 (Rec + Comm)
1982
1997
2007
Selectivity at Age
Age
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15


Rec + Comm
Fmult by fleet
0.0
0.2
0.4
0.6
0.8
1990
2000
2010
2020
Year

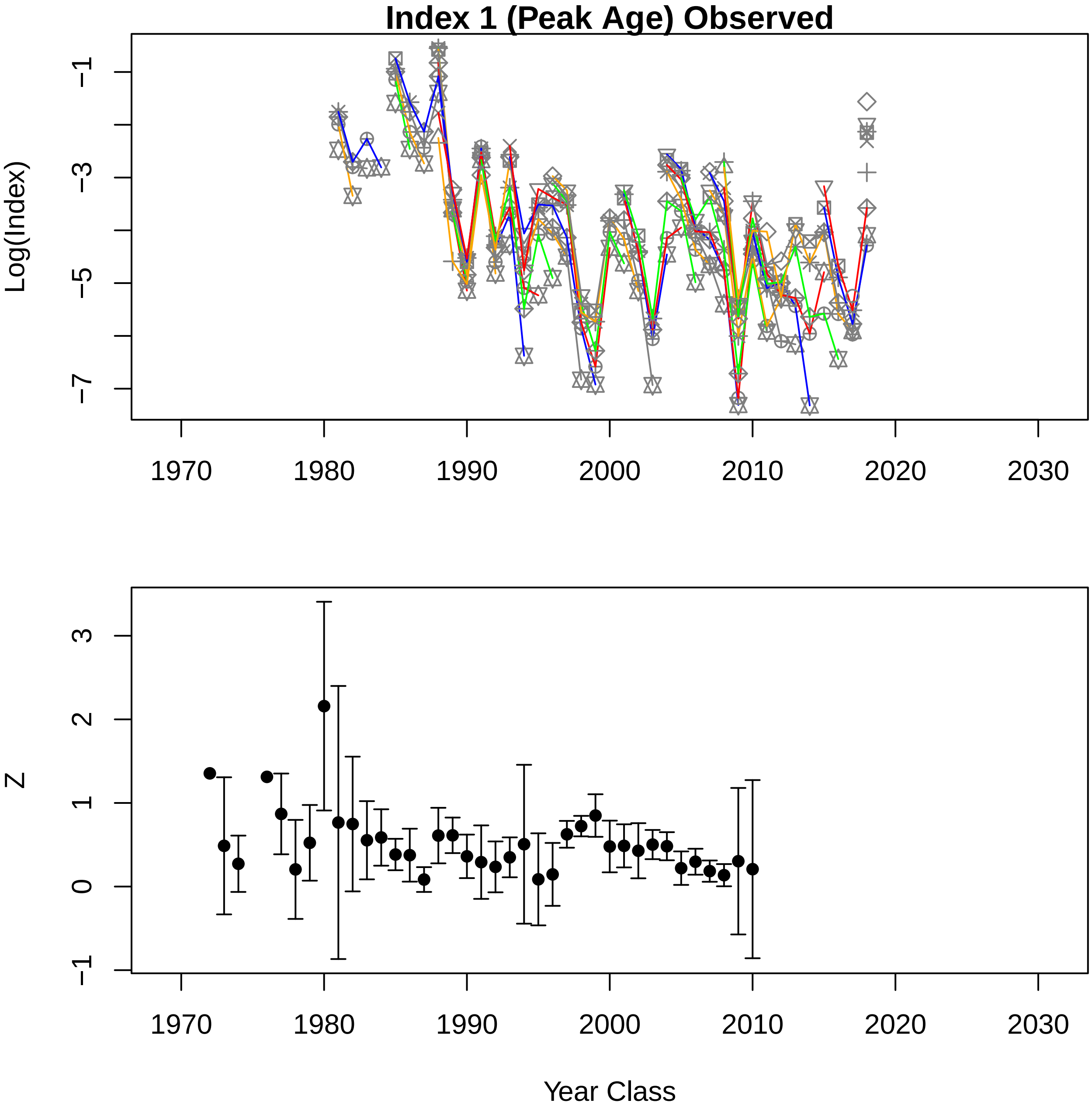

Indices
MA Trawl
RI Fall Trawl
MRIP CPUE
Selectivity at age
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
14
Age



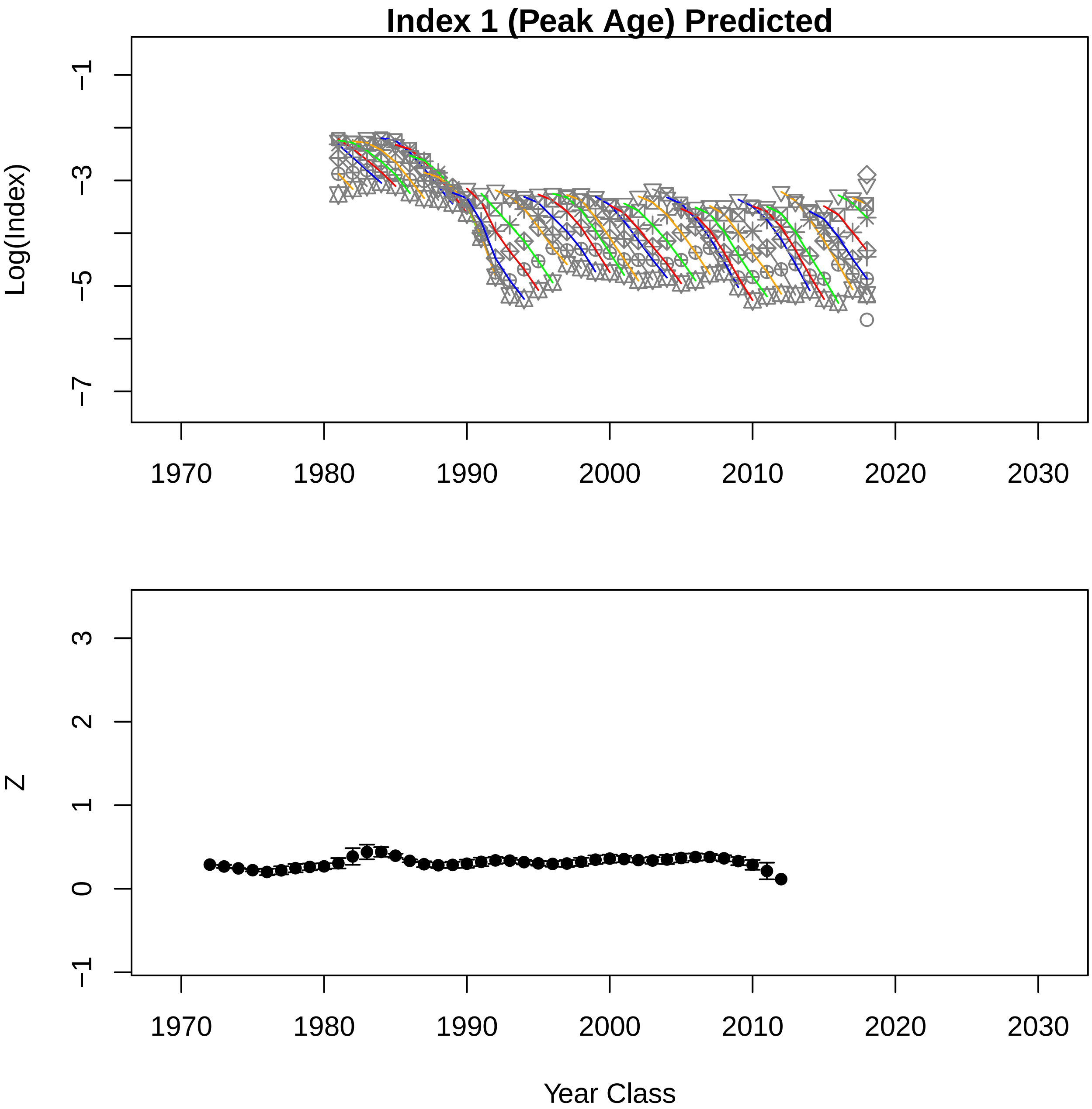
Catch (Peak Age) Observed
Log(Catch)
−2
0
2
4
1970
1980
1990
2000
2010
2020
2030
Z
−0.5
0.5
1.0
1.5
1970
1980
1990
2000
2010
2020
2030
Year Class

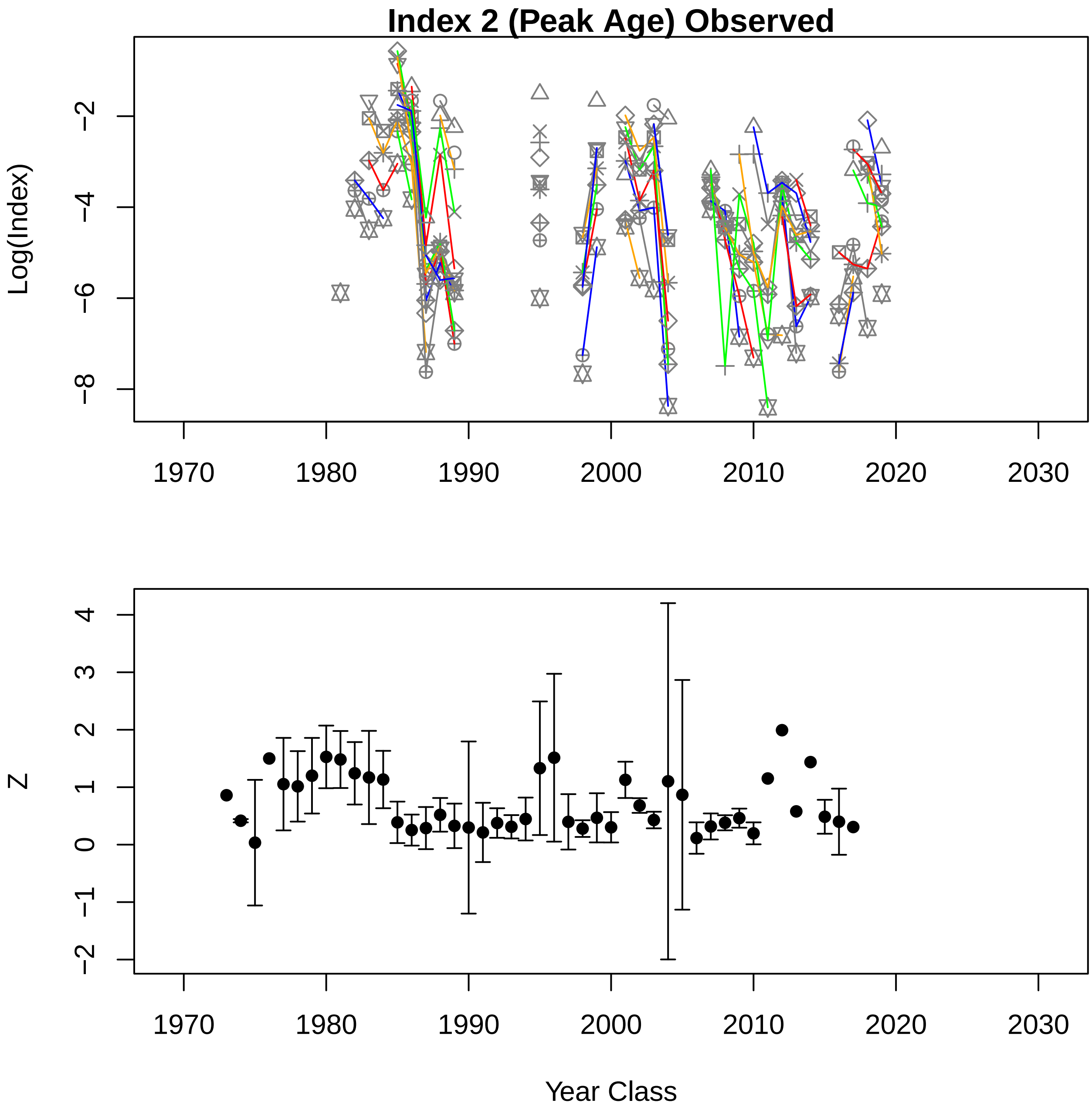


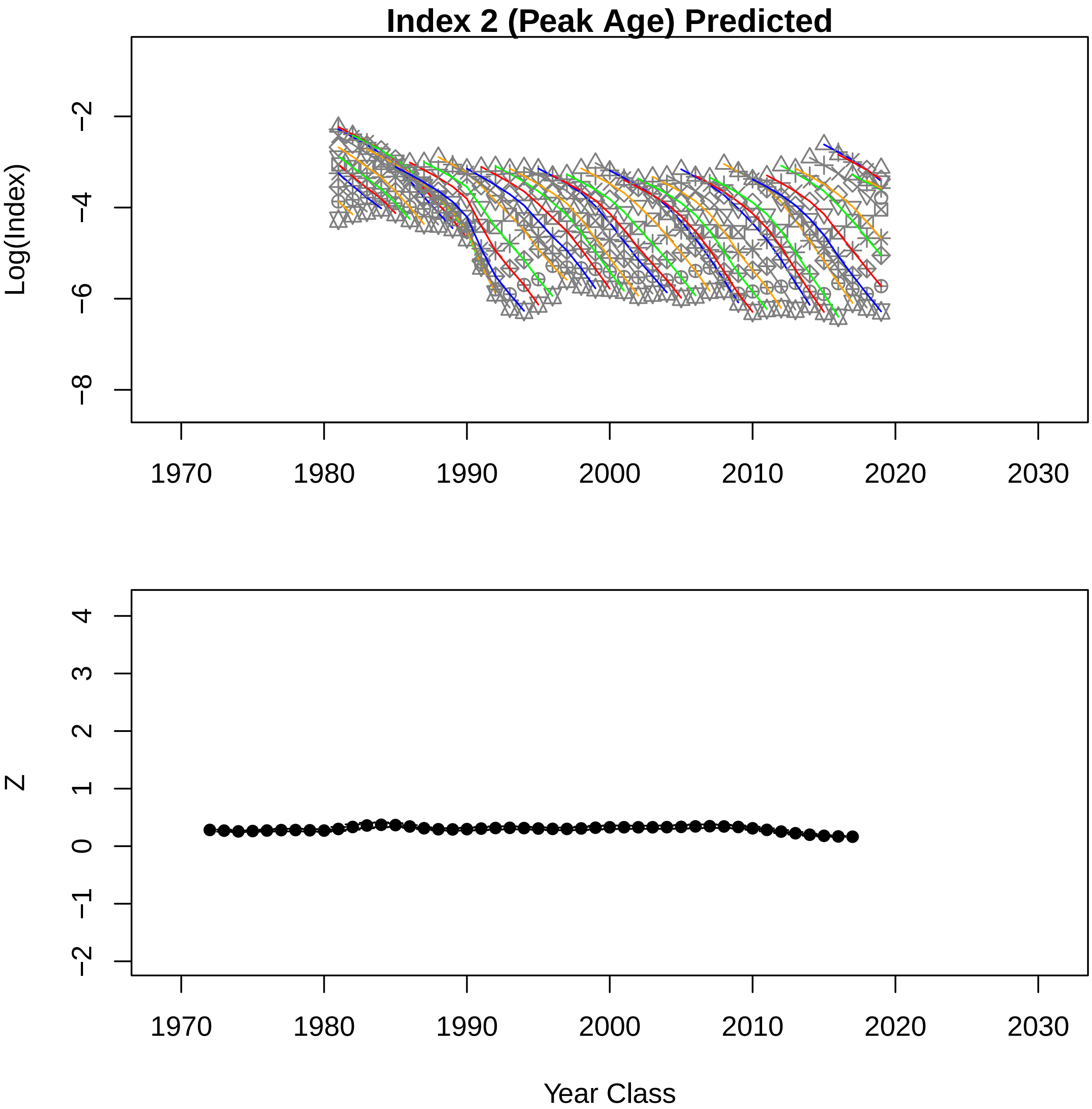
Catch (Peak Age) Predicted
Log(Catch)
−2
0
2
4
1970
1980
1990
2000
2010
2020
2030
Z
−0.5
0.5
1.0
1.5
1970
1980
1990
2000
2010
2020
2030
Year Class



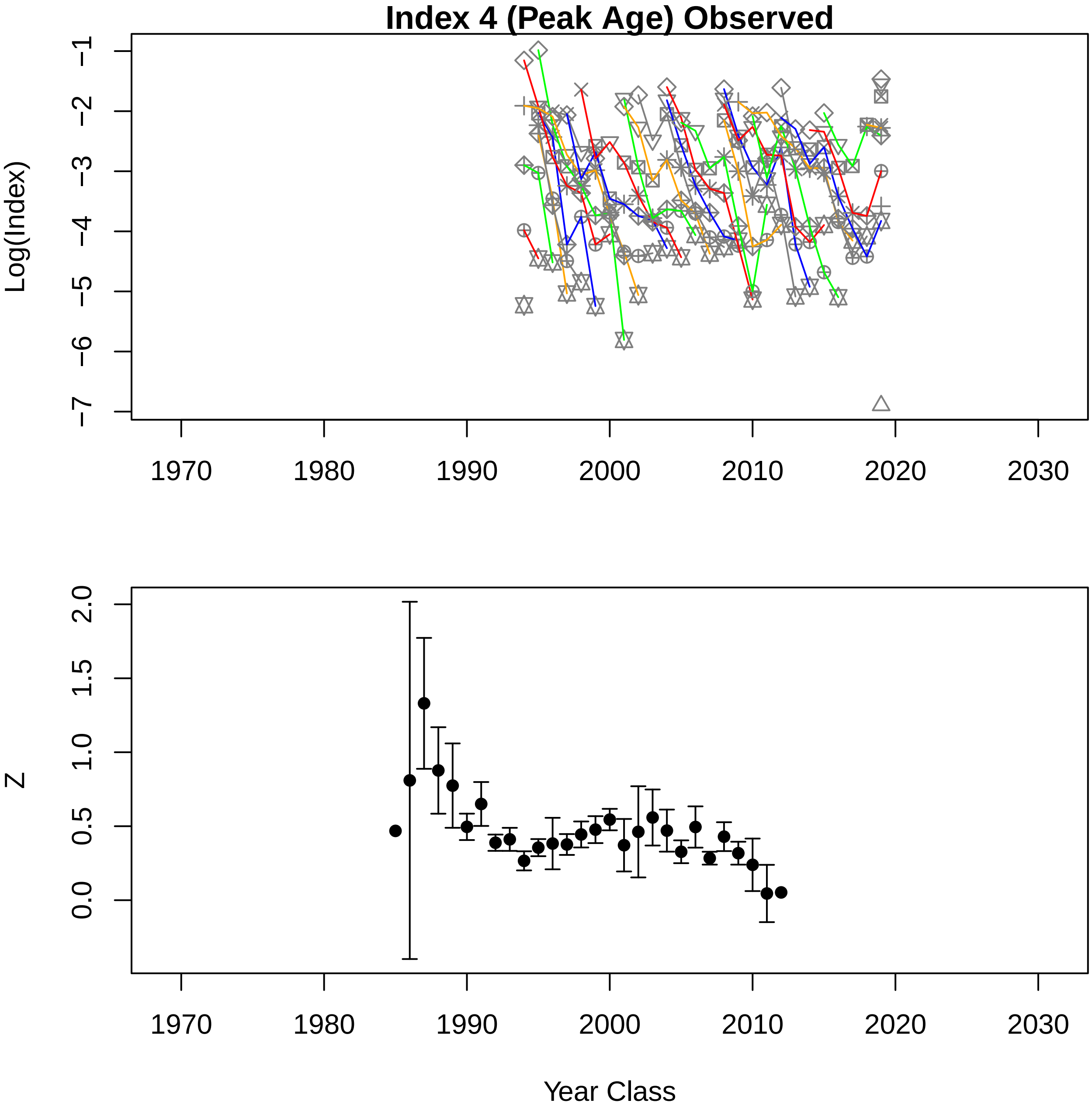
Index 1 (Peak Age) Observed
Log(Index)
−1
−3
−5
−7
1970
1980
1990
2000
2010
2020
2030
Z
3
2
1
0
−1
1970
1980
1990
2000
2010
2020
2030
Year Class

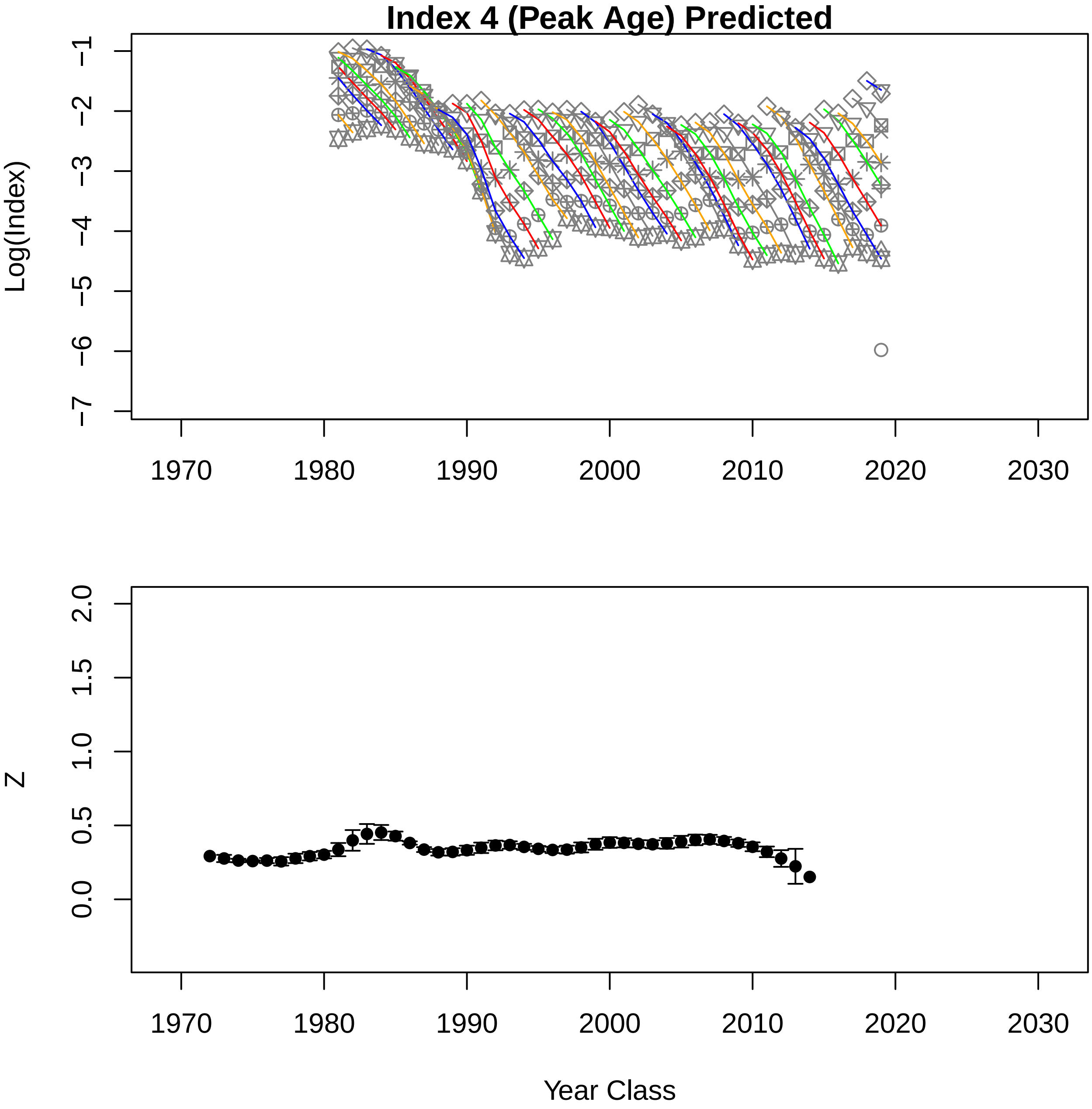

Index 1 (Peak Age) Predicted
Log(Index)
−1
−3
−5
−7
1970
1980
1990
2000
2010
2020
2030
Z
3
2
1
0
−1
1970
1980
1990
2000
2010
2020
2030
Year Class

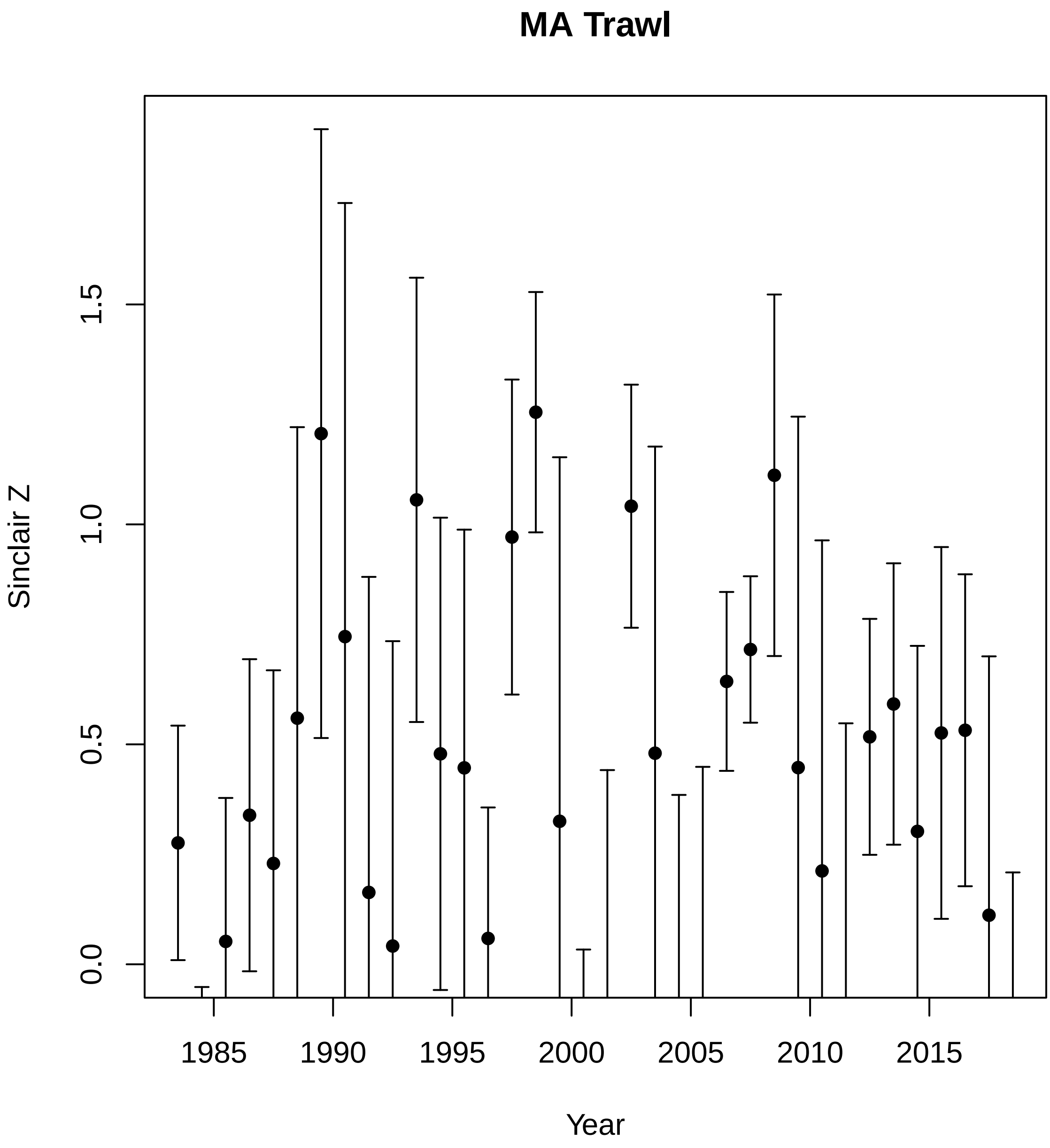

Index 2 (Peak Age) Observed
Log(Index)
−2
−4
−6
−8
1970
1980
1990
2000
2010
2020
2030
Z
4
3
2
1
0
−1
−2
1970
1980
1990
2000
2010
2020
2030
Year Class

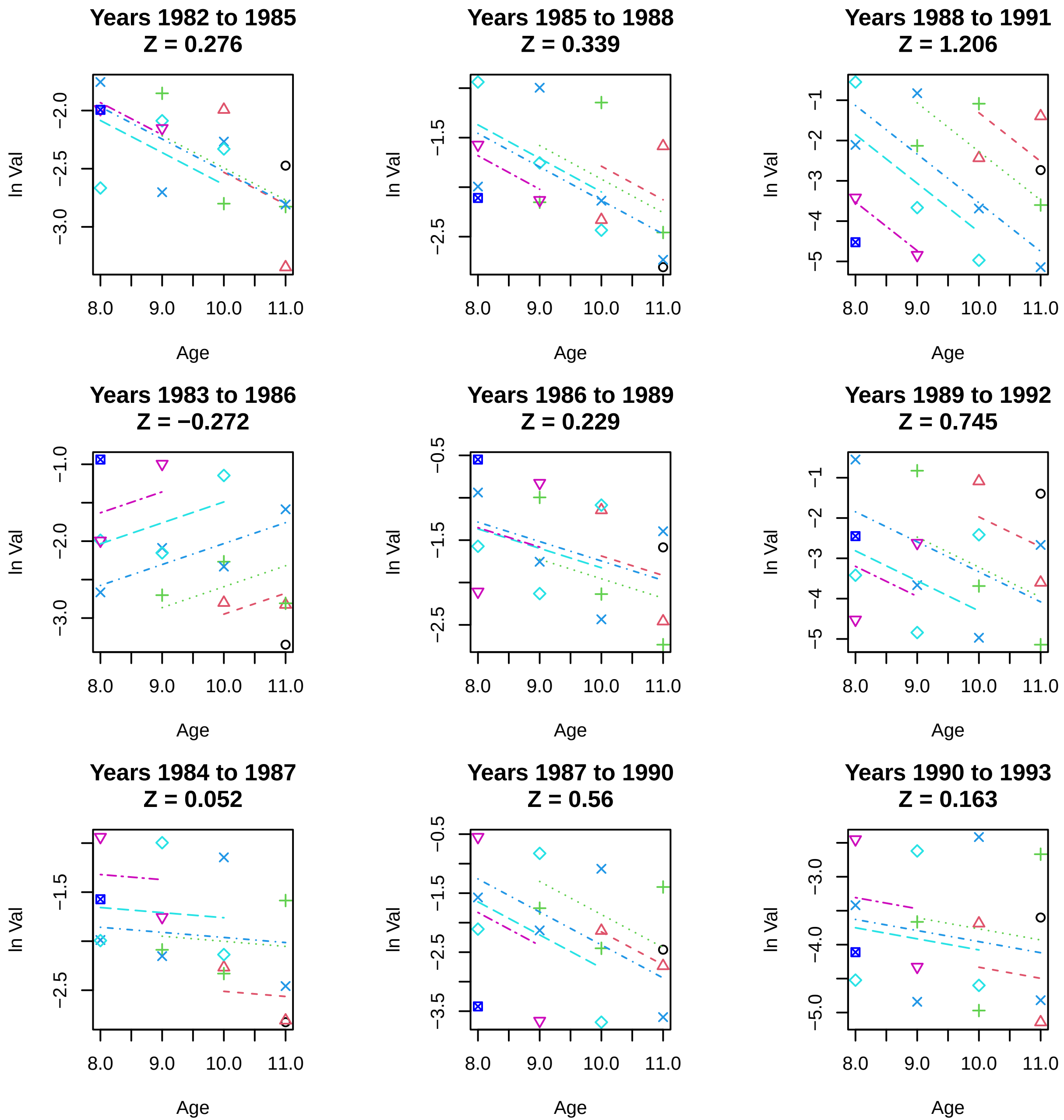


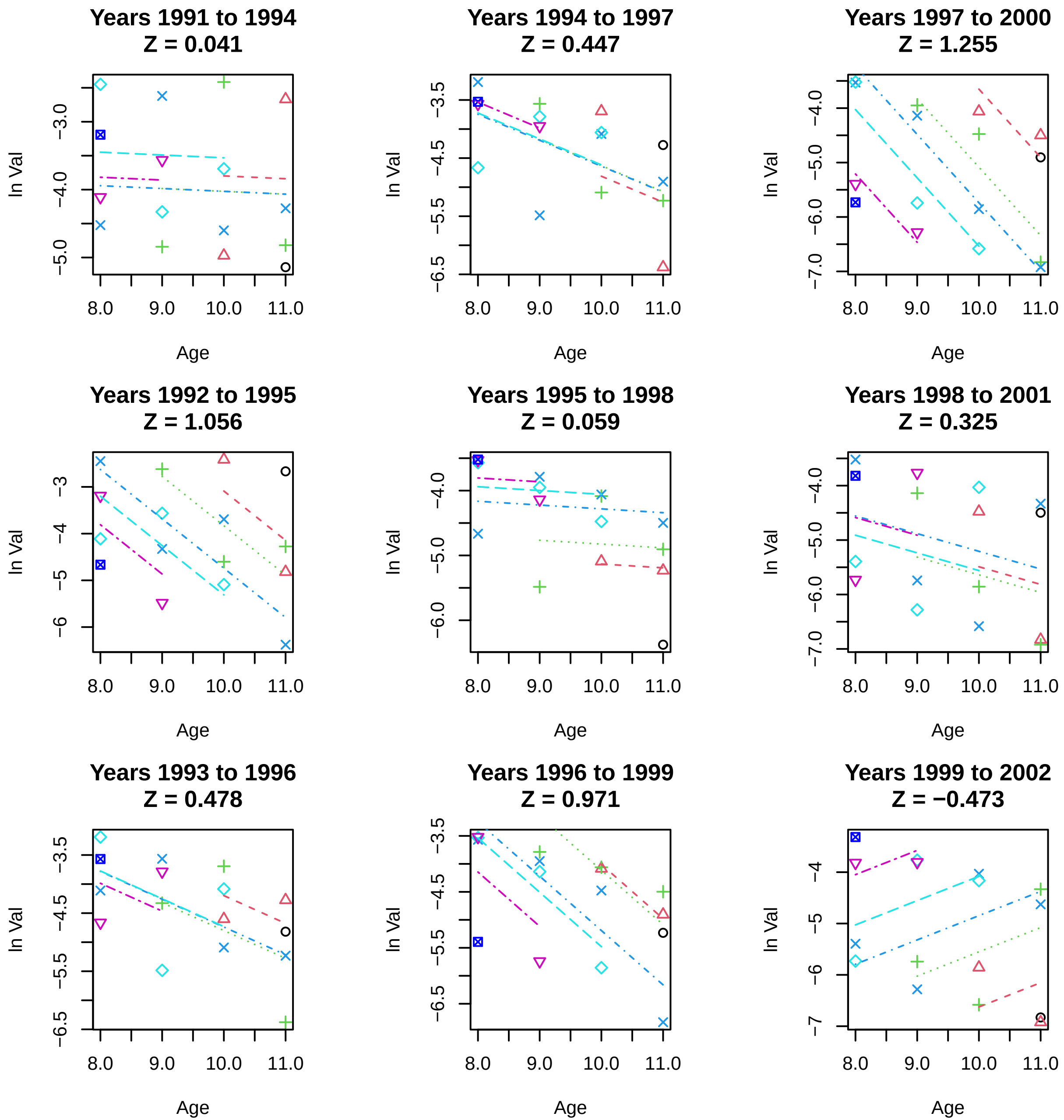
Index 2 (Peak Age) Predicted
Log(Index)
−2
−4
−6
−8
1970
1980
1990
2000
2010
2020
2030
Z
4
3
2
1
0
−1
−2
1970
1980
1990
2000
2010
2020
2030
Year Class

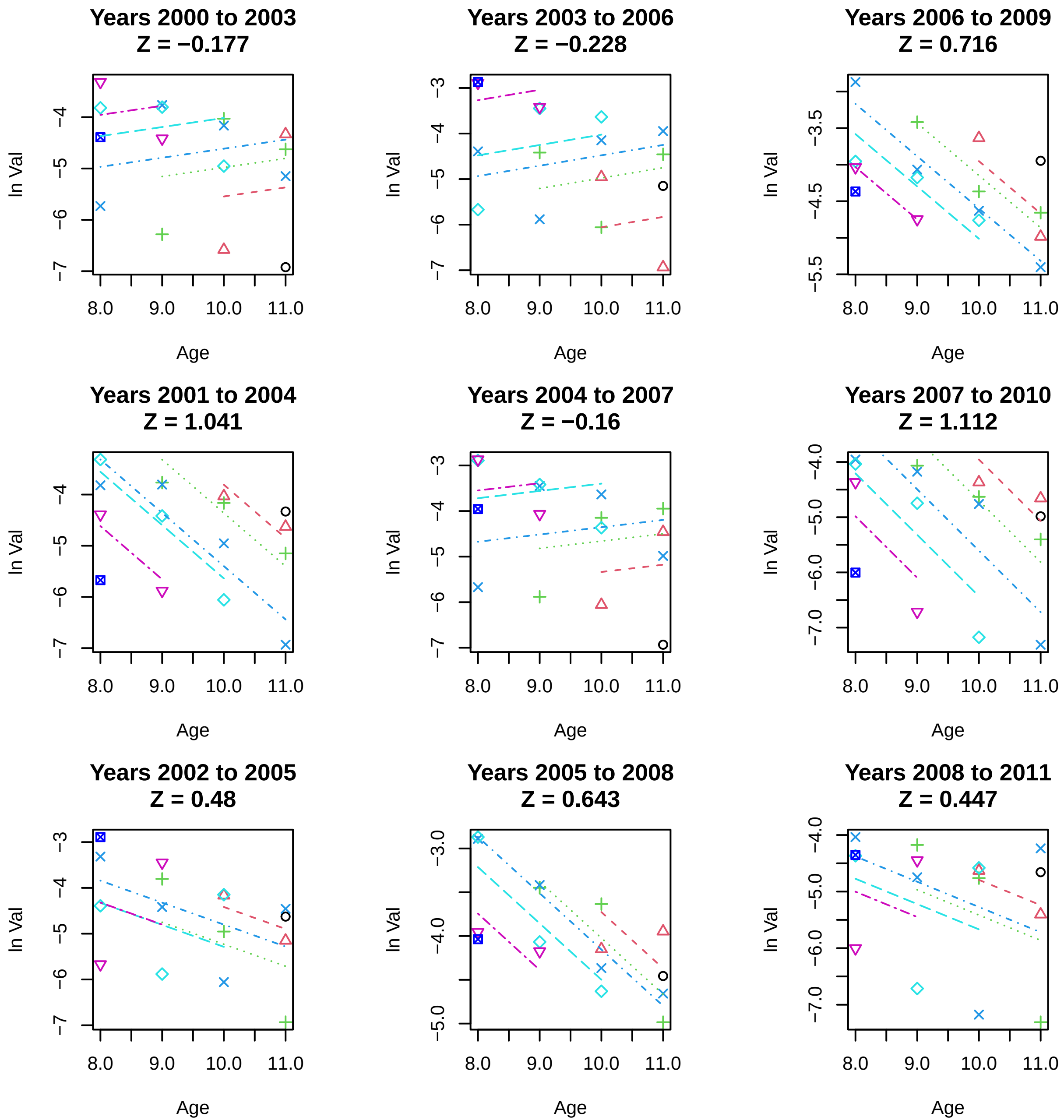

Index 4 (Peak Age) Observed
Log(Index)
−1
−2
−3
−4
−5
−6
−7
1970
1980
1990
2000
2010
2020
2030
Z
2.0
1.5
1.0
0.5
0.0
Year Class

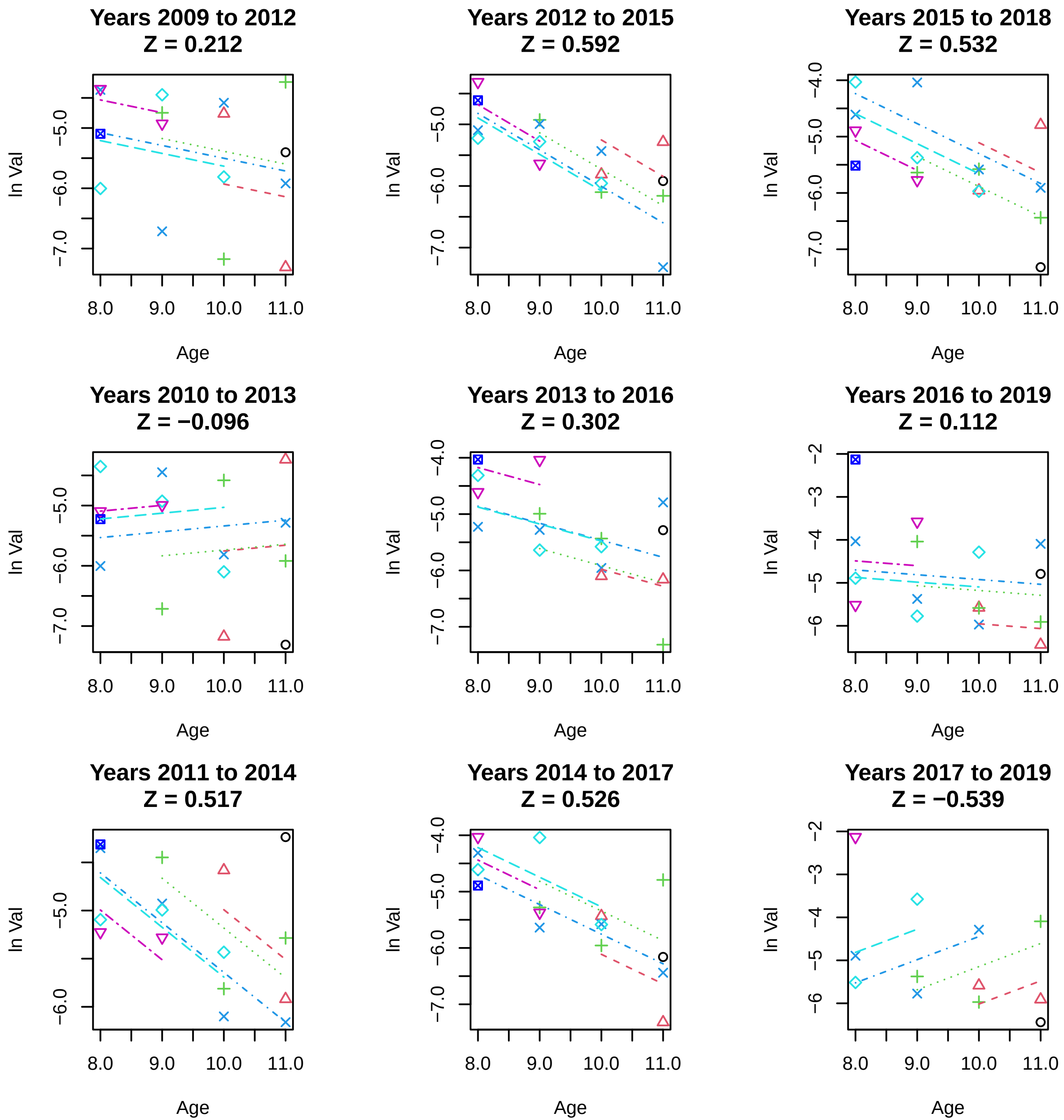

Index 4 (Peak Age) Predicted
Log(Index)
−1
−2
−3
−4
−5
−6
−7
1970
1980
1990
2000
2010
2020
2030
Z
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
2020
2030
Year Class

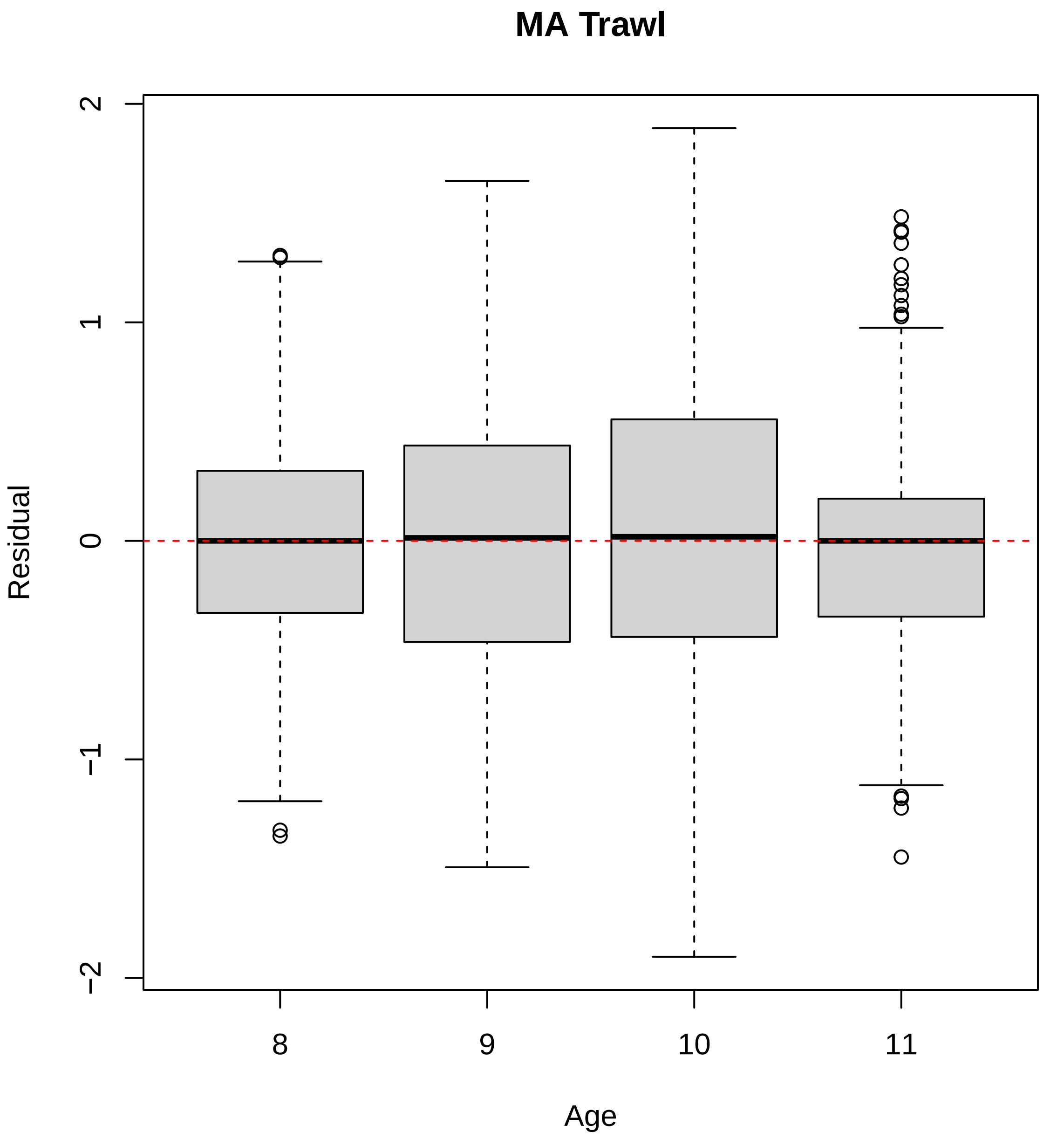

MA Trawl
Sinclair Z
0.0
0.5
1.0
1.5
1985
1990
1995
2000
2005
2010
2015
Year


Years 1982 to 1985
Z = 0.276
Years 1985 to 1988
Z = 0.339
Years 1988 to 1991
Z = 1.206
Years 1983 to 1986
Z = −0.272
Years 1986 to 1989
Z = 0.229
Years 1989 to 1992
Z = 0.745
Years 1984 to 1987
Z = 0.052
Years 1987 to 1990
Z = 0.56
Years 1990 to 1993
Z = 0.163
ln Val
Age
8.0
9.0
10.0
11.0

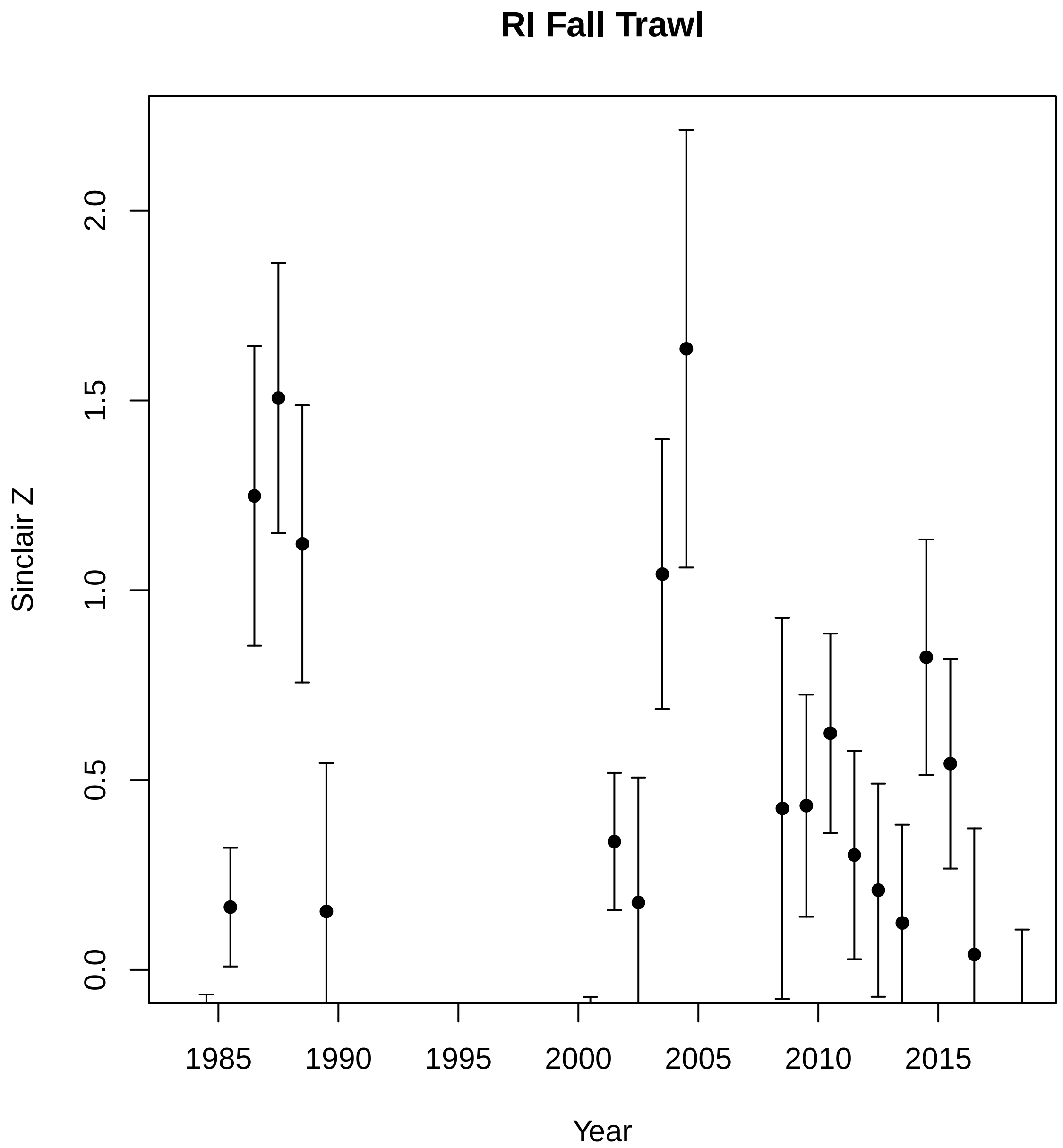

Years 1991 to 1994
Z = 0.041
Years 1994 to 1997
Z = 0.447
Years 1997 to 2000
Z = 1.255
Years 1992 to 1995
Z = 1.056
Years 1995 to 1998
Z = 0.059
Years 1998 to 2001
Z = 0.325
Years 1993 to 1996
Z = 0.478
Years 1996 to 1999
Z = 0.971
Years 1999 to 2002
Z = −0.473
ln Val
Age
8.0
9.0
10.0
11.0

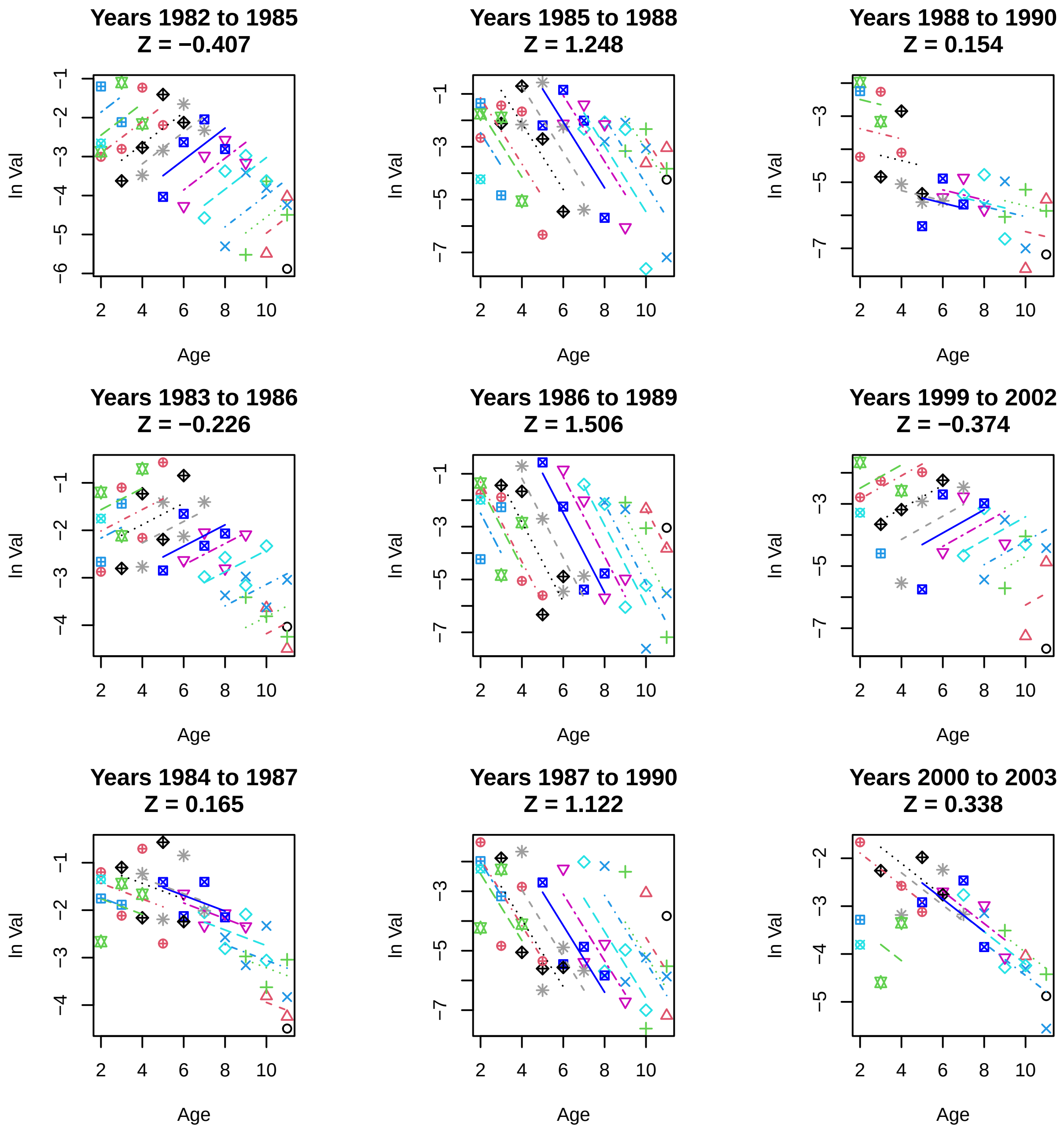

Years 2000 to 2003
Z = −0.177
Years 2003 to 2006
Z = −0.228
Years 2006 to 2009
Z = 0.716
Years 2001 to 2004
Z = 1.041
Years 2004 to 2007
Z = −0.16
Years 2007 to 2010
Z = 1.112
Years 2002 to 2005
Z = 0.48
Years 2005 to 2008
Z = 0.643
Years 2008 to 2011
Z = 0.447
ln Val
Age
8.0
9.0
10.0
11.0
−3
−4
−5
−6
−7
−3.5
−4.5
−5.5
−3.0
−4.0
−5.0
−6.0
−7.0

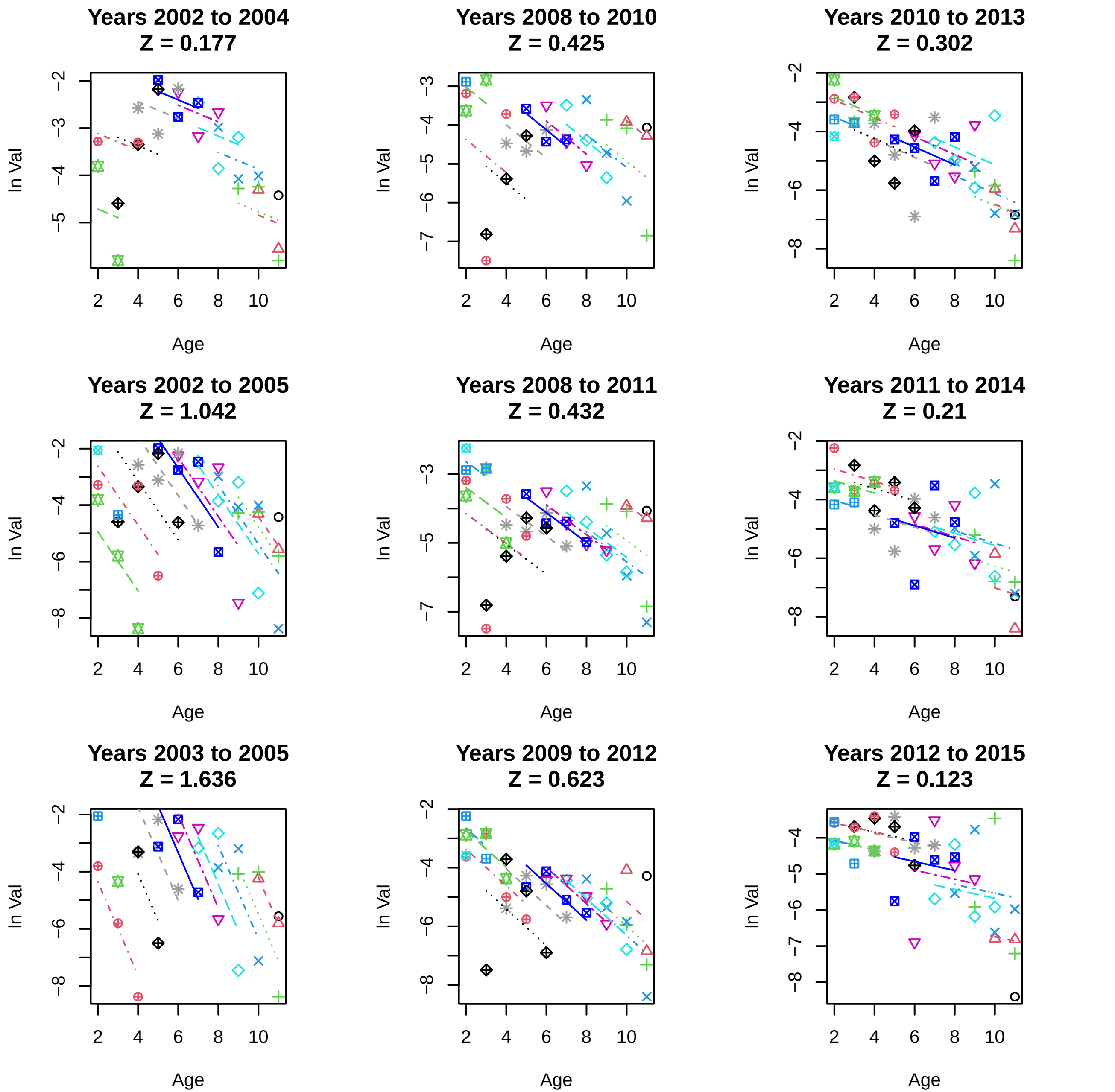

Years 2009 to 2012
Z = 0.212
Years 2012 to 2015
Z = 0.592
Years 2015 to 2018
Z = 0.532
Years 2010 to 2013
Z = −0.096
Years 2013 to 2016
Z = 0.302
Years 2016 to 2019
Z = 0.112
Years 2011 to 2014
Z = 0.517
Years 2014 to 2017
Z = 0.526
Years 2017 to 2019
Z = −0.539
ln Val
Age
8.0
9.0
10.0
11.0



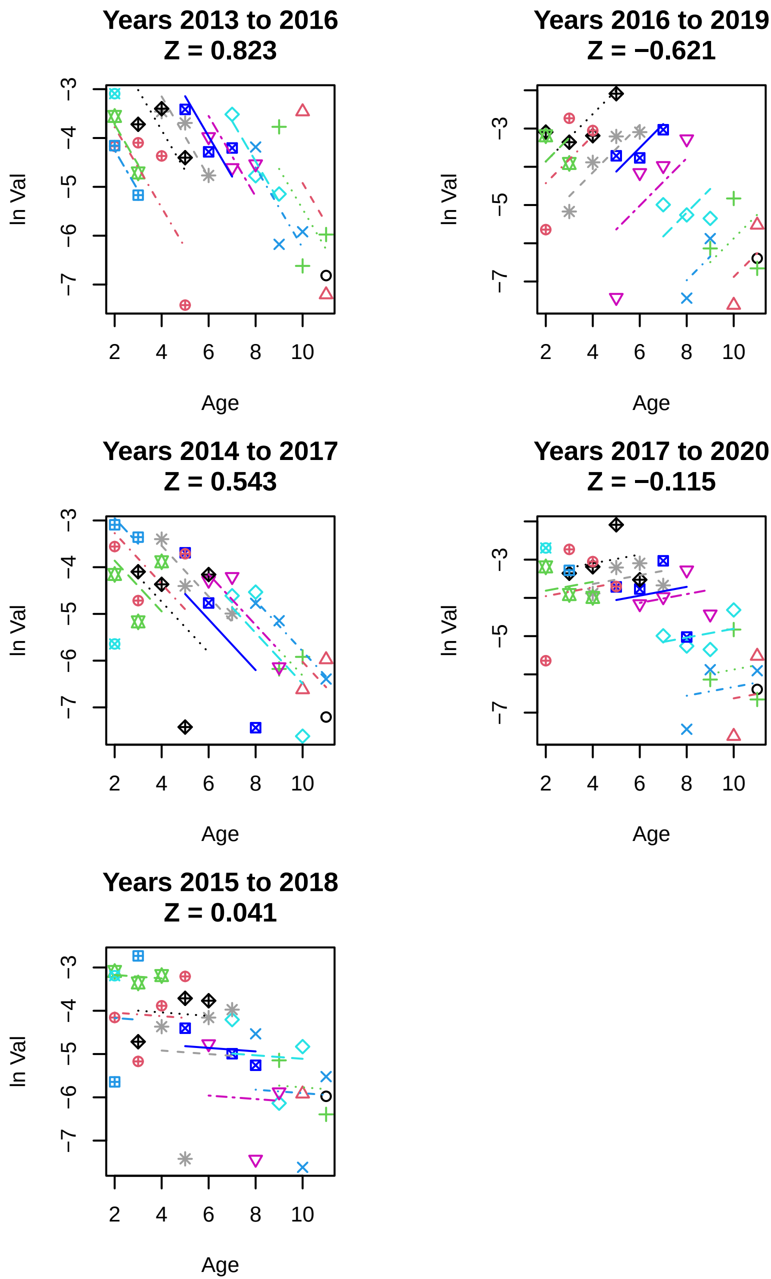
MA Trawl
Residual
Age
2
1
0
−1
−2
8
9
10
11

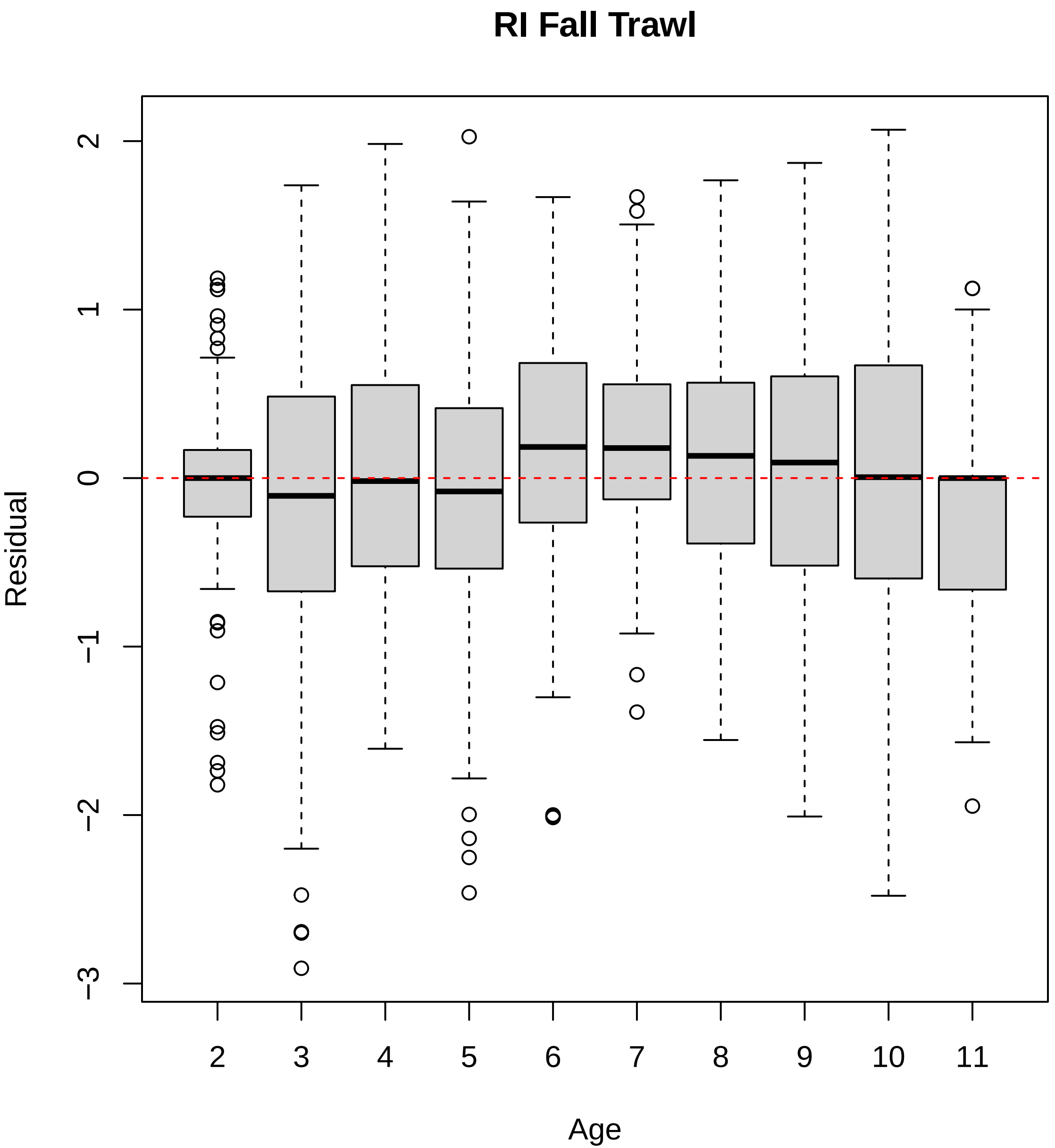

RI Fall Trawl
Sinclair Z
0.0
0.5
1.0
1.5
2.0
1985
1990
1995
2000
2005
2010
2015
Year


Years 1982 to 1985
Z = −0.407
Years 1985 to 1988
Z = 1.248
Years 1988 to 1990
Z = 0.154
Years 1983 to 1986
Z = −0.226
Years 1986 to 1989
Z = 1.506
Years 1999 to 2002
Z = −0.374
Years 1984 to 1987
Z = 0.165
Years 1987 to 1990
Z = 1.122
Years 2000 to 2003
Z = 0.338
ln Val
Age

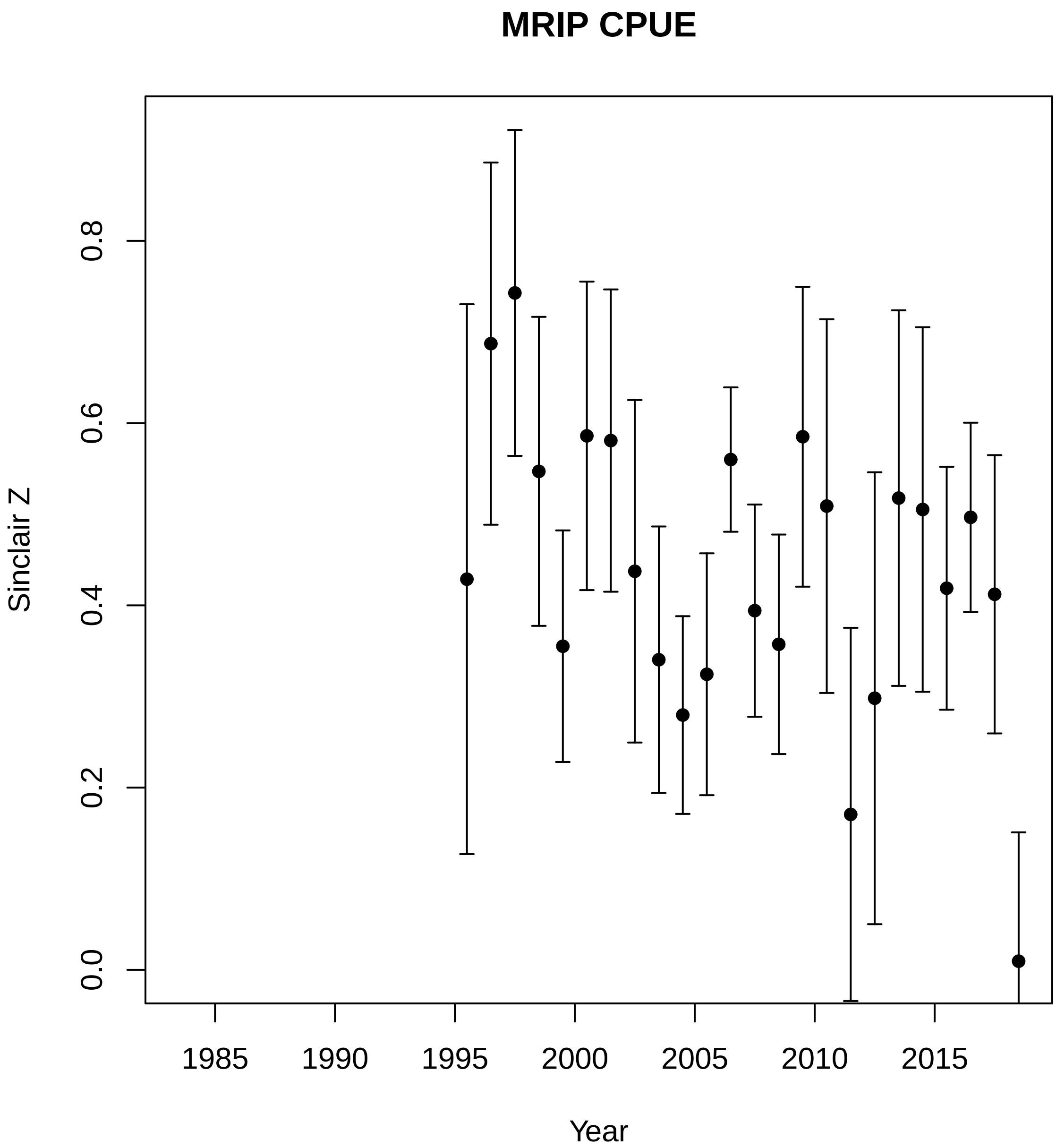


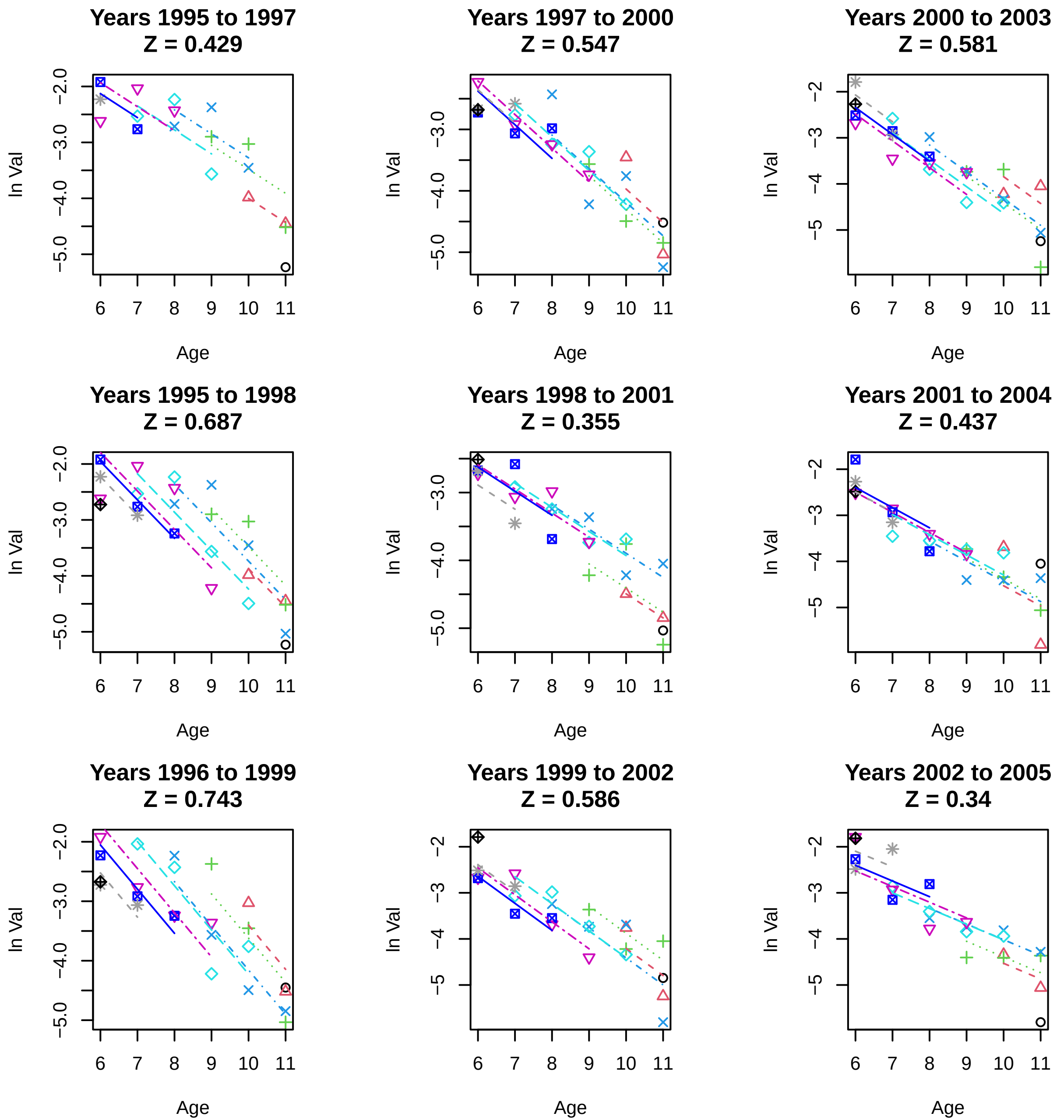
Years 2002 to 2004
Z = 0.177
Years 2008 to 2010
Z = 0.425
Years 2010 to 2013
Z = 0.302
Years 2002 to 2005
Z = 1.042
Years 2008 to 2011
Z = 0.432
Years 2011 to 2014
Z = 0.21
Years 2003 to 2005
Z = 1.636
Years 2009 to 2012
Z = 0.623
Years 2012 to 2015
Z = 0.123
ln Val
Age

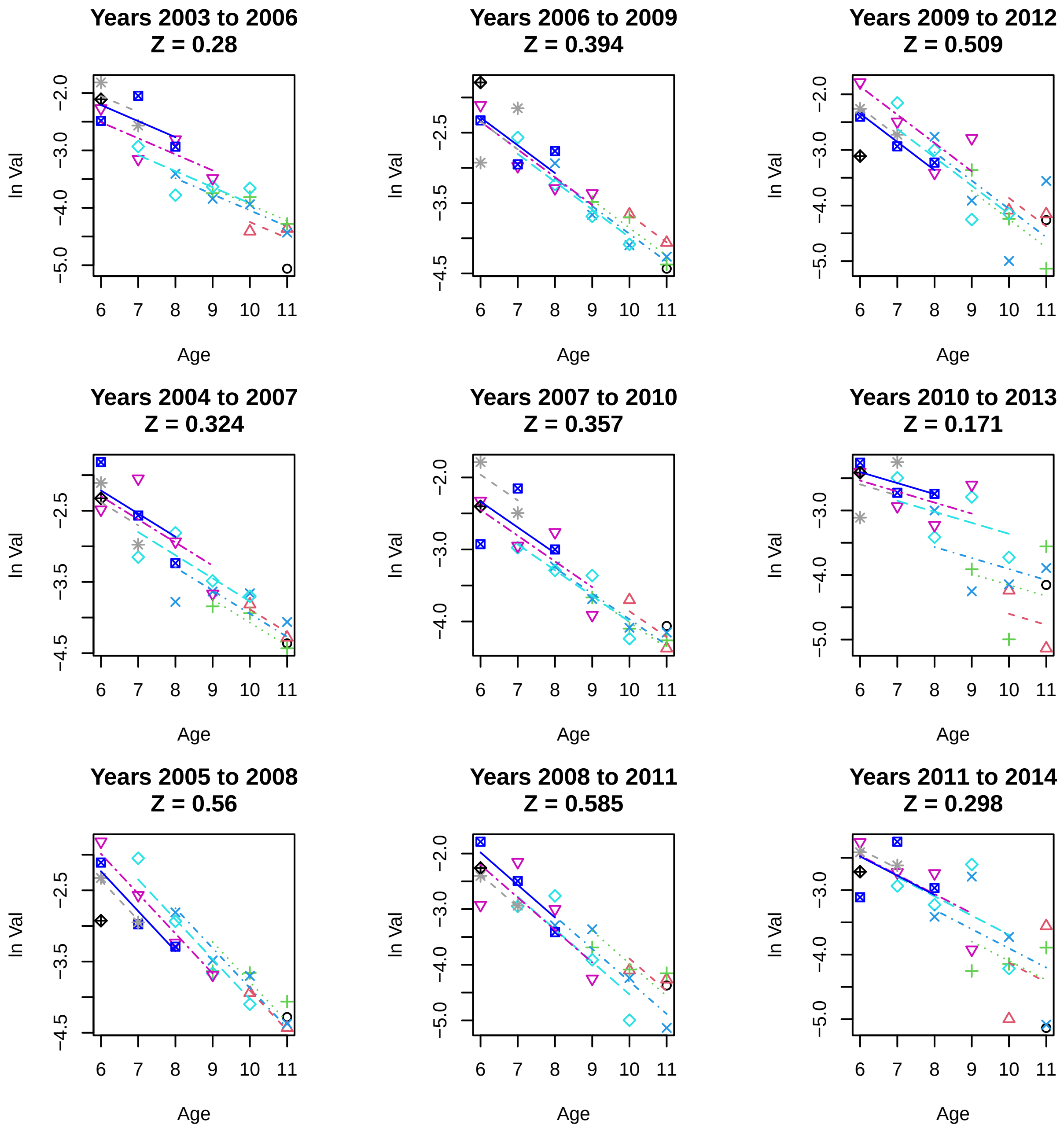

Years 2013 to 2016
Z = 0.823
Years 2016 to 2019
Z = −0.621
Years 2014 to 2017
Z = 0.543
Years 2017 to 2020
Z = −0.115
Years 2015 to 2018
Z = 0.041
ln Val
Age

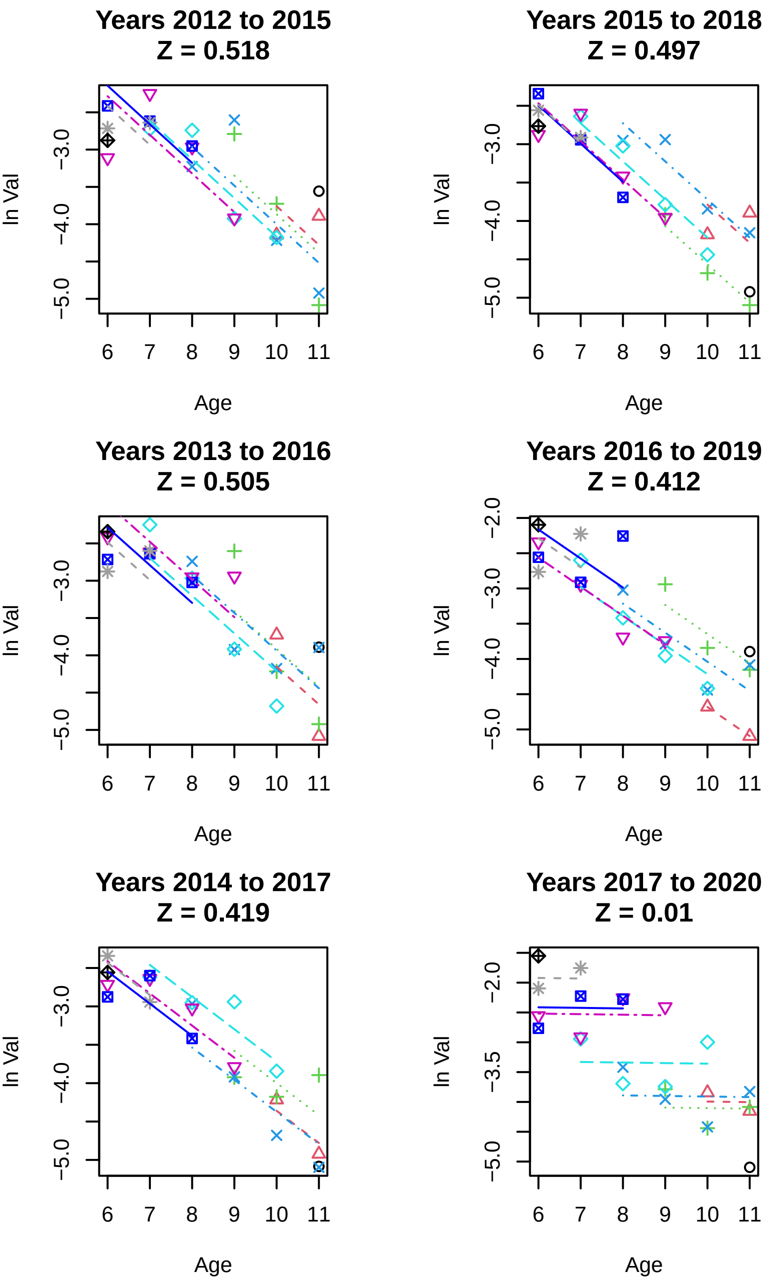


RI Fall Trawl
Residual
Age
2
1
0
−1
−2
−3
2
3
4
5
6
7
8
9
10
11

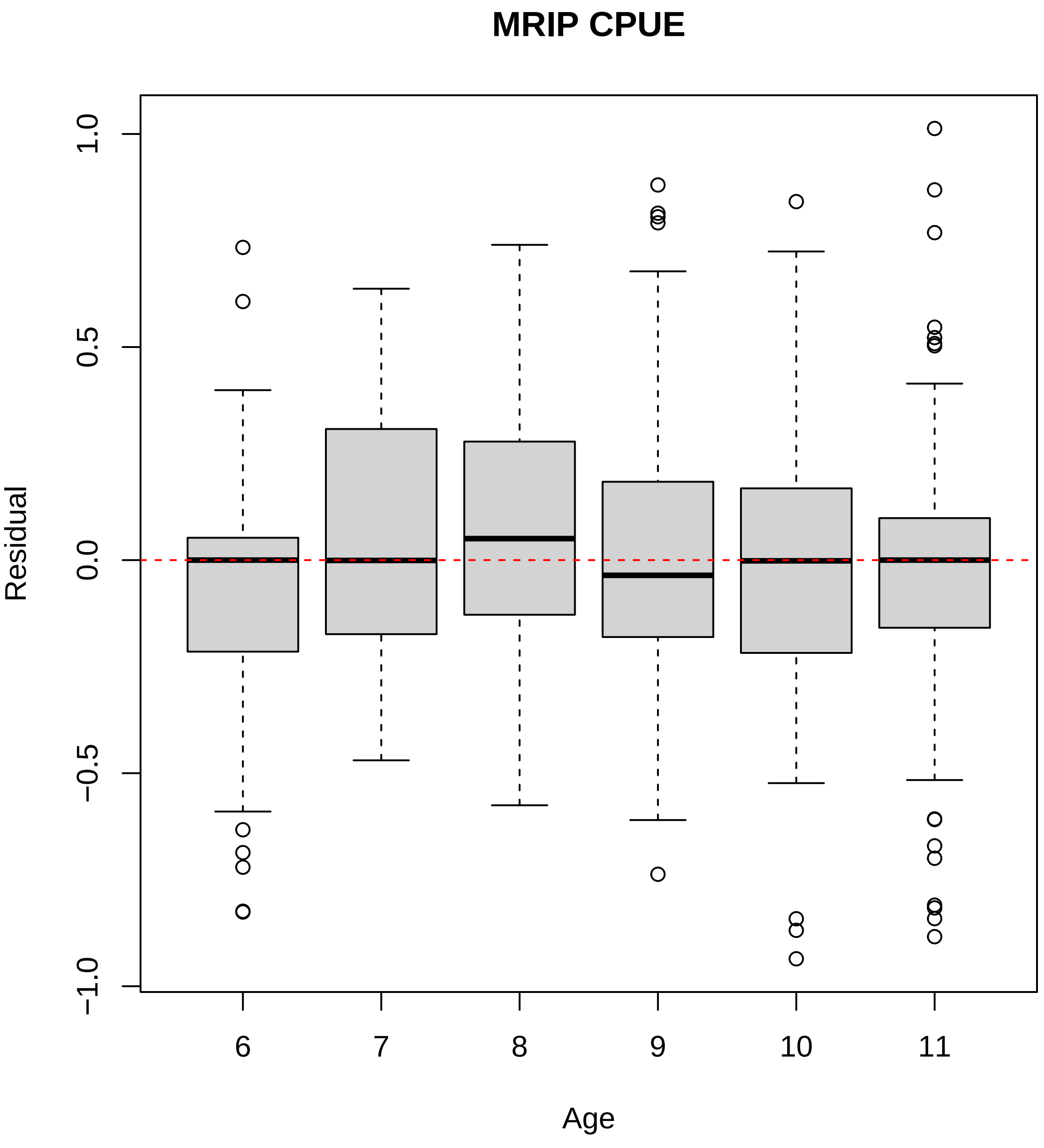

MRIP CPUE
Sinclair Z
0.0
0.2
0.4
0.6
0.8
1985
1990
1995
2000
2005
2010
2015
Year


Years 1995 to 1997
Z = 0.429
Years 1997 to 2000
Z = 0.547
Years 2000 to 2003
Z = 0.581
Years 1995 to 1998
Z = 0.687
Years 1998 to 2001
Z = 0.355
Years 2001 to 2004
Z = 0.437
Years 1996 to 1999
Z = 0.743
Years 1999 to 2002
Z = 0.586
Years 2002 to 2005
Z = 0.34
ln Val
Age

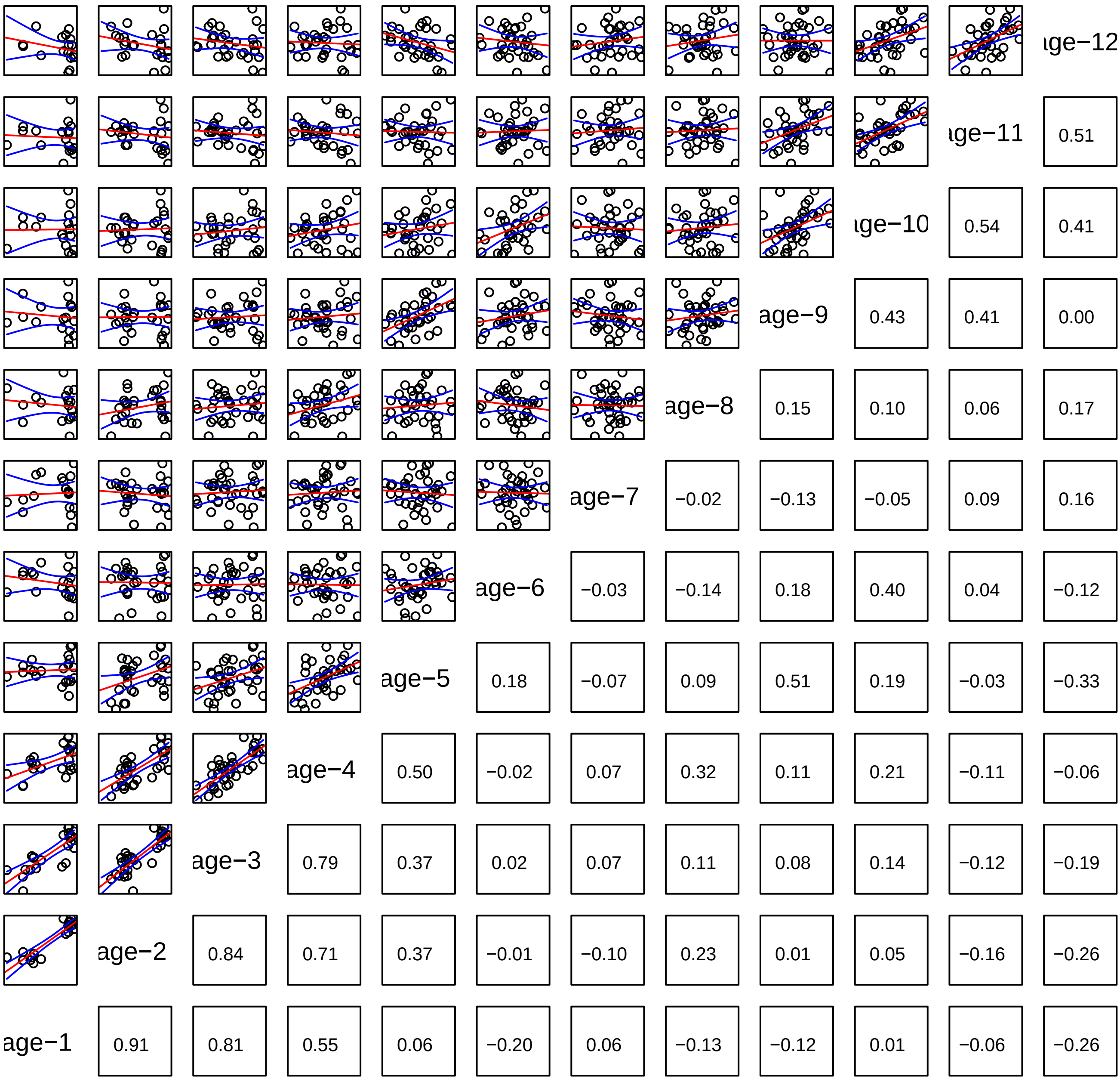

Years 2003 to 2006
Z = 0.28
Years 2006 to 2009
Z = 0.394
Years 2009 to 2012
Z = 0.509
Years 2004 to 2007
Z = 0.324
Years 2007 to 2010
Z = 0.357
Years 2010 to 2013
Z = 0.171
Years 2005 to 2008
Z = 0.56
Years 2008 to 2011
Z = 0.585
Years 2011 to 2014
Z = 0.298
ln Val
Age



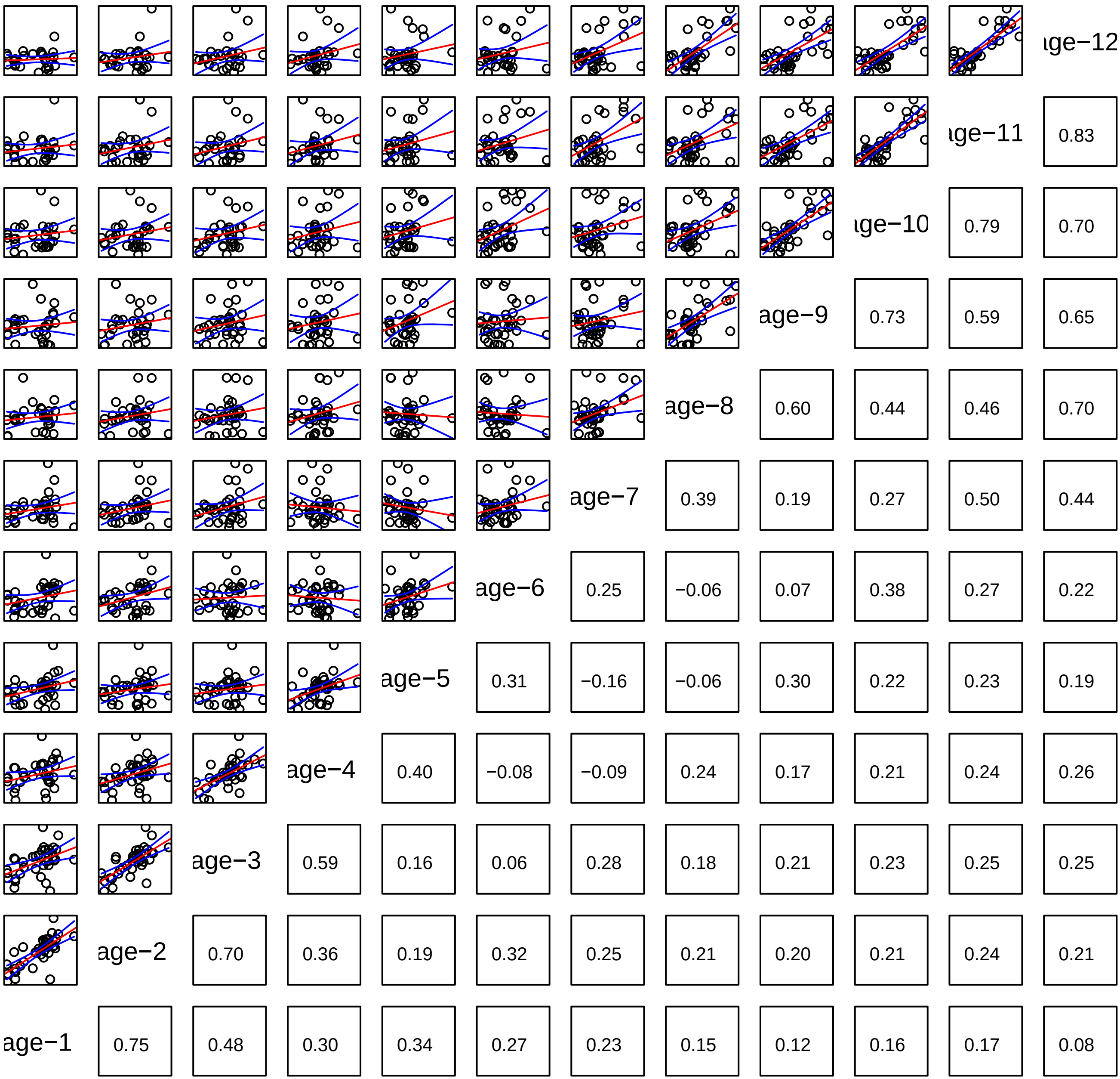
Years 2012 to 2015
Z = 0.518
Years 2015 to 2018
Z = 0.497
Years 2013 to 2016
Z = 0.505
Years 2016 to 2019
Z = 0.412
Years 2014 to 2017
Z = 0.419
Years 2017 to 2020
Z = 0.01
ln Val
Age
−2.0
−3.0
−3.5
−4.0
−5.0
6
7
8
9
10
11


MRIP CPUE
Residual
1.0
0.5
0.0
−0.5
−1.0
6
7
8
9
10
11
Age

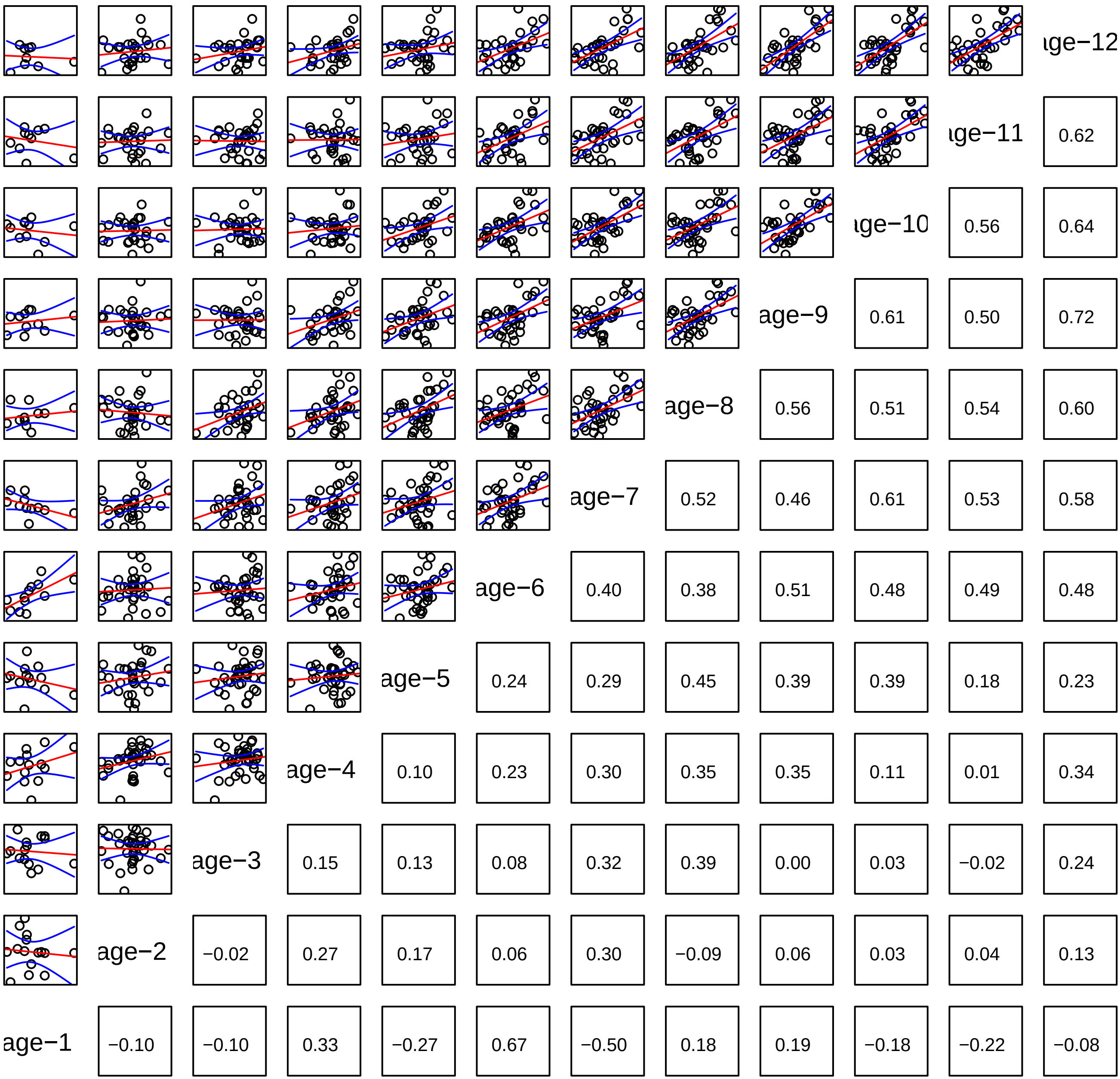
Catch Observed



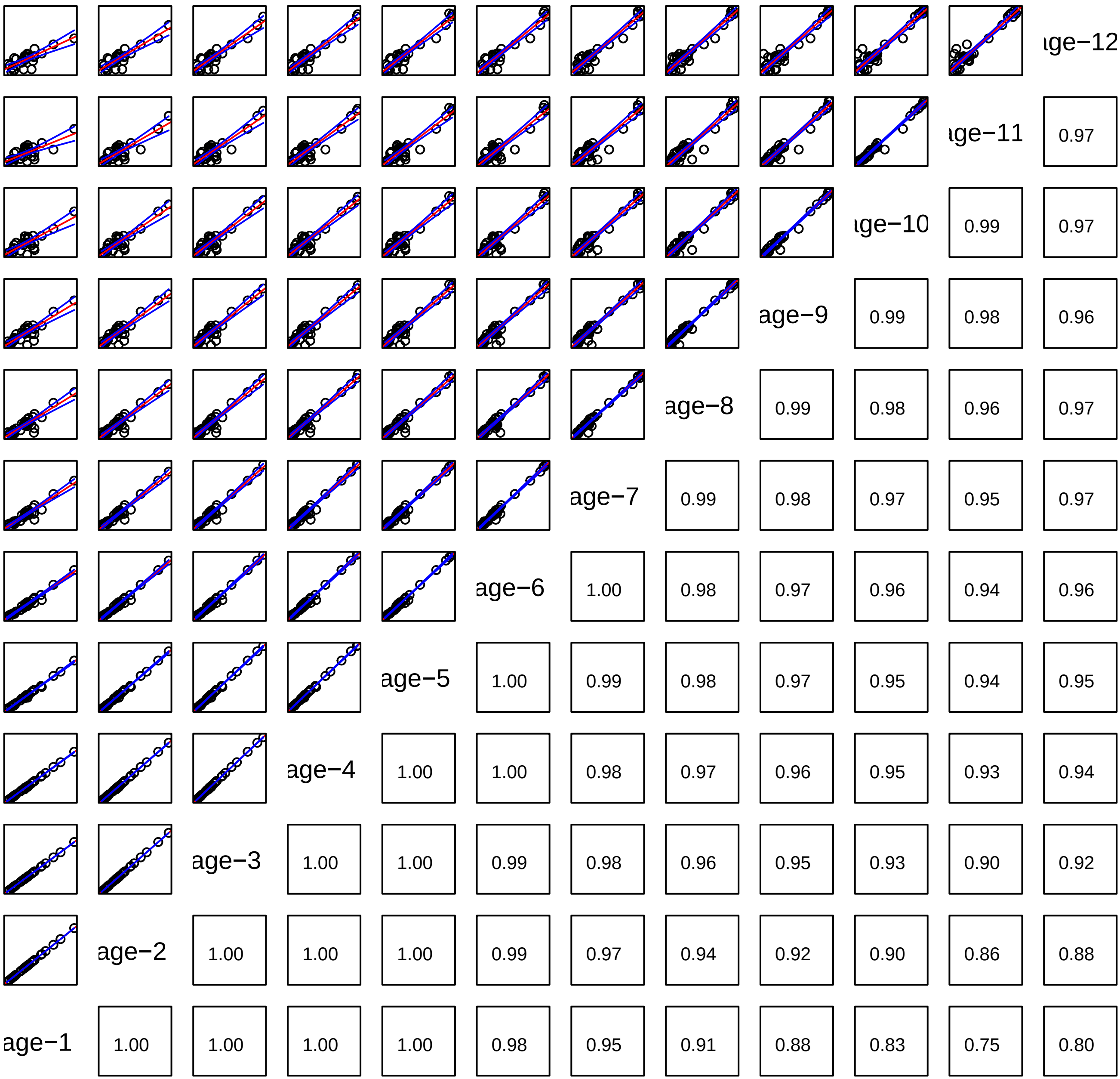
Catch Predicted



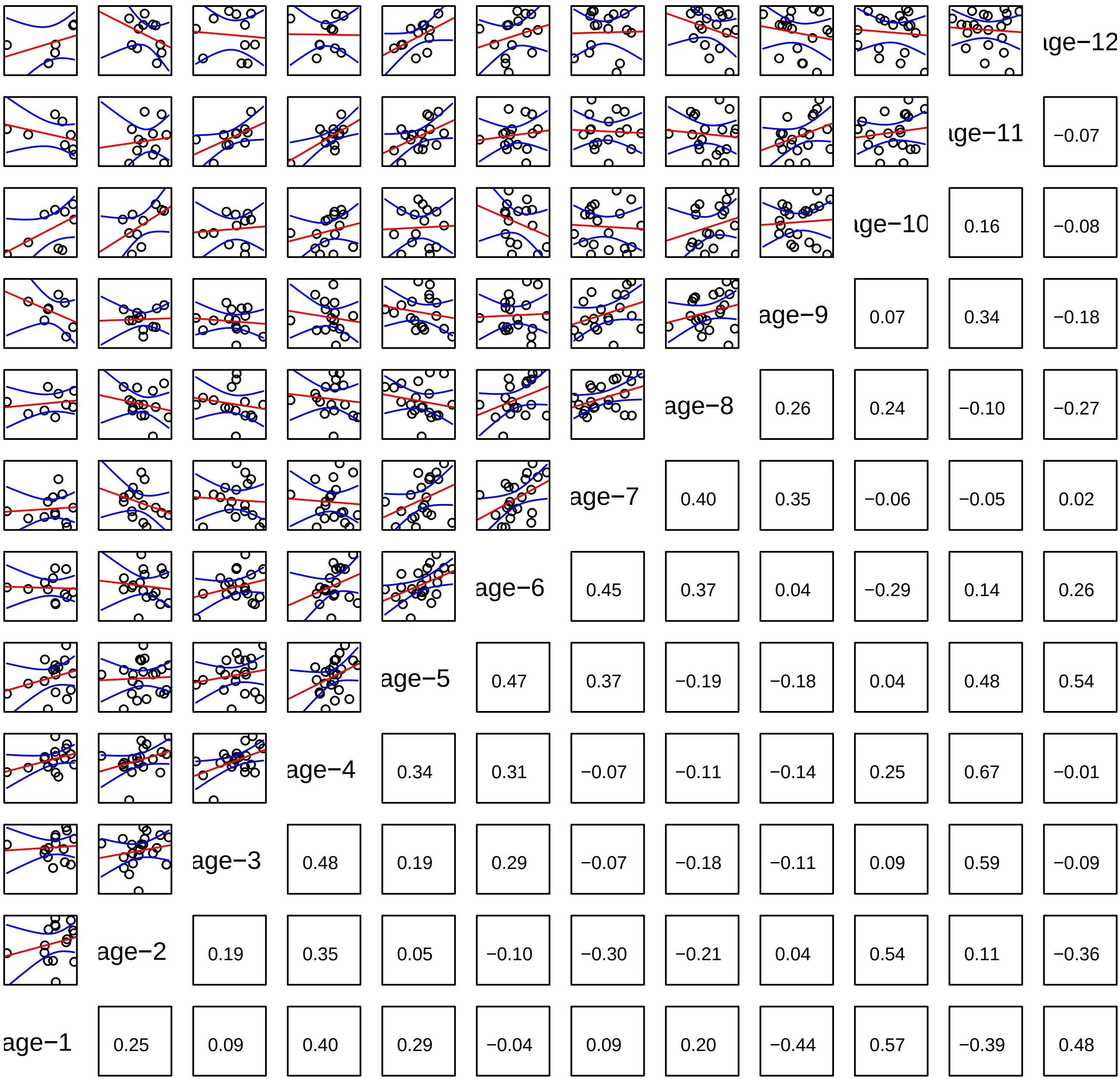
Index 1 (MA Trawl) Observed



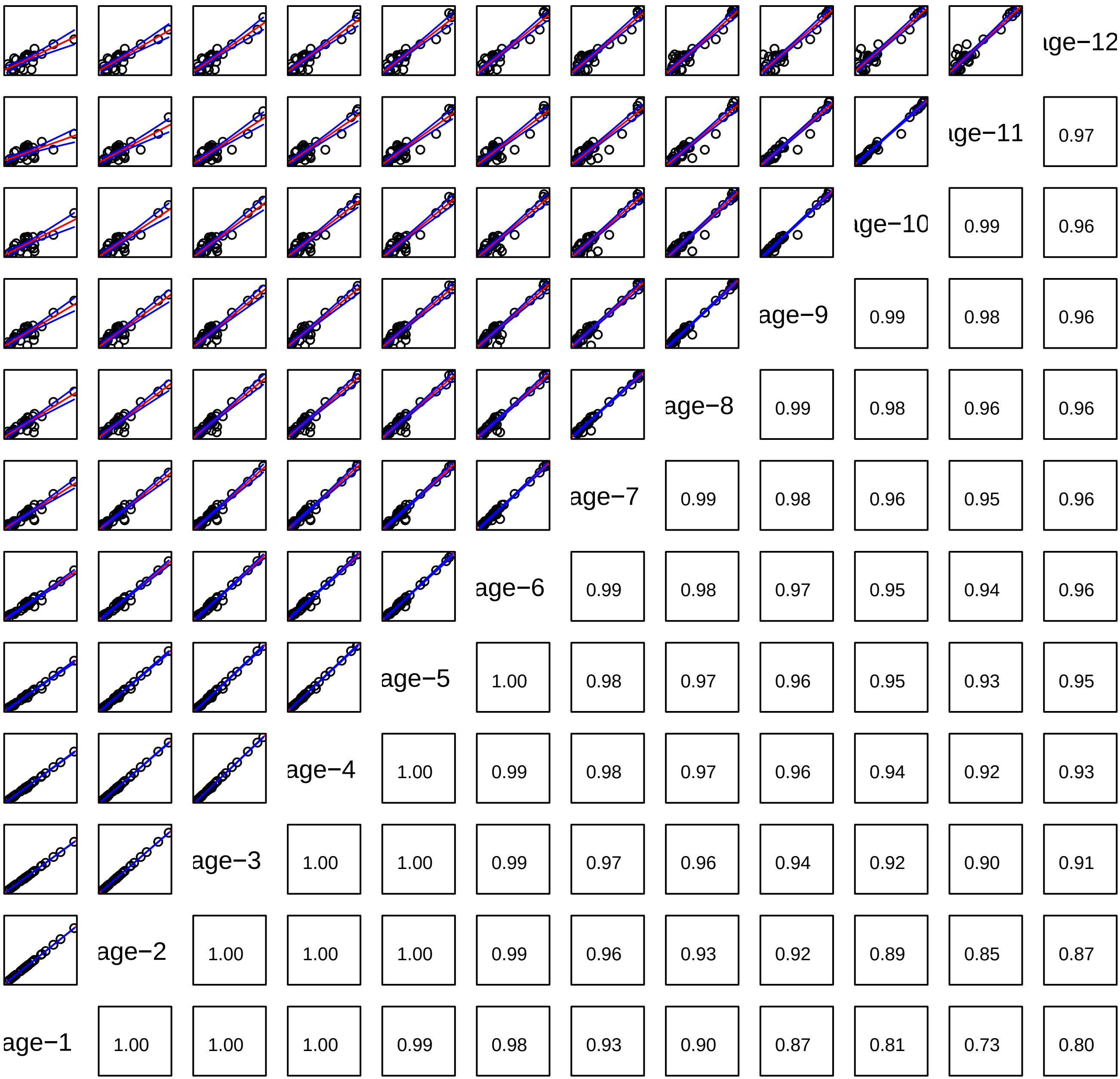
Index 1 (MA Trawl) Predicted



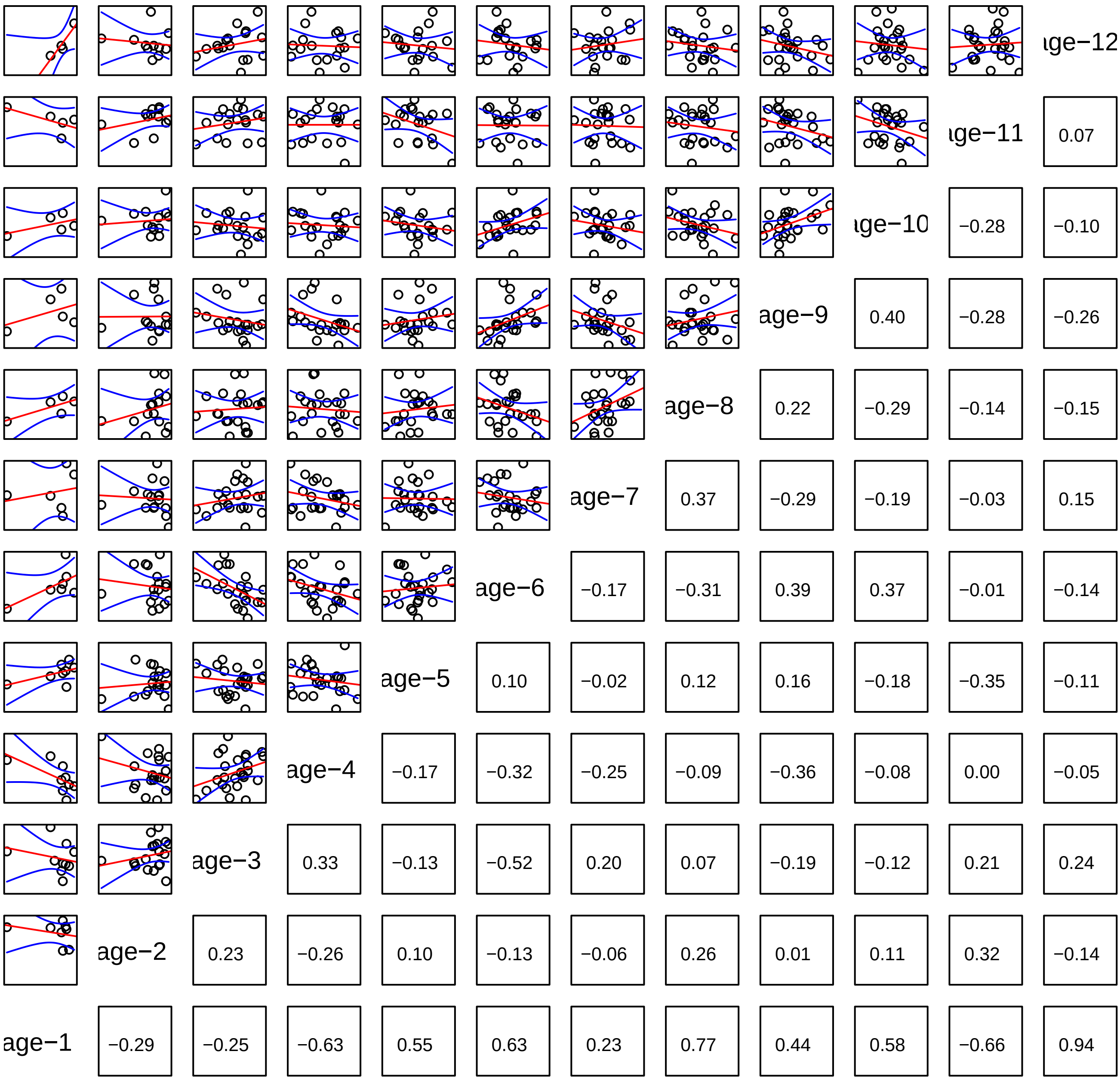
Index 2 (RI Fall Trawl) Observed



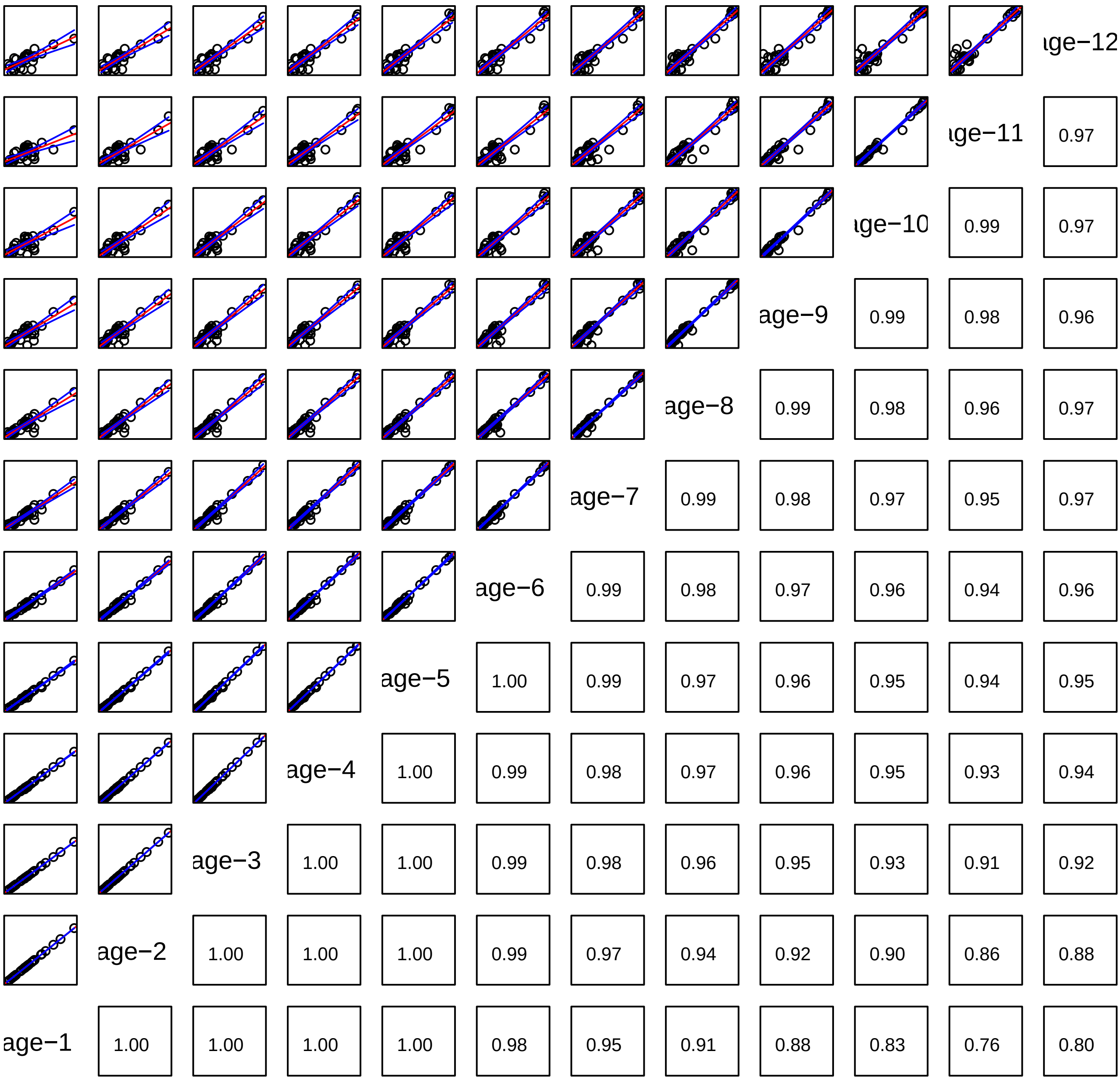
Index 2 (RI Fall Trawl) Predicted

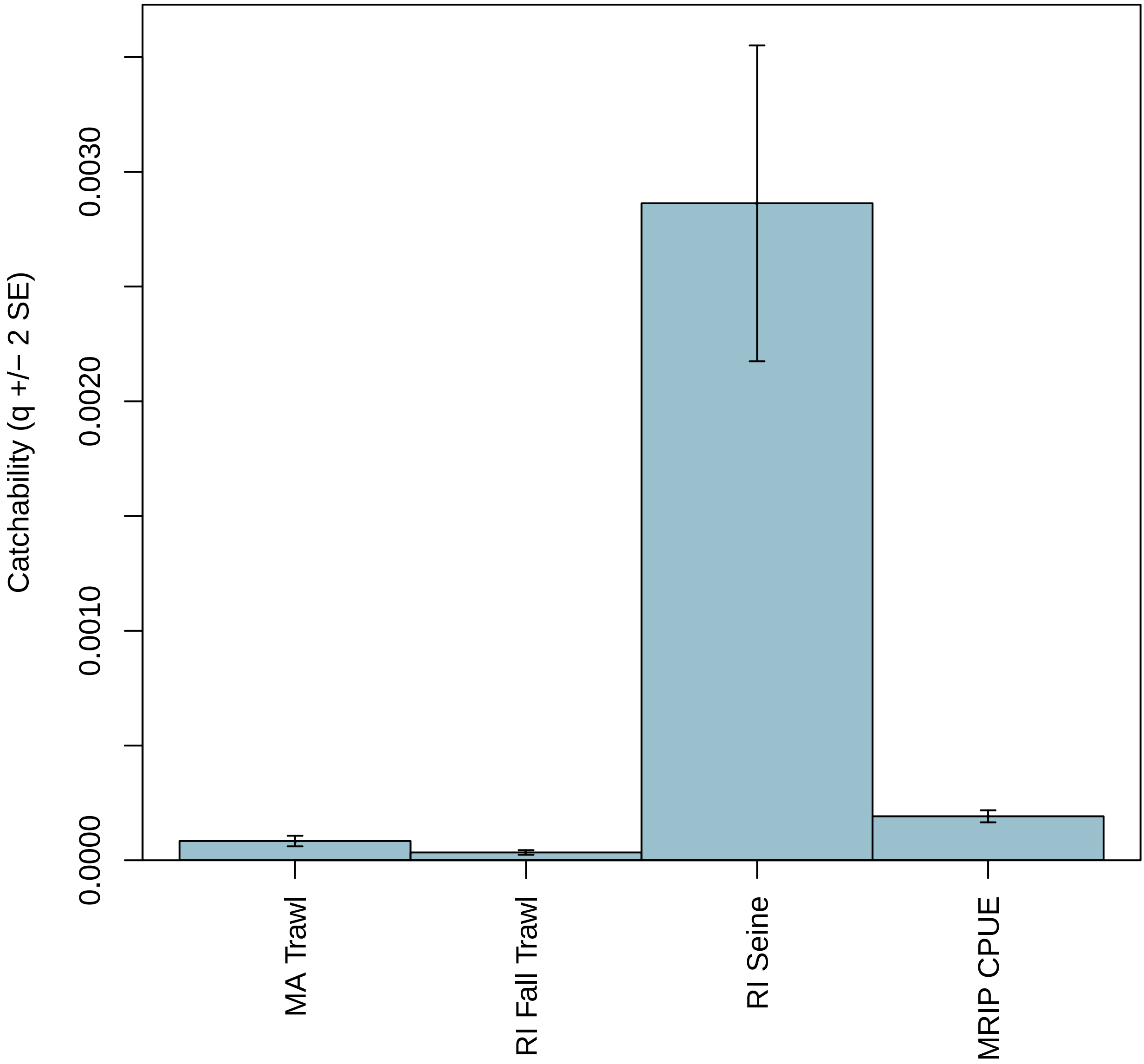


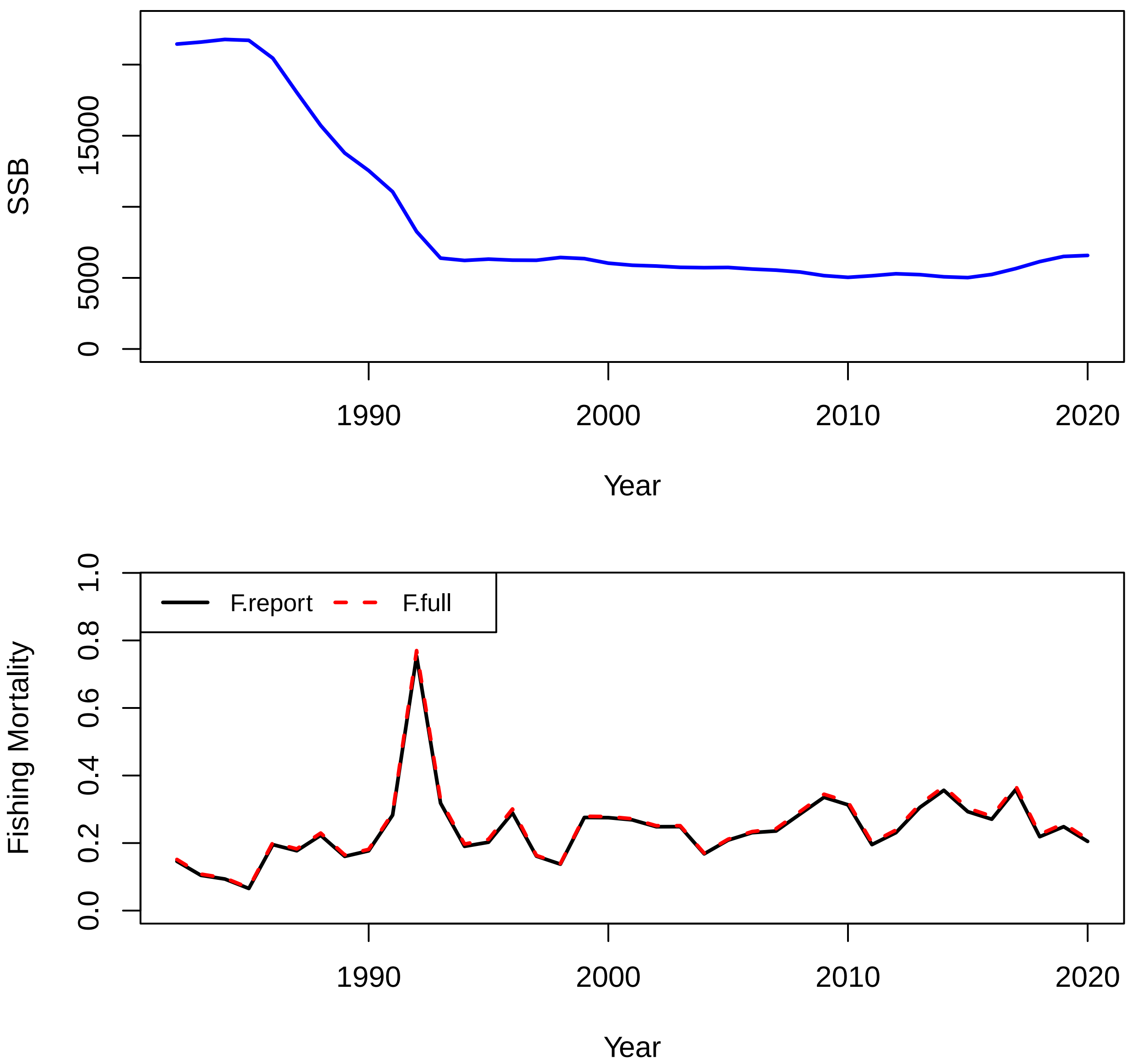
Index 4 (MRIP CPUE) Observed



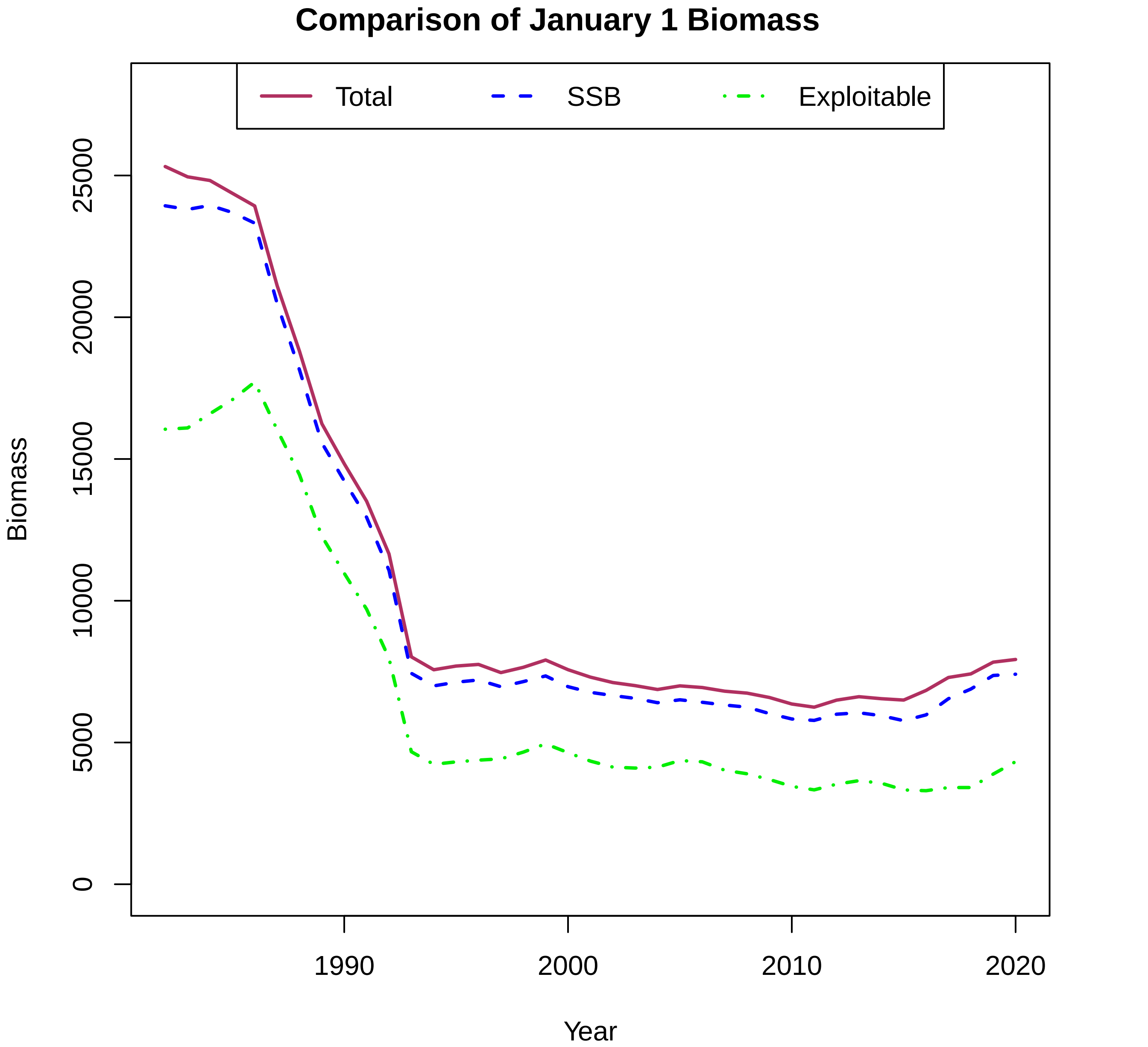
Index 4 (MRIP CPUE) Predicted



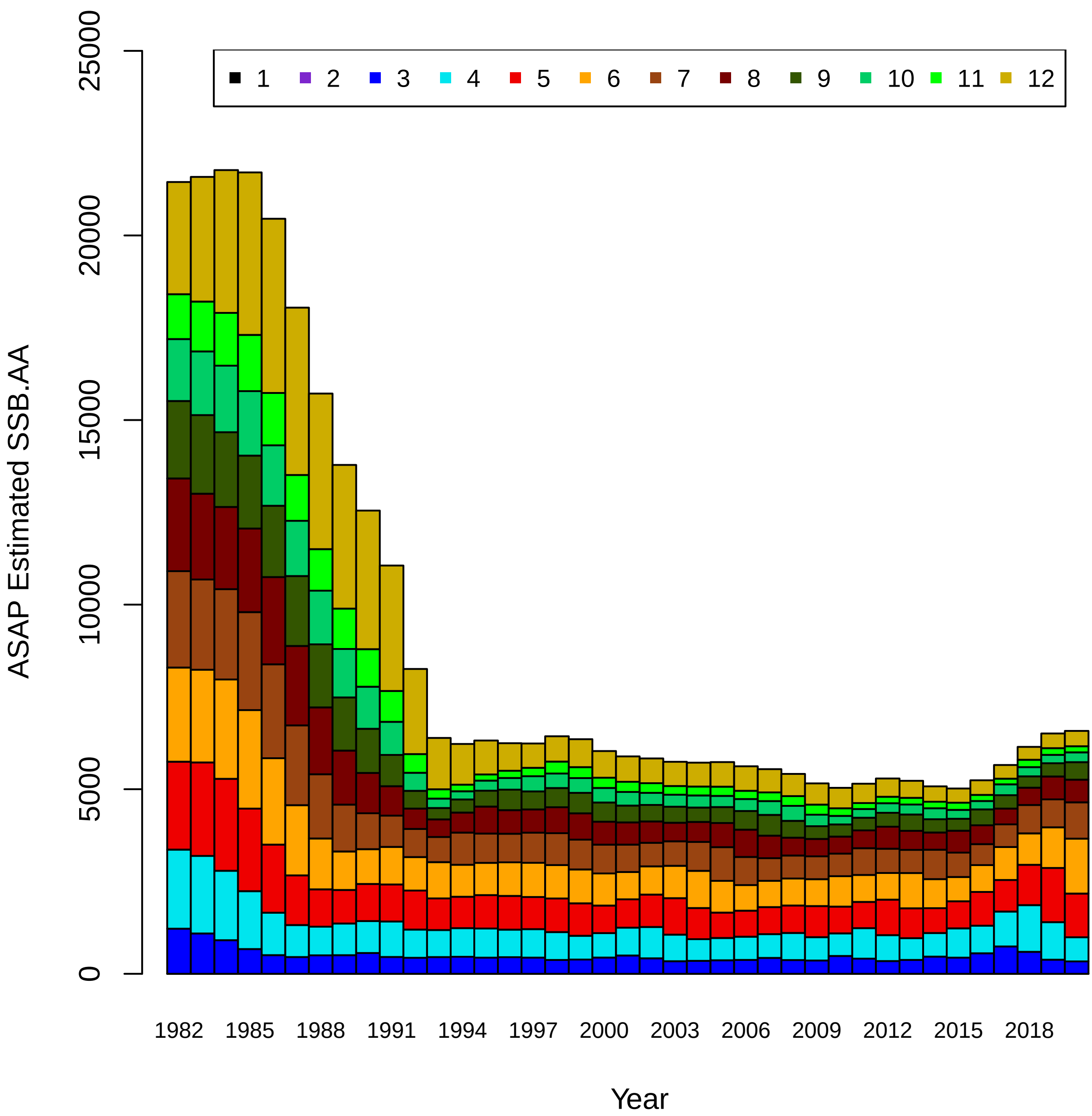

Catchability (q +/− 2 SE)
0.0000
0.0010
0.0020
0.0030
MA Trawl
RI Fall Trawl
RI Seine
MRIP CPUE



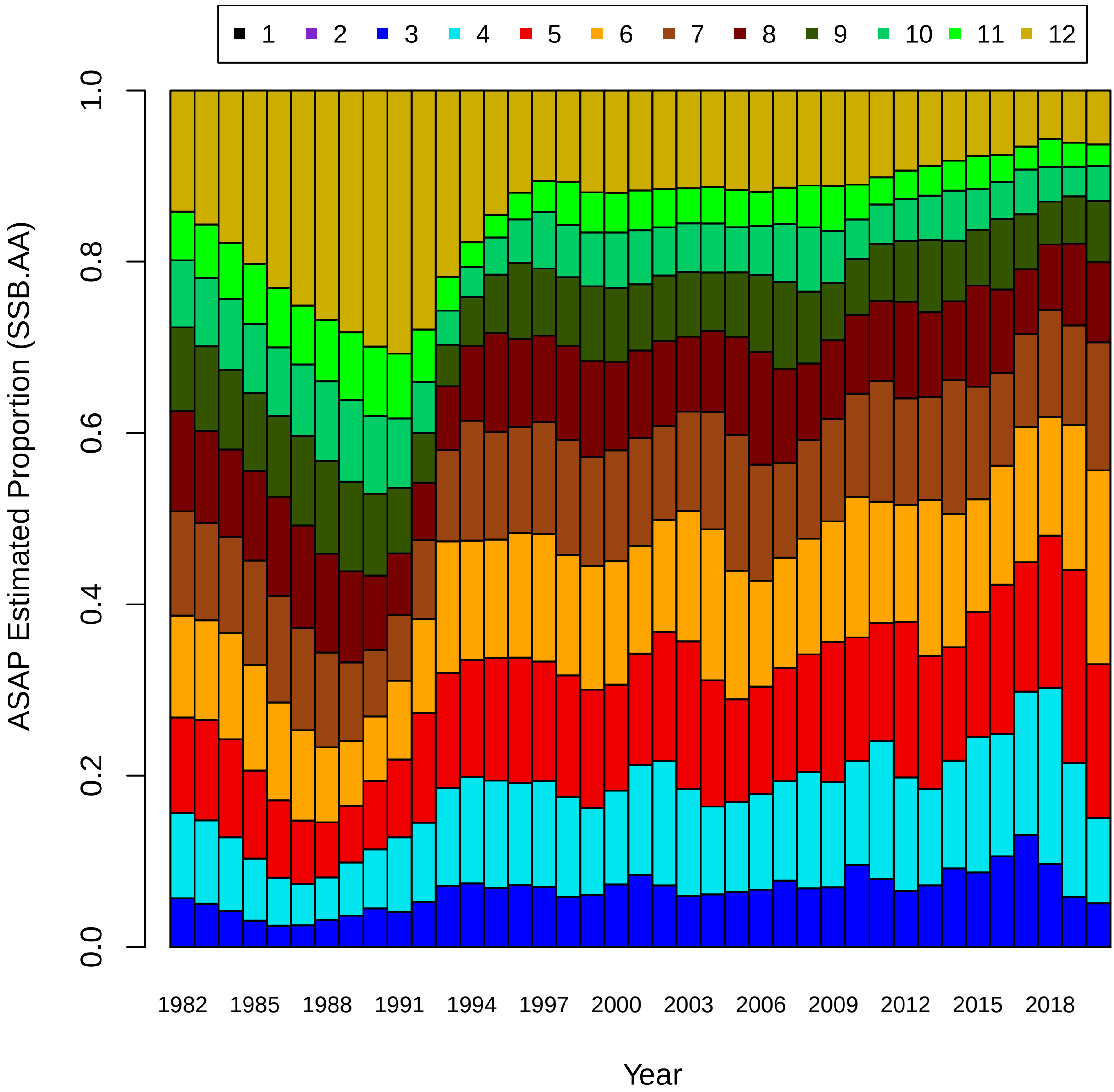
SSB
0
5000
15000
1990
2000
2010
2020
Year
Fishing Mortality
0.0
0.2
0.4
0.6
0.8
1.0
F.report
F.full
1990
2000
2010
2020
Year

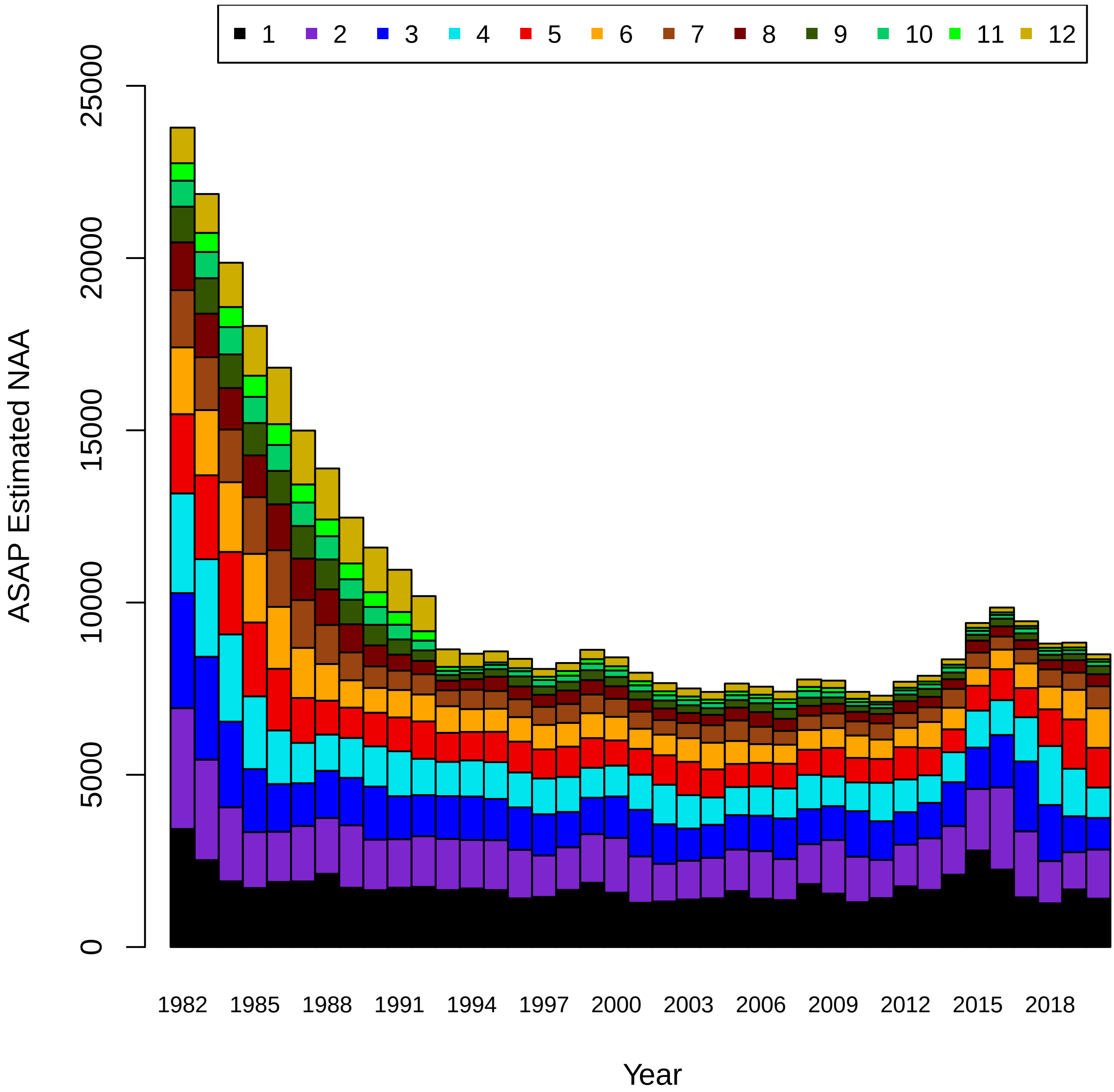


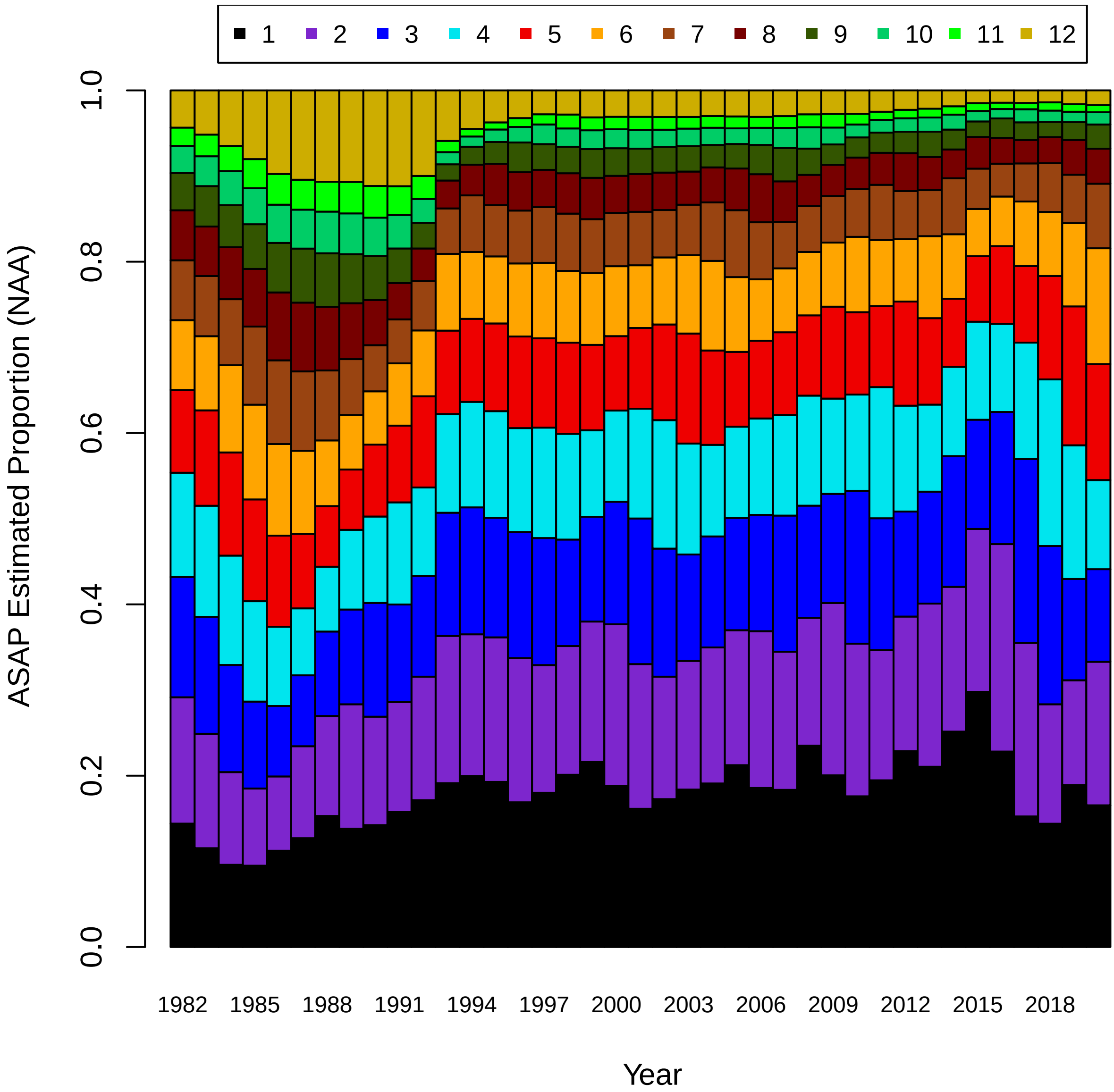
Comparison of January 1 Biomass
Total
SSB
Exploitable
Biomass
Year
0
5000
10000
15000
20000
25000
1990
2000
2010
2020



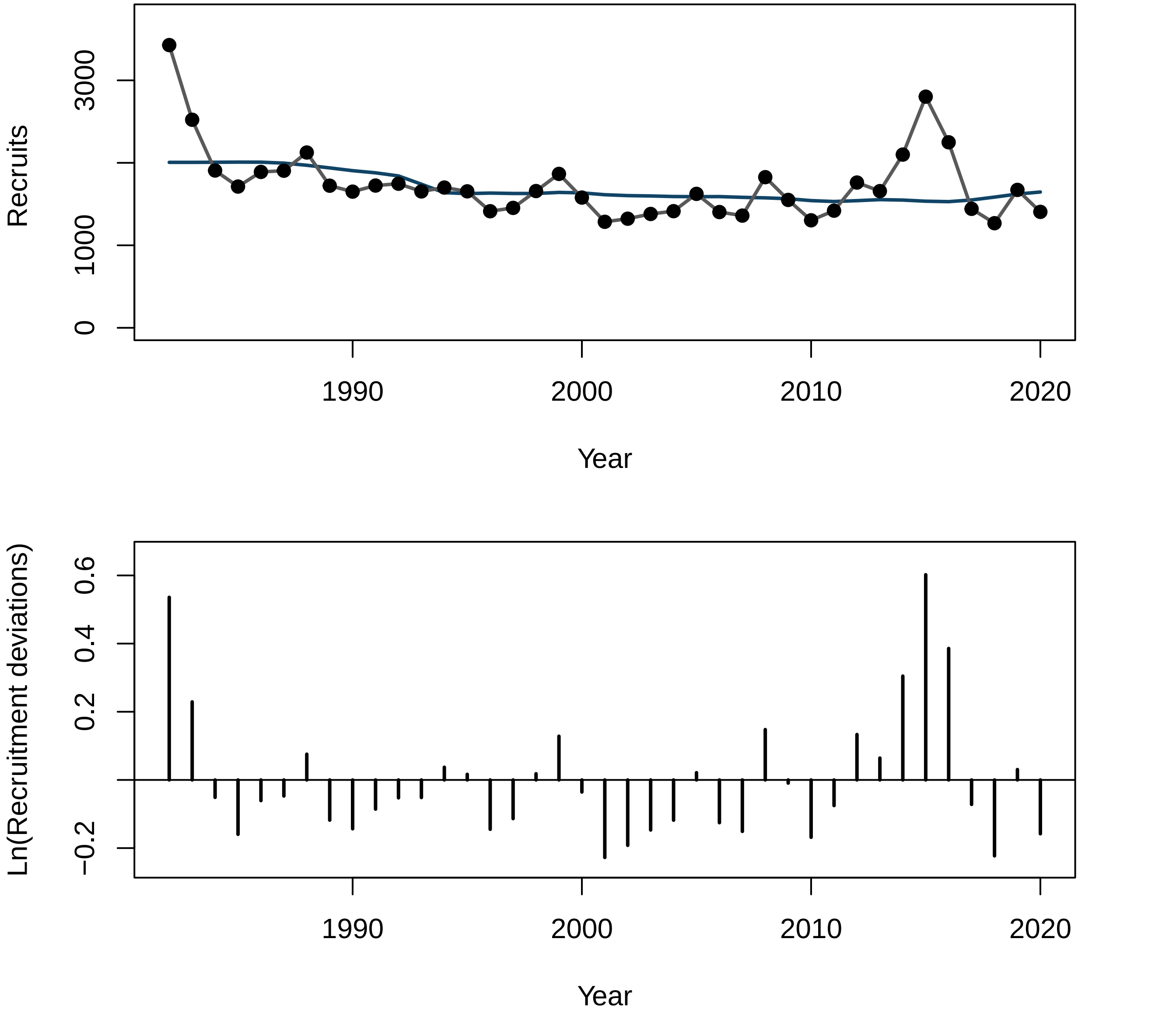
ASAP Estimated SSB.AA
Year
0
5000
10000
15000
20000
25000
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
1
2
3
4
5
6
7
8
9
10
11
12

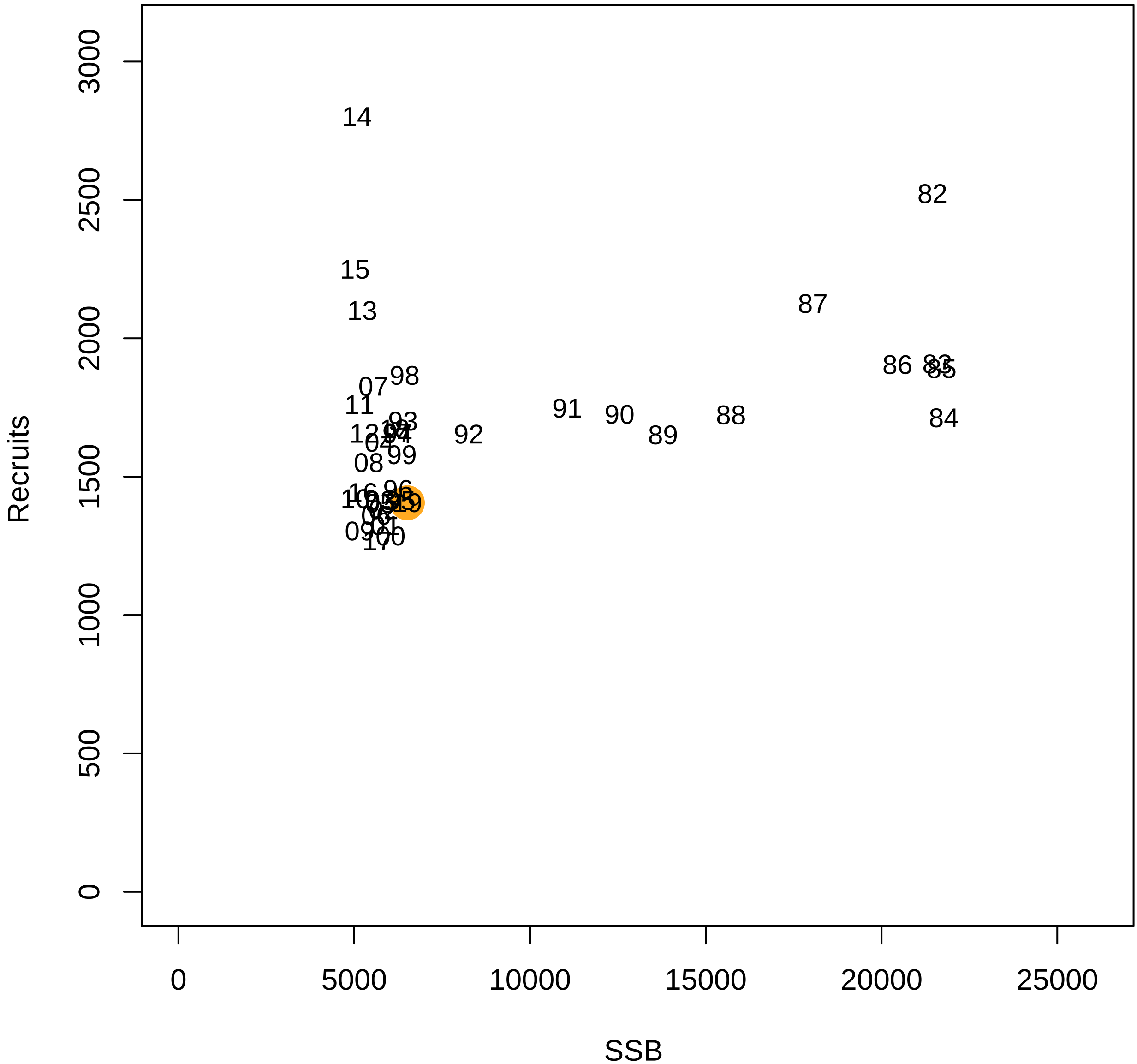

1 2 3 4 5 6 7 8 9 10 11 12
ASAP Estimated Proportion (SSB.AA)
0.0
0.2
0.4
0.6
0.8
1.0
1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018
Year


1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated NAA
0
5000
10000
15000
20000
25000
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
Year

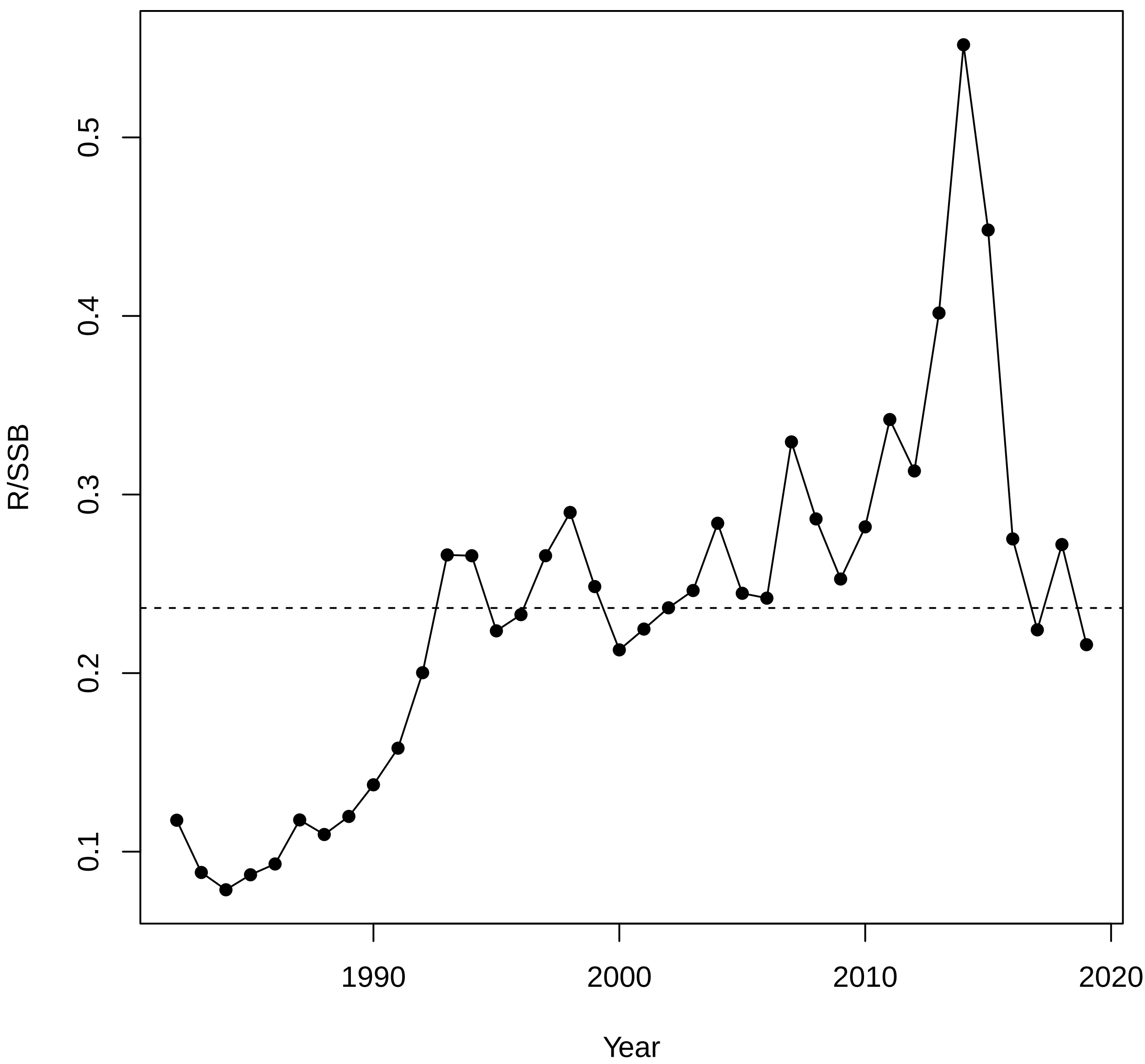


1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (NAA)
0.0
0.2
0.4
0.6
0.8
1.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
Year

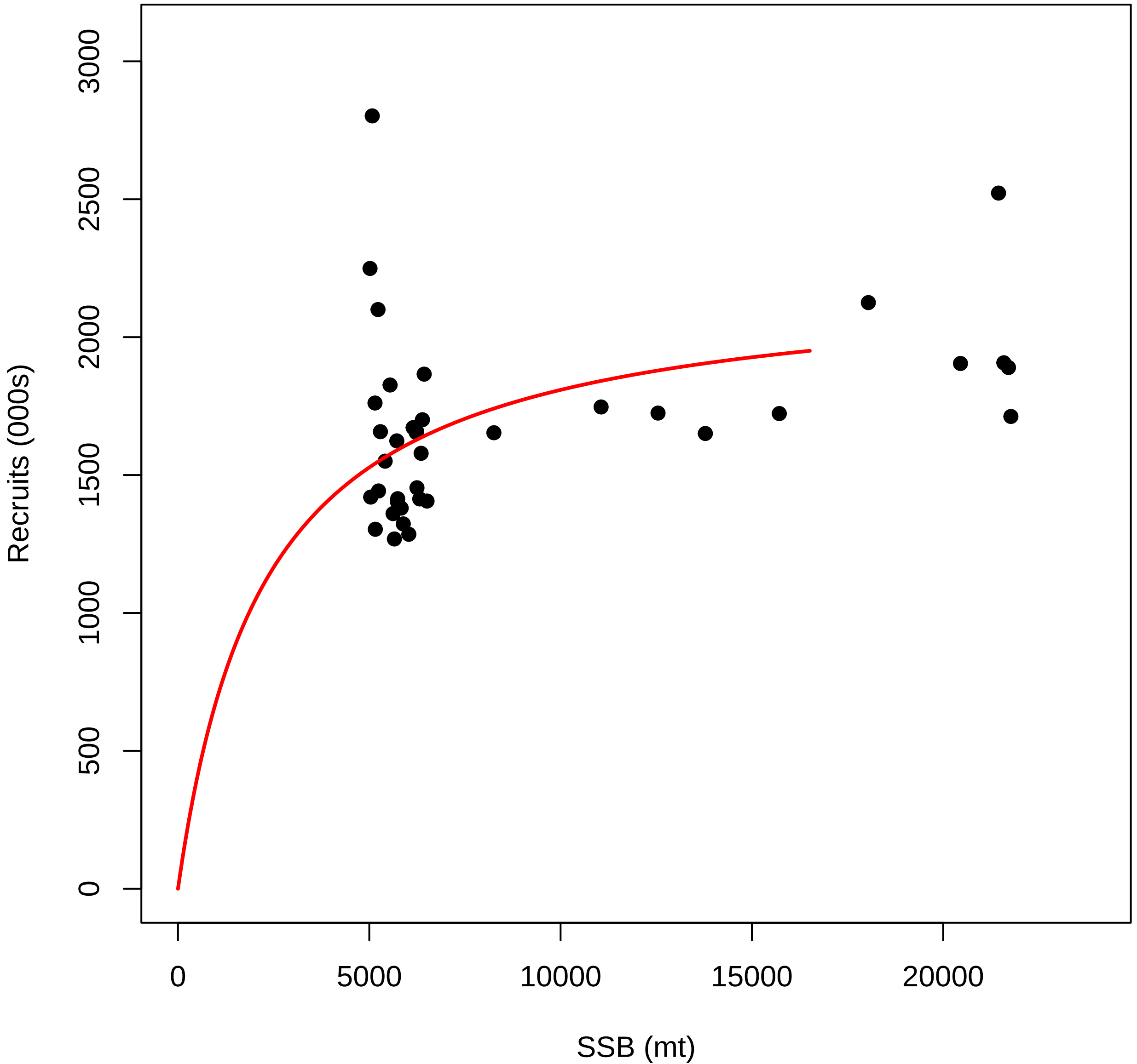

Recruits
0
1000
3000
1990
2000
2010
2020
Year
Ln(Recruitment deviations)
−0.2
0.2
0.4
0.6
1990
2000
2010
2020
Year



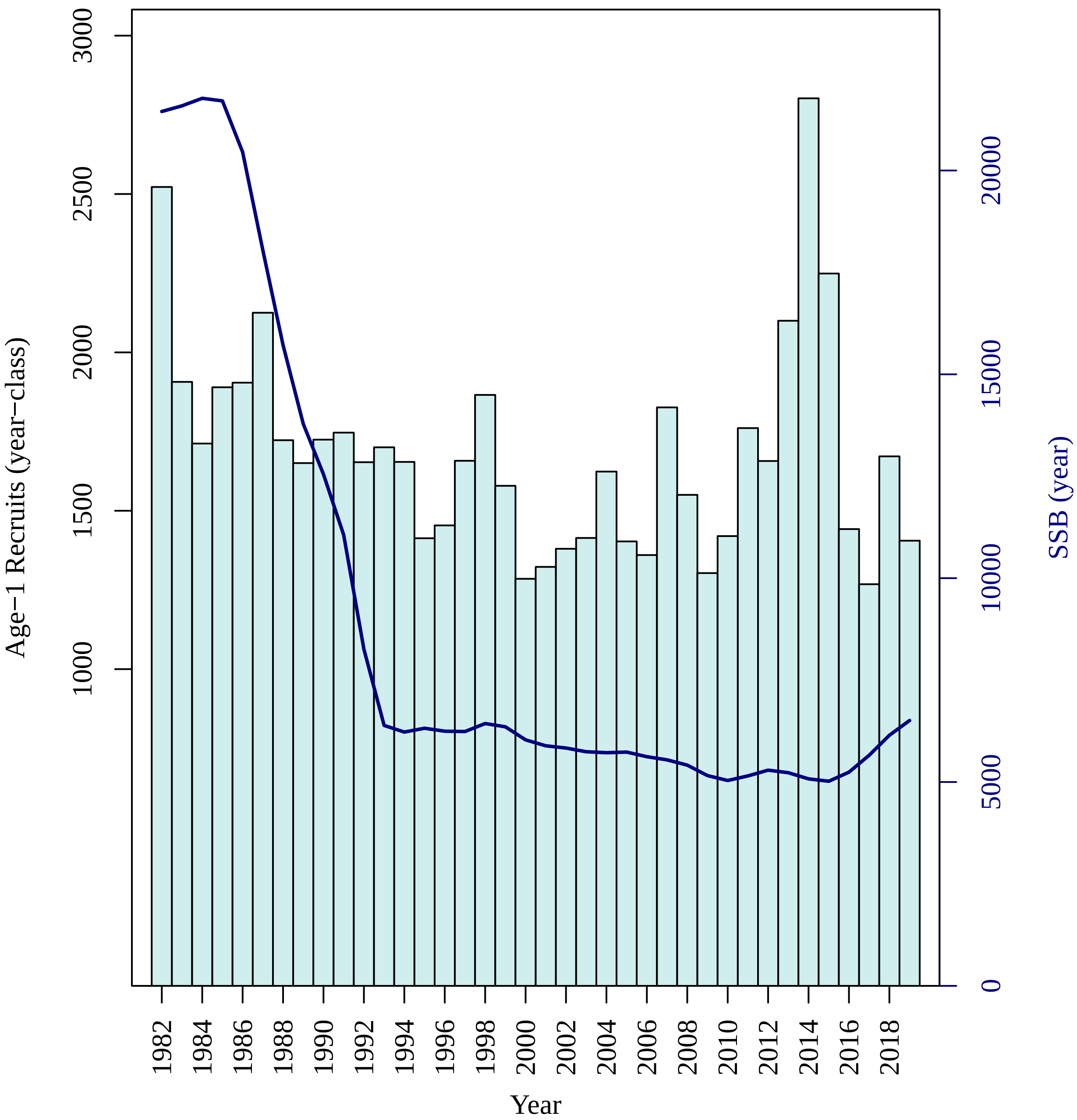
Recruits
SSB
0
500
1000
1500
2000
2500
3000
0
5000
10000
15000
20000
25000
14
82
15
87
13
86
84
98
07
11
91
90
88
89
92
93
99
08



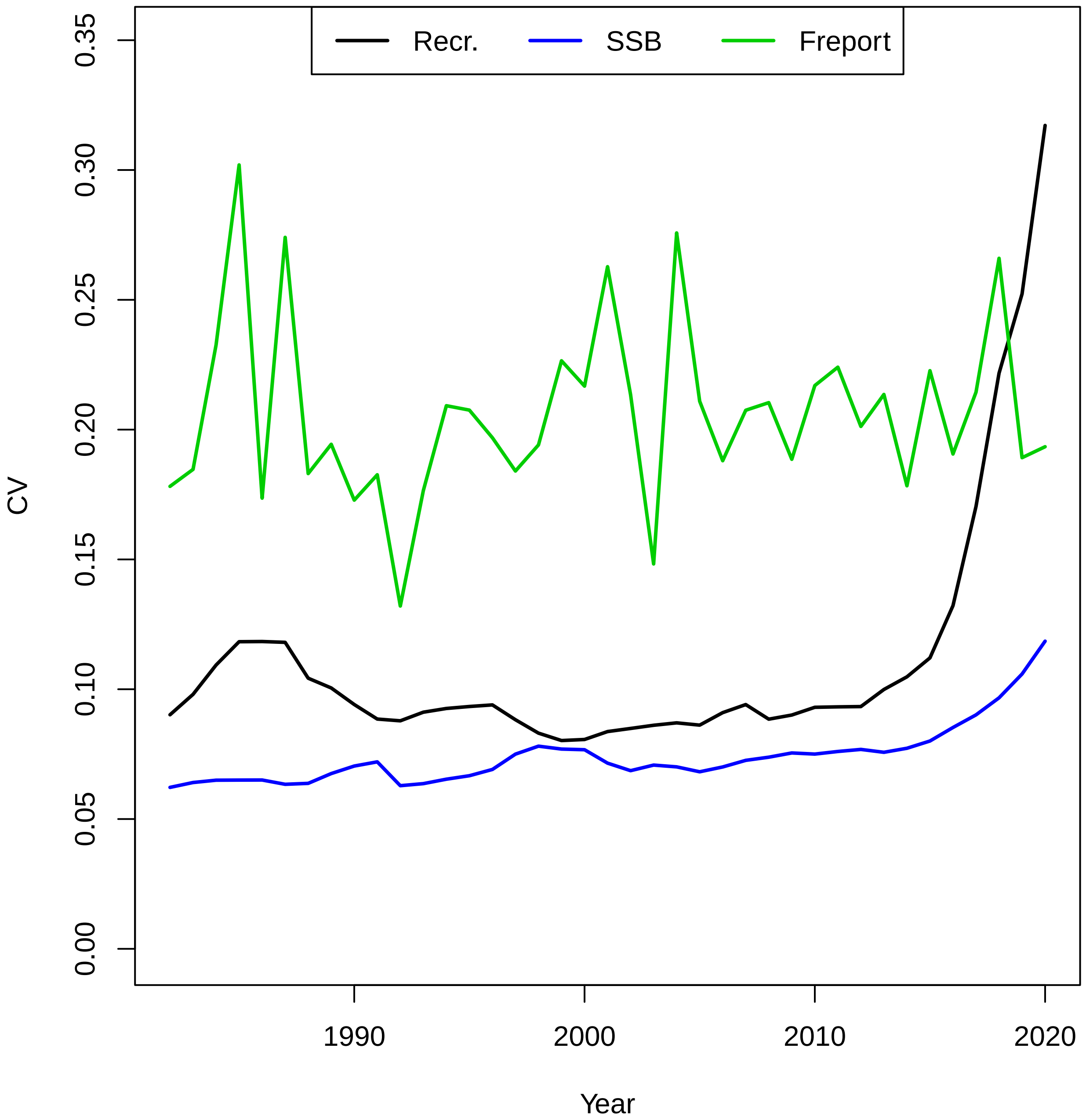
R/SSB
0.1
0.2
0.3
0.4
0.5
1990
2000
2010
2020
Year

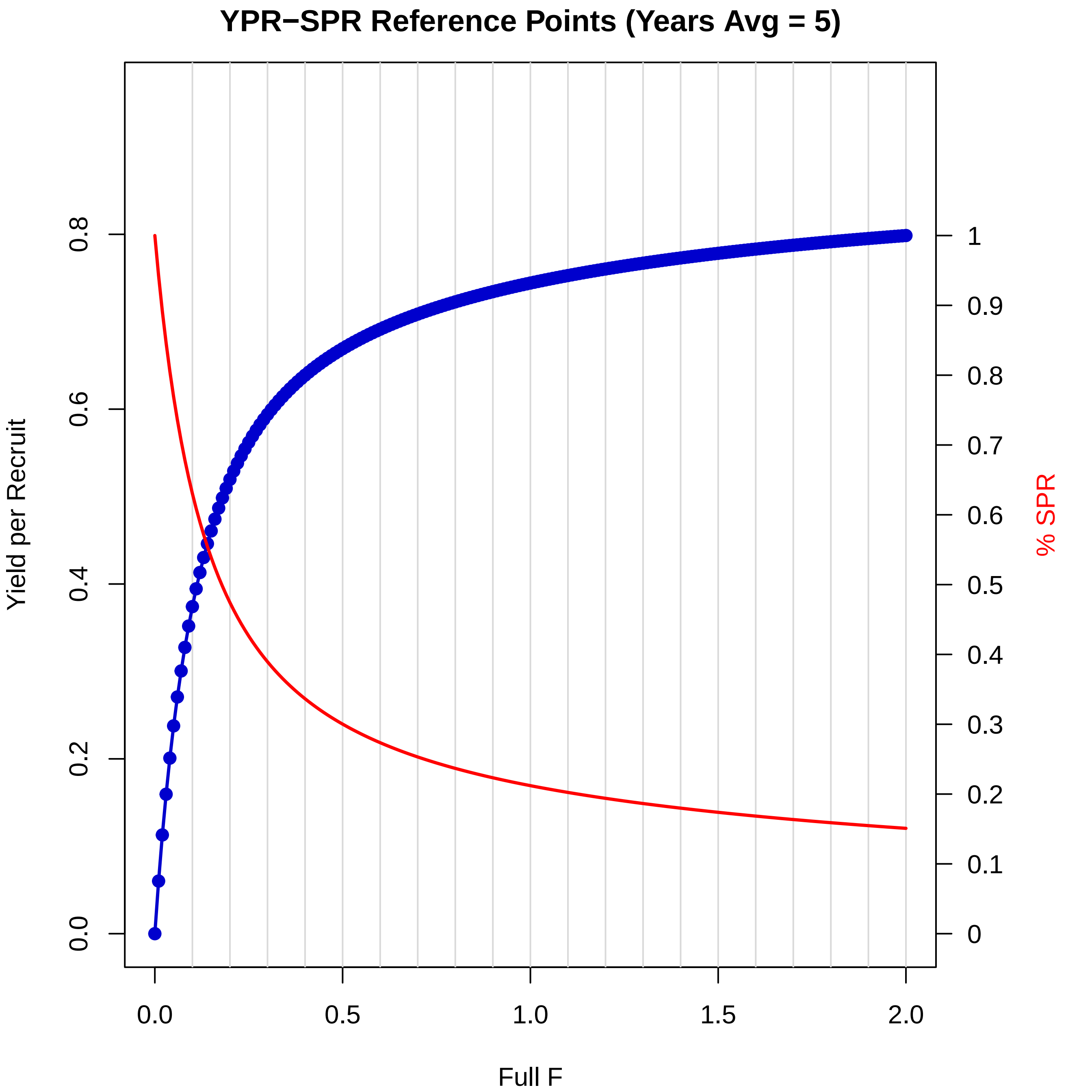


Recruits (000s)
0
500
1000
1500
2000
2500
3000
0
5000
10000
15000
20000
SSB (mt)



Age−1 Recruits (year−class)
3000
2500
2000
1500
1000
SSB (year)
20000
15000
10000
5000
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year

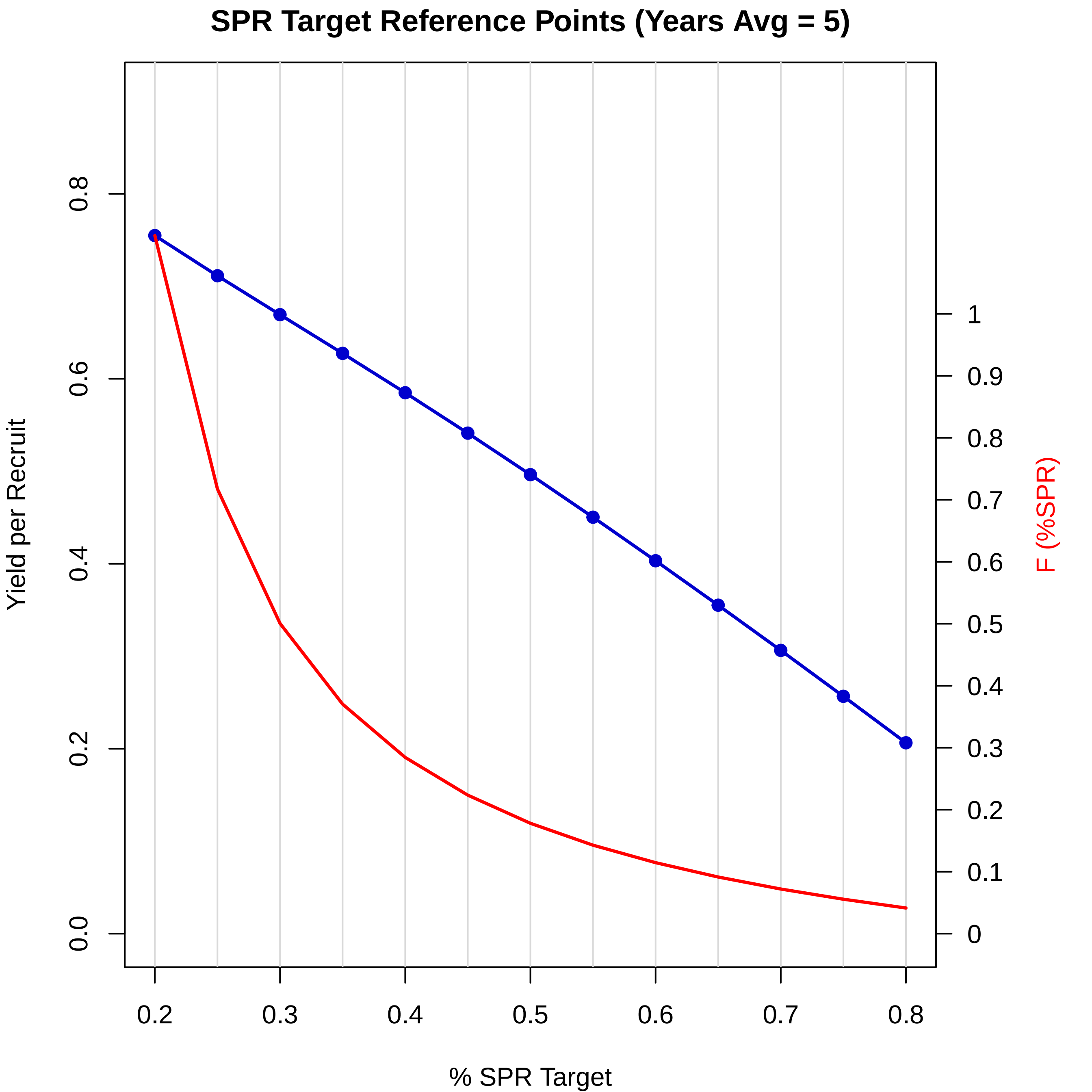

Recr.
SSB
Freport
CV
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Year
1990
2000
2010
2020



YPR−SPR Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.2
0.4
0.6
0.8
Full F
0.0
0.5
1.0
1.5
2.0
% SPR
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

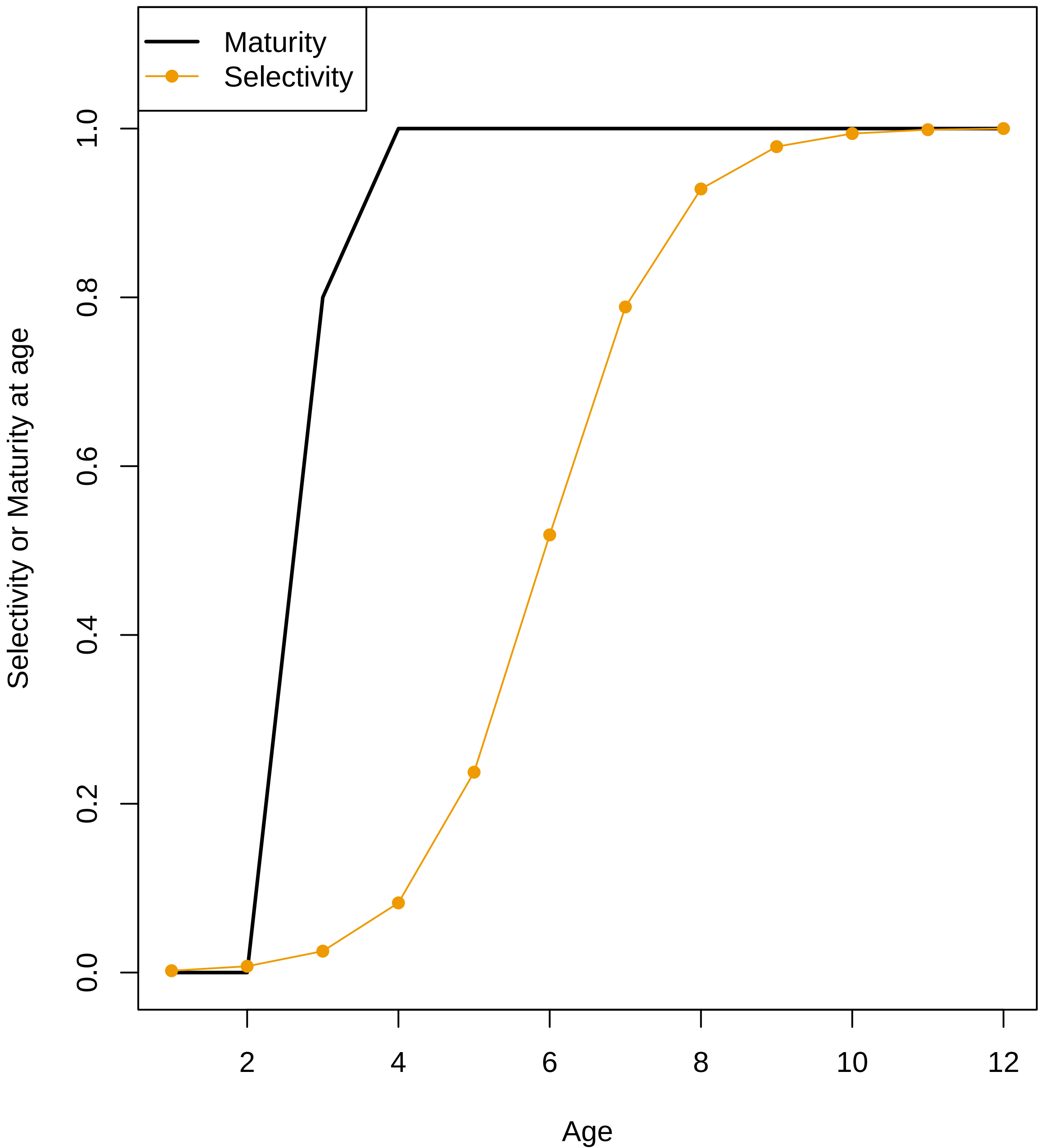
YPR−SPR Reference Points (Years Avg = 5)

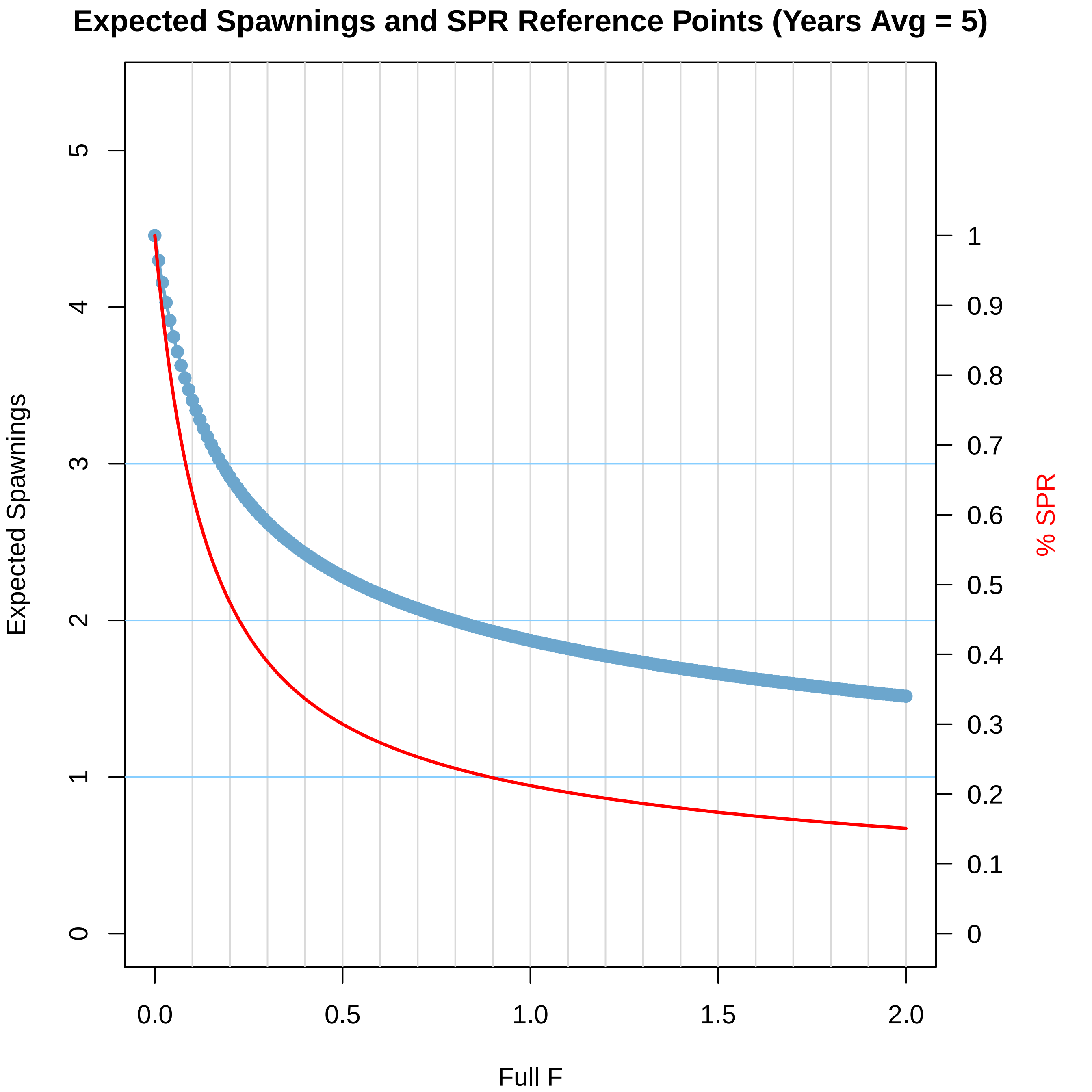
F	YPR	SPR	F	YPR	SPR	F	YPR	SPR
0	0	1	0.35	0.6188	0.3602	0.7	0.7087	0.2531
0.01	0.0602	0.9424	0.36	0.6232	0.3551	0.71	0.7103	0.2513
0.02	0.113	0.8914	0.37	0.6273	0.3502	0.72	0.7118	0.2496
0.03	0.1595	0.8461	0.38	0.6313	0.3454	0.73	0.7132	0.2478
0.04	0.2008	0.8055	0.39	0.6351	0.3409	0.74	0.7147	0.2462
0.05	0.2377	0.7689	0.4	0.6388	0.3365	0.75	0.7161	0.2445
0.06	0.2708	0.7359	0.41	0.6424	0.3323	0.76	0.7174	0.2429
0.07	0.3005	0.7059	0.42	0.6458	0.3282	0.77	0.7188	0.2413
0.08	0.3275	0.6785	0.43	0.6491	0.3243	0.78	0.7201	0.2398
0.09	0.3519	0.6534	0.44	0.6522	0.3205	0.79	0.7214	0.2383
0.1	0.3741	0.6304	0.45	0.6553	0.3168	0.8	0.7227	0.2368
0.11	0.3945	0.6092	0.46	0.6583	0.3133	0.81	0.724	0.2353
0.12	0.4131	0.5896	0.47	0.6611	0.3098	0.82	0.7252	0.2339
0.13	0.4303	0.5714	0.48	0.6639	0.3065	0.83	0.7264	0.2325
0.14	0.4461	0.5545	0.49	0.6666	0.3033	0.84	0.7276	0.2311
0.15	0.4607	0.5388	0.5	0.6692	0.3002	0.85	0.7288	0.2297
0.16	0.4742	0.5242	0.51	0.6717	0.2972	0.86	0.7299	0.2284
0.17	0.4868	0.5105	0.52	0.6741	0.2942	0.87	0.7311	0.2271
0.18	0.4985	0.4976	0.53	0.6765	0.2914	0.88	0.7322	0.2258
0.19	0.5095	0.4855	0.54	0.6788	0.2886	0.89	0.7333	0.2246
0.2	0.5197	0.4742	0.55	0.6811	0.2859	0.9	0.7344	0.2233
0.21	0.5292	0.4635	0.56	0.6833	0.2833	0.91	0.7354	0.2221
0.22	0.5382	0.4534	0.57	0.6854	0.2808	0.92	0.7365	0.2209
0.23	0.5466	0.4439	0.58	0.6875	0.2783	0.93	0.7375	0.2197
0.24	0.5546	0.4349	0.59	0.6895	0.2759	0.94	0.7385	0.2186
0.25	0.5621	0.4263	0.6	0.6914	0.2736	0.95	0.7395	0.2175
0.26	0.5692	0.4182	0.61	0.6934	0.2713	0.96	0.7405	0.2163
0.27	0.5759	0.4105	0.62	0.6952	0.2691	0.97	0.7414	0.2152
0.28	0.5822	0.4031	0.63	0.6971	0.2669	0.98	0.7424	0.2141
0.29	0.5883	0.3961	0.64	0.6988	0.2648	0.99	0.7433	0.2131
0.3	0.594	0.3894	0.65	0.7006	0.2627	1	0.7443	0.212
0.31	0.5994	0.3831	0.66	0.7023	0.2607	1.01	0.7452	0.211
0.32	0.6046	0.377	0.67	0.704	0.2587	1.02	0.7461	0.21
0.33	0.6096	0.3712	0.68	0.7056	0.2568	1.03	0.747	0.209
0.34	0.6143	0.3656	0.69	0.7072	0.2549	1.04	0.7478	0.208


SPR Target Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.2
0.4
0.6
0.8
F (%SPR)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
% SPR Target

SPR Target Reference Points (Years Avg = 5)

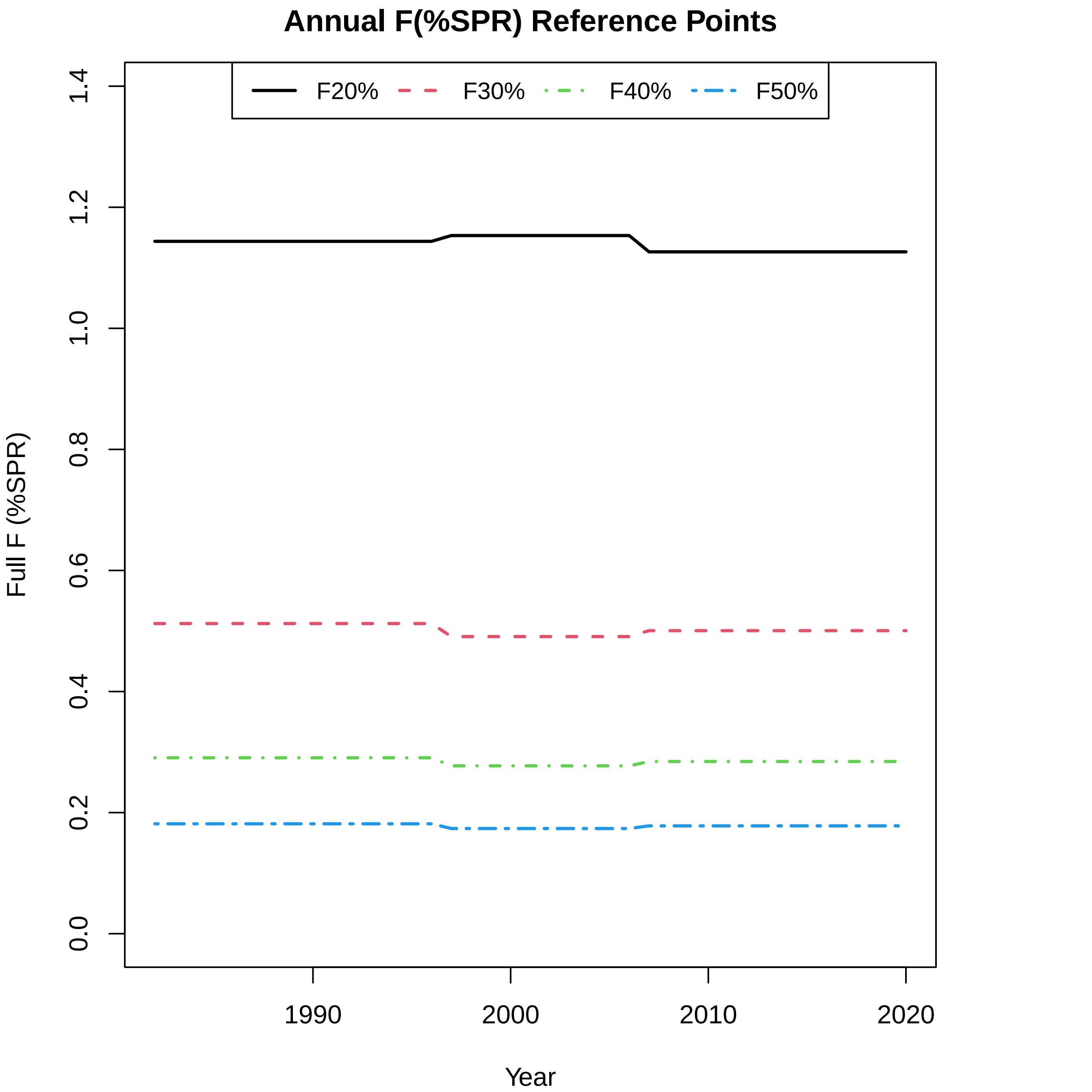
% SPR	F(%SPR)	YPR
0.2	1.1263	0.7549
0.25	0.7175	0.7114
0.3	0.5006	0.6693
0.35	0.3703	0.6275
0.4	0.2844	0.5849
0.45	0.2235	0.5412
0.5	0.1781	0.4964
0.55	0.1428	0.4503
0.6	0.1146	0.4032
0.65	0.0914	0.3552
0.7	0.0721	0.3063
0.75	0.0556	0.2567
0.8	0.0414	0.2064

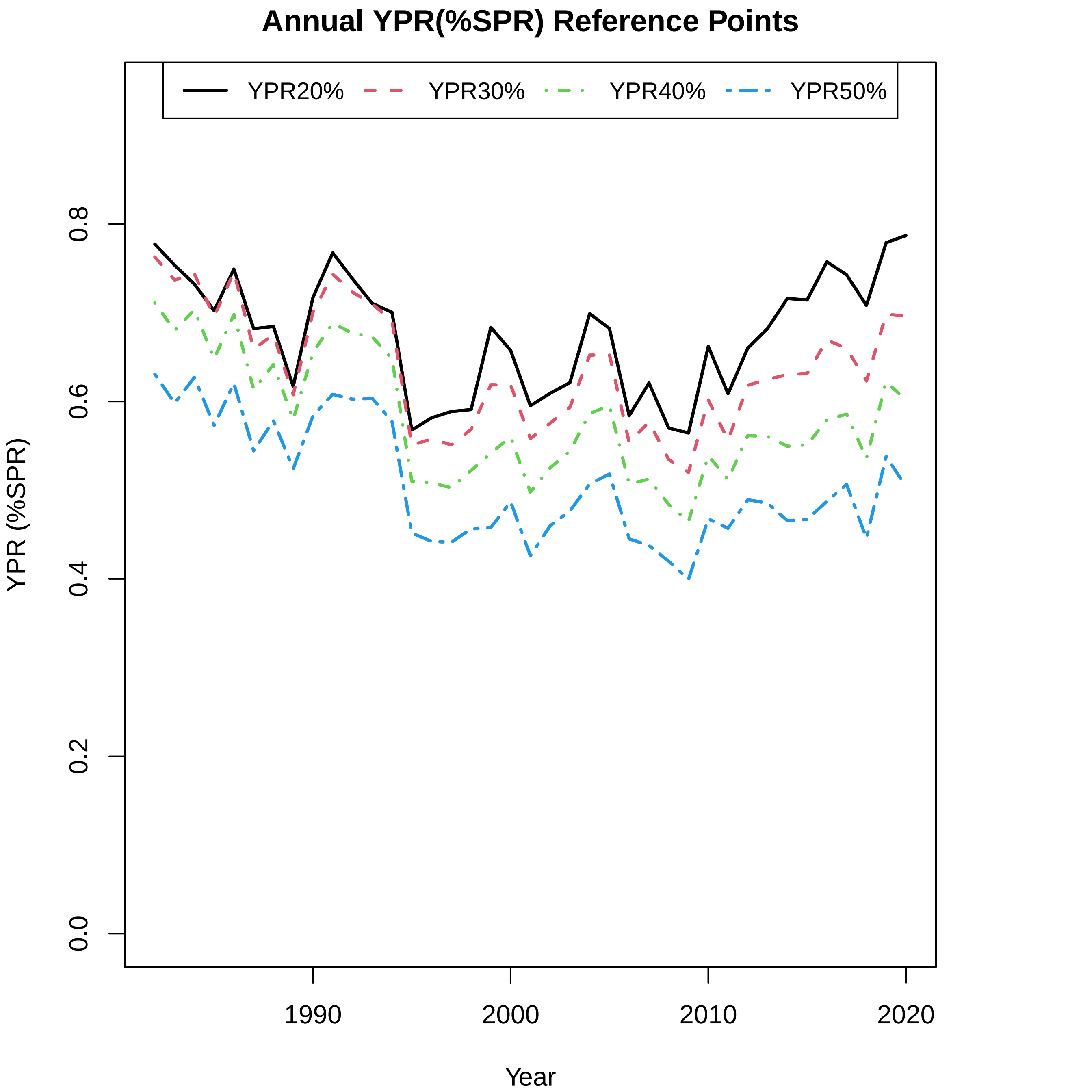

Maturity
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
Selectivity or Maturity at age
2
4
6
8
10
12
Age


Expected Spawnings and SPR Reference Points (Years Avg = 5)
Expected Spawnings
% SPR
Full F
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.0
0.5
1.0
1.5
2.0

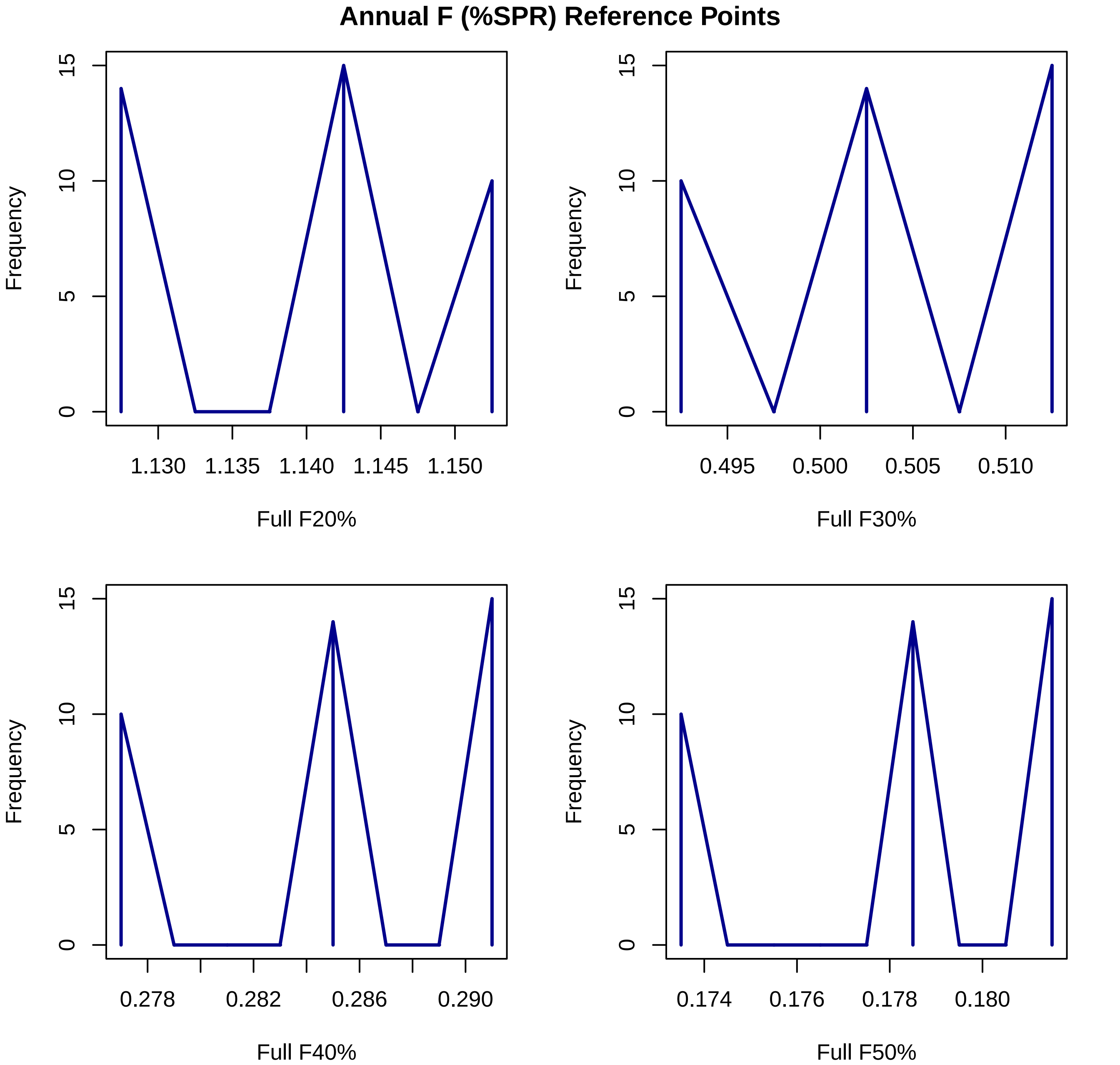
Expected Spawnings & SPR Reference Points (Years Avg = 5)

F	E[Sp]	SPR	F	E[Sp]	SPR	F	E[Sp]	SPR
0	4.4562	1	0.35	2.5167	0.3602	0.7	2.0733	0.2531
0.01	4.2975	0.9424	0.36	2.4974	0.3551	0.71	2.065	0.2513
0.02	4.1559	0.8914	0.37	2.4787	0.3502	0.72	2.0568	0.2496
0.03	4.0288	0.8461	0.38	2.4607	0.3454	0.73	2.0487	0.2478
0.04	3.9139	0.8055	0.39	2.4431	0.3409	0.74	2.0407	0.2462
0.05	3.8096	0.7689	0.4	2.4261	0.3365	0.75	2.0329	0.2445
0.06	3.7144	0.7359	0.41	2.4096	0.3323	0.76	2.0252	0.2429
0.07	3.6272	0.7059	0.42	2.3936	0.3282	0.77	2.0177	0.2413
0.08	3.5469	0.6785	0.43	2.378	0.3243	0.78	2.0102	0.2398
0.09	3.4727	0.6534	0.44	2.3629	0.3205	0.79	2.0029	0.2383
0.1	3.4039	0.6304	0.45	2.3482	0.3168	0.8	1.9957	0.2368
0.11	3.3399	0.6092	0.46	2.3338	0.3133	0.81	1.9886	0.2353
0.12	3.2802	0.5896	0.47	2.3199	0.3098	0.82	1.9816	0.2339
0.13	3.2244	0.5714	0.48	2.3063	0.3065	0.83	1.9747	0.2325
0.14	3.1721	0.5545	0.49	2.293	0.3033	0.84	1.9679	0.2311
0.15	3.1229	0.5388	0.5	2.2801	0.3002	0.85	1.9612	0.2297
0.16	3.0765	0.5242	0.51	2.2675	0.2972	0.86	1.9546	0.2284
0.17	3.0328	0.5105	0.52	2.2551	0.2942	0.87	1.9481	0.2271
0.18	2.9914	0.4976	0.53	2.2431	0.2914	0.88	1.9417	0.2258
0.19	2.9522	0.4855	0.54	2.2314	0.2886	0.89	1.9354	0.2246
0.2	2.9149	0.4742	0.55	2.2199	0.2859	0.9	1.9291	0.2233
0.21	2.8795	0.4635	0.56	2.2086	0.2833	0.91	1.923	0.2221
0.22	2.8458	0.4534	0.57	2.1976	0.2808	0.92	1.9169	0.2209
0.23	2.8137	0.4439	0.58	2.1869	0.2783	0.93	1.9109	0.2197
0.24	2.783	0.4349	0.59	2.1764	0.2759	0.94	1.905	0.2186
0.25	2.7536	0.4263	0.6	2.166	0.2736	0.95	1.8991	0.2175
0.26	2.7255	0.4182	0.61	2.1559	0.2713	0.96	1.8934	0.2163
0.27	2.6986	0.4105	0.62	2.146	0.2691	0.97	1.8877	0.2152
0.28	2.6727	0.4031	0.63	2.1363	0.2669	0.98	1.8821	0.2141
0.29	2.6478	0.3961	0.64	2.1268	0.2648	0.99	1.8765	0.2131
0.3	2.6239	0.3894	0.65	2.1175	0.2627	1	1.871	0.212
0.31	2.6009	0.3831	0.66	2.1083	0.2607	1.01	1.8656	0.211
0.32	2.5787	0.377	0.67	2.0993	0.2587	1.02	1.8602	0.21
0.33	2.5573	0.3712	0.68	2.0905	0.2568	1.03	1.8549	0.209
0.34	2.5367	0.3656	0.69	2.0819	0.2549	1.04	1.8497	0.208

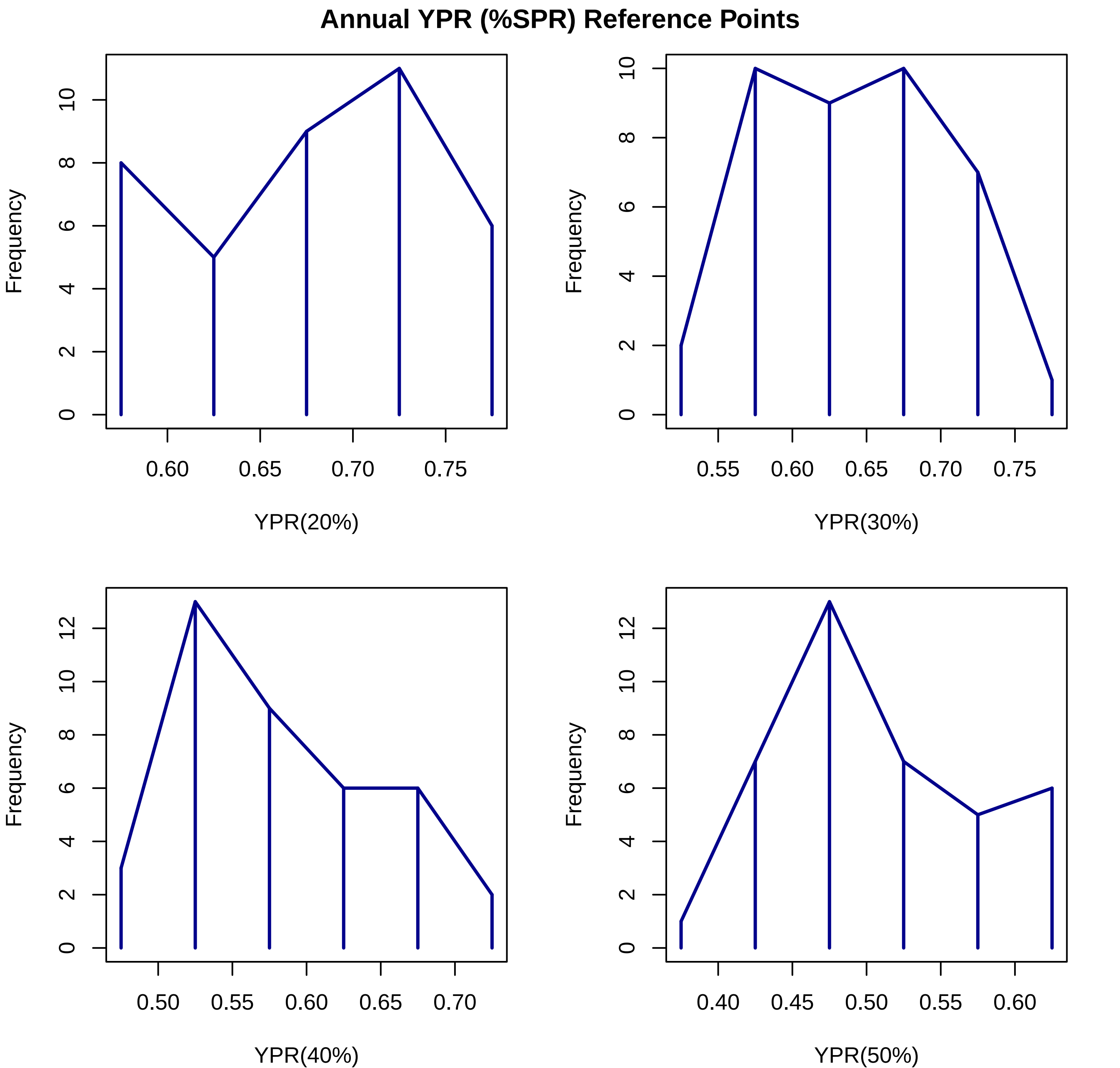

Annual F(%SPR) Reference Points
F20%
F30%
F40%
F50%
Full F (%SPR)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1990
2000
2010
2020
Year



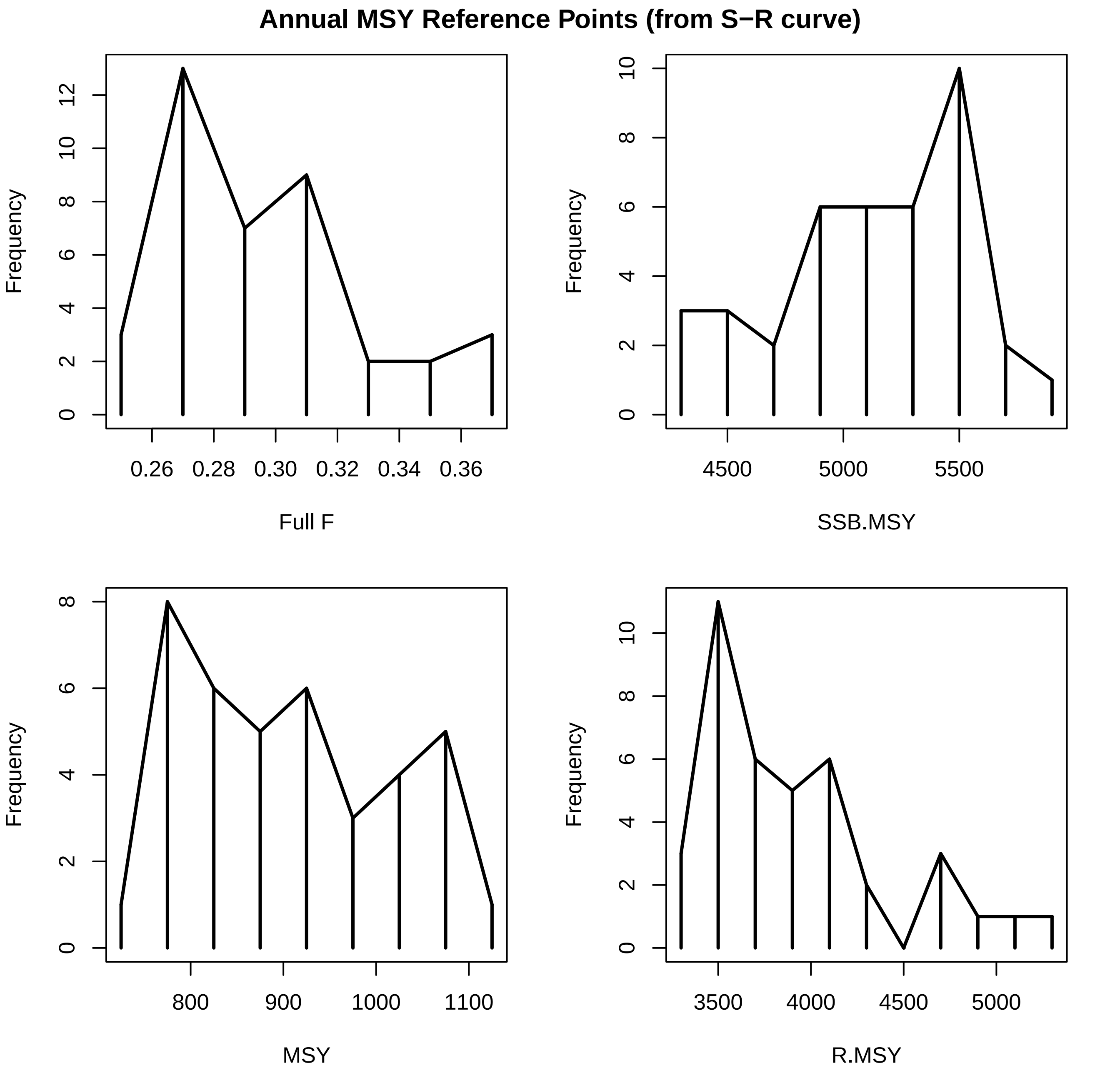
Annual YPR(%SPR) Reference Points
YPR20%
YPR30%
YPR40%
YPR50%
0.0
0.2
0.4
0.6
0.8
YPR (%SPR)
1990
2000
2010
2020
Year



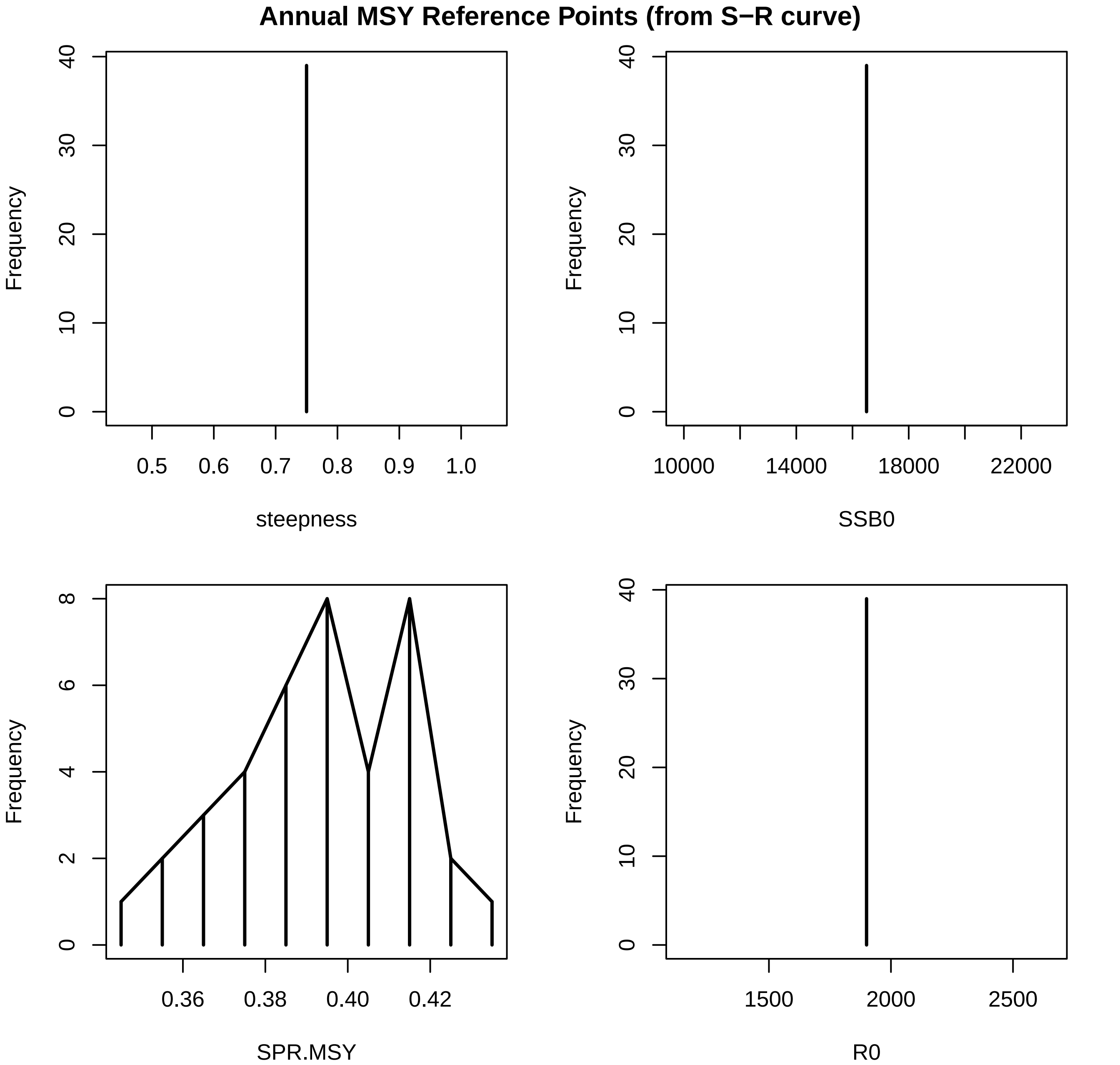
Annual F (%SPR) Reference Points
Frequency
0
5
10
15
1.130
1.135
1.140
1.145
1.150
Full F20%
0.495
0.500
0.505
0.510
Full F30%
0.278
0.282
0.286
0.290
Full F40%
0.174
0.176
0.178
0.180
Full F50%

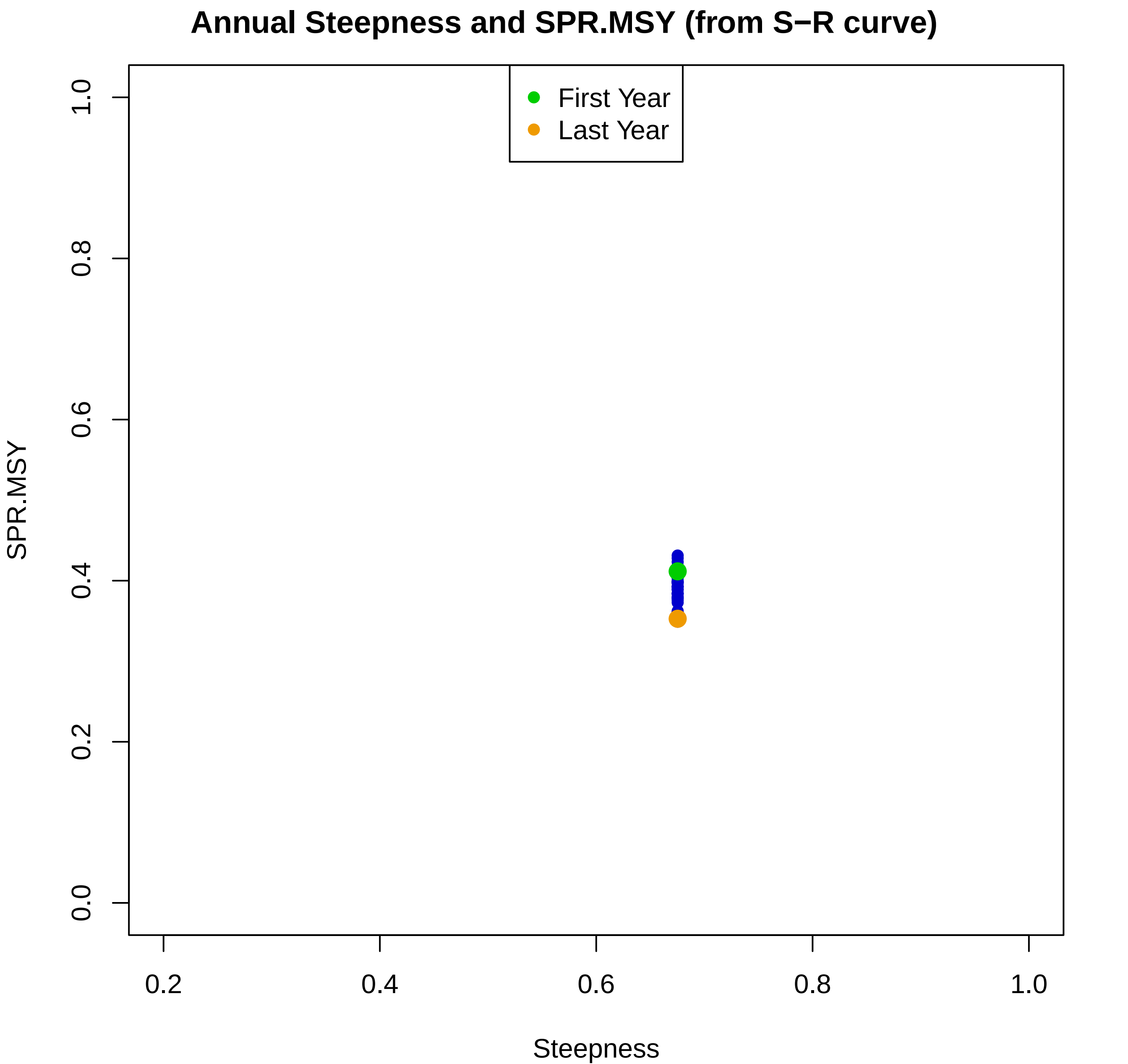


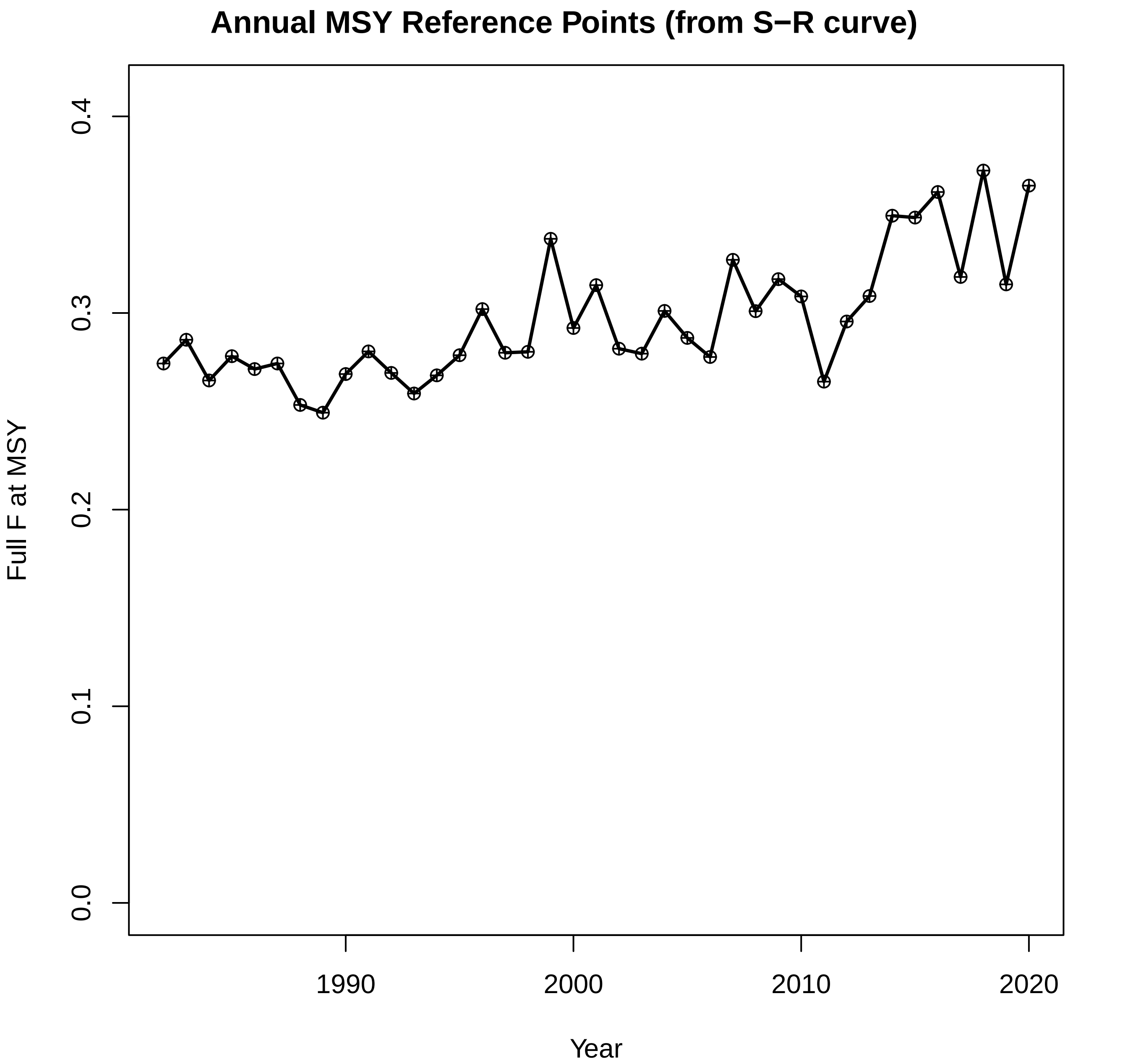
Annual YPR (%SPR) Reference Points
Frequency
YPR(20%)
YPR(30%)
YPR(40%)
YPR(50%)
0
2
4
6
8
10
12
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75



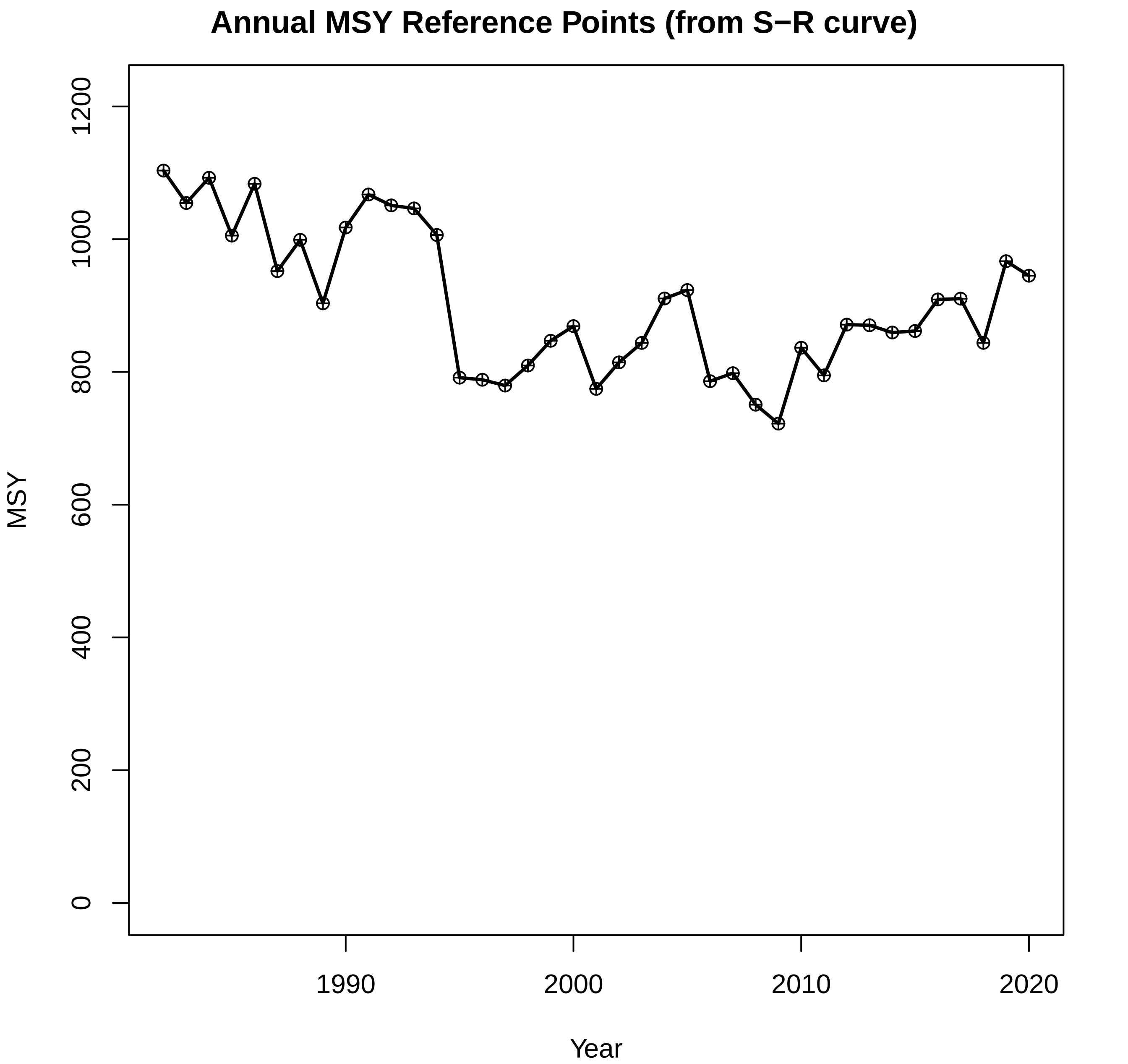
Annual MSY Reference Points (from S−R curve)
Frequency
Full F
0.26
0.28
0.30
0.32
0.34
0.36
0
2
4
6
8
10
12
SSB.MSY
4500
5000
5500
MSY
800
900
1000
1100
R.MSY
3500
4000
4500
5000

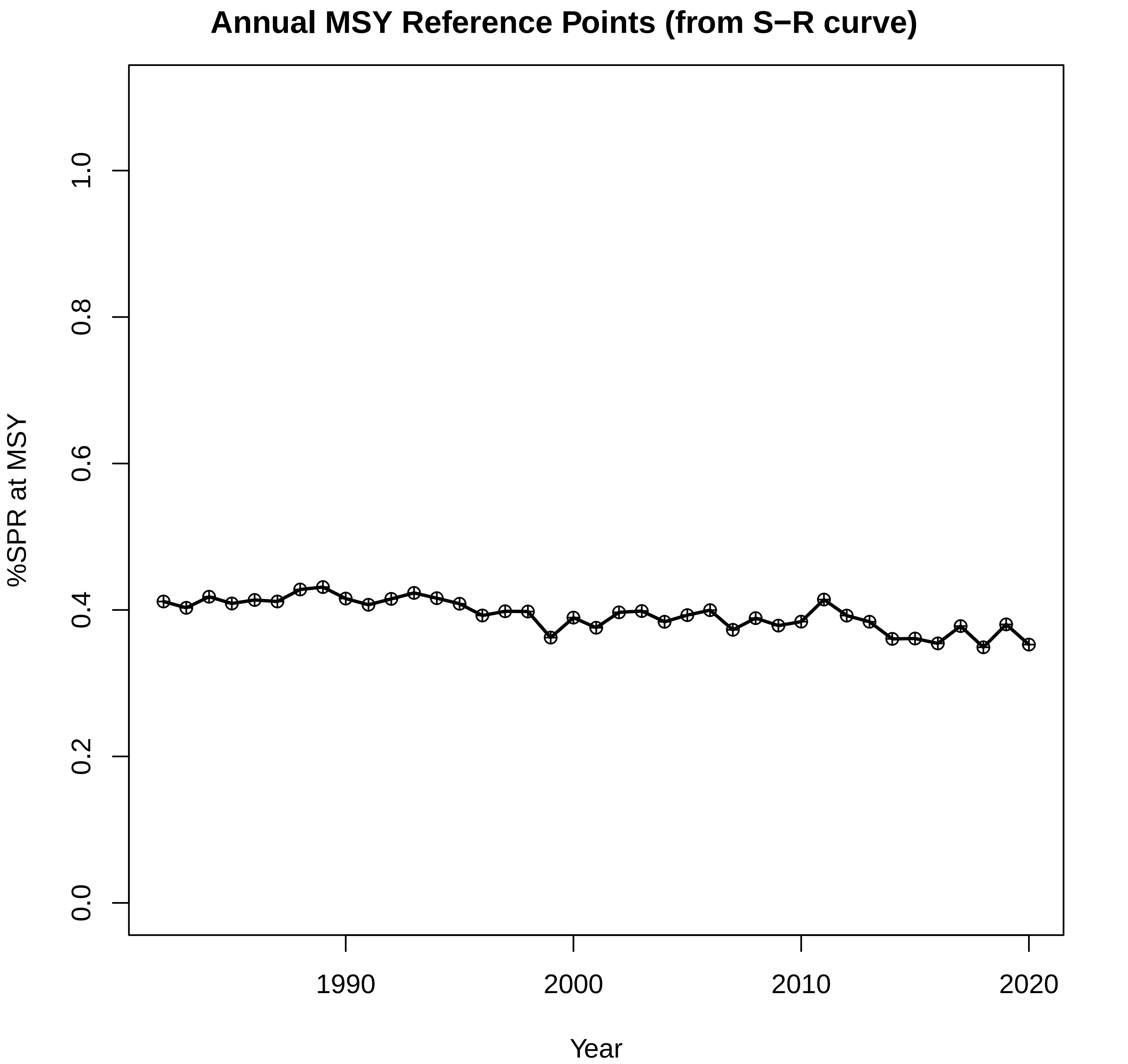

Annual MSY Reference Points (from S−R curve)
Frequency
0
10
20
30
40
0.5
0.6
0.7
0.8
0.9
1.0
steepness
10000
14000
18000
22000
SSB0
0
2
4
6
8
0.36
0.38
0.40
0.42
SPR.MSY
1500
2000
2500
R0

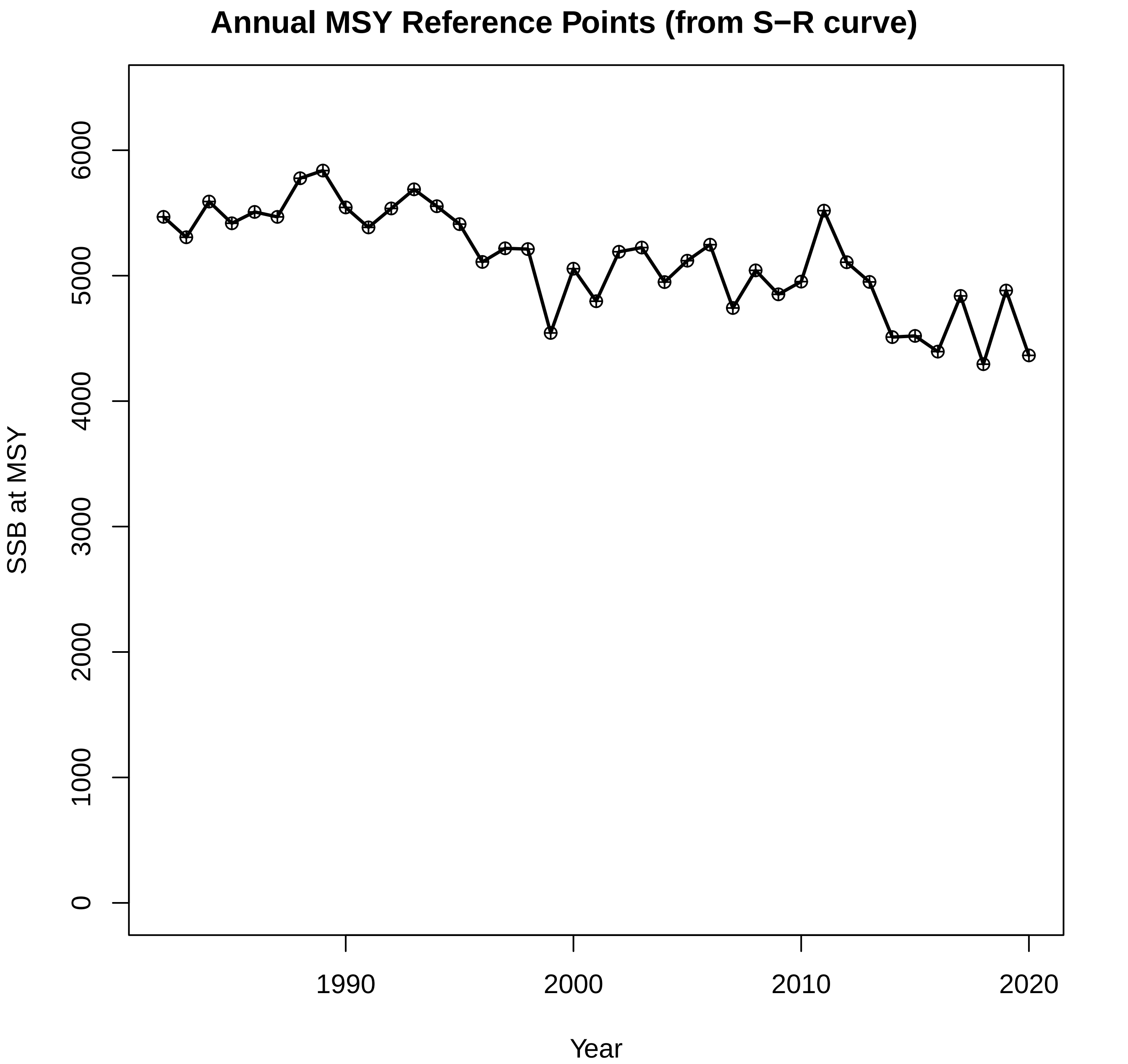

Annual Steepness and SPR.MSY (from S−R curve)
First Year
Last Year
SPR.MSY
0.0
0.2
0.4
0.6
0.8
1.0
Steepness
0.2
0.4
0.6
0.8
1.0

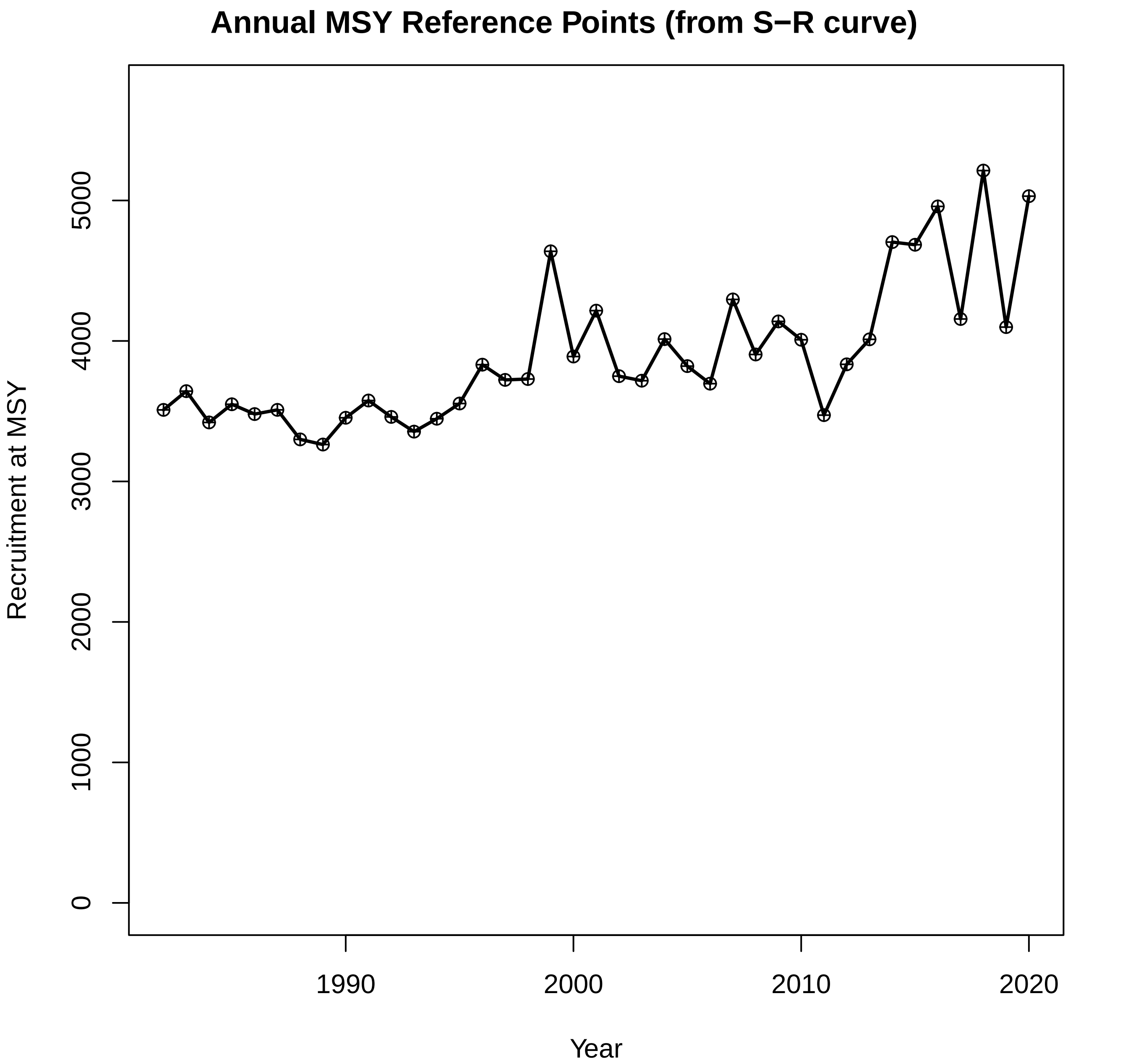


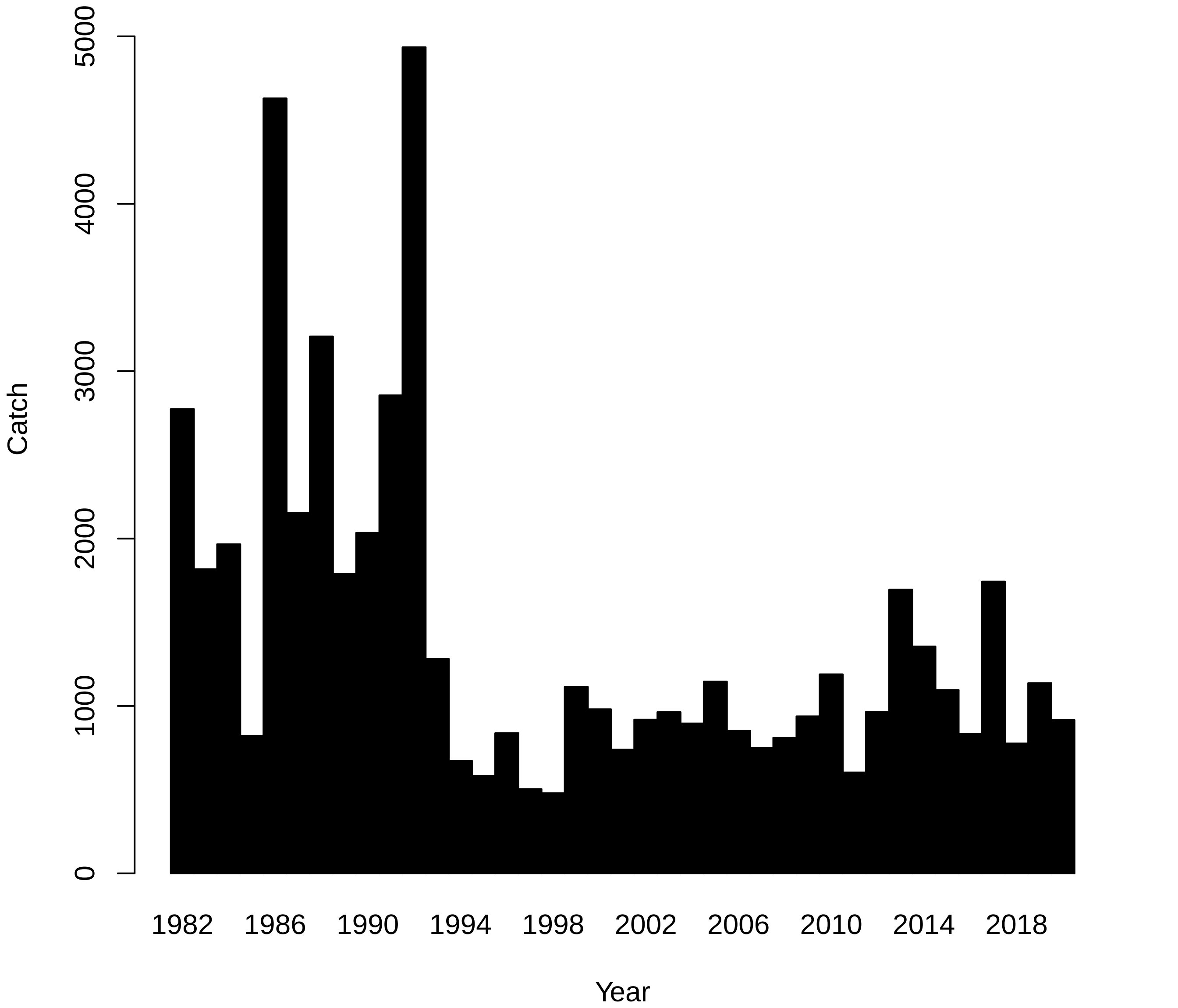
Annual MSY Reference Points (from S−R curve)
Full F at MSY
0.0
0.1
0.2
0.3
0.4
1990
2000
2010
2020
Year


Annual MSY Reference Points (from S−R curve)
MSY
Year
0
200
400
600
800
1000
1200
1990
2000
2010
2020

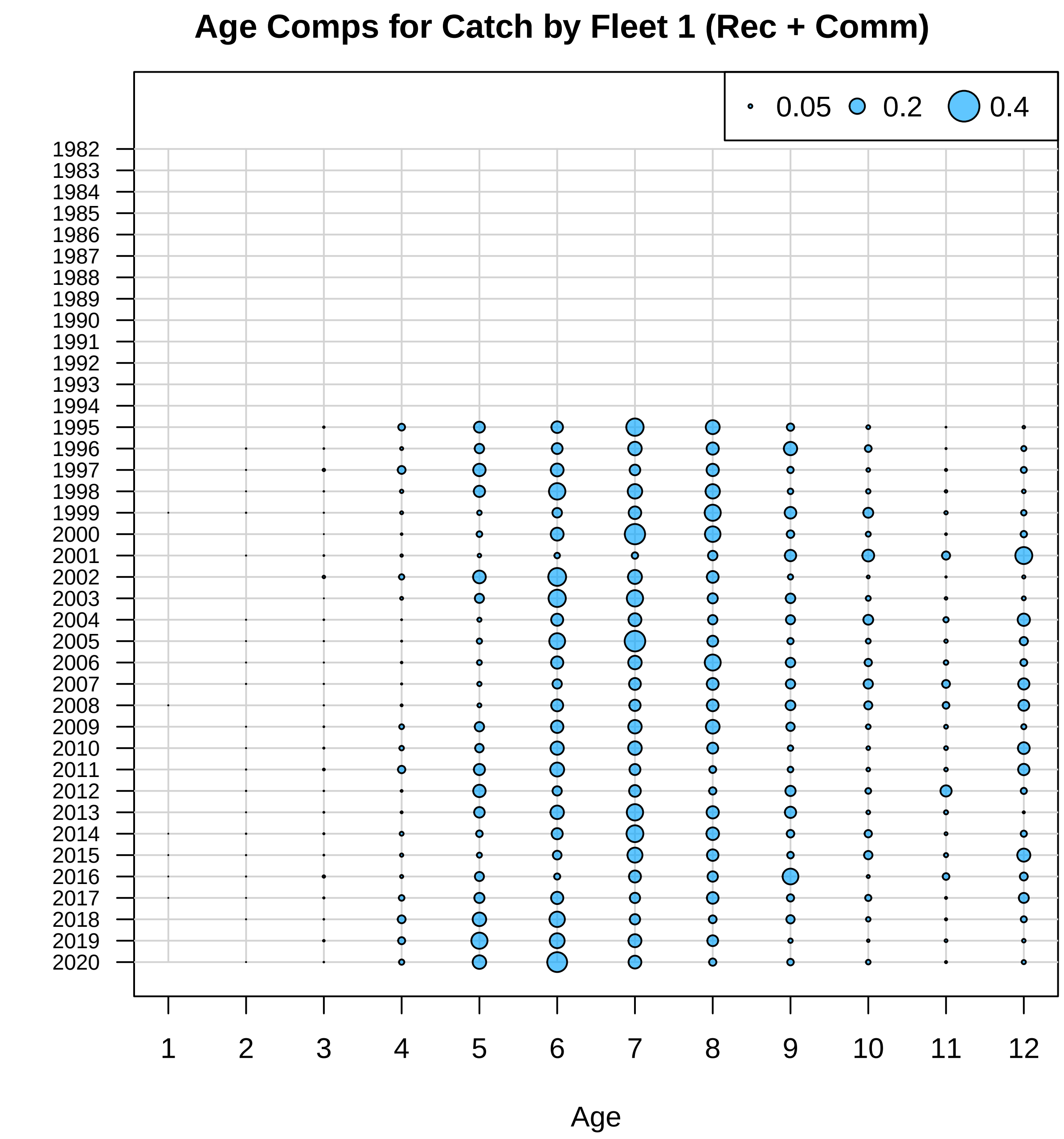

Annual MSY Reference Points (from S−R curve)
%SPR at MSY
0.0
0.2
0.4
0.6
0.8
1.0
1990
2000
2010
2020
Year

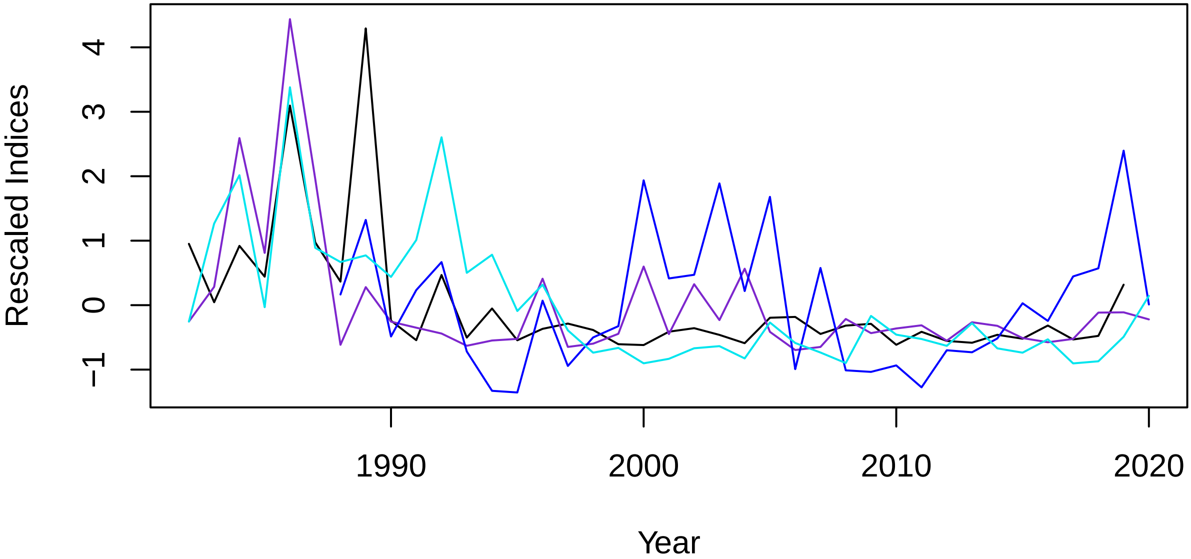

Annual MSY Reference Points (from S−R curve)
SSB at MSY
0
1000
2000
3000
4000
5000
6000
1990
2000
2010
2020
Year


Annual MSY Reference Points (from S−R curve)
Recruitment at MSY
0
1000
2000
3000
4000
5000
1990
2000
2010
2020
Year

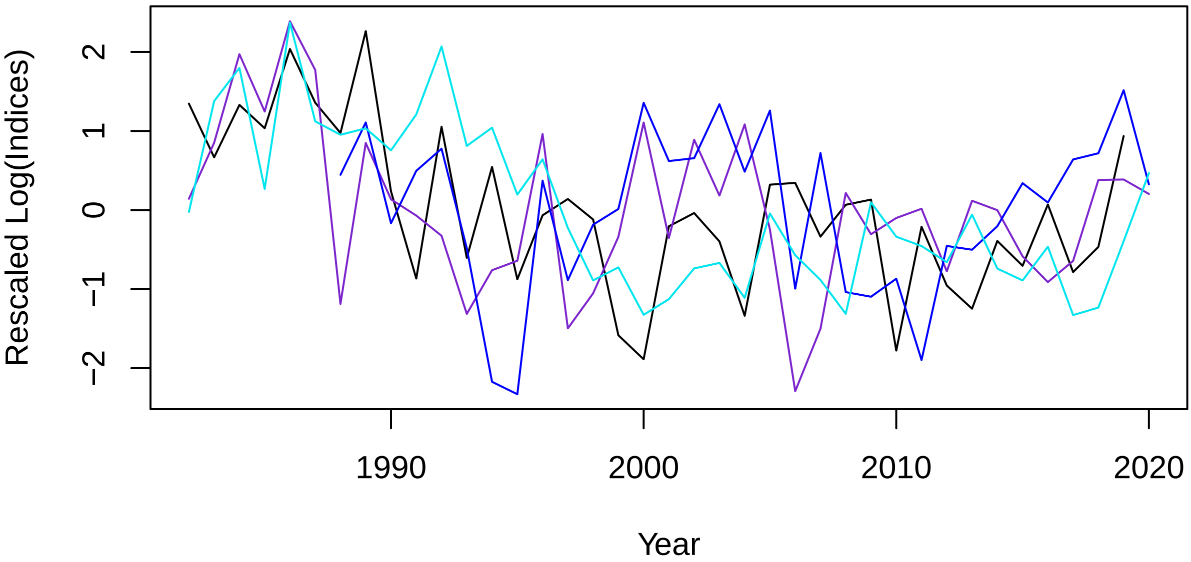


Catch
0
1000
2000
3000
4000
5000
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year

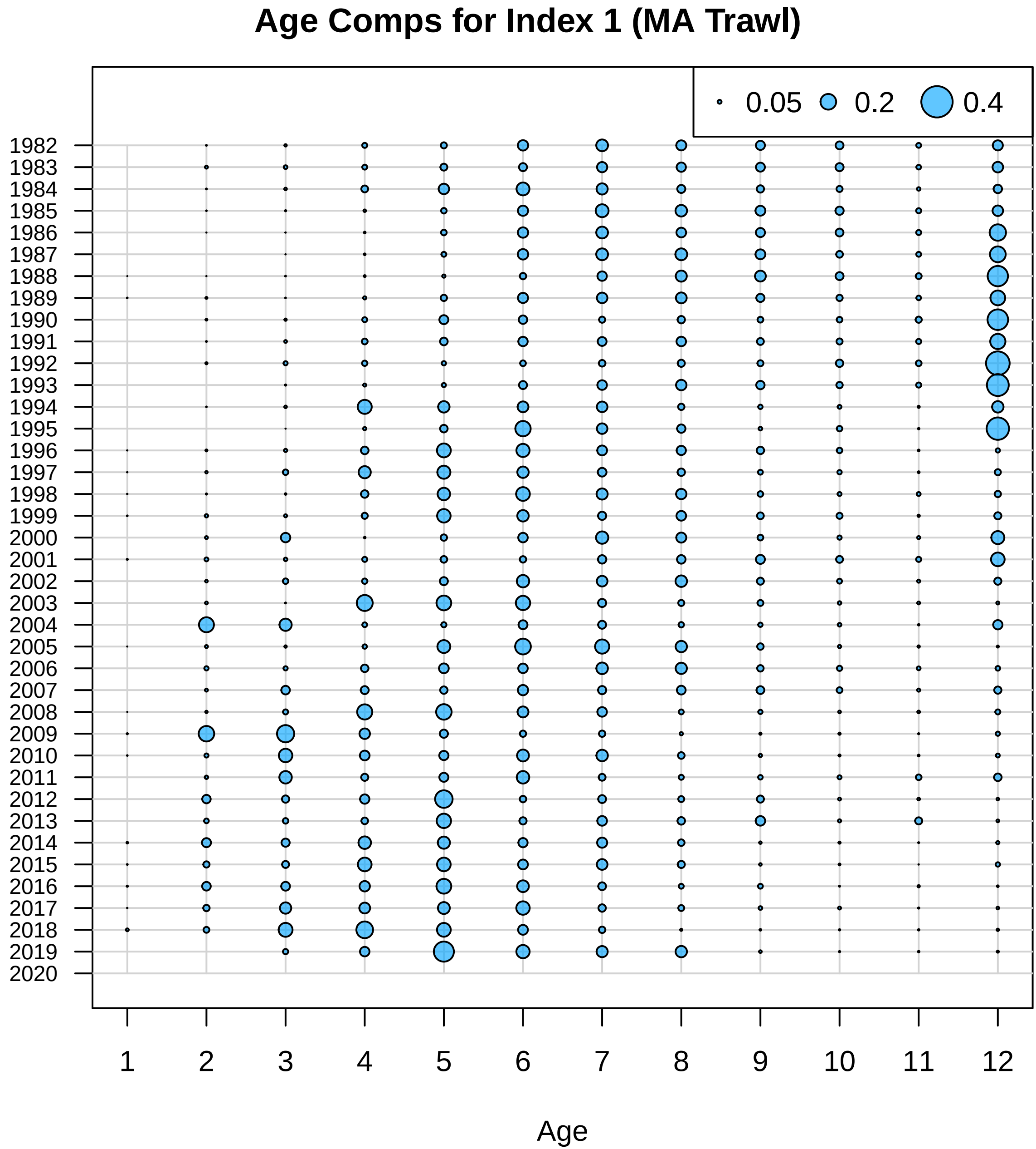

Age Comps for Catch by Fleet 1 (Rec + Comm)
0.05
0.2
0.4
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age

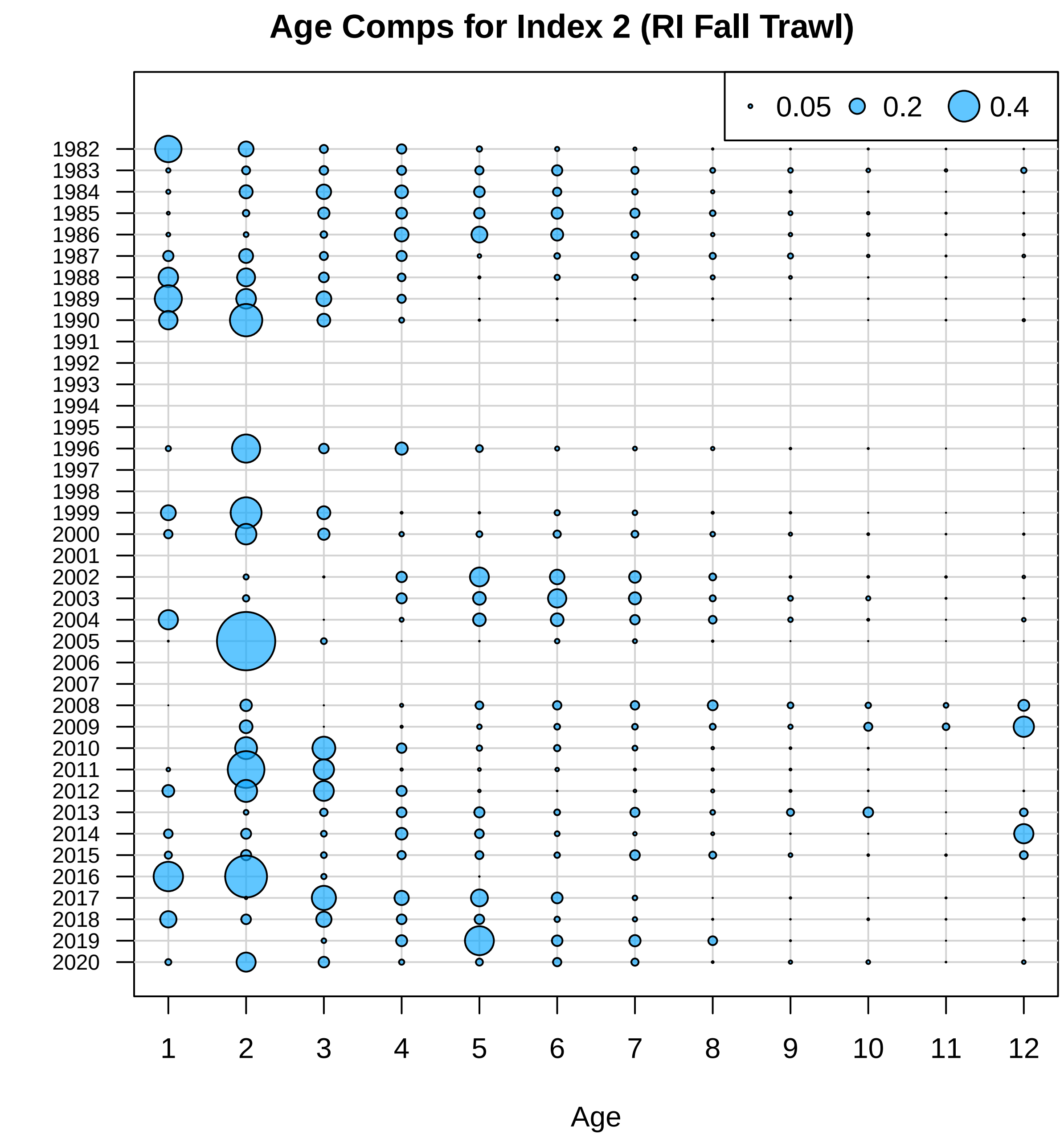


Rescaled Indices
4
3
2
1
0
−1
1990
2000
2010
2020
Year

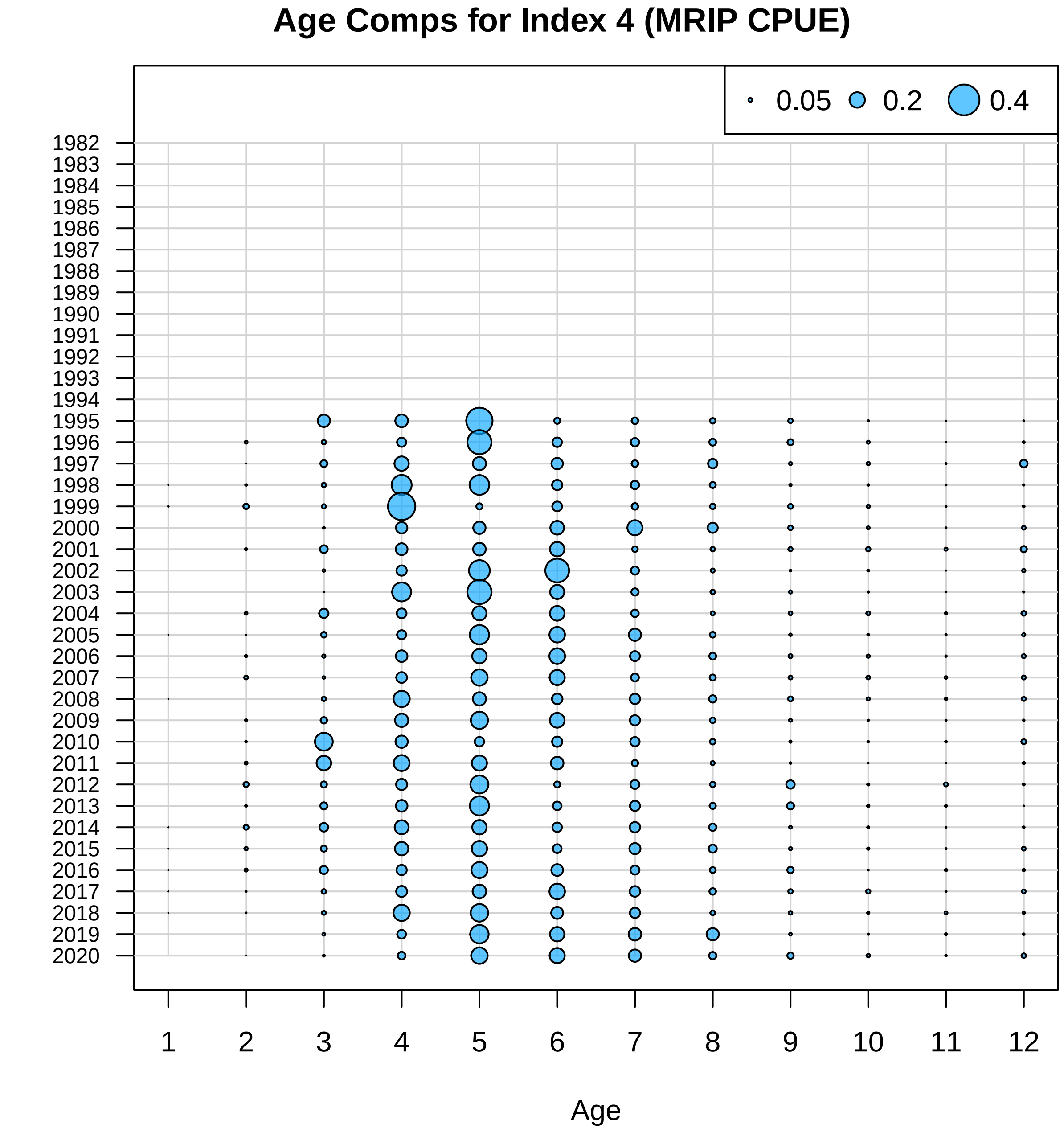


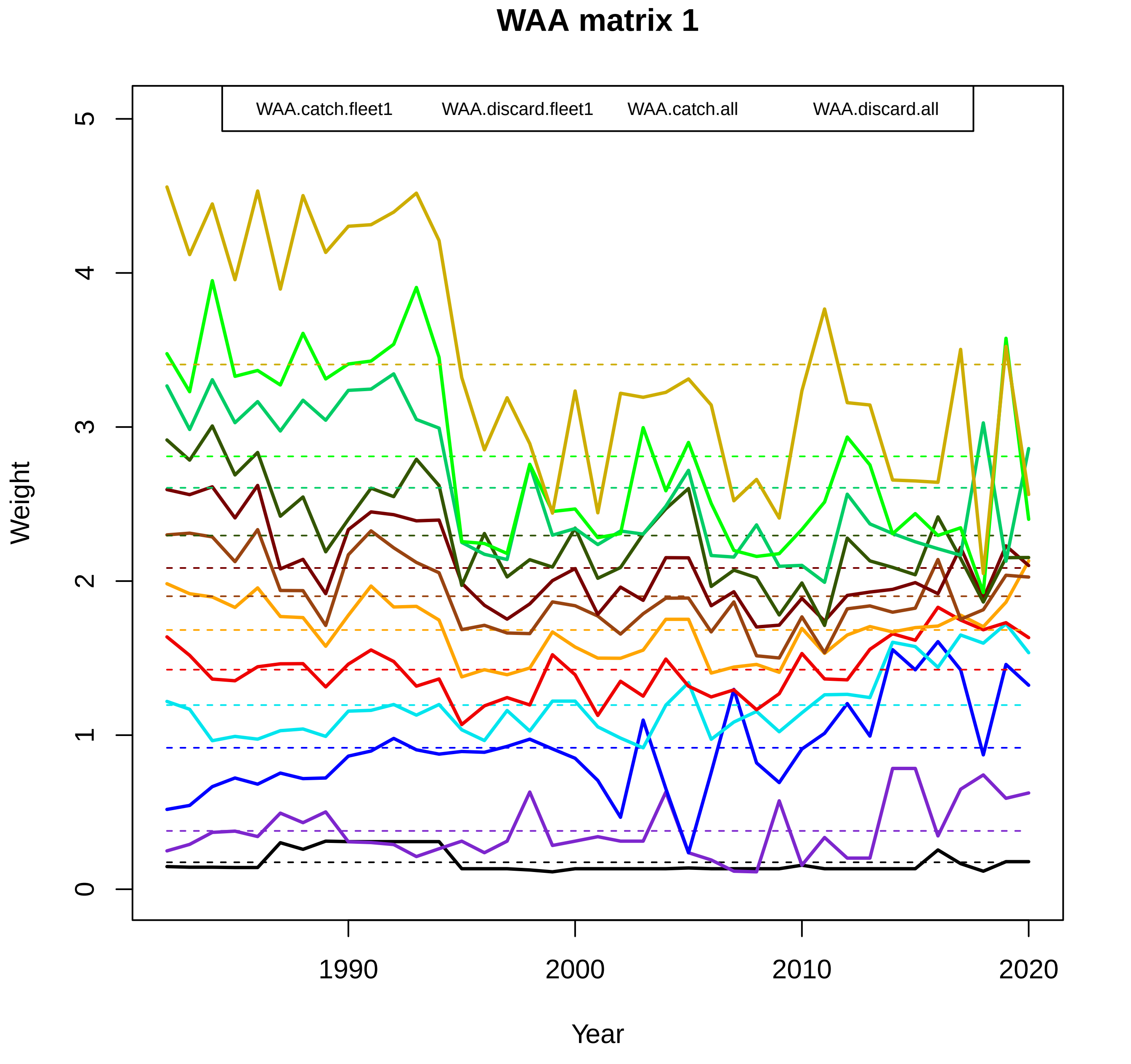
Rescaled Log(Indices)
2
1
0
−1
−2
1990
2000
2010
2020
Year

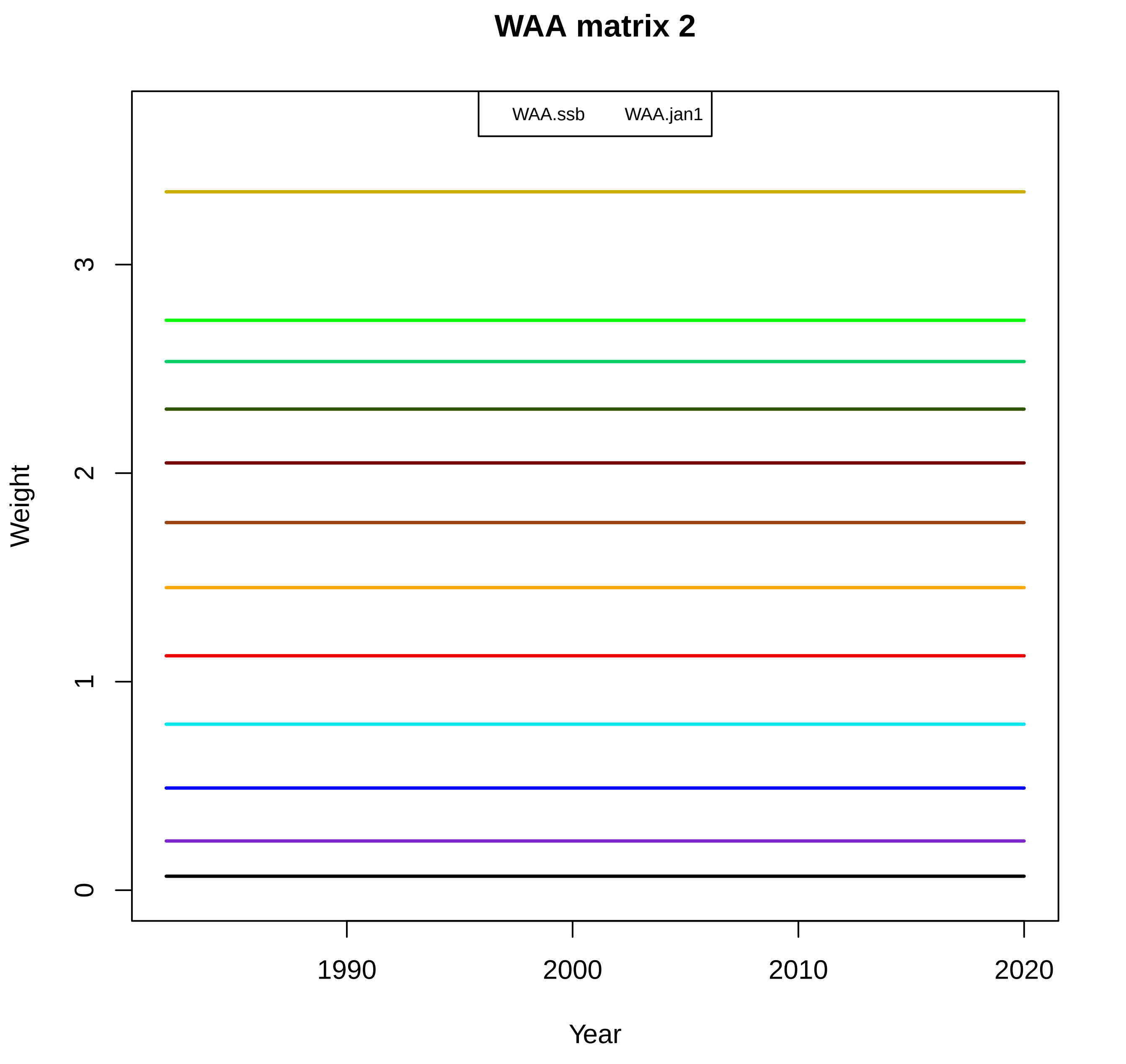

Age Comps for Index 1 (MA Trawl)
0.05
0.2
0.4
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age

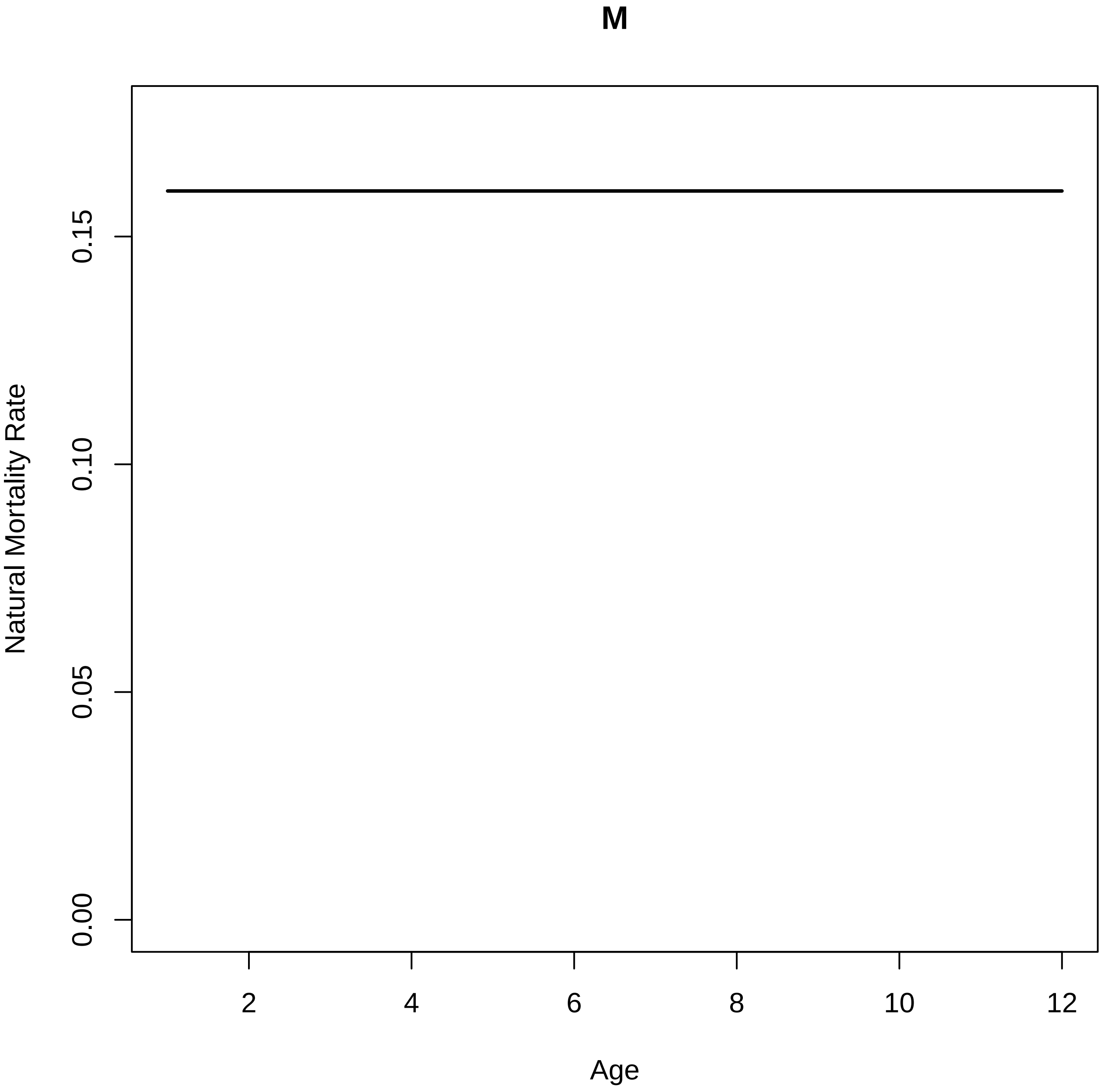


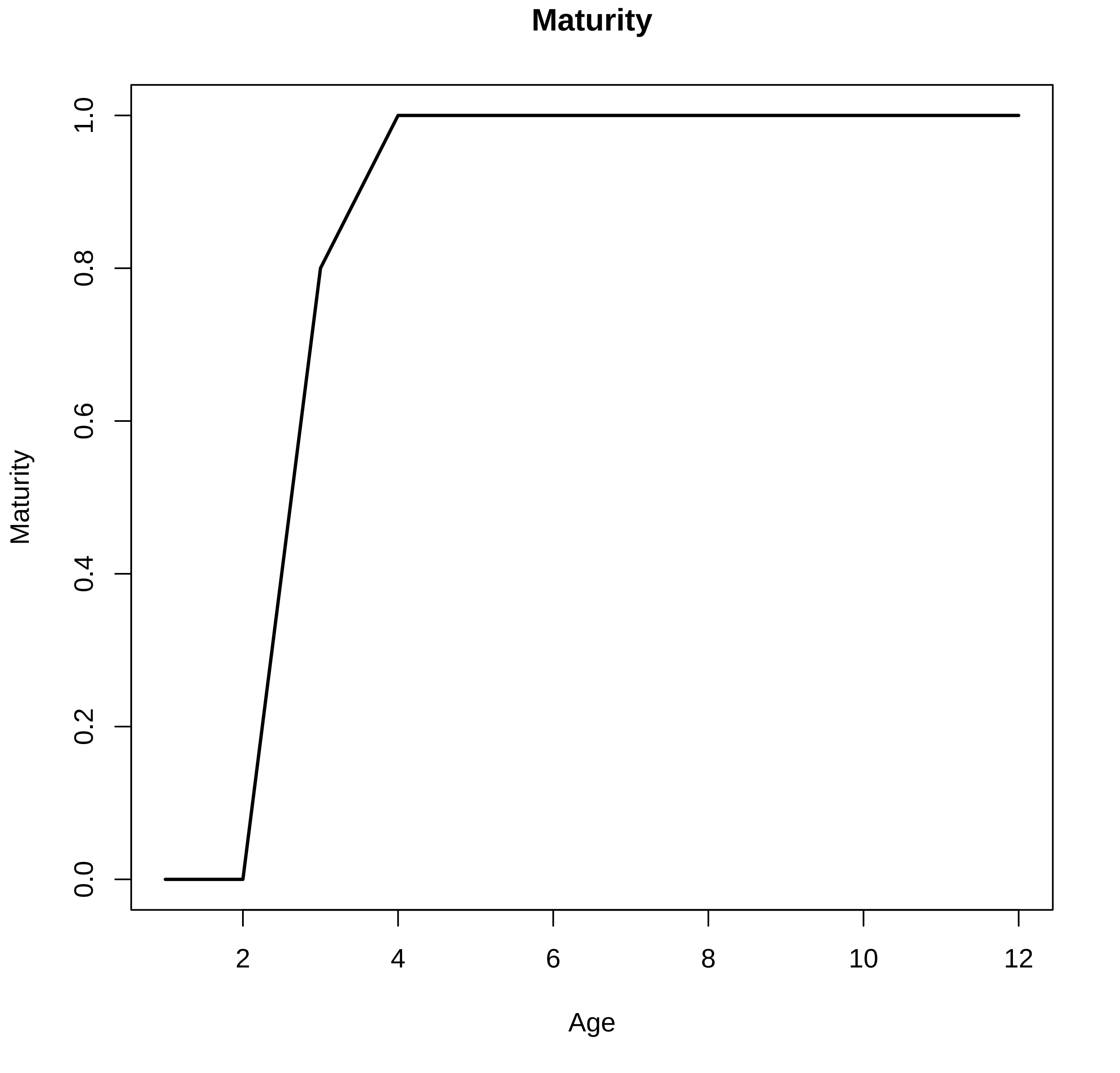
Age Comps for Index 2 (RI Fall Trawl)
0.05
0.2
0.4
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age


Age Comps for Index 4 (MRIP CPUE)
0.05
0.2
0.4
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
1
2
3
4
5
6
7
8
9
10
11
12
Age


WAA matrix 1
WAA.catch.fleet1
WAA.discard.fleet1
WAA.catch.all
WAA.discard.all
Weight
0
1
2
3
4
5
1990
2000
2010
2020
Year


WAA matrix 2
WAA.ssb
WAA.jan1
Weight
0
1
2
3
1990
2000
2010
2020
Year


M
Natural Mortality Rate
0.00
0.05
0.10
0.15
2
4
6
8
10
12
Age


Maturity
1.0
0.8
0.6
0.4
0.2
0.0
Maturity
2
4
6
8
10
12
Age

Tautog Stock Assessment Update
MARI Region 2021

MARI Appendix 2: Retrospective Adjustment and Sensitivity Runs

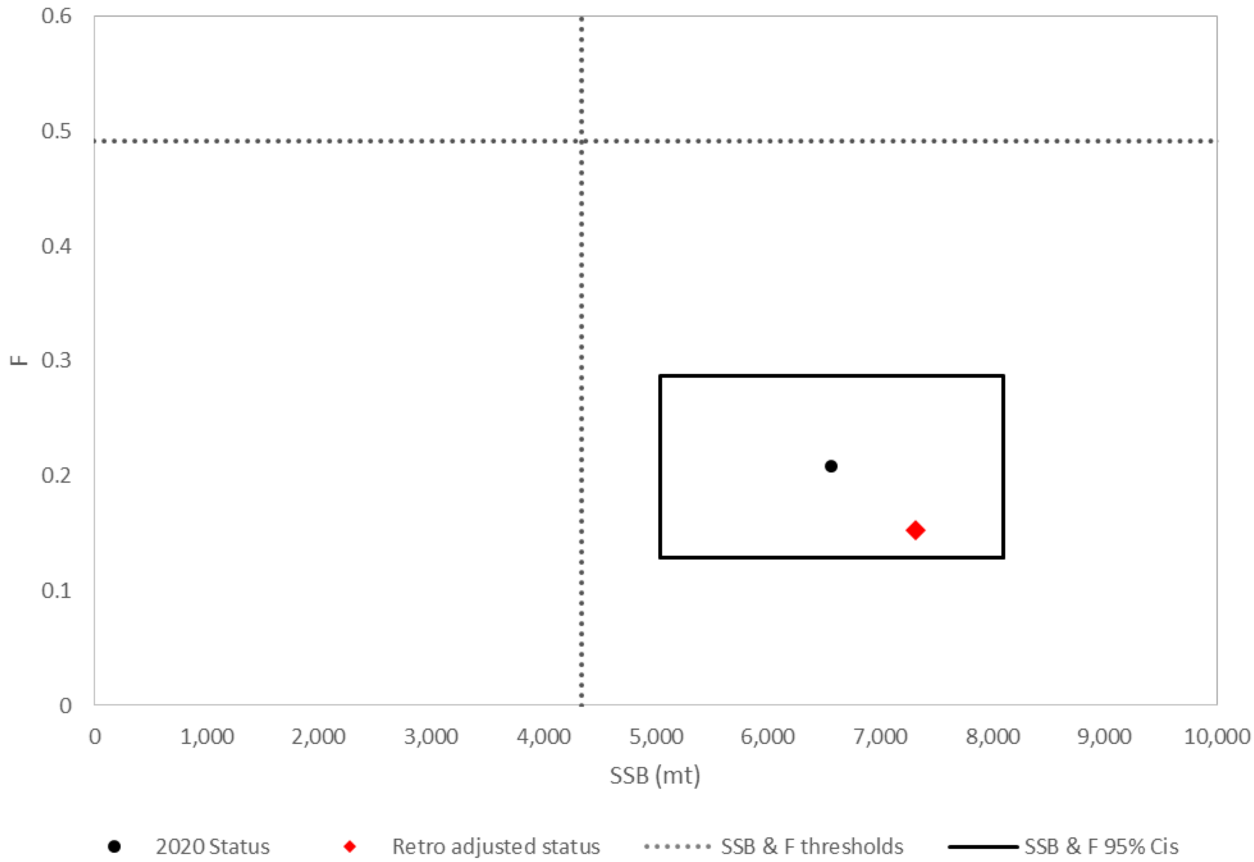


Figure A2.1. Comparison of retrospective adjusted status in 2020 with the base model status. Solid black lines indicate the 95% confidence intervals of the estimates of SSB and F.

2020 value: from .rep file or .std file. F is N-weighted average F (FReport) ages 8-12.
Mohn's Rho: from ASAP retro output based on 7 peels. F is ages 8-12 weighted by N.
Std Dev: from .std file. F is N-weighted average F.
Fthreshold: F30% from .rep file
SSB threshold: Equilibrium SSB @ F30% from agepro

The retro adjustment is using average N-weighted F rather than Fmult. Fmult is used in the actual calculation of overfishing and to develop the overfished reference point. However, the ASAP GUI for retrospective patterns reports average F. So this retrospective adjustment isn't exactly what would be done, but it is a good approximation and a similar result would be expected if the calculations were done using Fmult instead (and a three-year average).

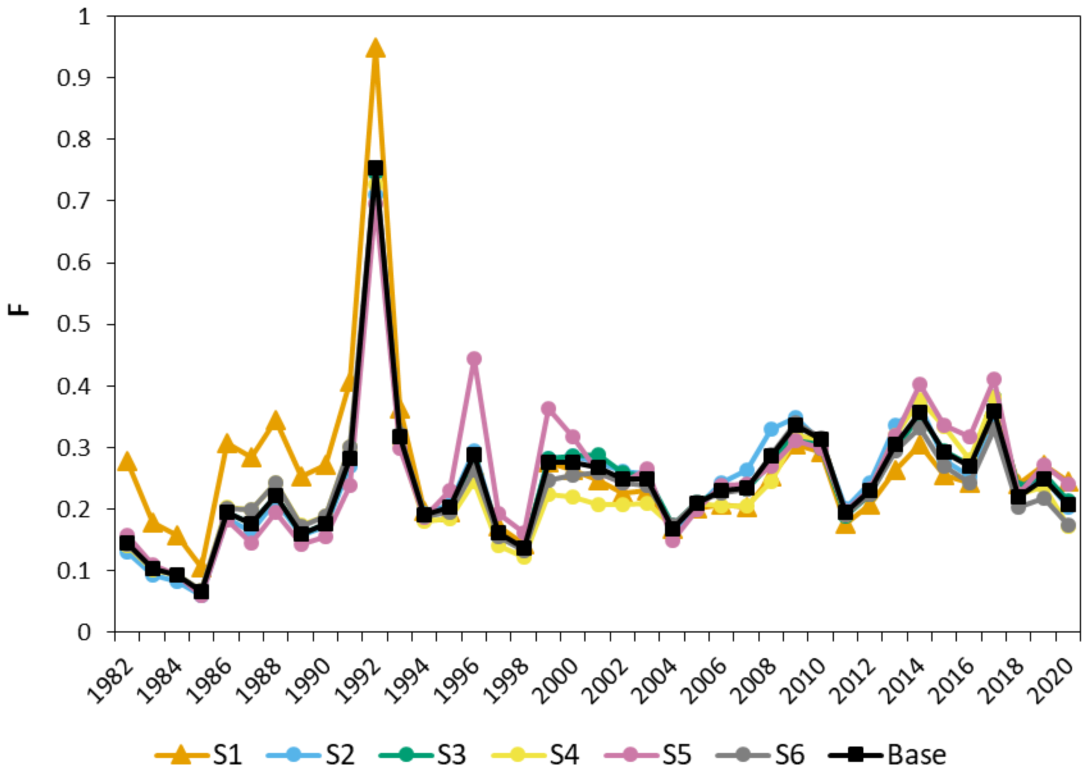


Figure A2.2. Estimates of annual F for sensitivity runs of the ASAP model.

Sensitivity Run

1 Exclude MA trawl survey

2 Exclude RI trawl survey

3 Exclude RI seine survey

4 Exclude MRIP index

5 Alternate MRIP index using 2020 imputed data

6 Survey CVs unadjusted for optimizing diagnostic RMSE error

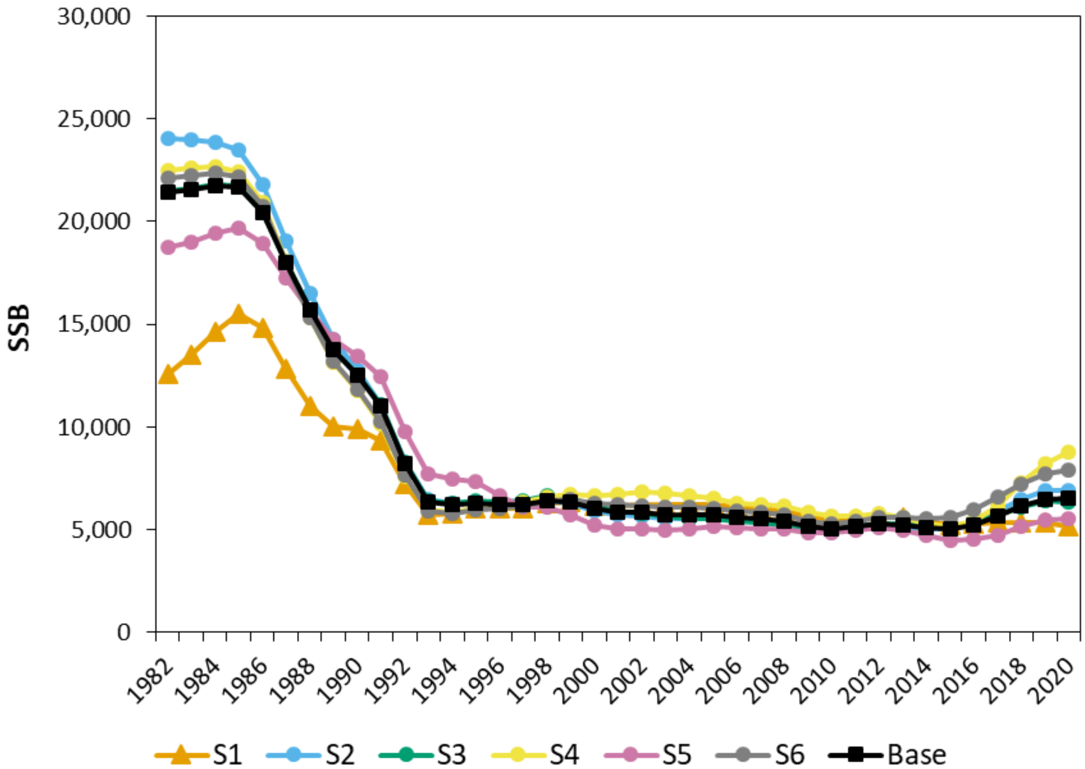


Figure A2.3. Estimates of annual SSB for sensitivity runs of the ASAP model.

Sensitivity Run
1 Exclude MA trawl survey
2 Exclude RI trawl survey
3 Exclude RI seine survey
4 Exclude MRIP index
5 Alternate MRIP index using 2020 imputed data
6 Survey CVs unadjusted for optimizing diagnostic RMSE error

Tautog Stock Assessment Update
LIS Region 2021

Appendix 1: ASAP Input, Diagnostic, and Results Plots for the Base Run

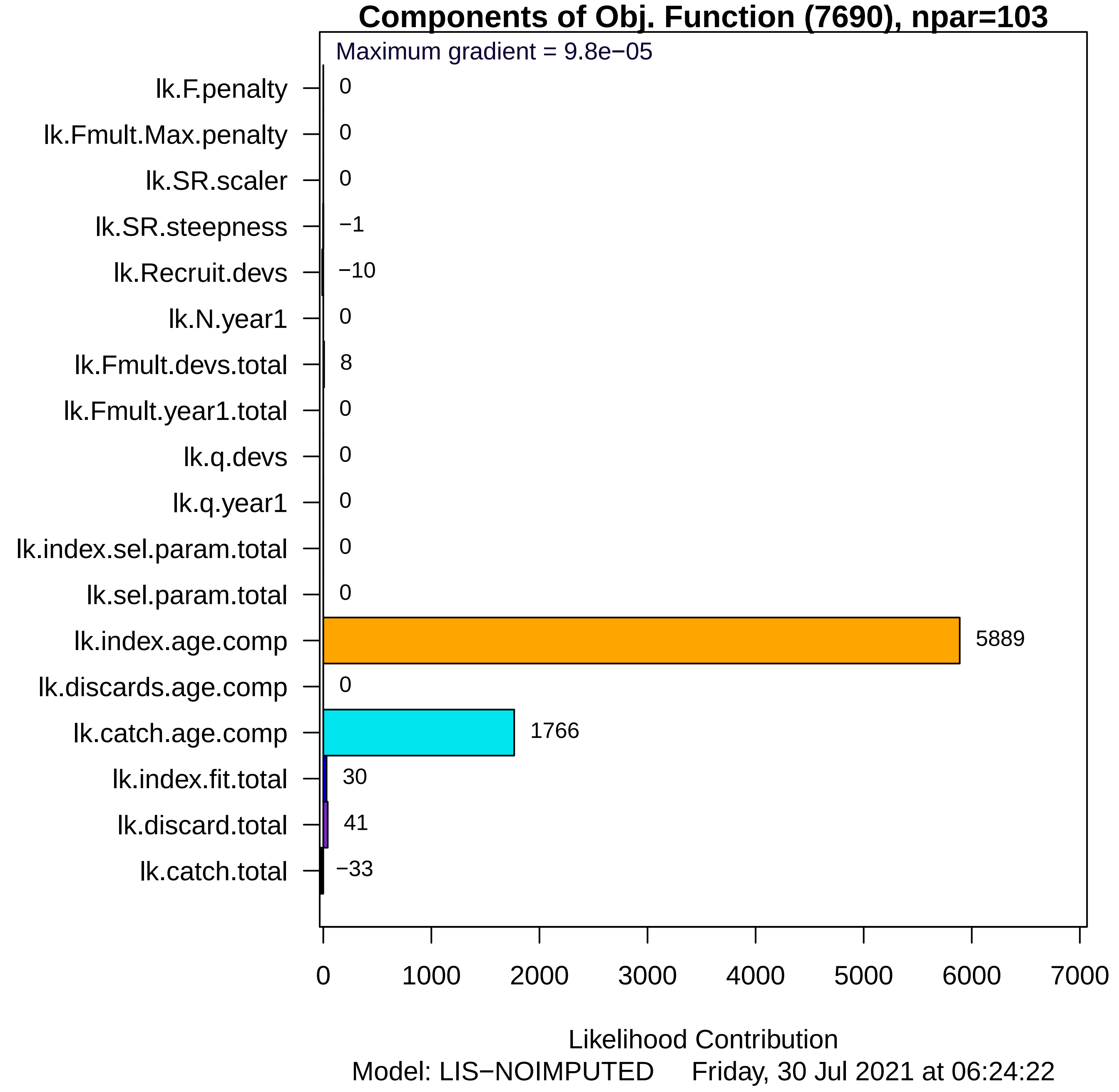
File = LIS−NOIMPUTED.dat

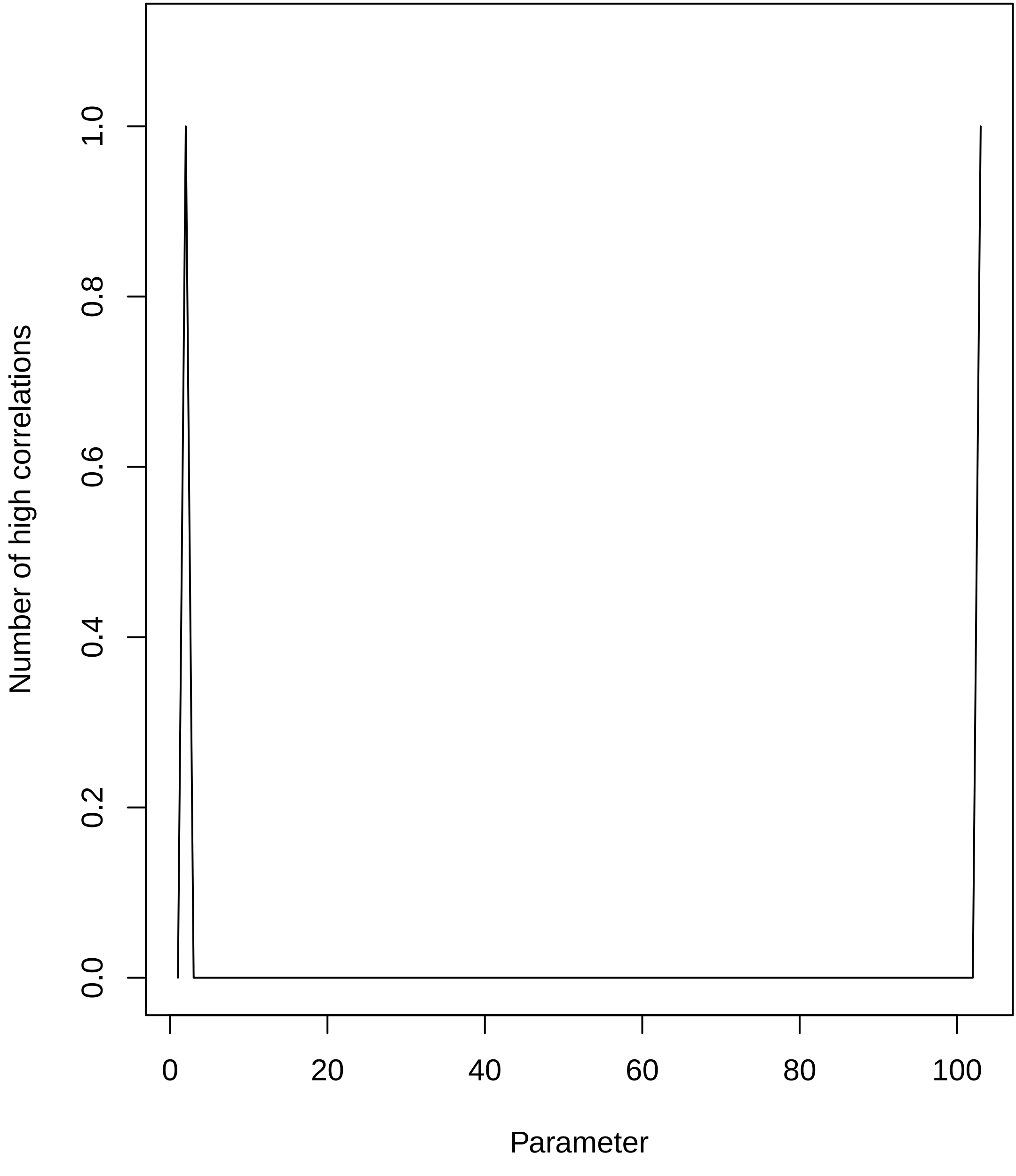
ASAP3 run on Friday, 30 Jul 2021 at 06:24:22

Connecticut\UCONN\Projects\Tautog_ASMFC\Stock_Assessment2020\ASAP

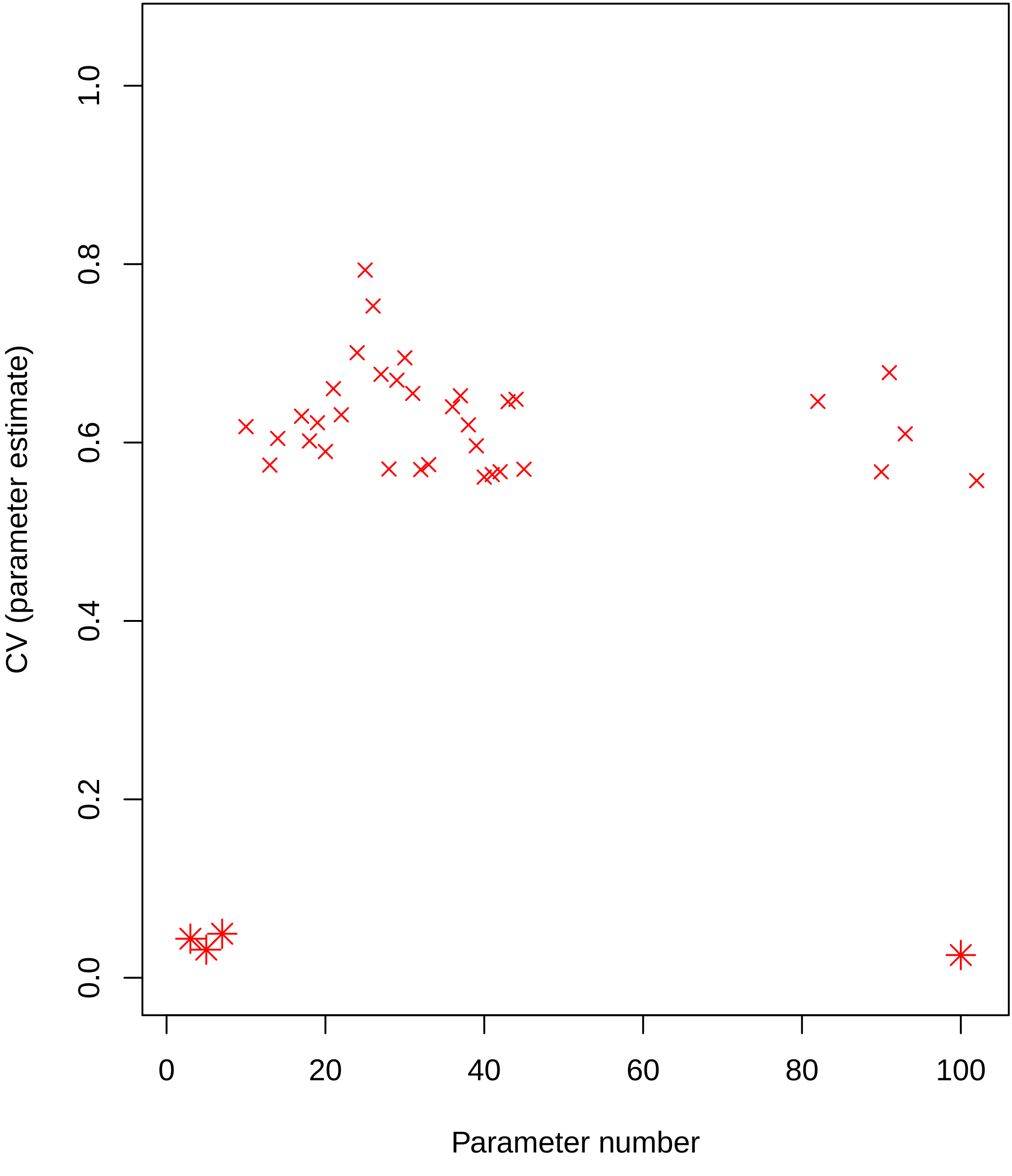
ASAPplots version = 0.2.17

npar = 103, maximum gradient = 9.82948e−005


Components of Obj. Function (7690), npar=103
Maximum gradient = 9.8e−05
lk.F.penalty
lk.Fmult.Max.penalty
lk.SR.scaler
lk.SR.steepness
lk.Recruit.devs
lk.N.year1
lk.Fmult.devs.total
lk.Fmult.year1.total
lk.q.devs
lk.q.year1
lk.index.sel.param.total
lk.sel.param.total
lk.index.age.comp
lk.discards.age.comp
lk.catch.age.comp
lk.index.fit.total
lk.discard.total
lk.catch.total
0
0
0
−1
−10
0
8
0
0
0
0
0
5889
0
1766
30
41
−33
0
1000
2000
3000
4000
5000
6000
7000
Likelihood Contribution
Model: LIS−NOIMPUTED Friday, 30 Jul 2021 at 06:24:22

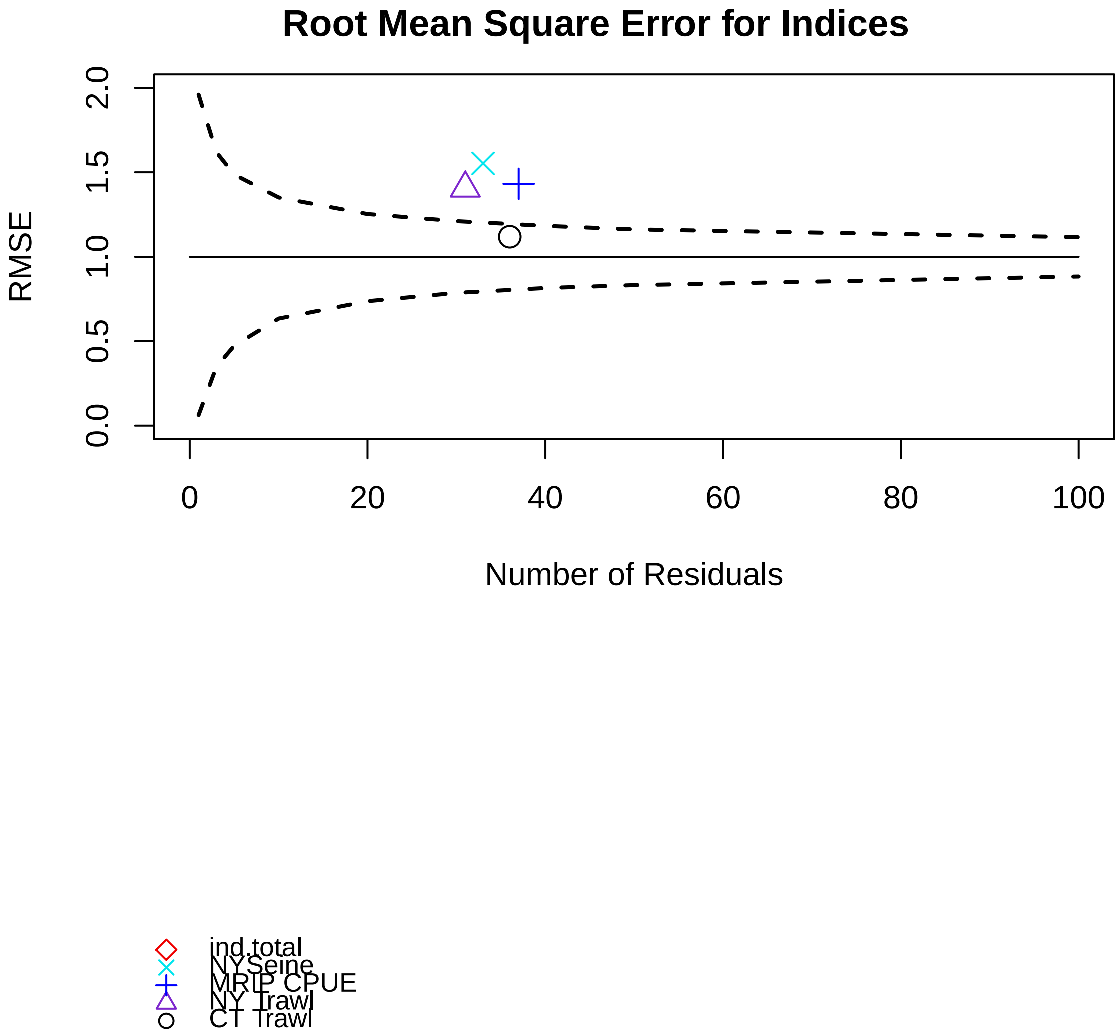


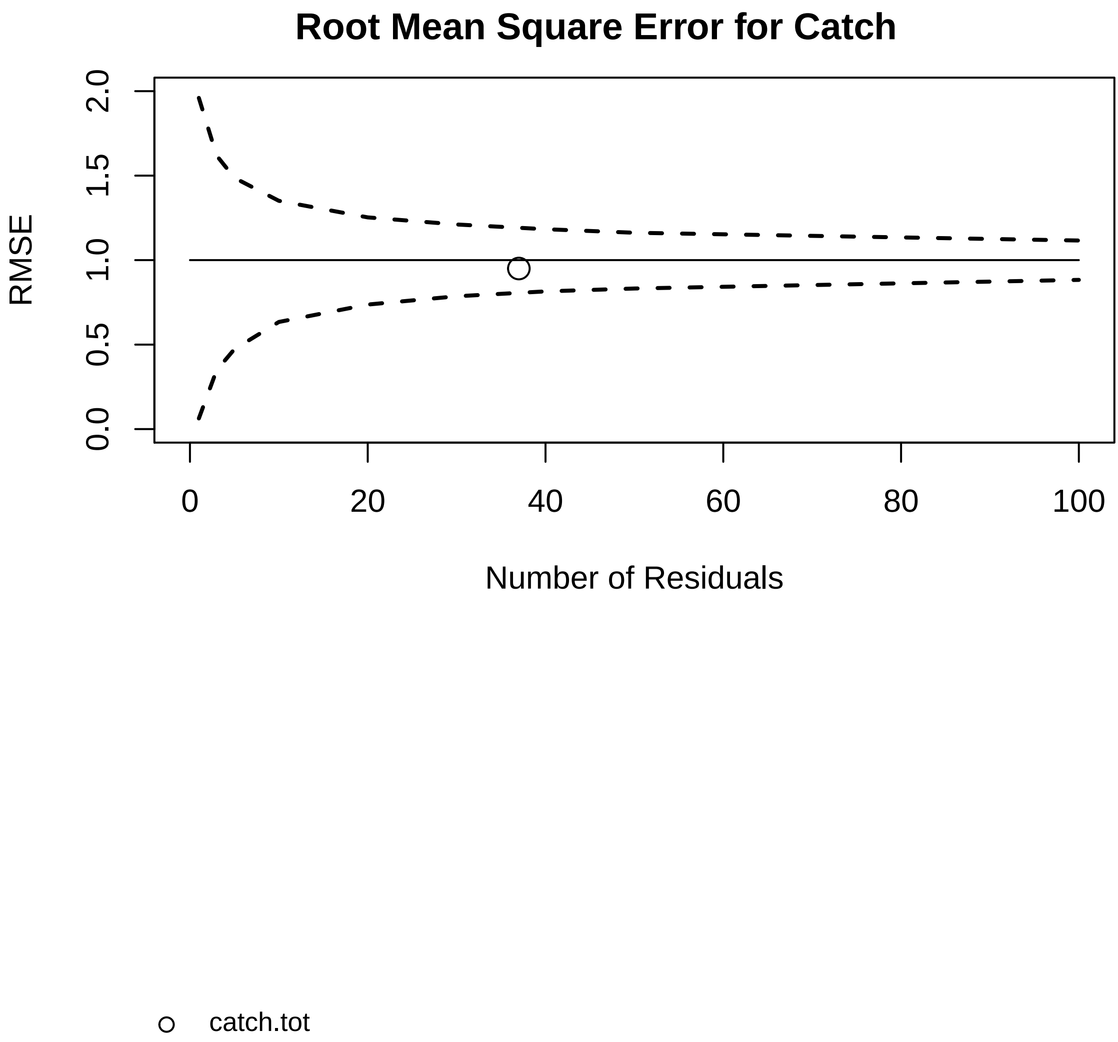
Number of high correlations
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Parameter


CV (parameter estimate)
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Parameter number

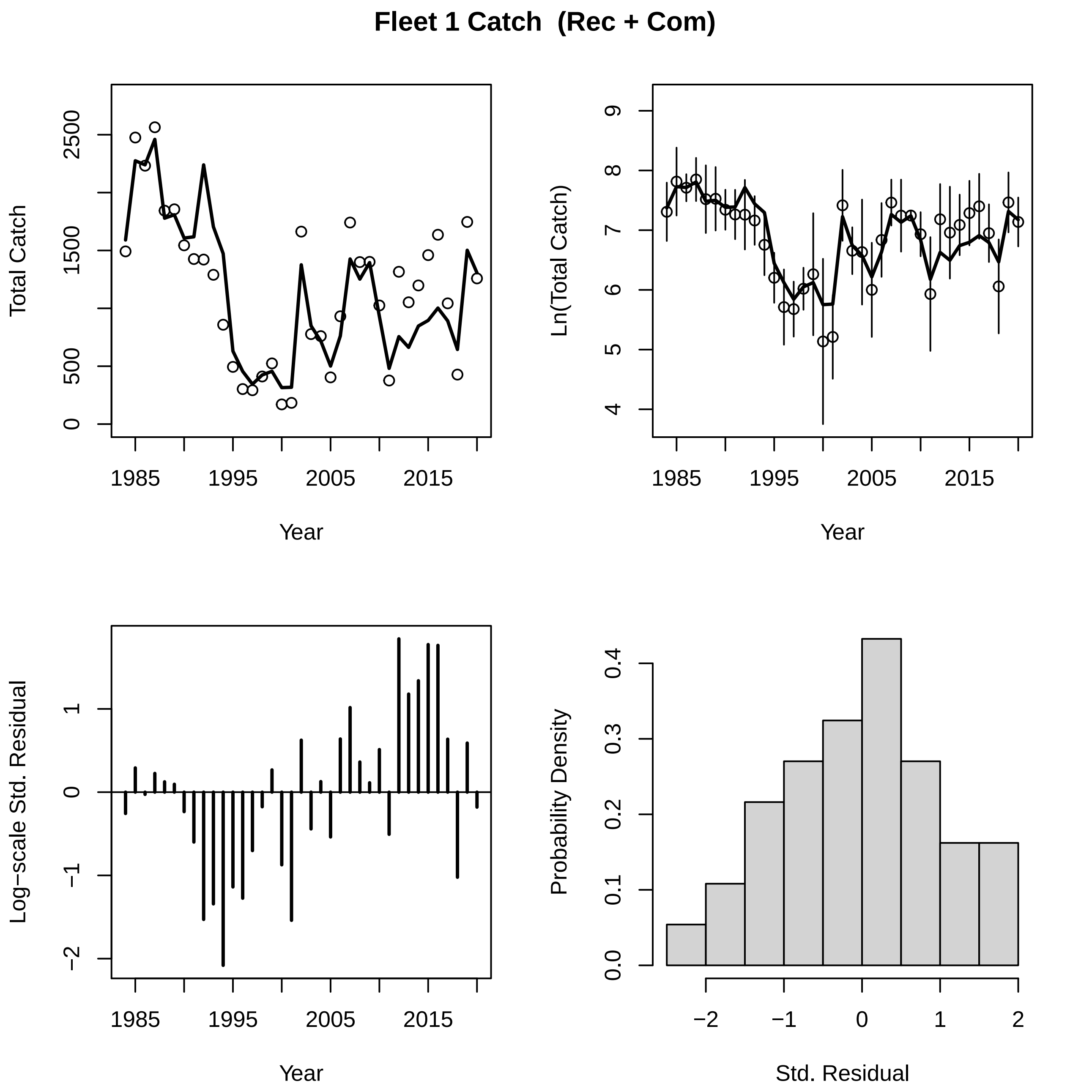
Root Mean Square Error computed from Standardized Residuals

Component	# resids	RMSE
catch.tot	37	0.95
discard.tot	0	0
ind01	36	1.12
ind02	31	1.41
ind03	37	1.43
ind04	33	1.55
ind.total	137	1.38
N.year1	0	0
Fmult.year1	0	0
Fmult.devs.total	36	0.923
recruit.devs	37	0.64
fleet.sel.params	0	0
index.sel.params	0	0
q.year1	0	0
q.devs	0	0
SR.steepness	1	0.126
SR.scaler	0	0


Root Mean Square Error for Indices
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
ind.total
NYSeine
MRIP CPUE
NY Trawl
CT Trawl

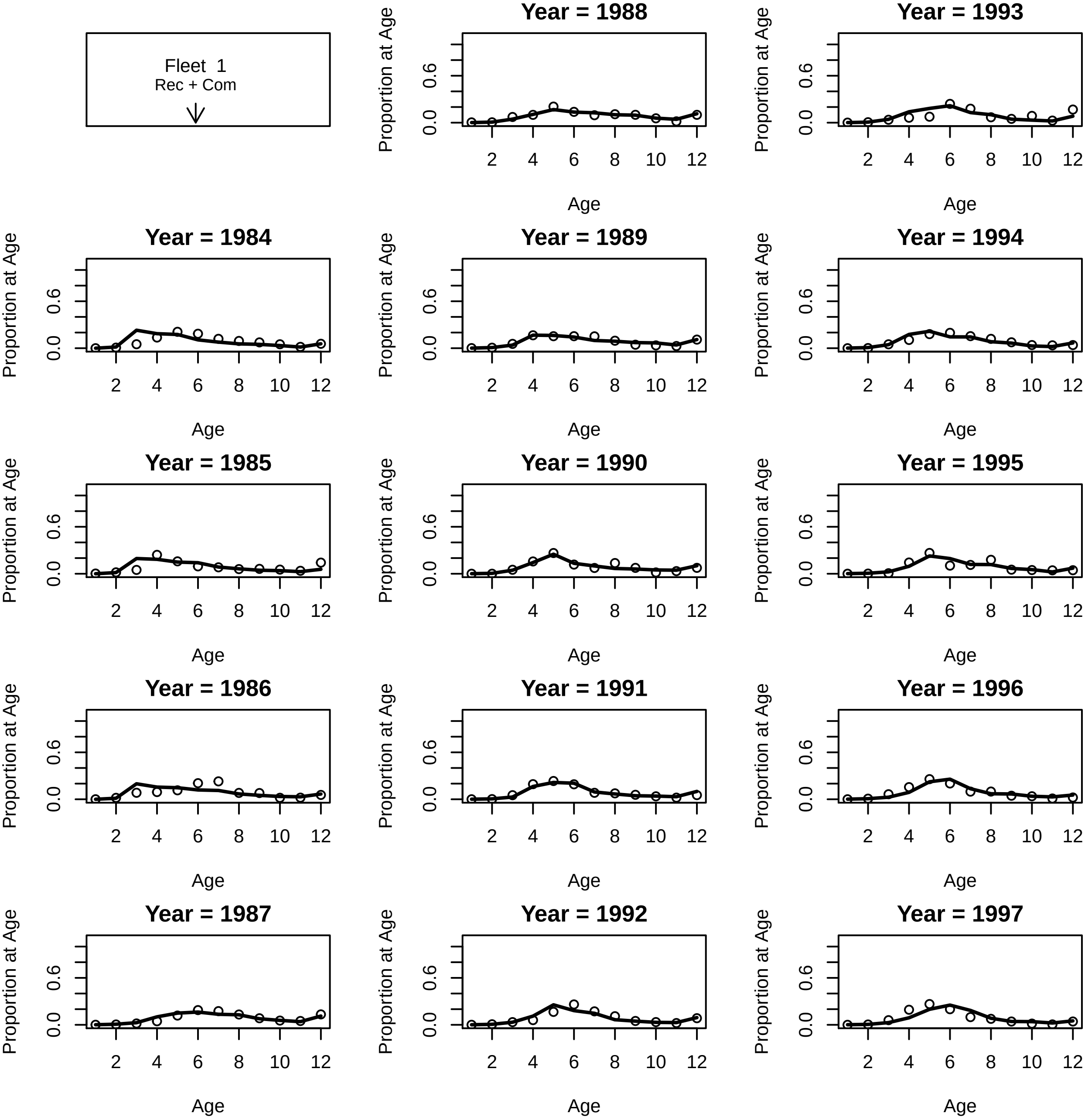


Root Mean Square Error for Catch
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
catch.tot

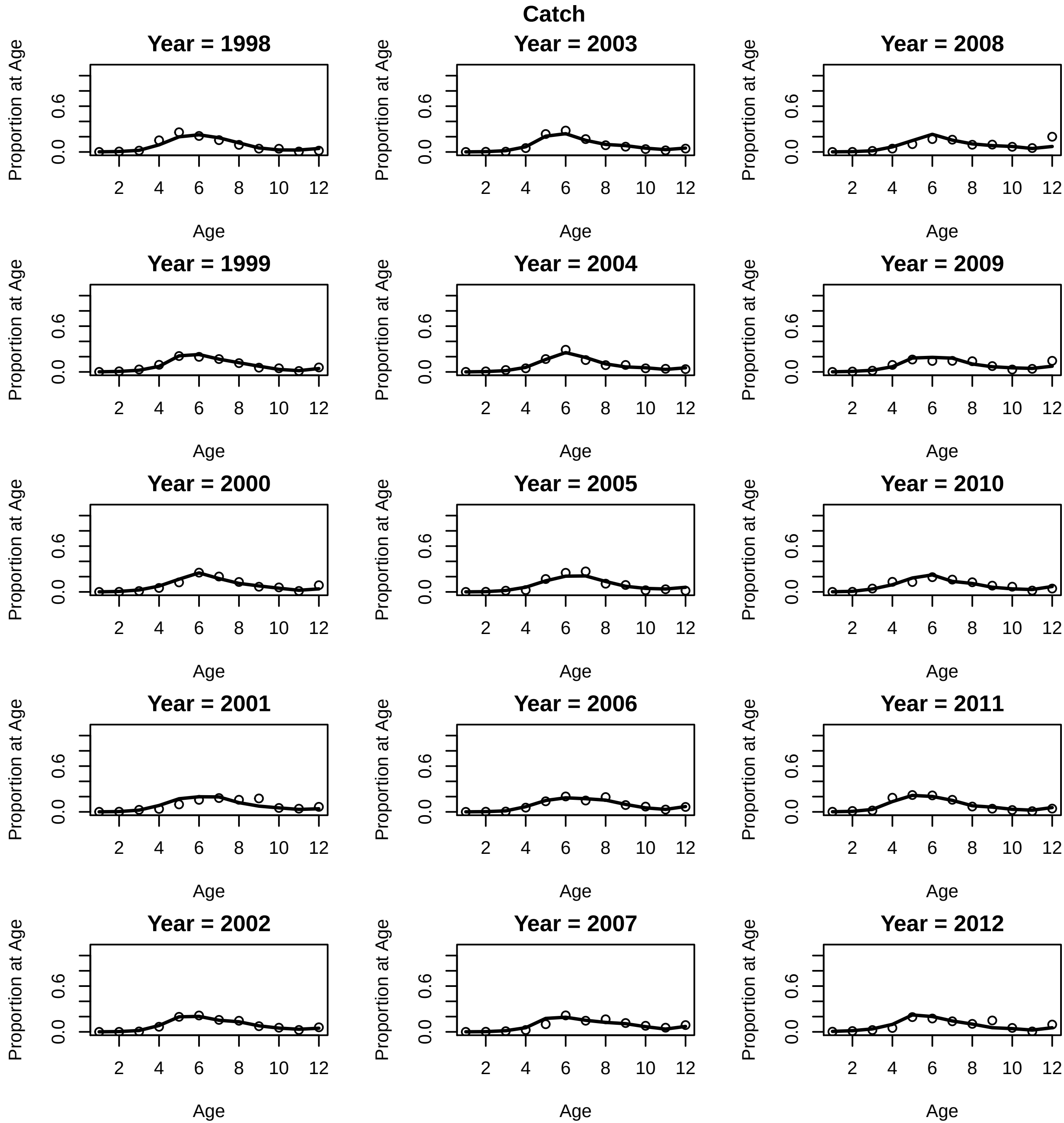


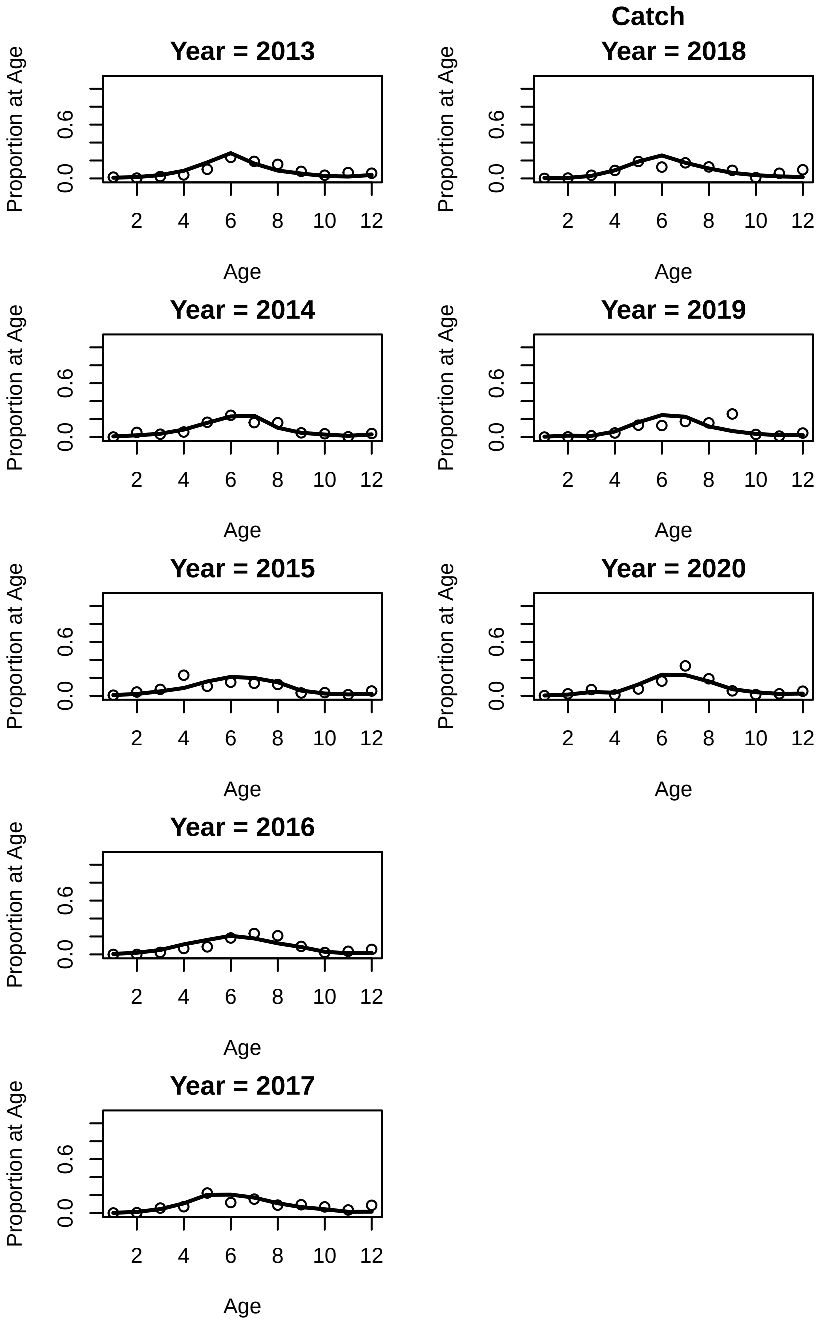
Fleet 1 Catch (Rec + Com)
Total Catch
Year
Ln(Total Catch)
Year
Log−scale Std. Residual
Year
Probability Density
Std. Residual

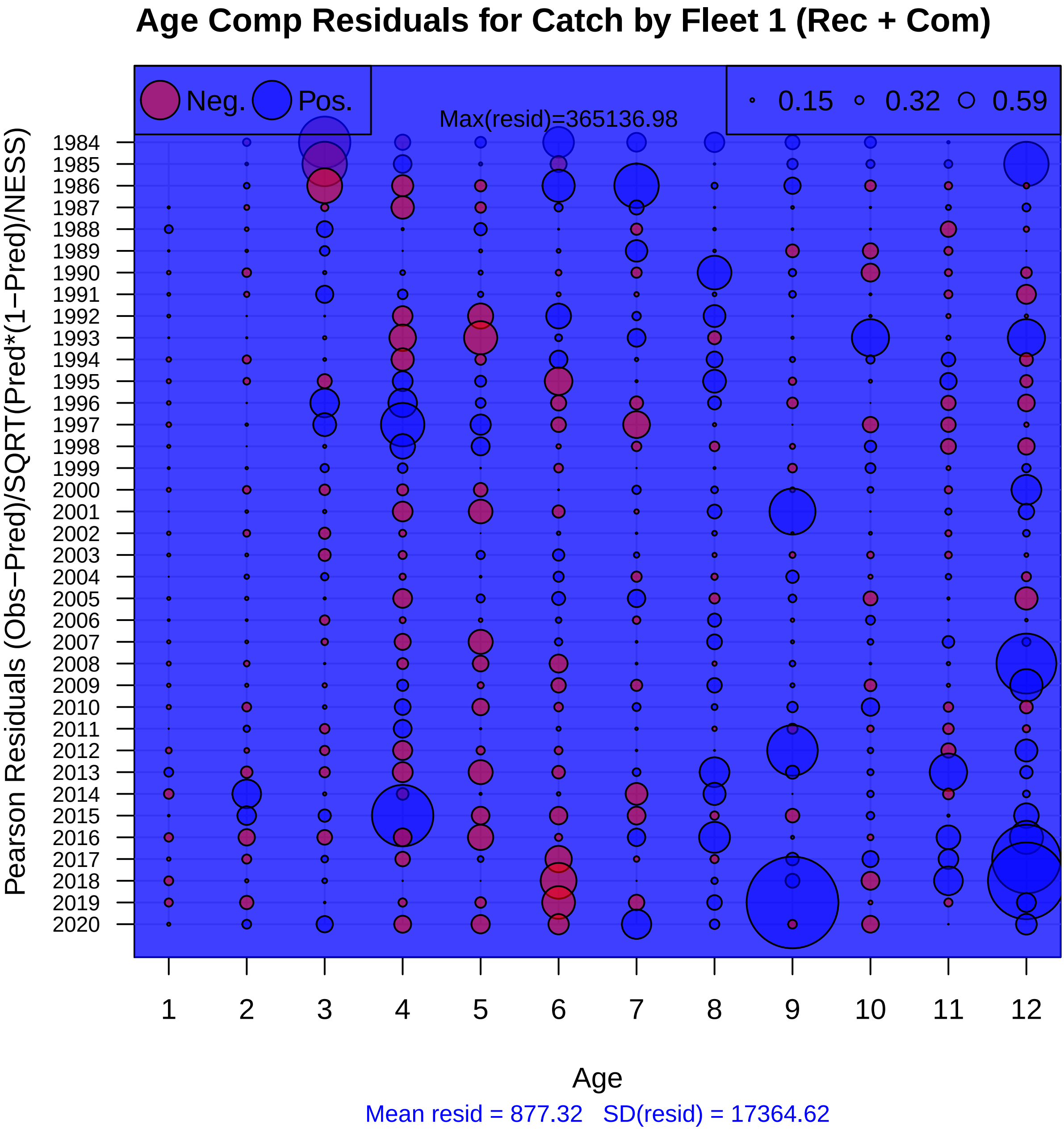
Catch

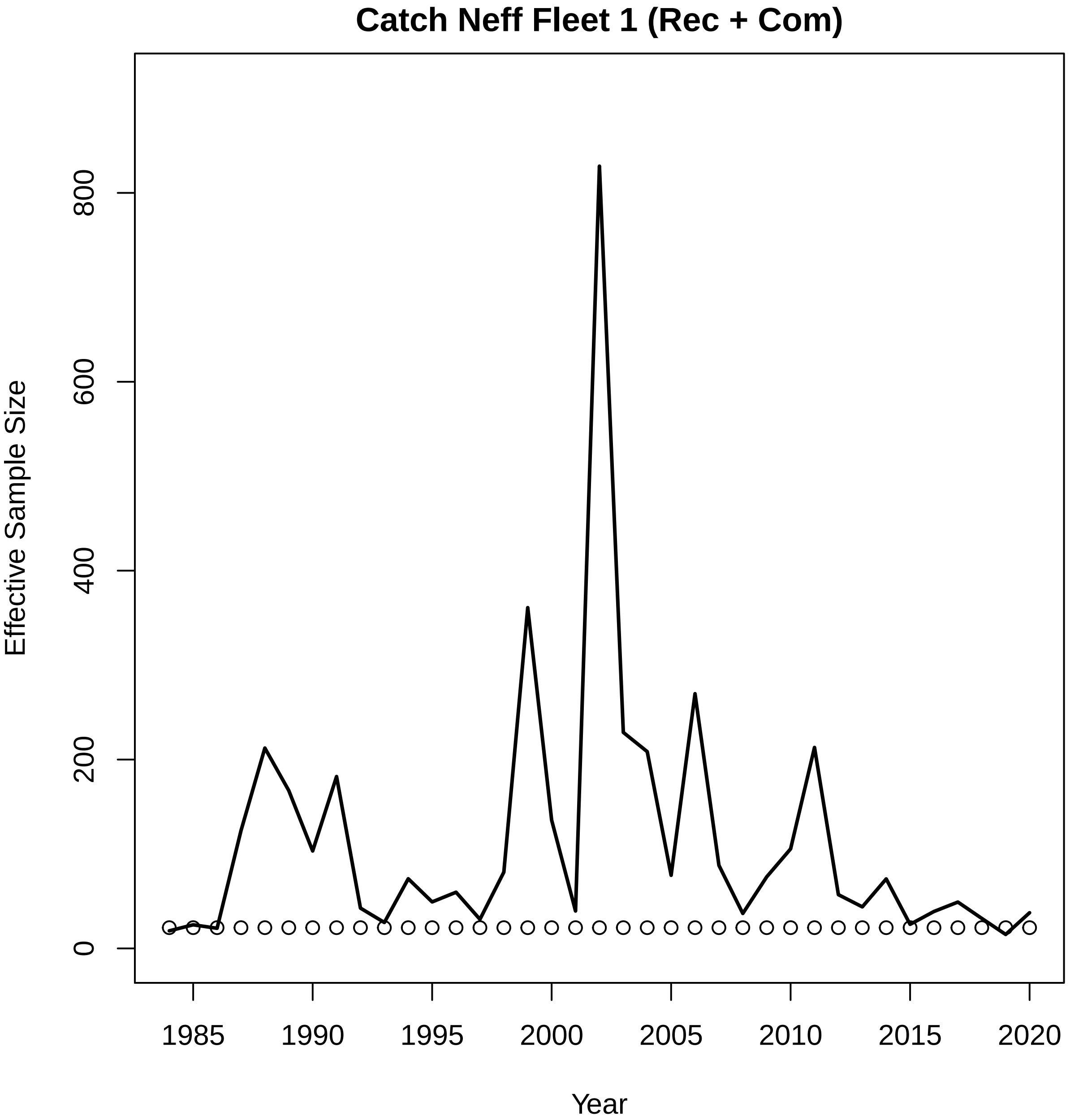


Fleet 1
Rec + Com
Year = 1984
Year = 1985
Year = 1986
Year = 1987
Year = 1988
Year = 1989
Year = 1990
Year = 1991
Year = 1992
Year = 1993
Year = 1994
Year = 1995
Year = 1996
Year = 1997
Proportion at Age
0.0
0.6
Age
2
4
6
8
10
12

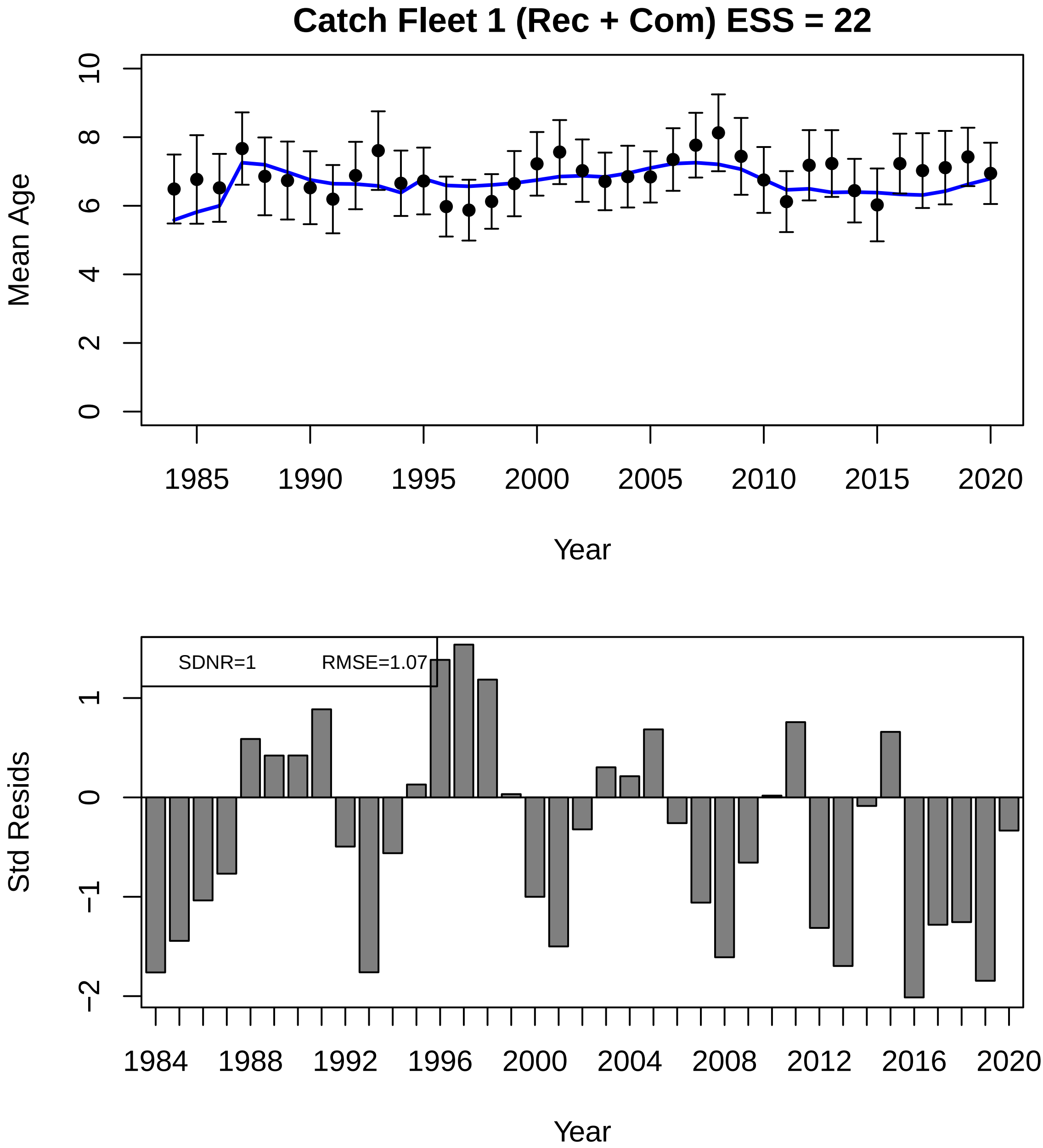

Catch
Year = 1998
Year = 2003
Year = 2008
Year = 1999
Year = 2004
Year = 2009
Year = 2000
Year = 2005
Year = 2010
Year = 2001
Year = 2006
Year = 2011
Year = 2002
Year = 2007
Year = 2012
Proportion at Age
0.0
0.6
Age
2
4
6
8
10
12


Catch
Year = 2013
Year = 2014
Year = 2015
Year = 2016
Year = 2017
Year = 2018
Year = 2019
Year = 2020
Proportion at Age
0.0
0.6
Age
2
4
6
8
10
12

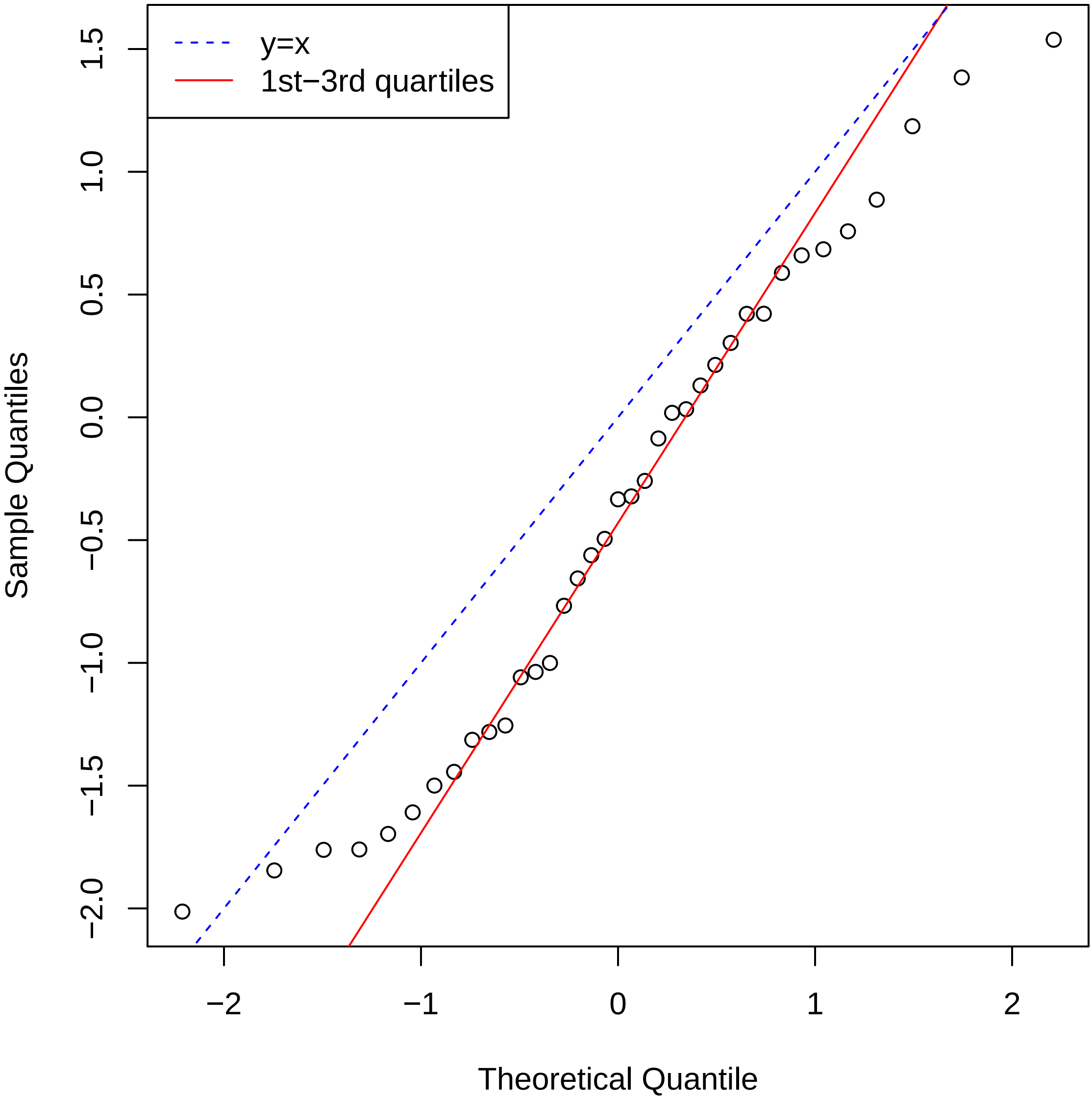

Age Comp Residuals for Catch by Fleet 1 (Rec + Com)
Neg.
Pos.
Max(resid)=365136.98
0.15
0.32
0.59
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = 877.32 SD(resid) = 17364.62



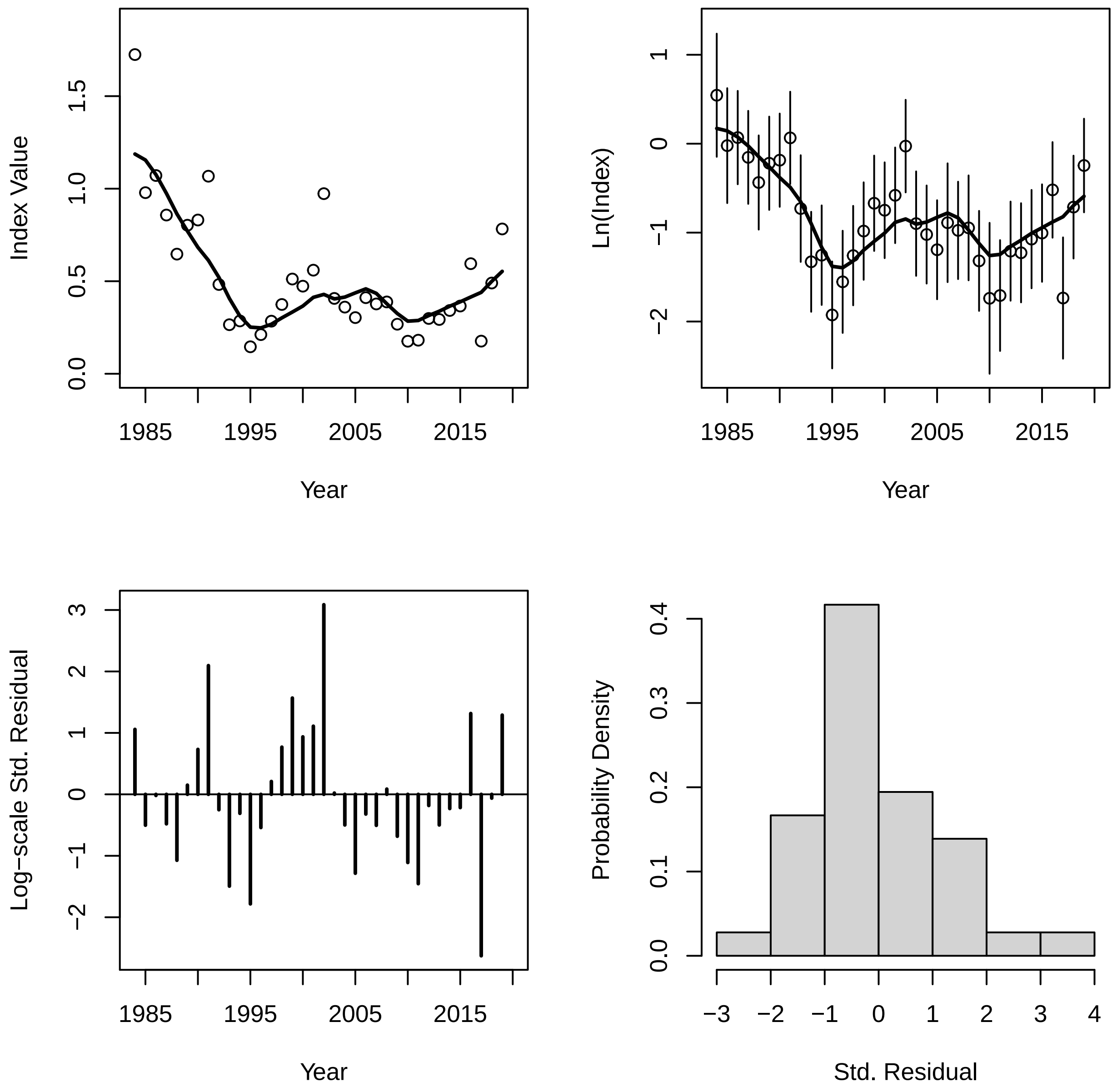
Catch Neff Fleet 1 (Rec + Com)
Effective Sample Size
0
200
400
600
800
1985
1990
1995
2000
2005
2010
2015
2020
Year


Catch Fleet 1 (Rec + Com) ESS = 22
Mean Age
0
2
4
6
8
10
1985
1990
1995
2000
2005
2010
2015
2020
Year
SDNR=1
RMSE=1.07
Std Resids
−2
−1
0
1
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year

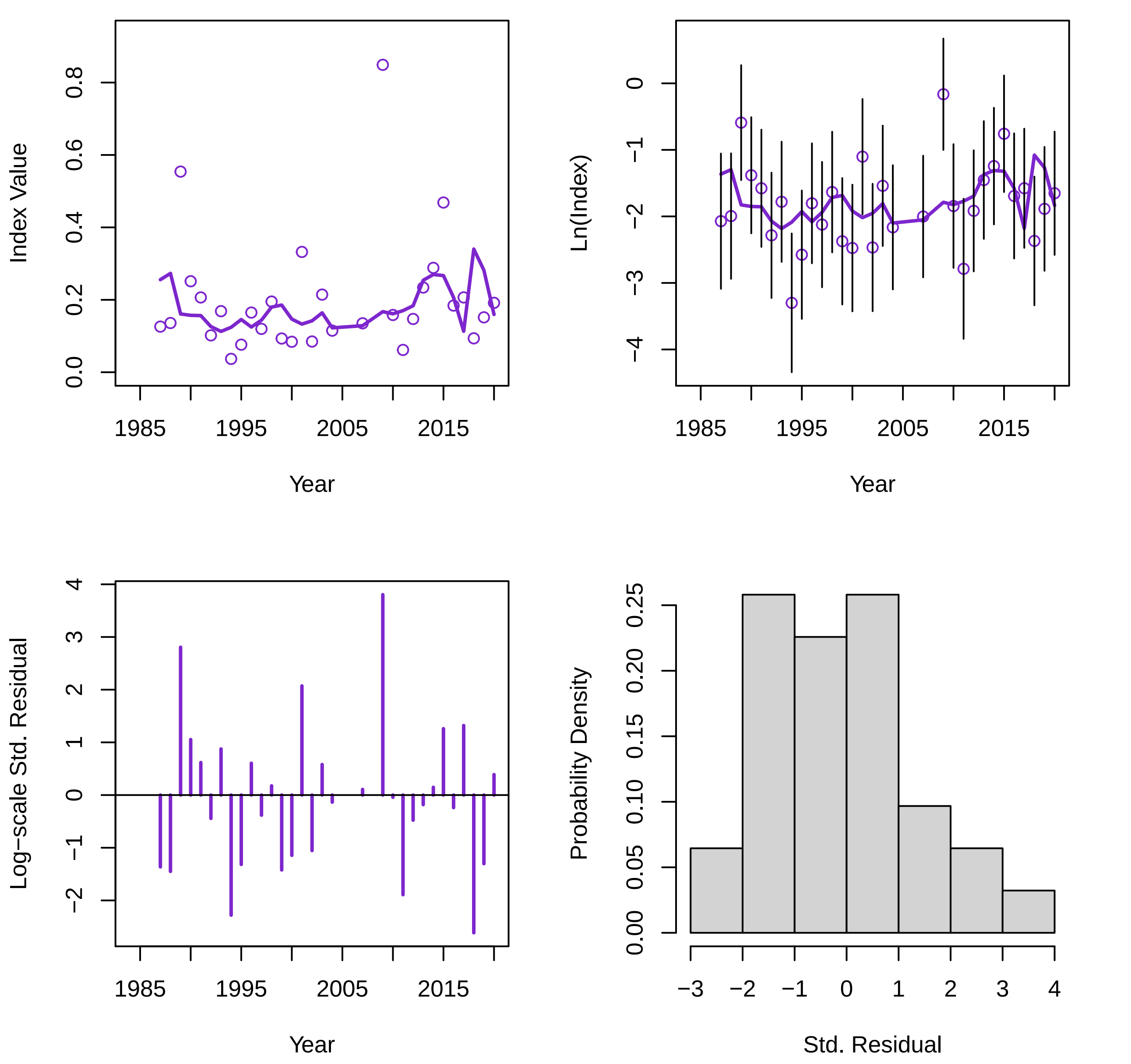
Catch Fleet 1 (Rec + Com) ESS = 22

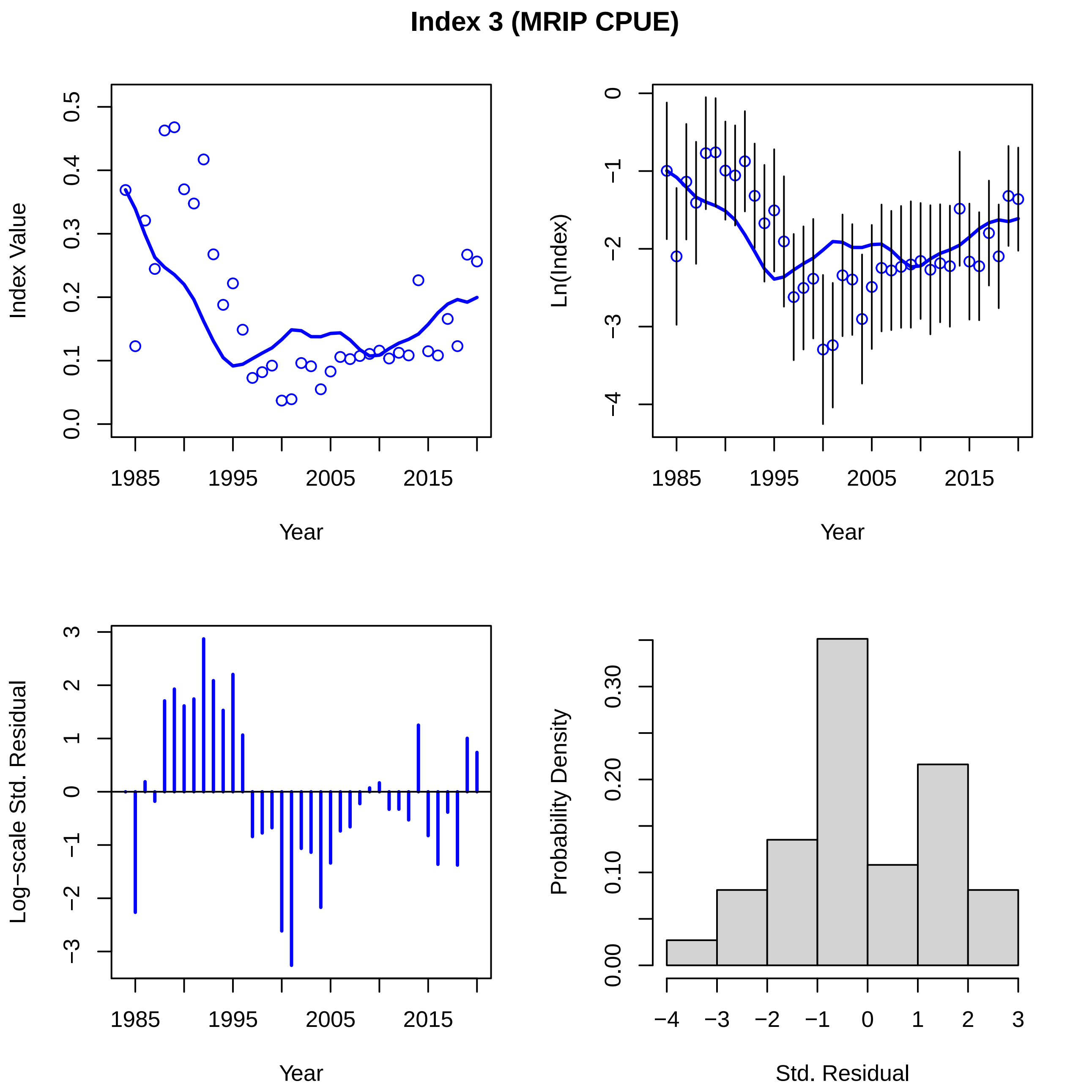


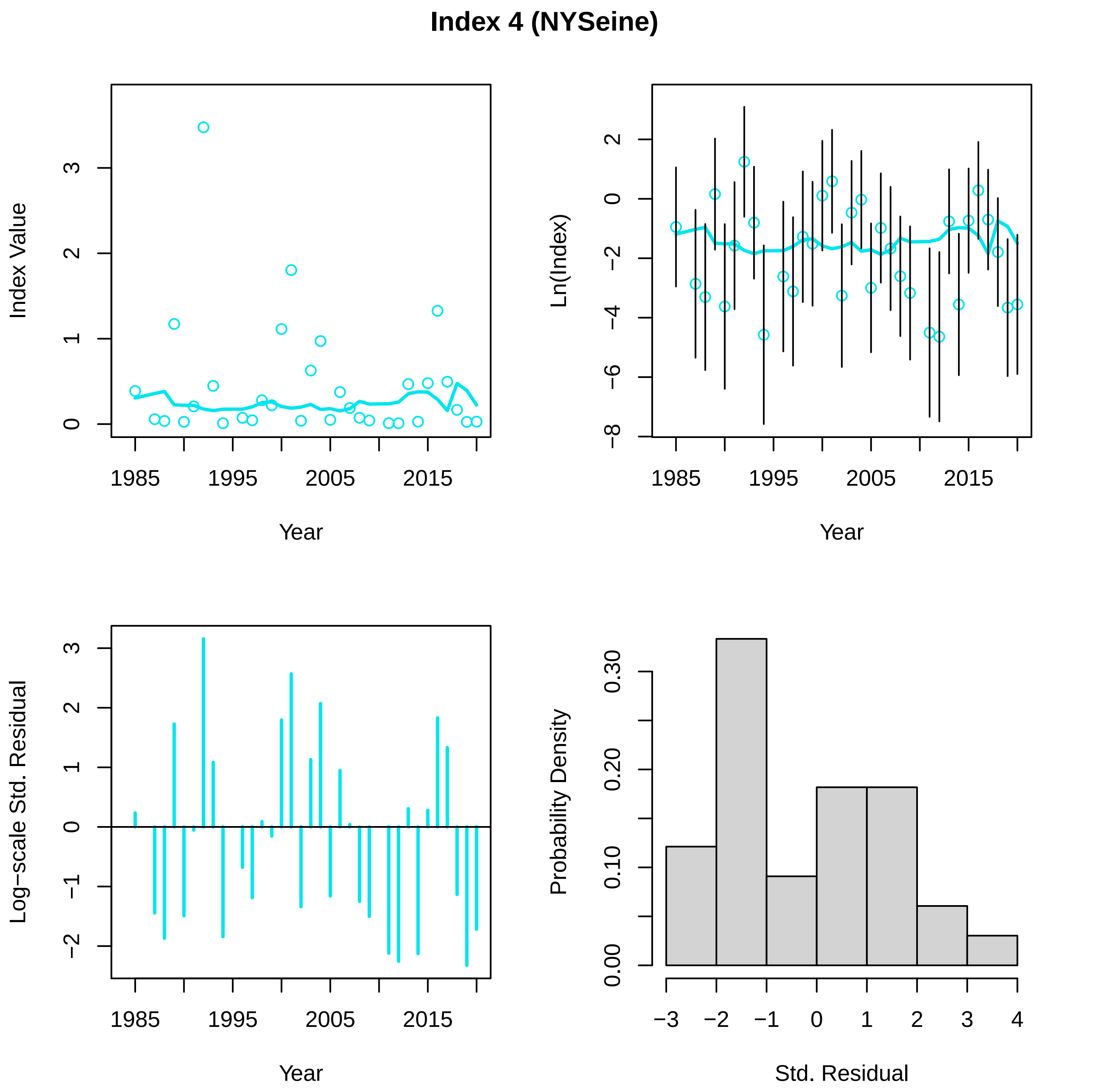
Index 1 (CT Trawl)



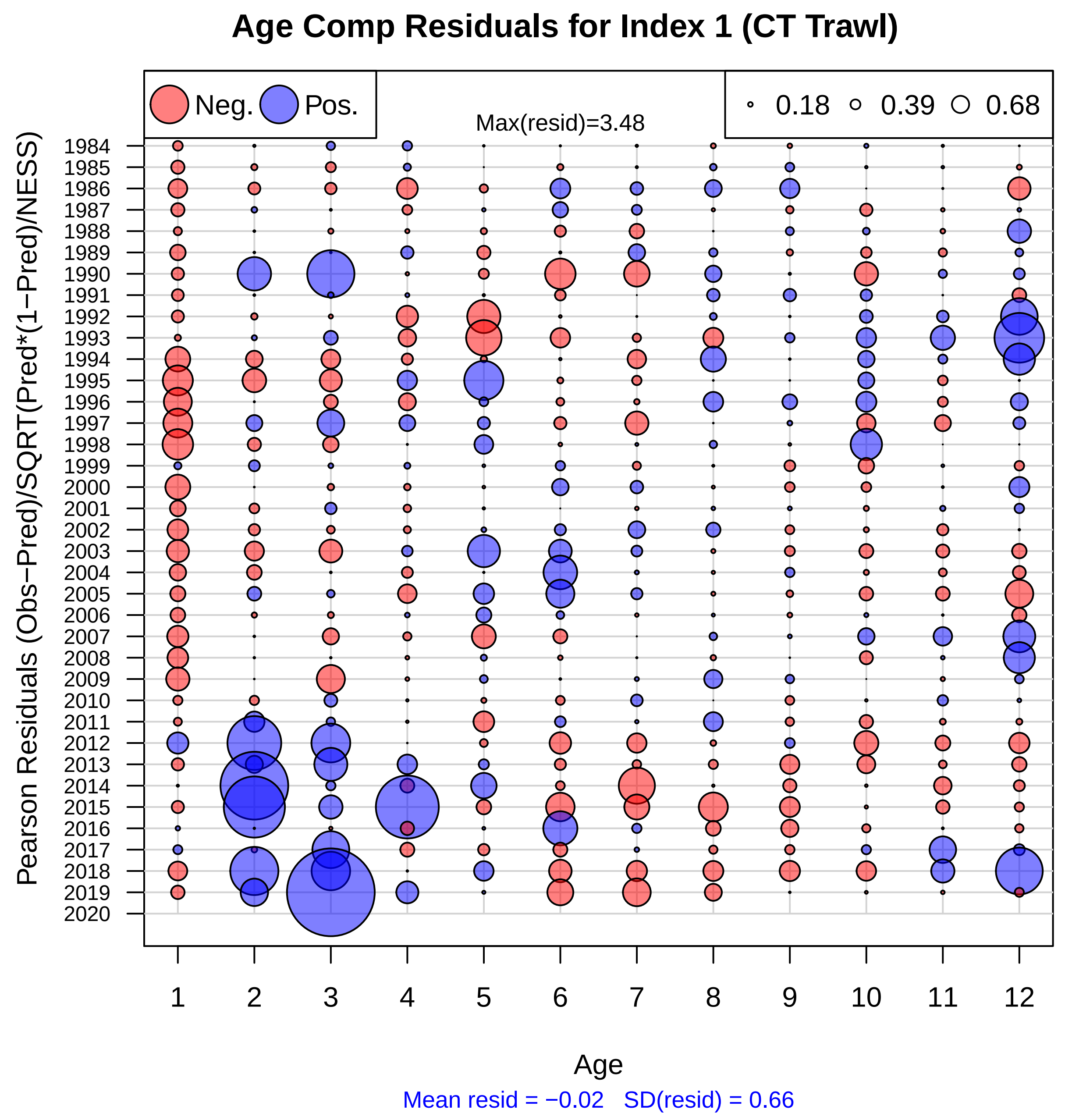
Index 2 (NY Trawl)



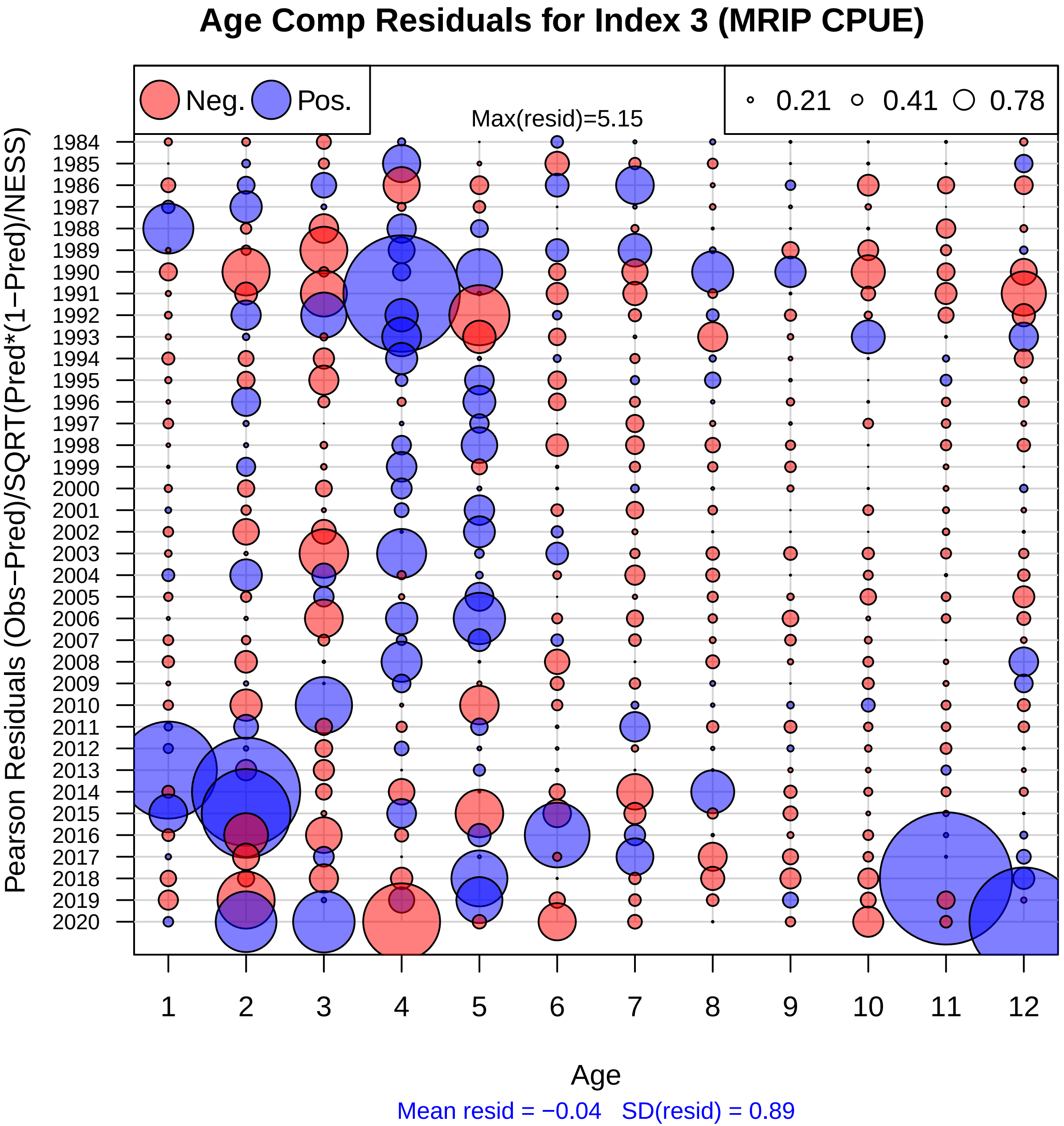

Index 3 (MRIP CPUE)
Index Value
Year
Ln(Index)
Year
Log−scale Std. Residual
Year
Probability Density
Std. Residual
1985
1995
2005
2015
0.0
0.1
0.2
0.3
0.4
0.5
0
−1
−2
−3
−4
3
2
1
0.00
0.10
0.20
0.30

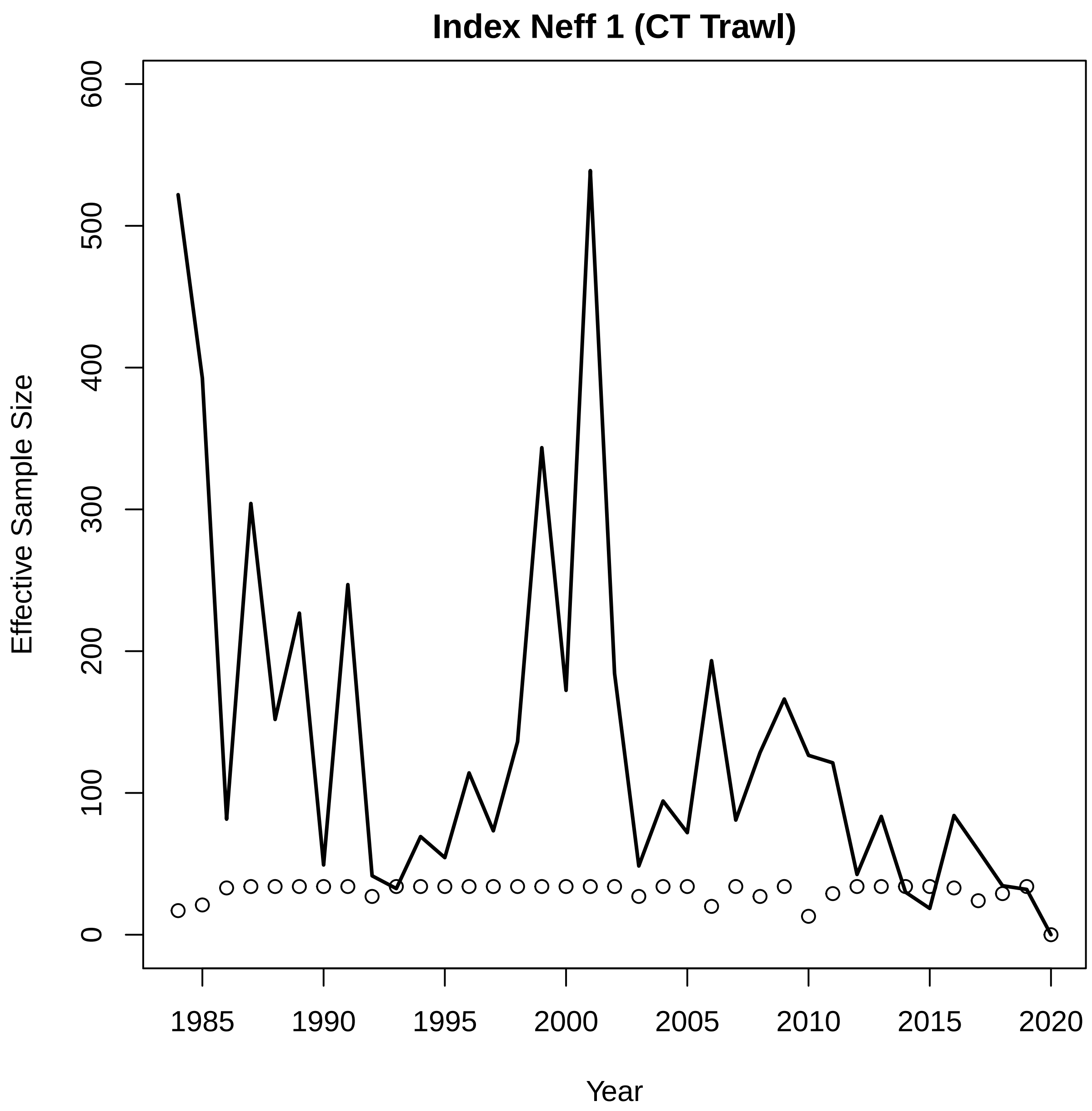


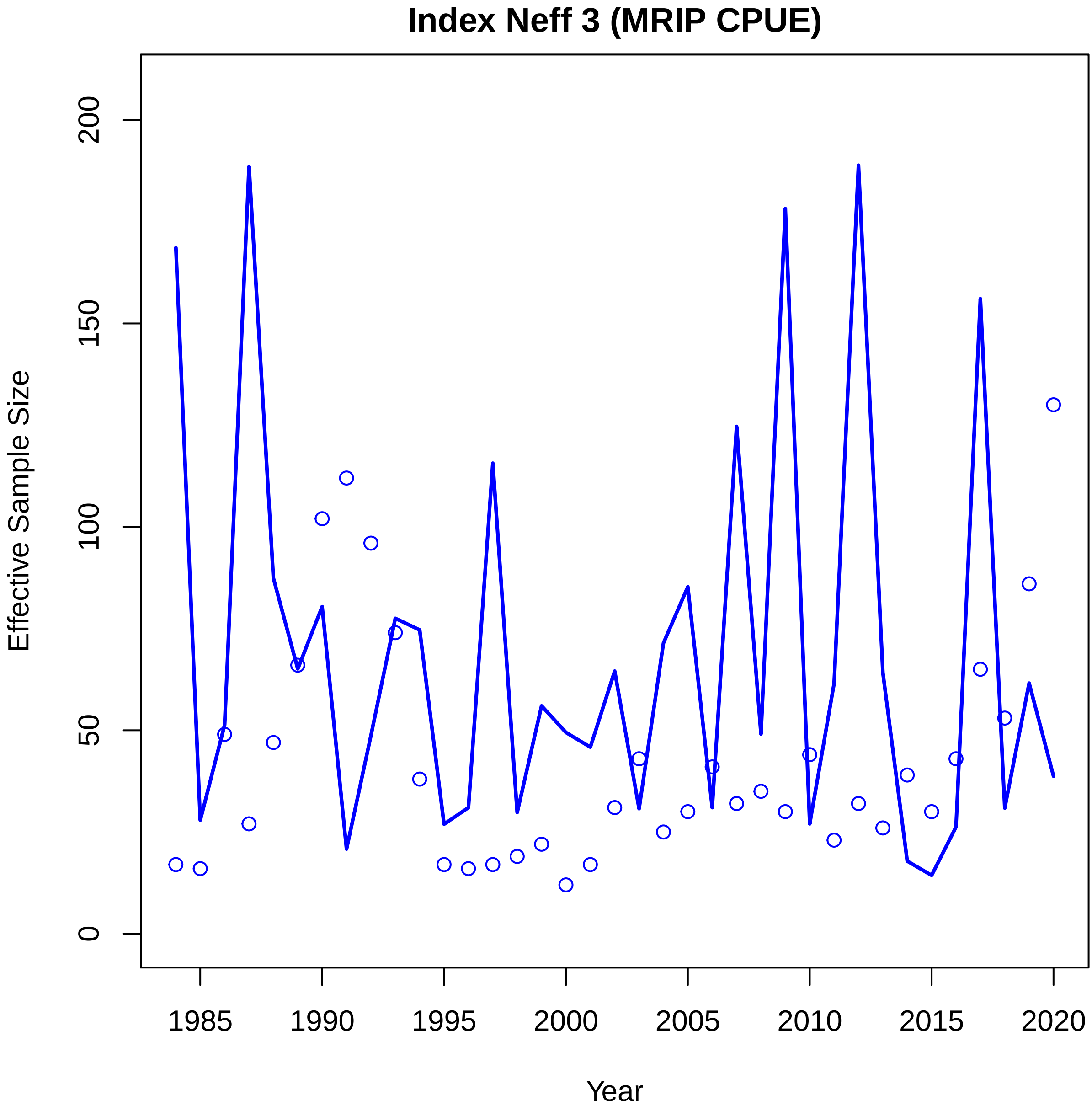
Index 4 (NYSeine)
Index Value
Year
Ln(Index)
Year
Log−scale Std. Residual
Year
Probability Density
Std. Residual

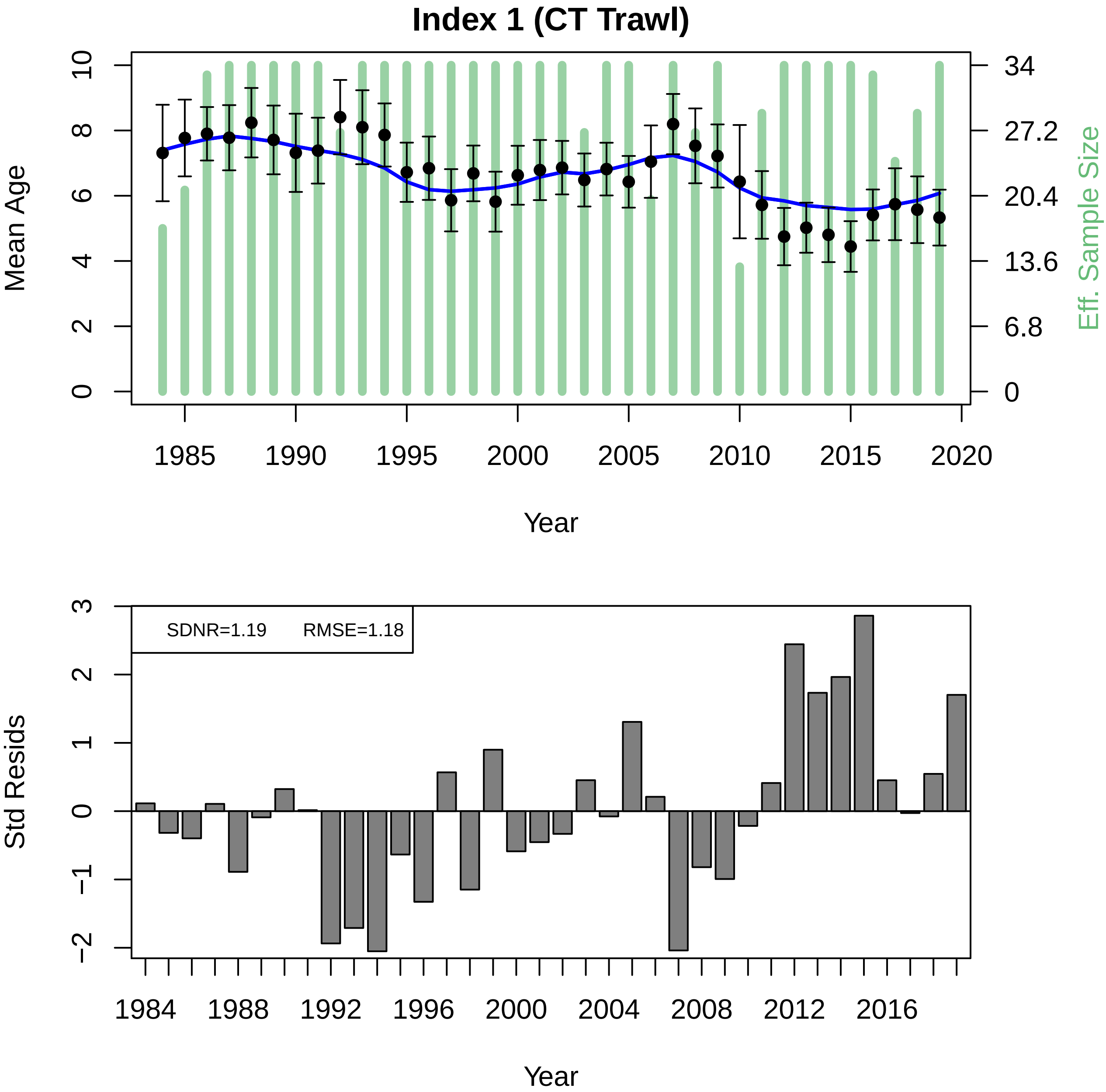


Age Comp Residuals for Index 1 (CT Trawl)
Neg.
Pos.
0.18
0.39
0.68
Max(resid)=3.48
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.02 SD(resid) = 0.66

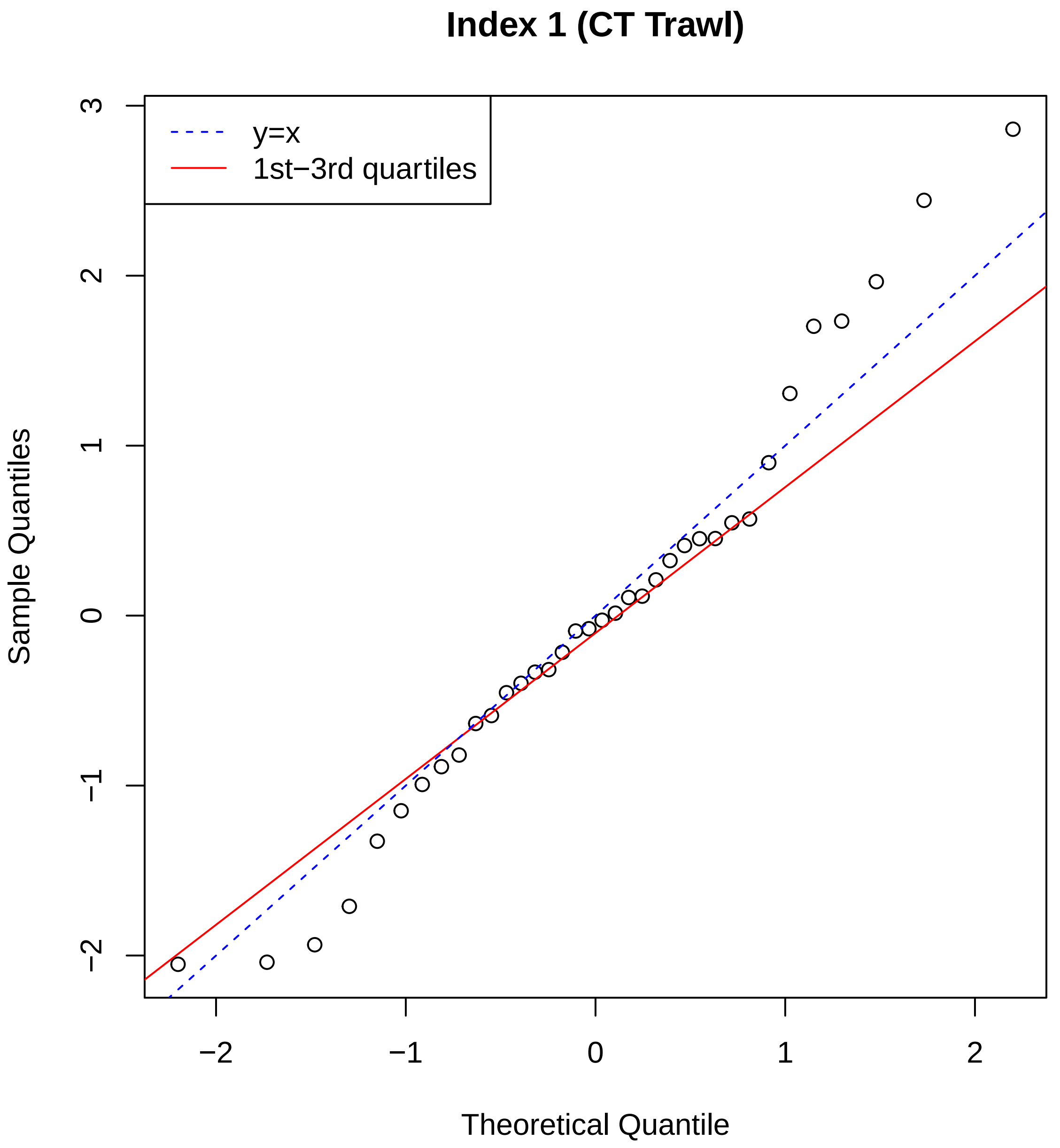

Age Comp Residuals for Index 3 (MRIP CPUE)
Neg.
Pos.
0.21
0.41
0.78
Max(resid)=5.15
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1 2 3 4 5 6 7 8 9 10 11 12
Age
Mean resid = −0.04 SD(resid) = 0.89

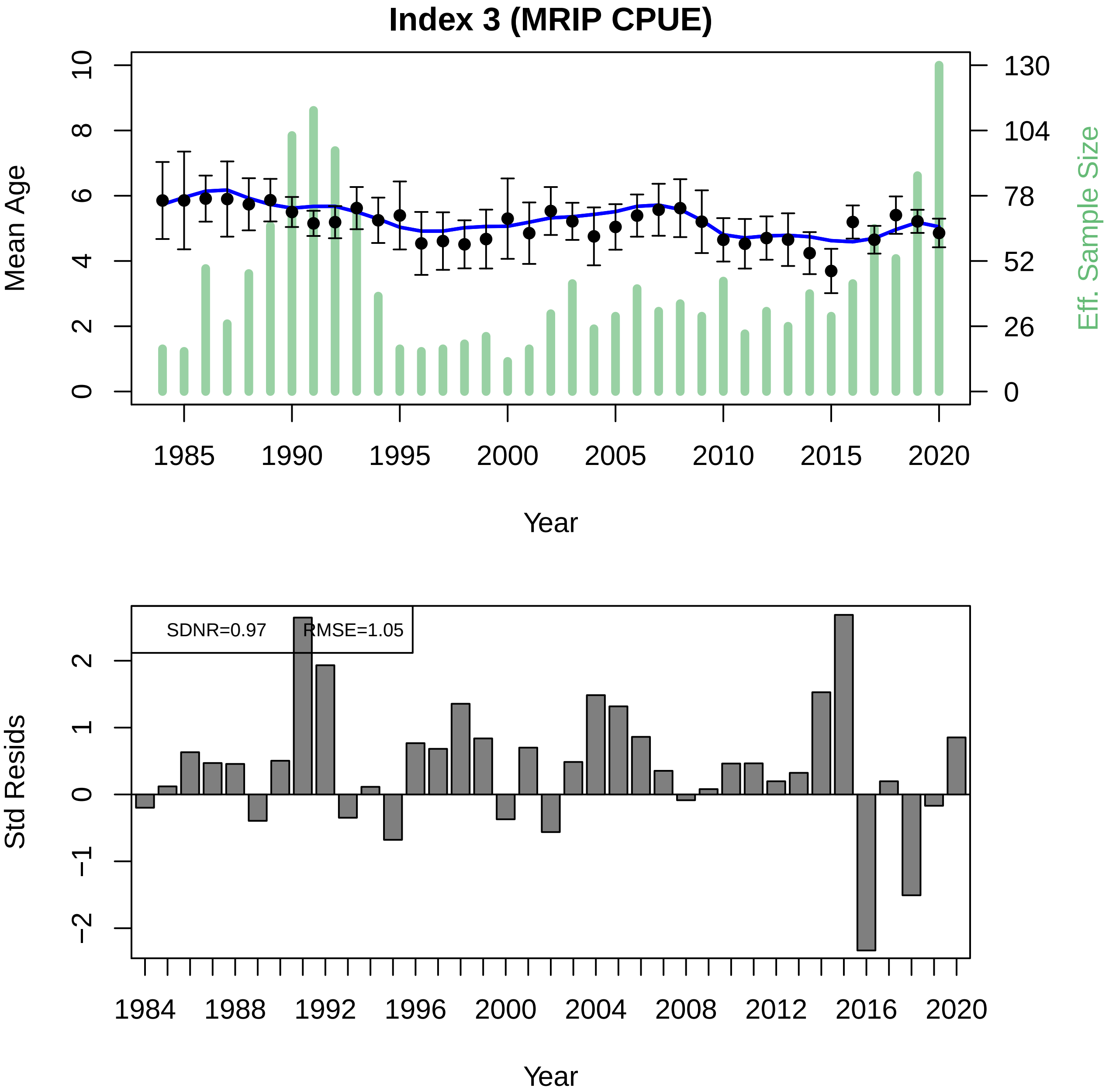

Index Neff 1 (CT Trawl)
Effective Sample Size
Year
0
100
200
300
400
500
600
1985
1990
1995
2000
2005
2010
2015
2020

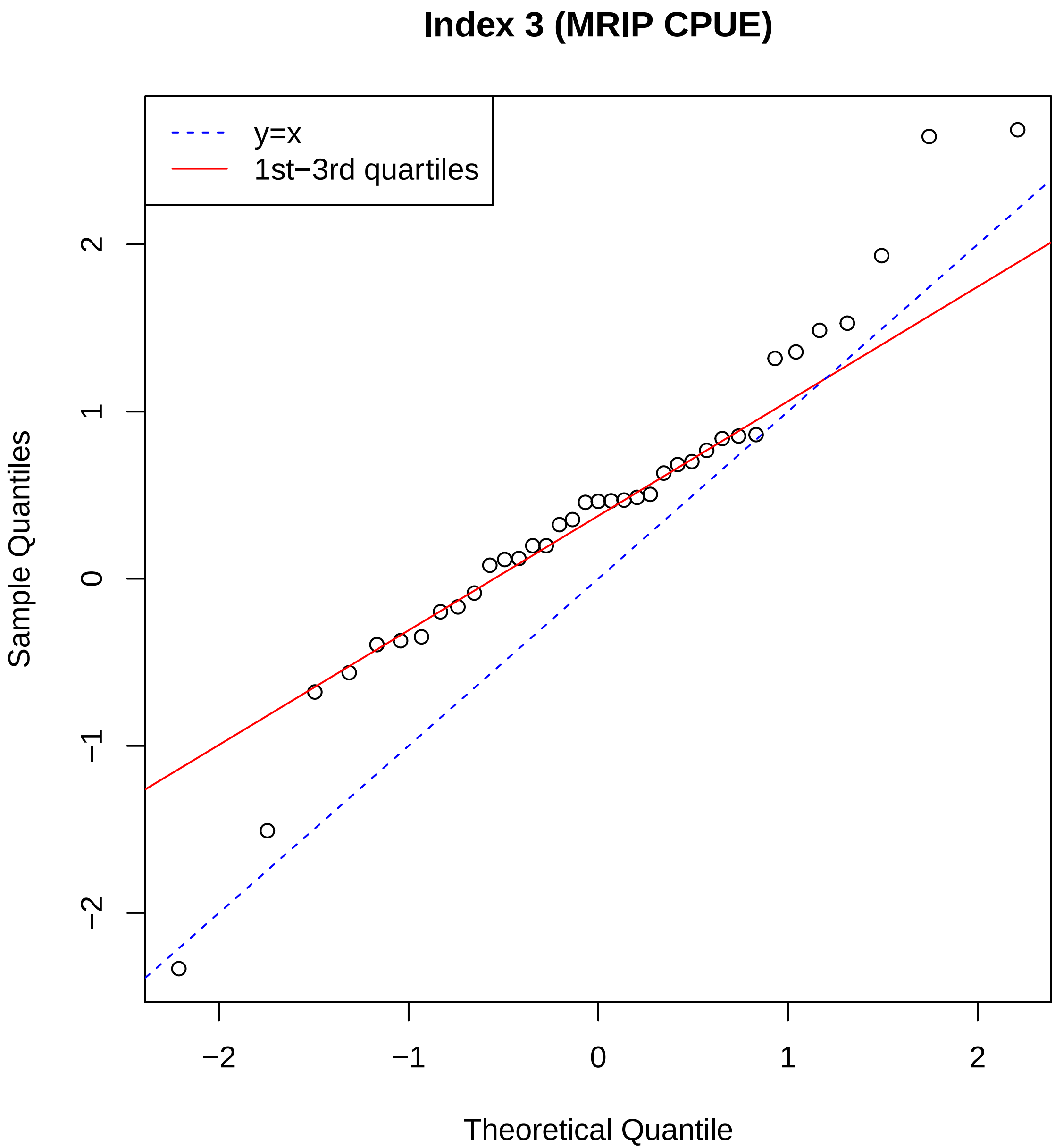

Index Neff 3 (MRIP CPUE)
Effective Sample Size
Year
0
50
100
150
200
1985
1990
1995
2000
2005
2010
2015
2020



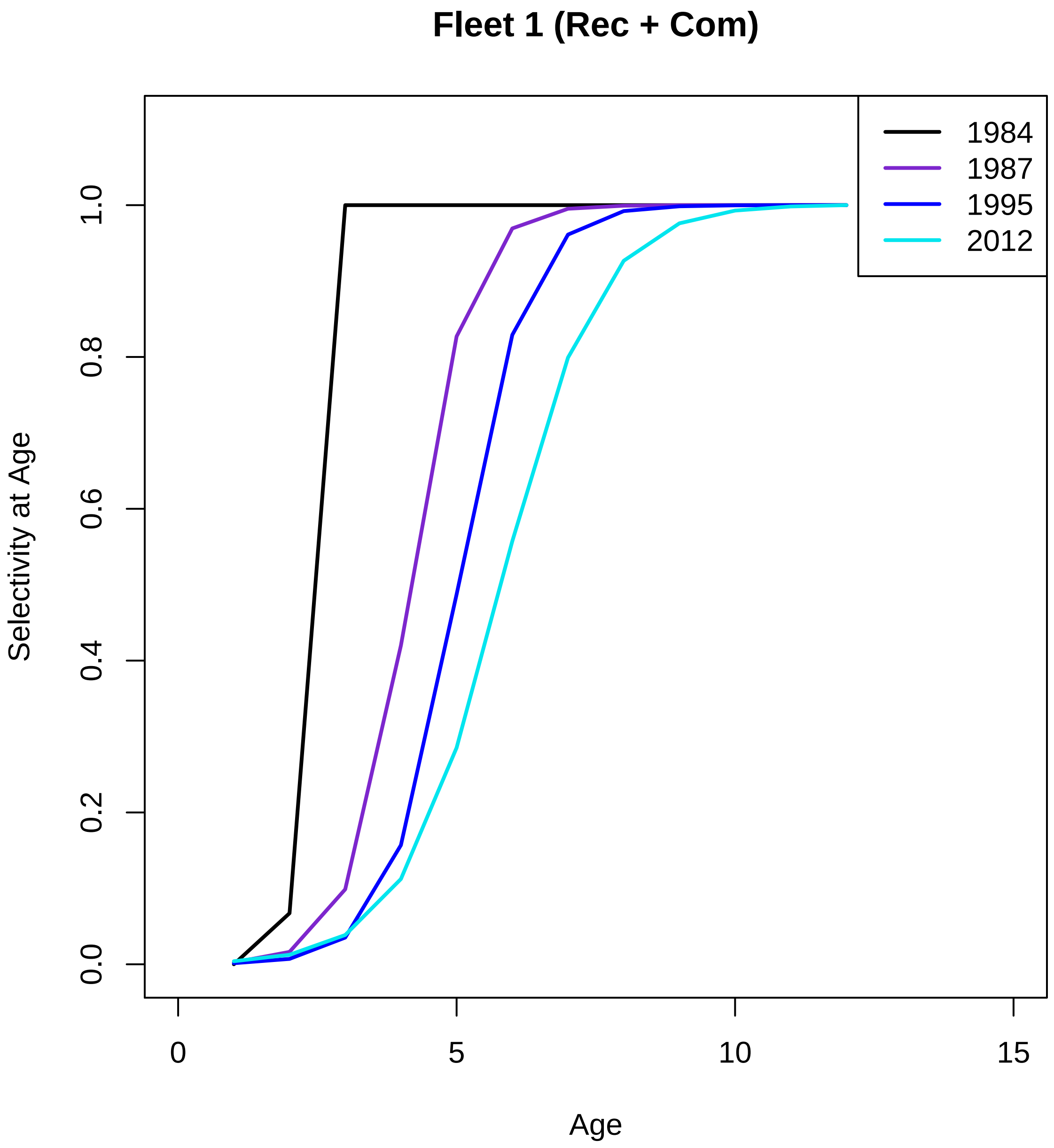
Index 1 (CT Trawl)
Mean Age
Eff. Sample Size
Year
SDNR=1.19
RMSE=1.18
Std Resids
Year

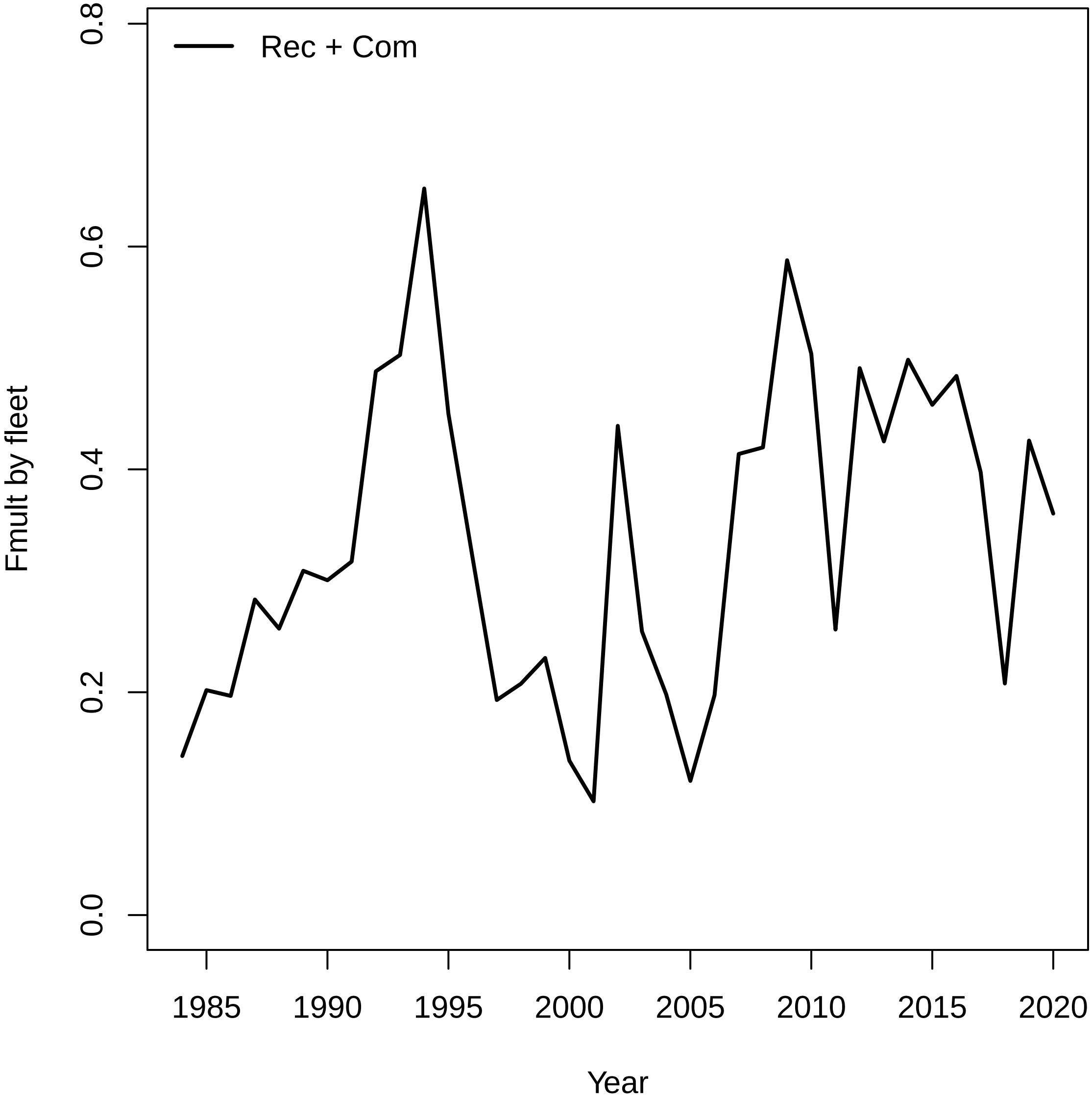

Index 1 (CT Trawl)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2
3


Index 3 (MRIP CPUE)
Mean Age
Eff. Sample Size
Year
SDNR=0.97
RMSE=1.05
Std Resids
Year

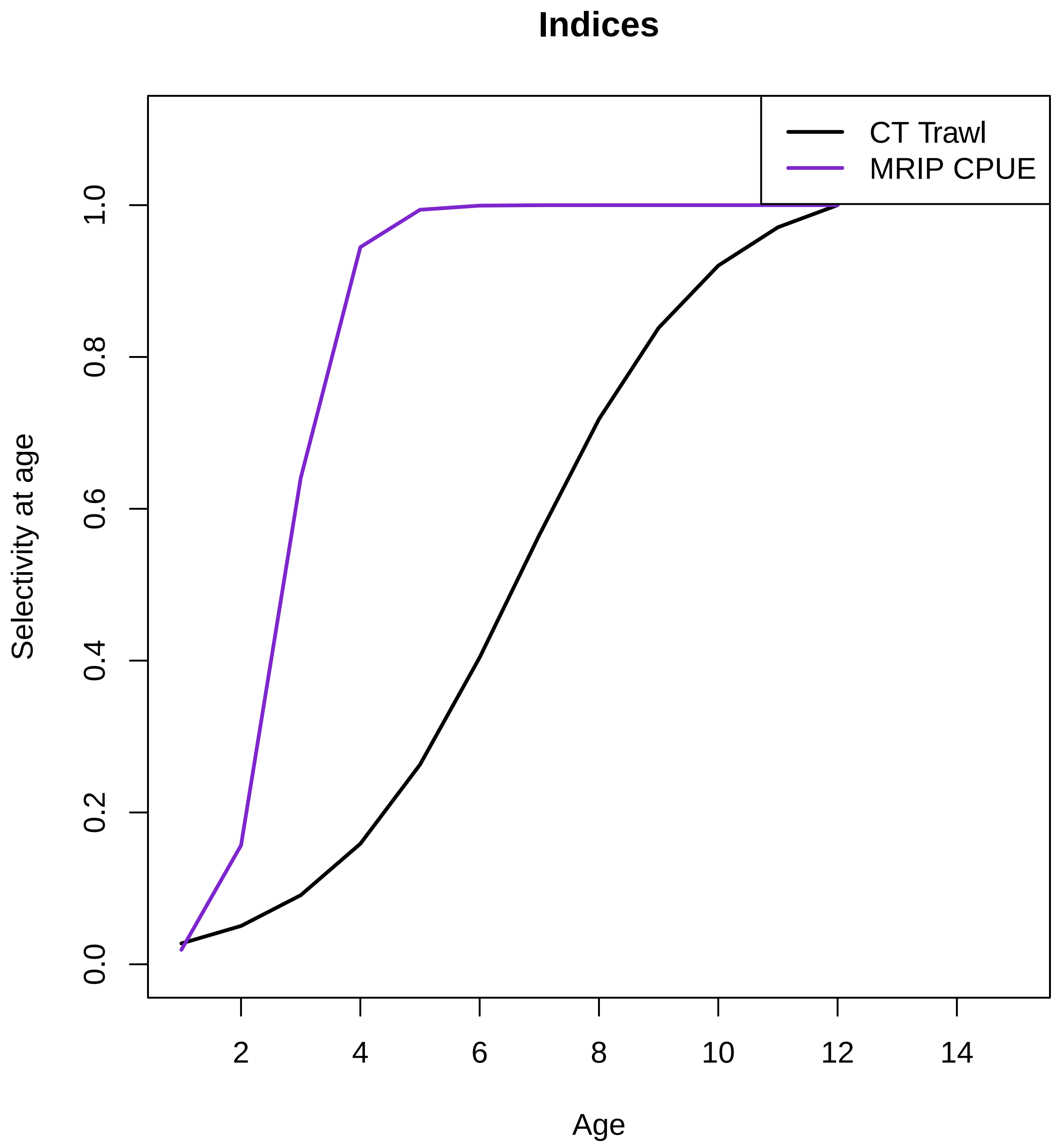


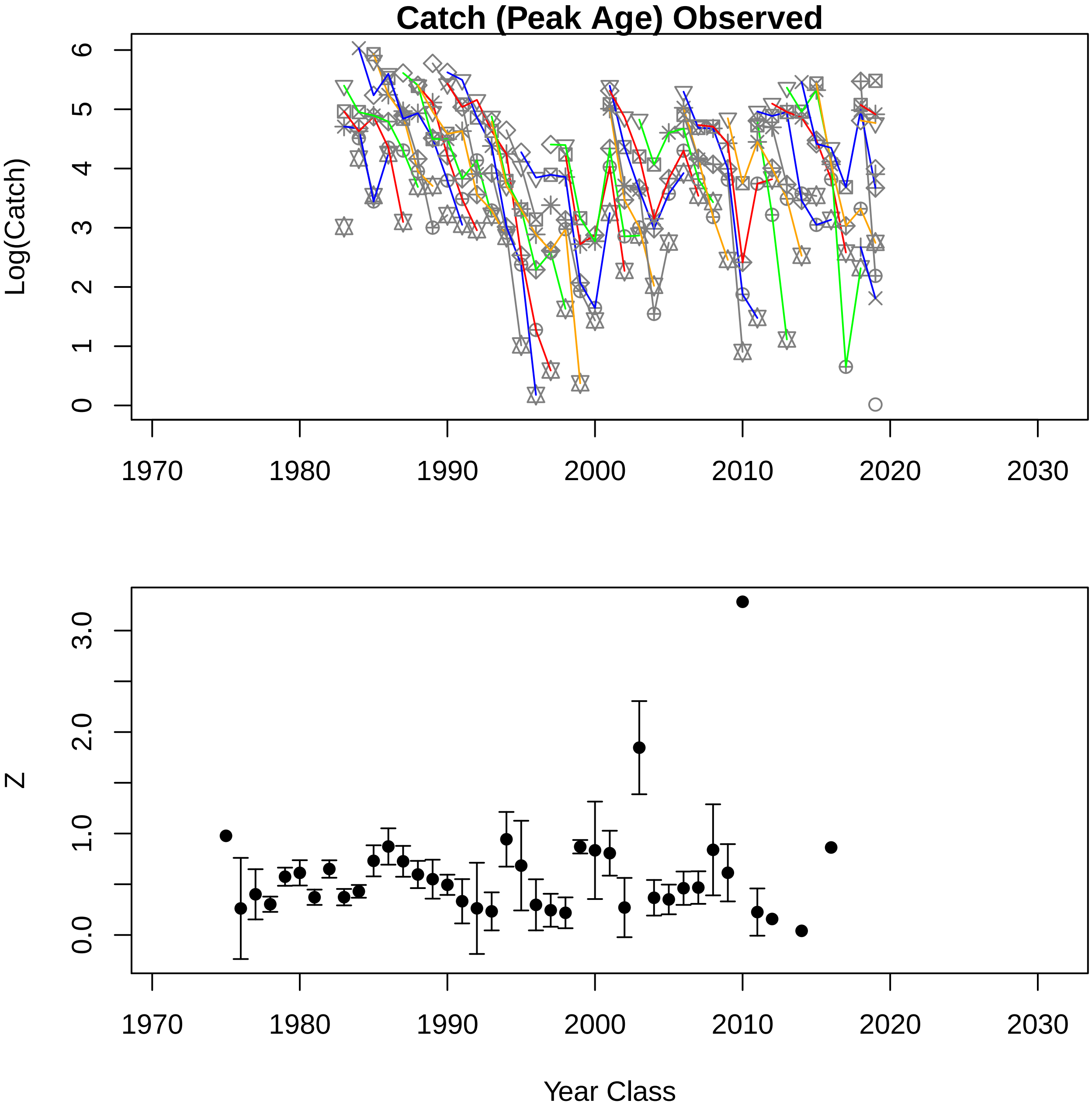
Index 3 (MRIP CPUE)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2


Fleet 1 (Rec + Com)
1984
1987
1995
2012
Selectivity at Age
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
Age

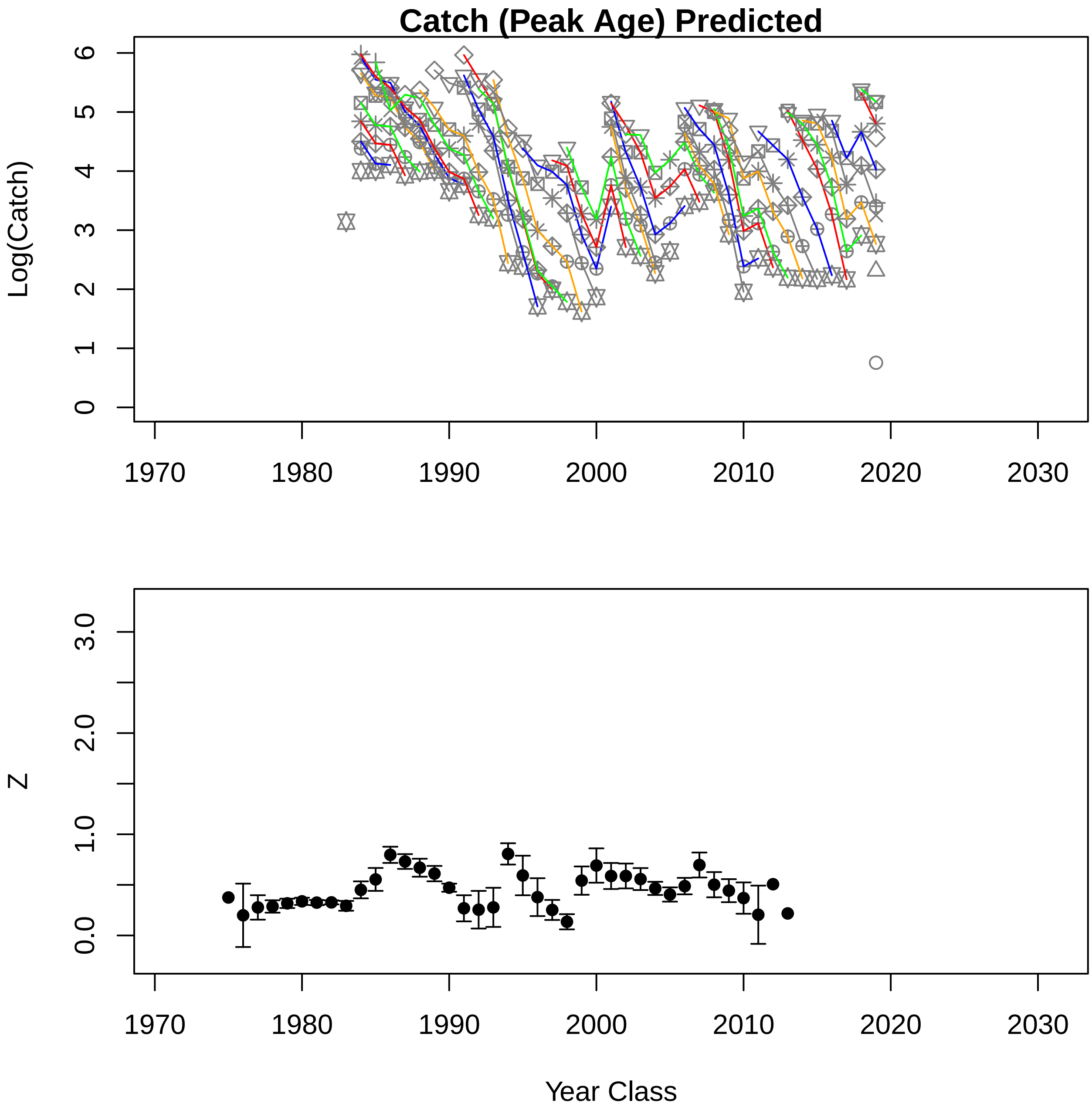


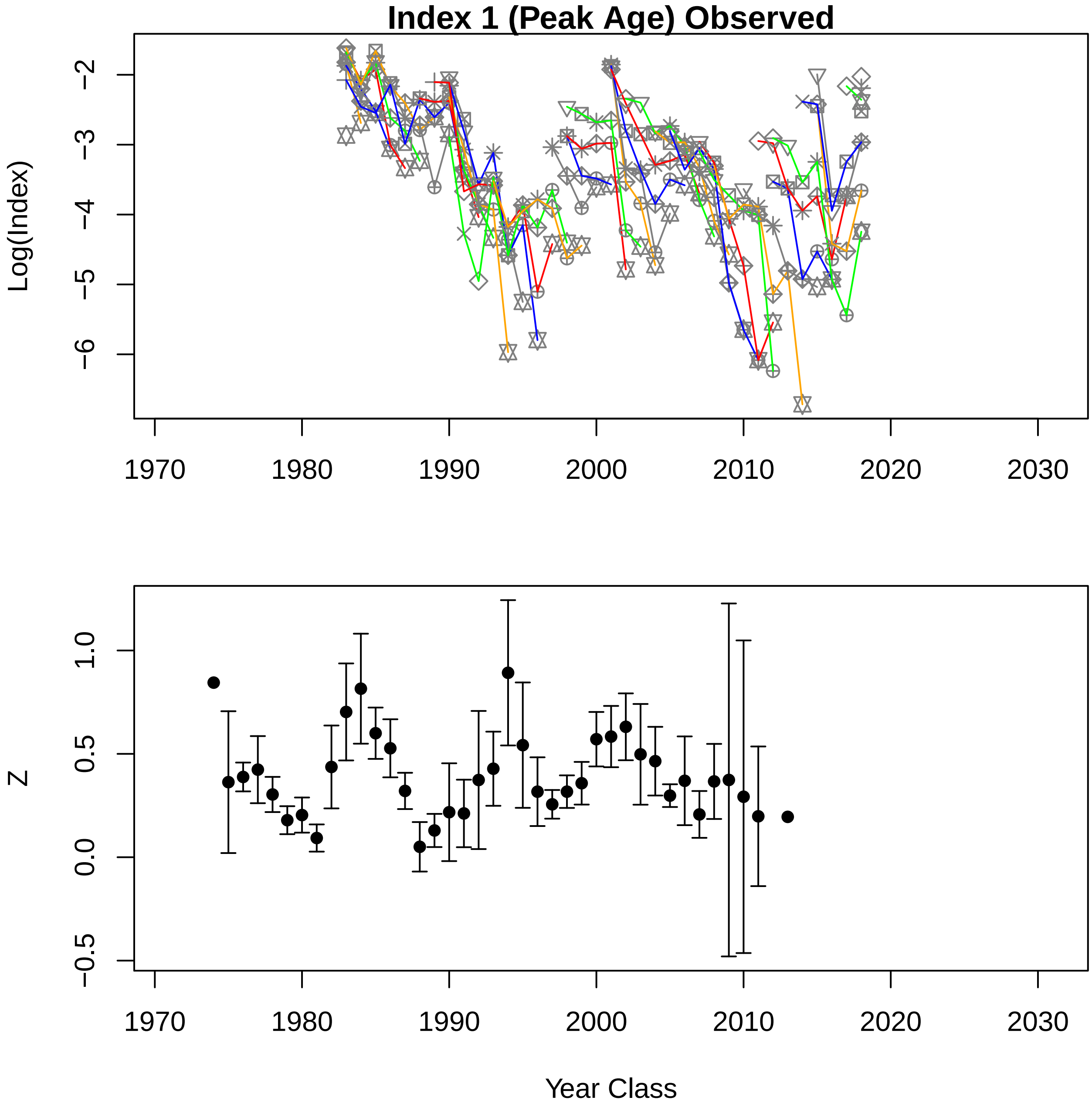
Rec + Com
Fmult by fleet
0.0
0.2
0.4
0.6
0.8
1985
1990
1995
2000
2005
2010
2015
2020
Year


Indices
CT Trawl
MRIP CPUE
Selectivity at age
0.0
0.2
0.4
0.6
0.8
1.0
Age
2
4
6
8
10
12
14

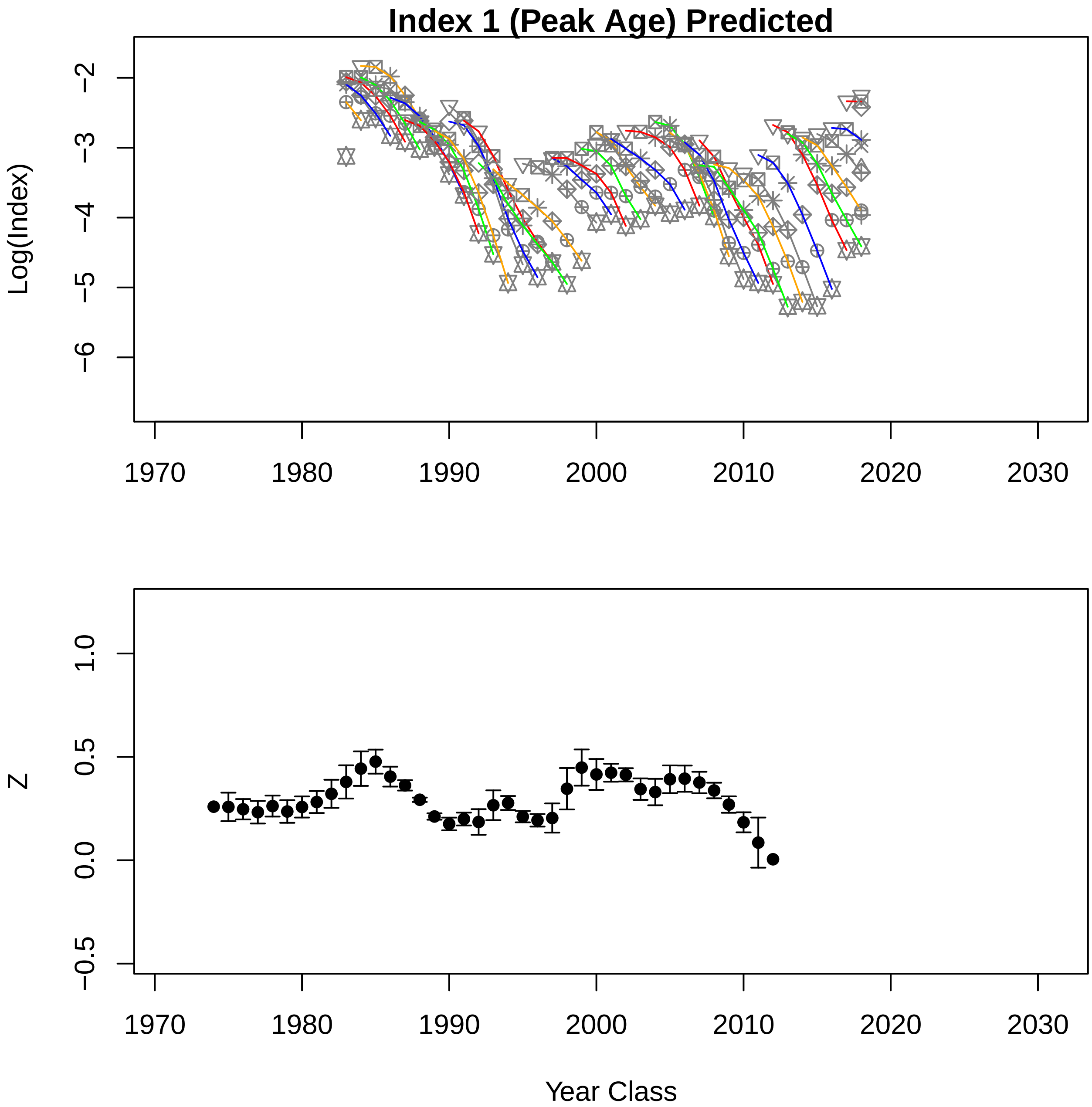


Catch (Peak Age) Observed
Log(Catch)
0
1
2
3
4
5
6
1970
1980
1990
2000
2010
2020
2030
Z
0.0
1.0
2.0
3.0
1970
1980
1990
2000
2010
2020
2030
Year Class

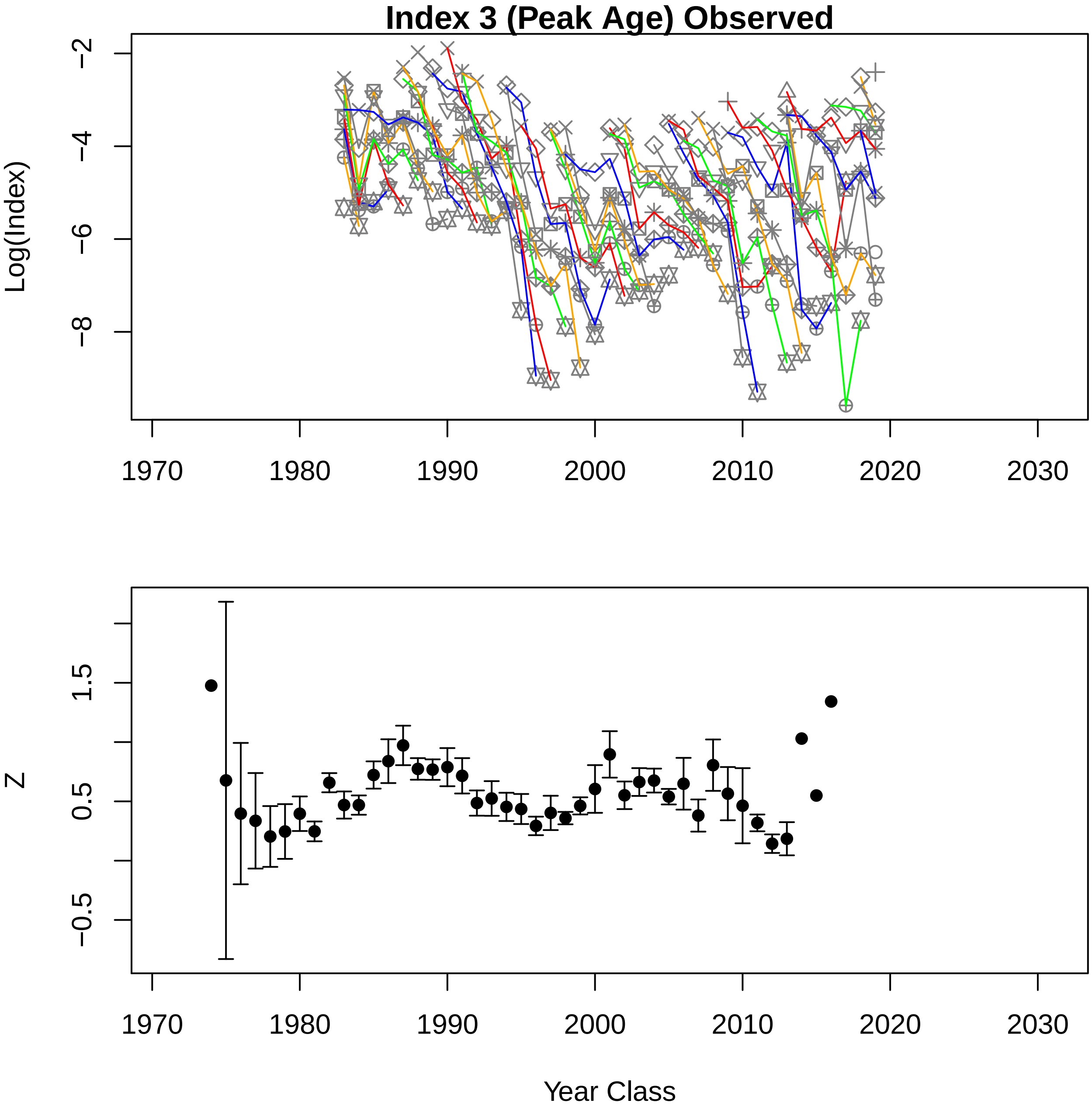

Catch (Peak Age) Predicted
Log(Catch)
0
1
2
3
4
5
6
1970
1980
1990
2000
2010
2020
2030
Z
0.0
1.0
2.0
3.0
Year Class



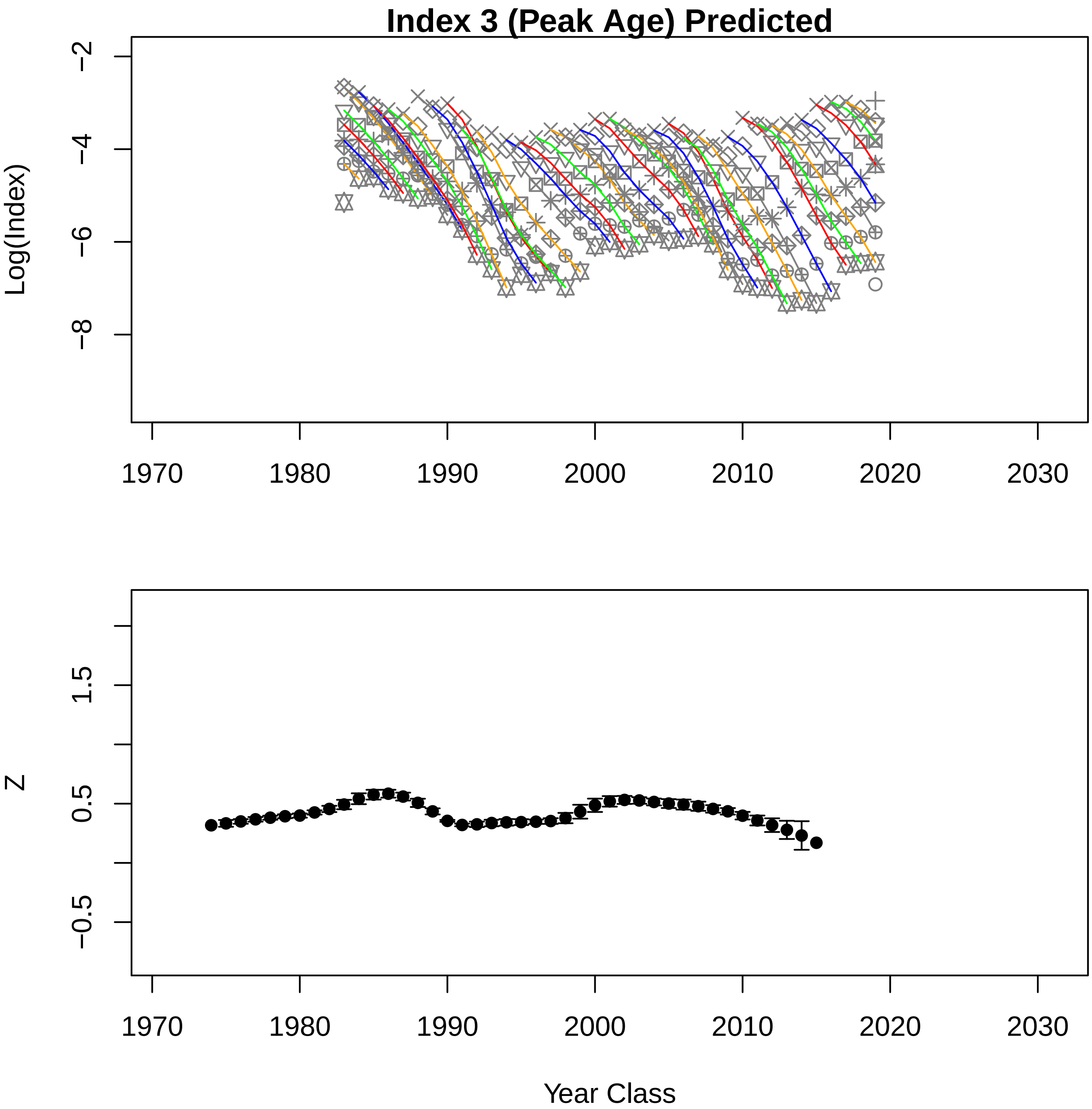
Index 1 (Peak Age) Observed
Log(Index)
−2
−3
−4
−5
−6
1970
1980
1990
2000
2010
2020
2030
Z
1.0
0.5
0.0
−0.5
1970
1980
1990
2000
2010
2020
2030
Year Class



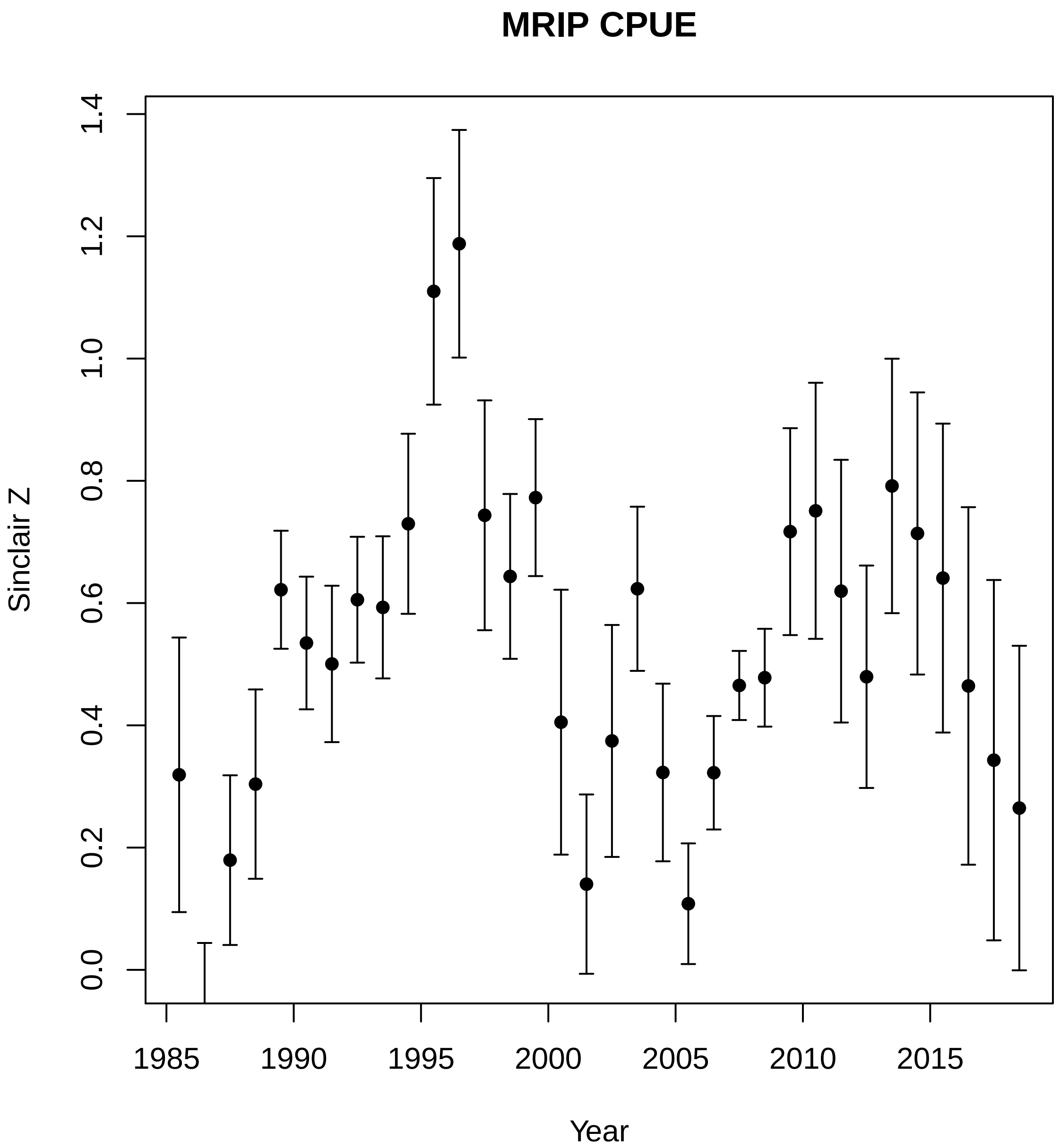
Index 1 (Peak Age) Predicted
Log(Index)
−2
−3
−4
−5
−6
1970
1980
1990
2000
2010
2020
2030
Z
1.0
0.5
0.0
−0.5
Year Class



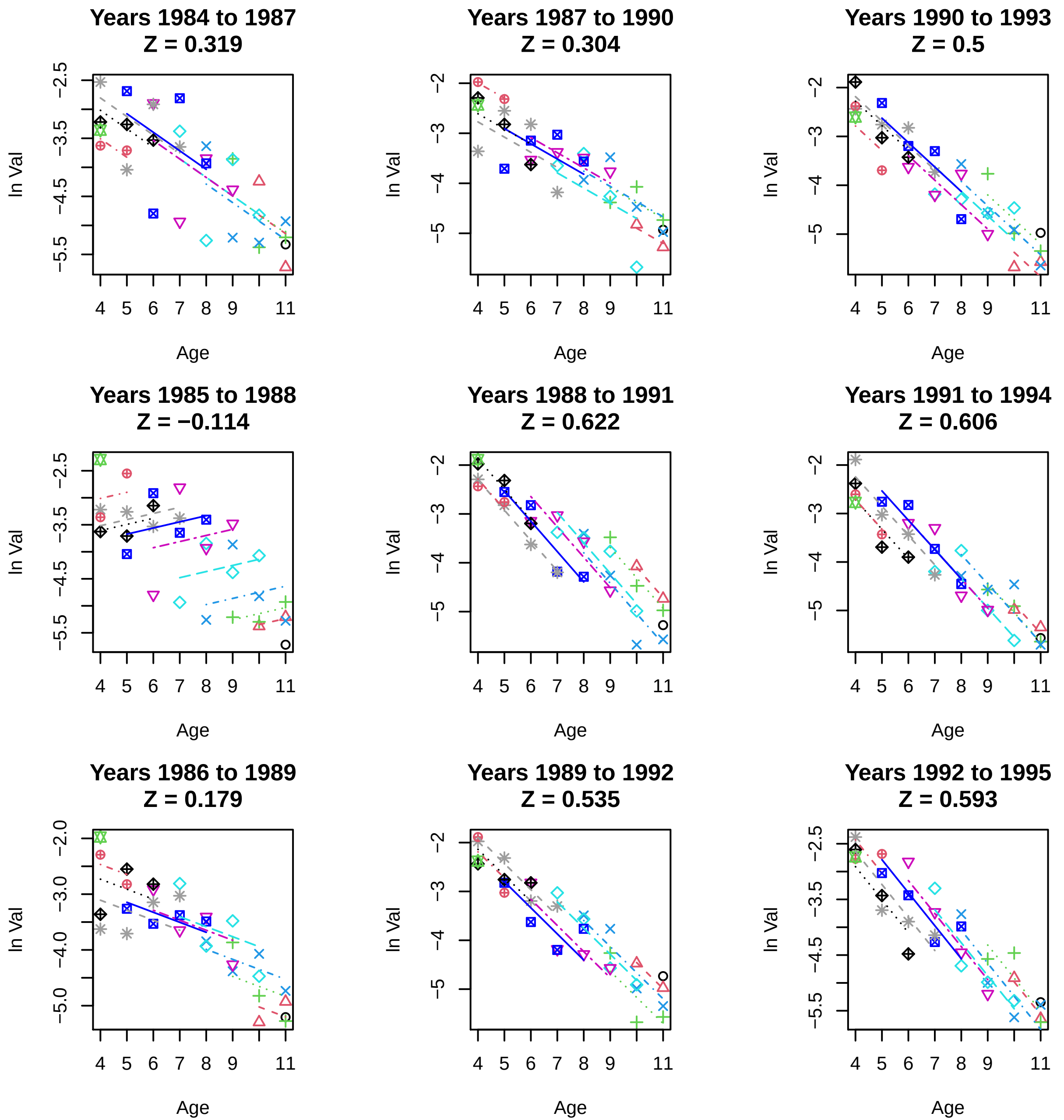
Index 3 (Peak Age) Observed
Log(Index)
−2
−4
−6
−8
1970
1980
1990
2000
2010
2020
2030
Z
1.5
0.5
−0.5
1970
1980
1990
2000
2010
2020
2030
Year Class

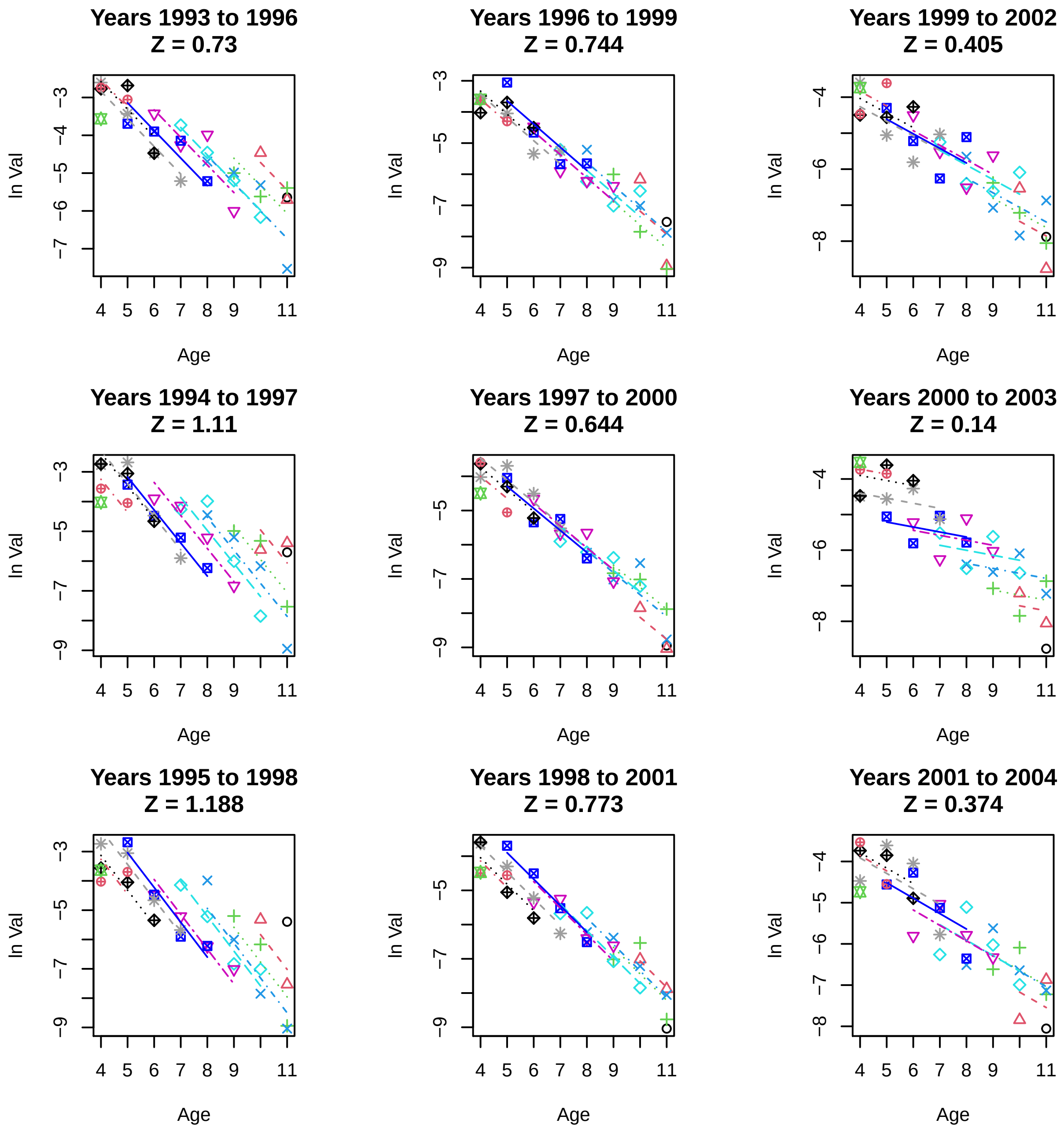


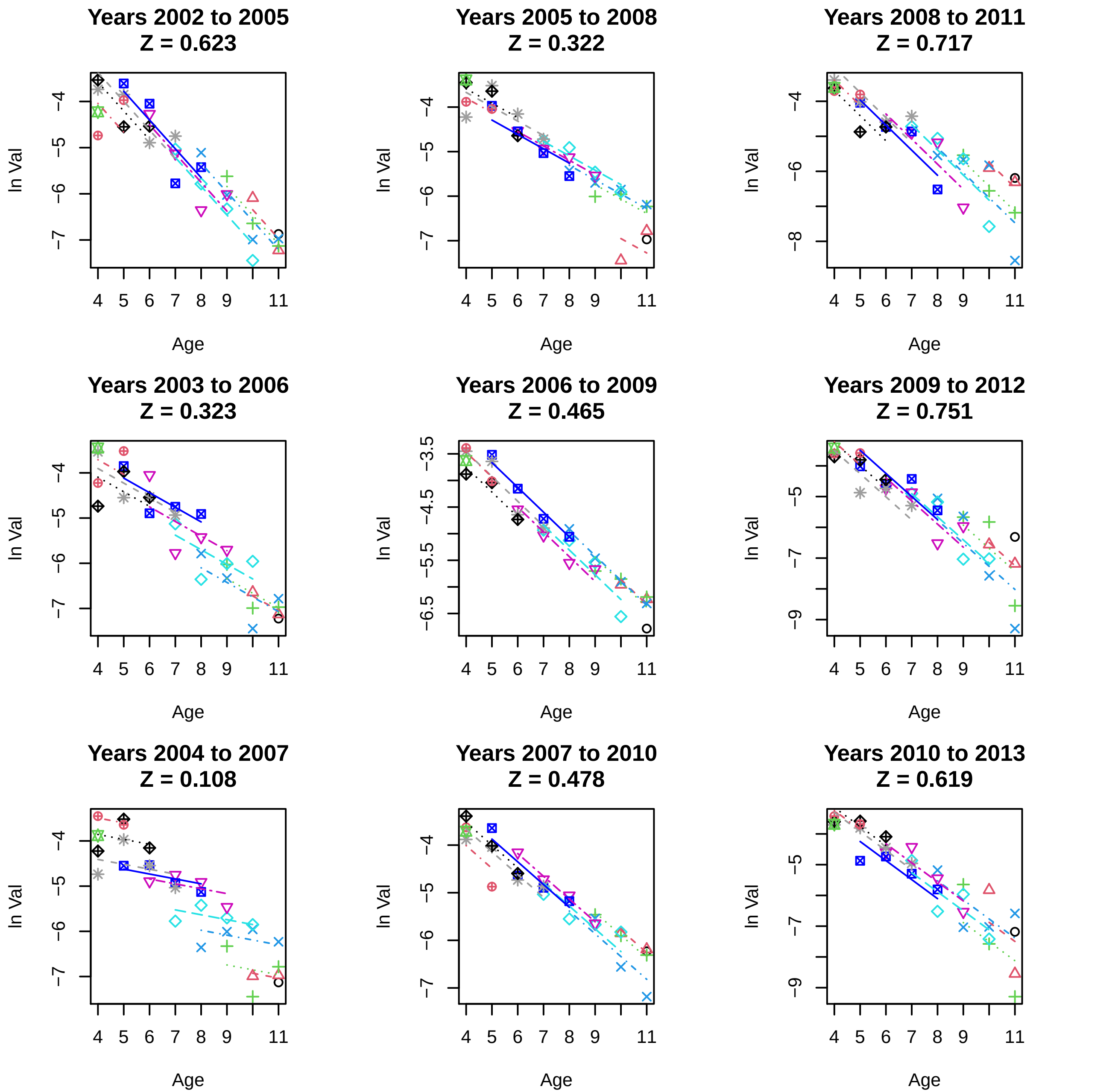
Index 3 (Peak Age) Predicted
Log(Index)
−2
−4
−6
−8
1970
1980
1990
2000
2010
2020
2030
Z
−0.5
0.5
1.5
Year Class



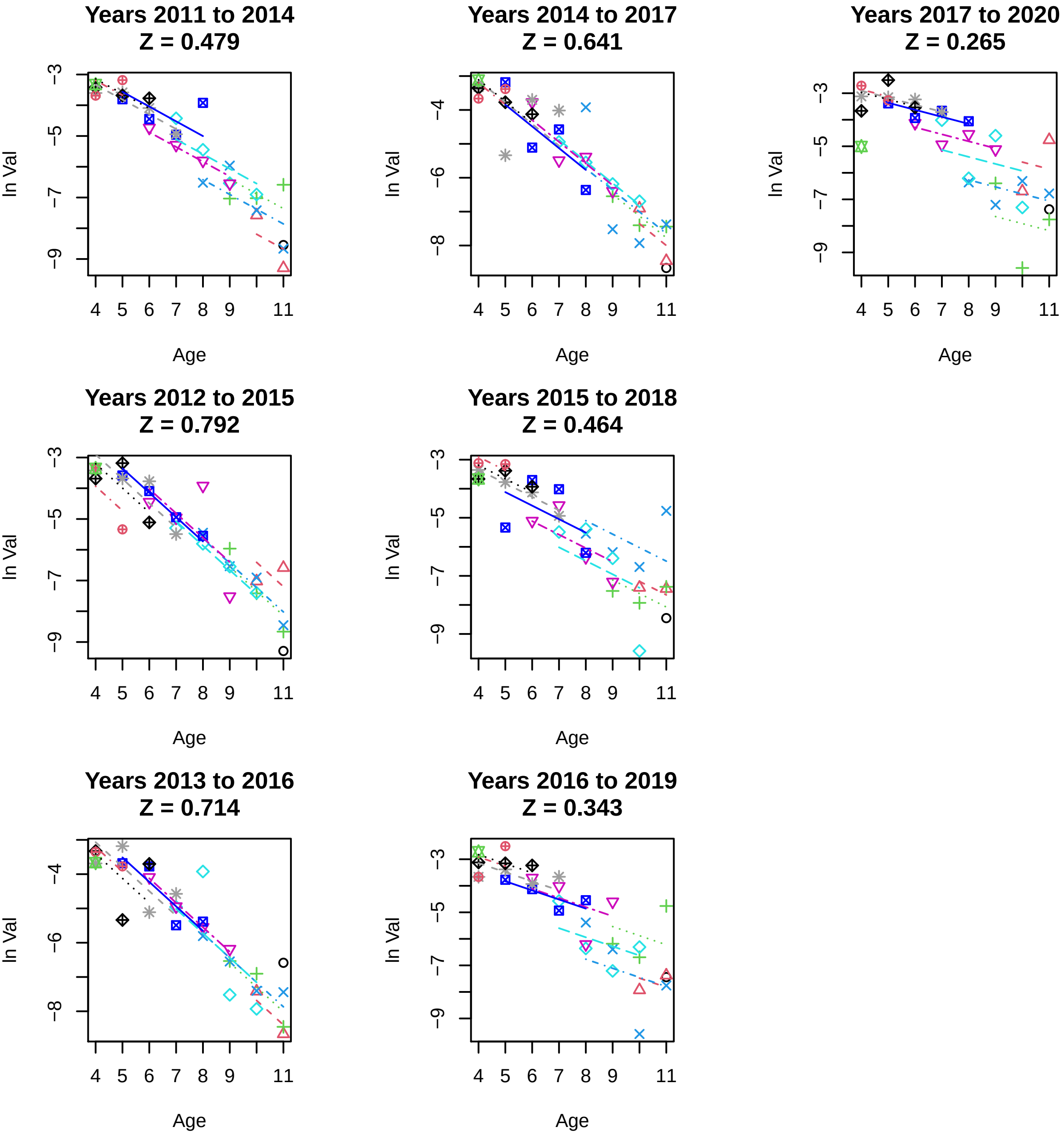
MRIP CPUE
Sinclair Z
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1985
1990
1995
2000
2005
2010
2015
Year

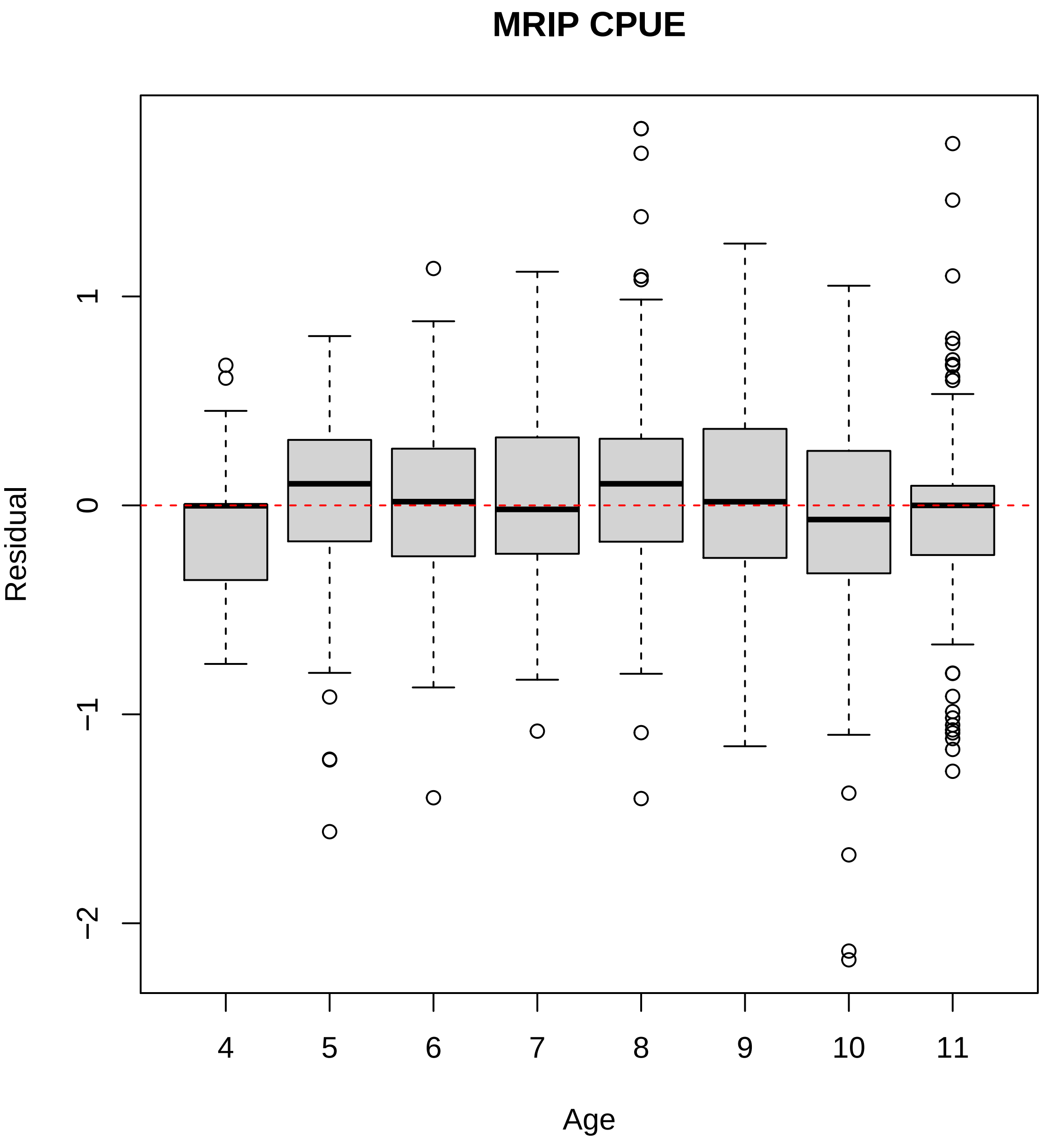

Years 1984 to 1987
Z = 0.319
Years 1987 to 1990
Z = 0.304
Years 1990 to 1993
Z = 0.5
Years 1985 to 1988
Z = −0.114
Years 1988 to 1991
Z = 0.622
Years 1991 to 1994
Z = 0.606
Years 1986 to 1989
Z = 0.179
Years 1989 to 1992
Z = 0.535
Years 1992 to 1995
Z = 0.593
ln Val
Age

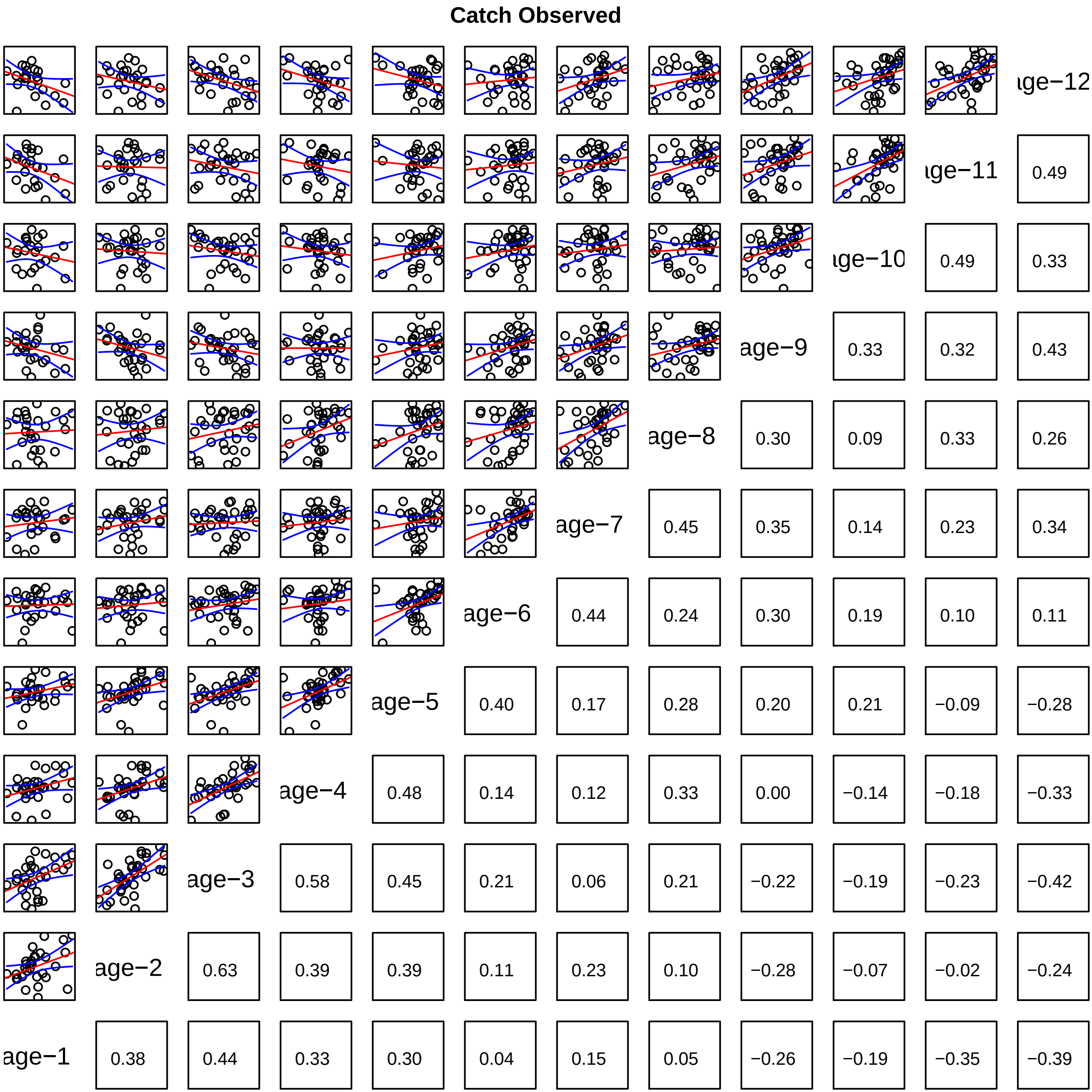

Years 1993 to 1996
Z = 0.73
Years 1996 to 1999
Z = 0.744
Years 1999 to 2002
Z = 0.405
Years 1994 to 1997
Z = 1.11
Years 1997 to 2000
Z = 0.644
Years 2000 to 2003
Z = 0.14
Years 1995 to 1998
Z = 1.188
Years 1998 to 2001
Z = 0.773
Years 2001 to 2004
Z = 0.374
ln Val
Age
4 5 6 7 8 9 11



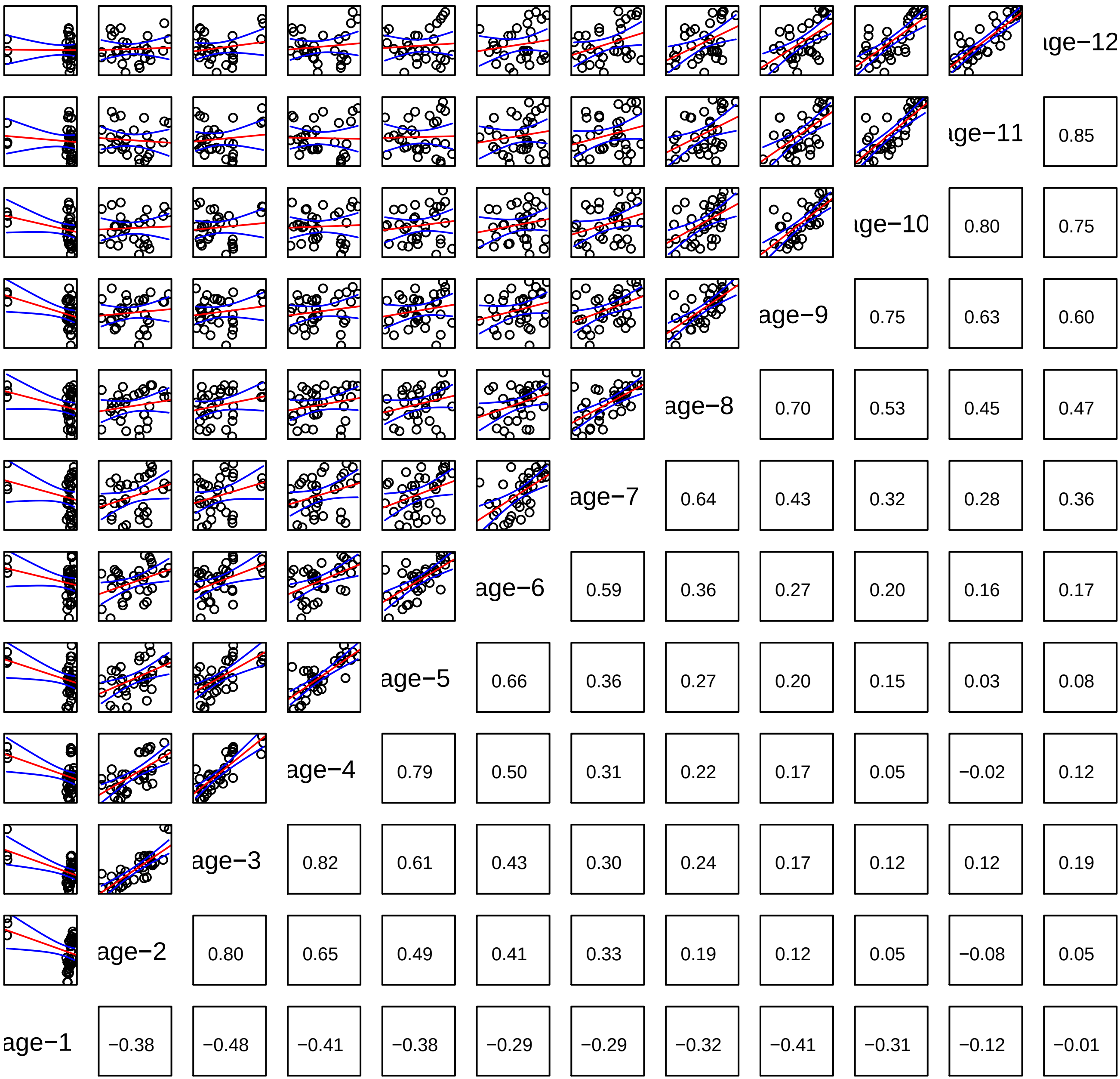
Years 2002 to 2005
Z = 0.623
Years 2005 to 2008
Z = 0.322
Years 2008 to 2011
Z = 0.717
Years 2003 to 2006
Z = 0.323
Years 2006 to 2009
Z = 0.465
Years 2009 to 2012
Z = 0.751
Years 2004 to 2007
Z = 0.108
Years 2007 to 2010
Z = 0.478
Years 2010 to 2013
Z = 0.619
ln Val
Age


Years 2011 to 2014
Z = 0.479
Years 2014 to 2017
Z = 0.641
Years 2017 to 2020
Z = 0.265
Years 2012 to 2015
Z = 0.792
Years 2015 to 2018
Z = 0.464
Years 2013 to 2016
Z = 0.714
Years 2016 to 2019
Z = 0.343
ln Val
Age
4 5 6 7 8 9 11
−3 −5 −7 −9
−4 −6 −8

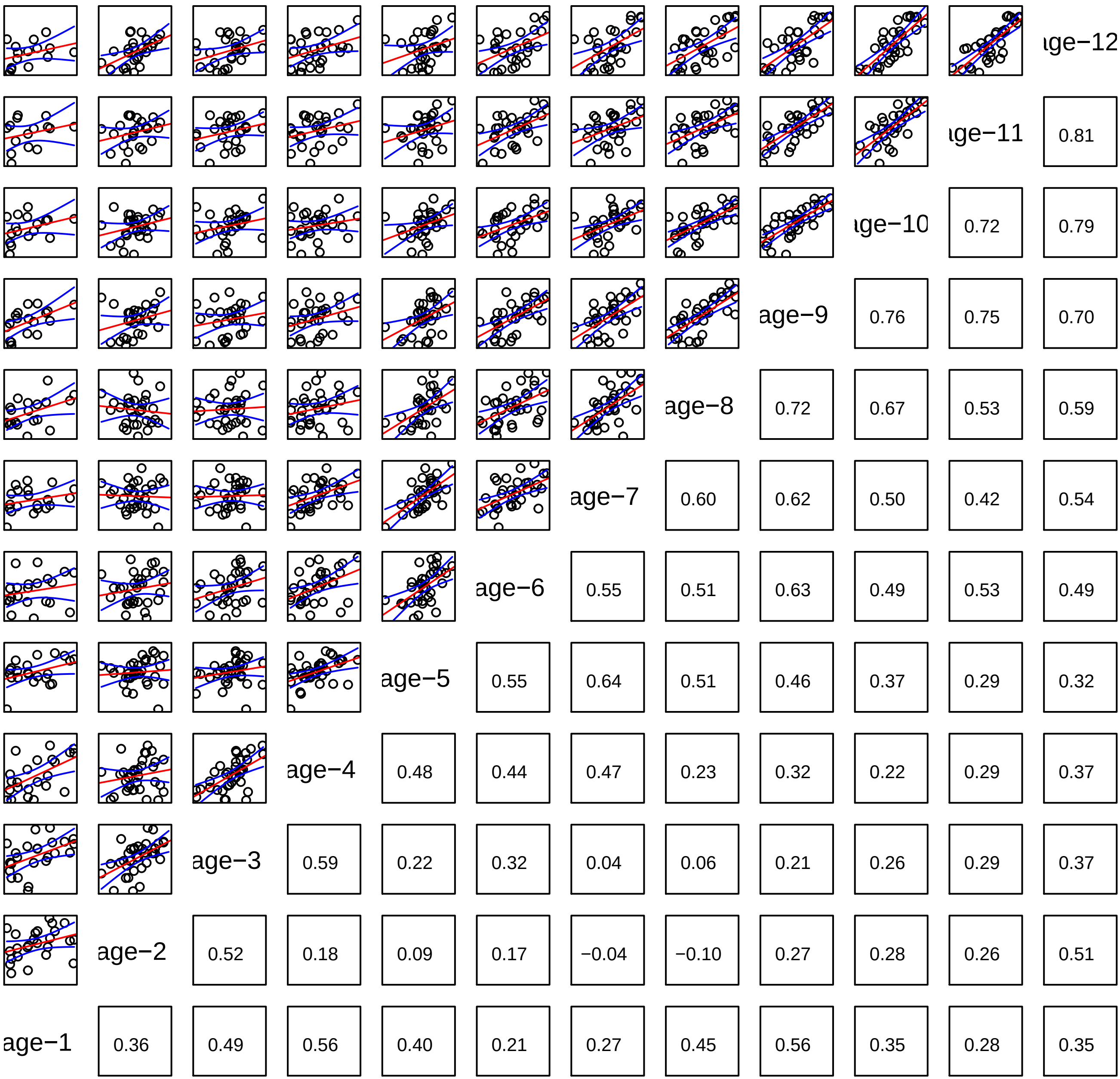

MRIP CPUE
Residual
Age
1
0
−1
−2
4
5
6
7
8
9
10
11


Catch Observed
age−12
age−11
0.49
age−10
0.49 0.33
age−9
0.33 0.32 0.43
age−8
0.30 0.09 0.33 0.26
age−7
0.45 0.35 0.14 0.23 0.34
age−6
0.44 0.24 0.30 0.19 0.10 0.11
age−5
0.40 0.17 0.28 0.20 0.21 −0.09 −0.28
age−4
0.48 0.14 0.12 0.33 0.00 −0.14 −0.18 −0.33
age−3
0.58 0.45 0.21 0.06 0.21 −0.22 −0.19 −0.23 −0.42
age−2
0.63 0.39 0.39 0.11 0.23 0.10 −0.28 −0.07 −0.02 −0.24
age−1
0.38 0.44 0.33 0.30 0.04 0.15 0.05 −0.26 −0.19 −0.35 −0.39

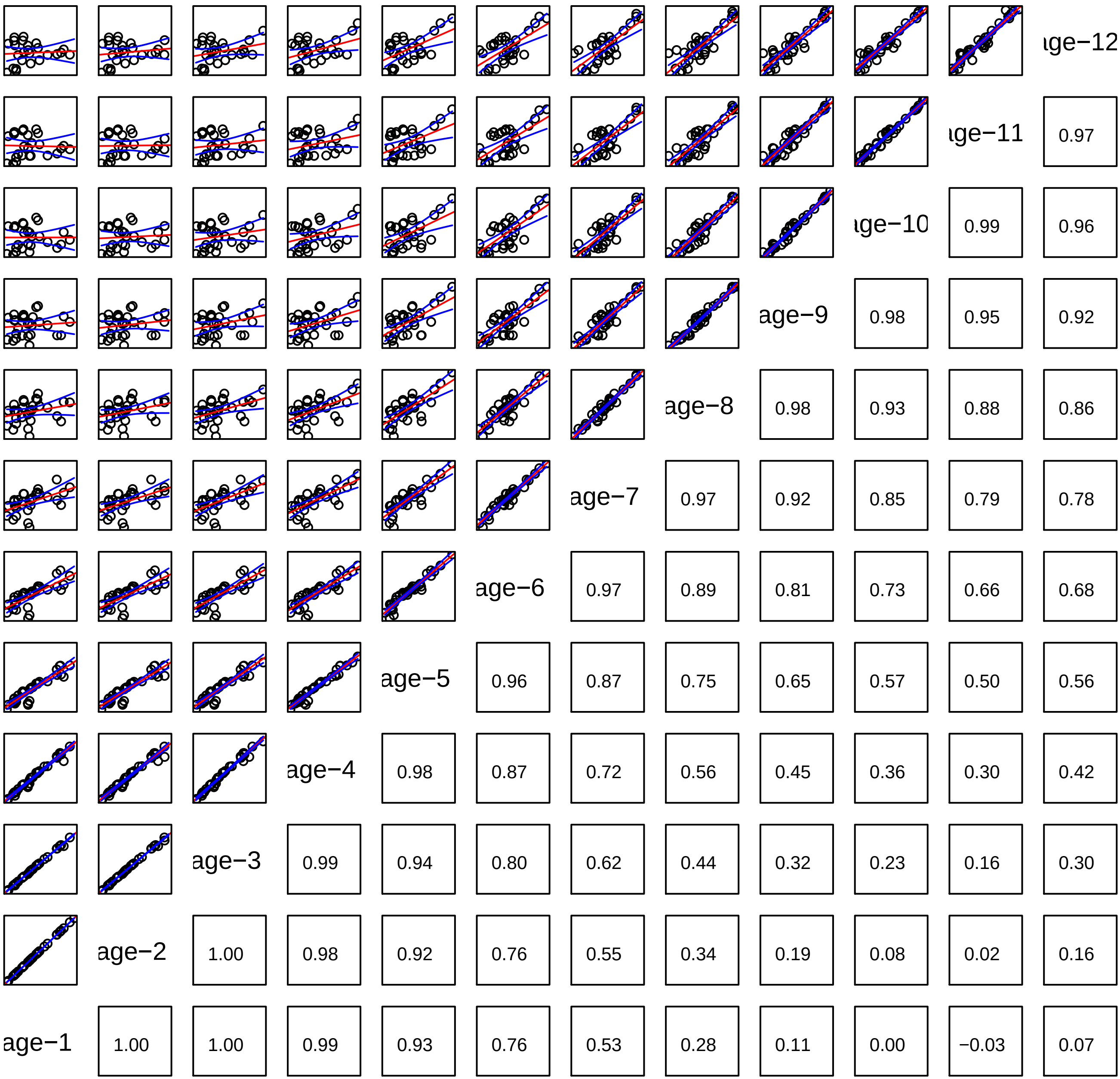
Catch Predicted



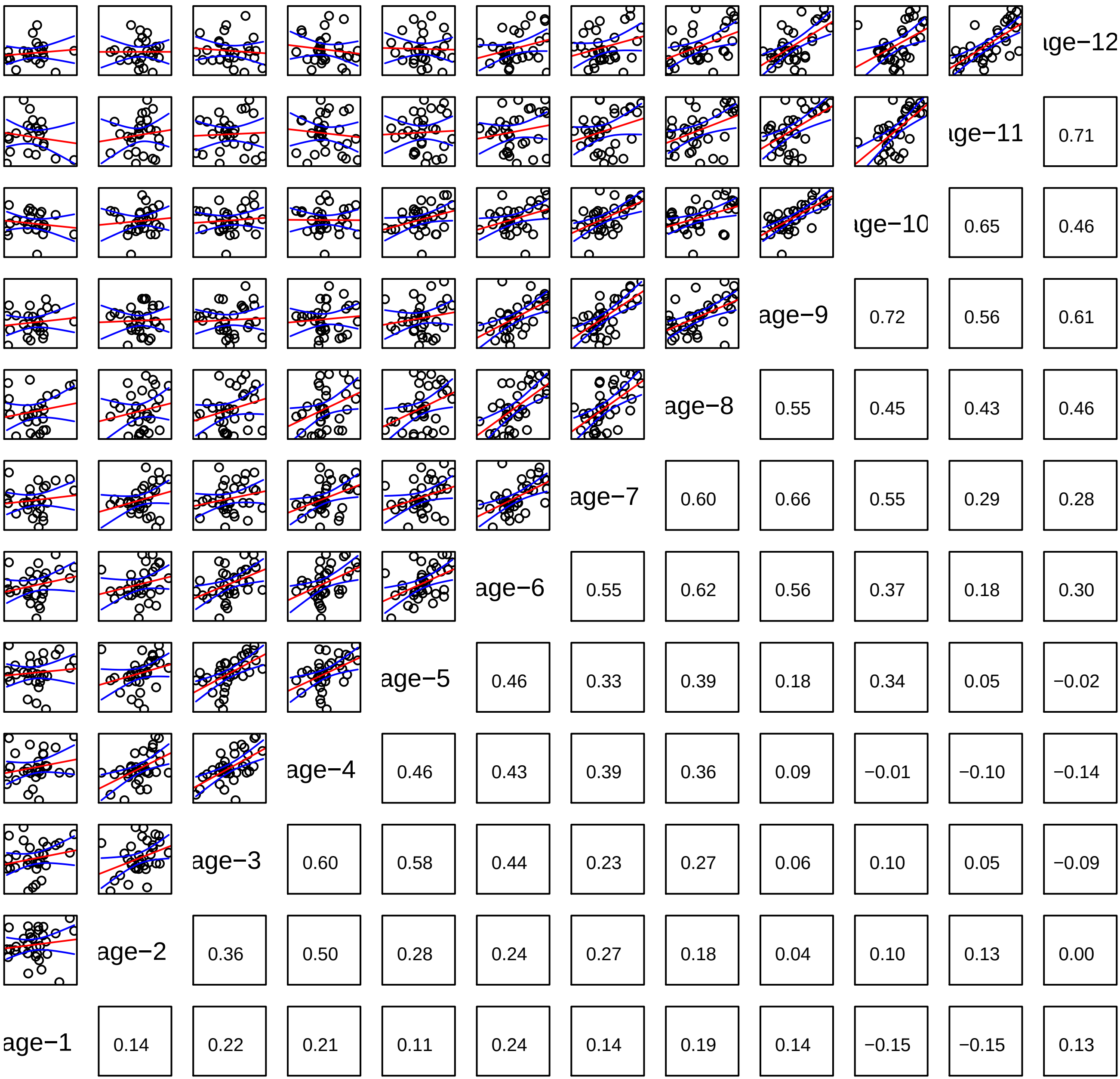
Index 1 (CT Trawl) Observed



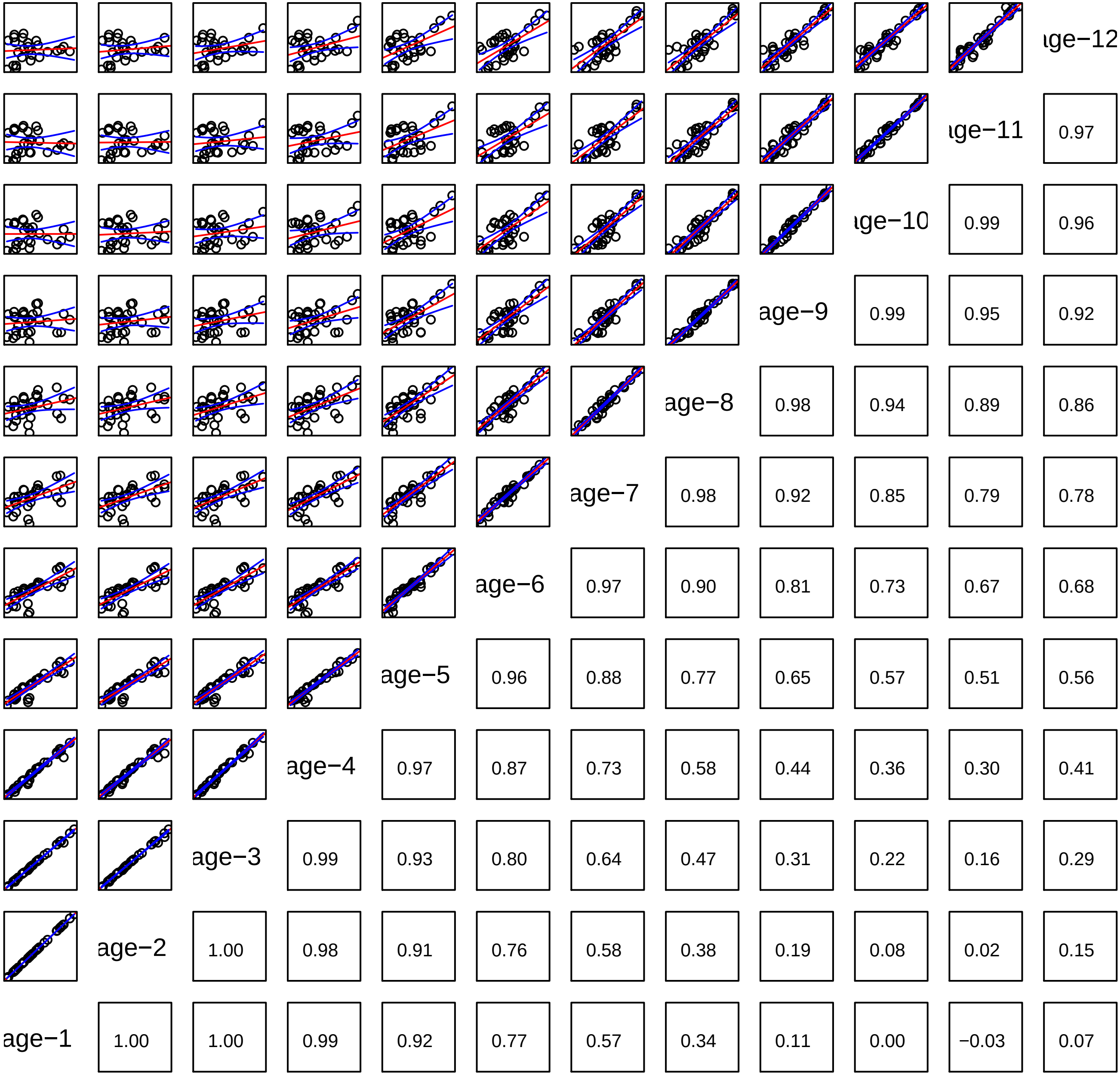
Index 1 (CT Trawl) Predicted

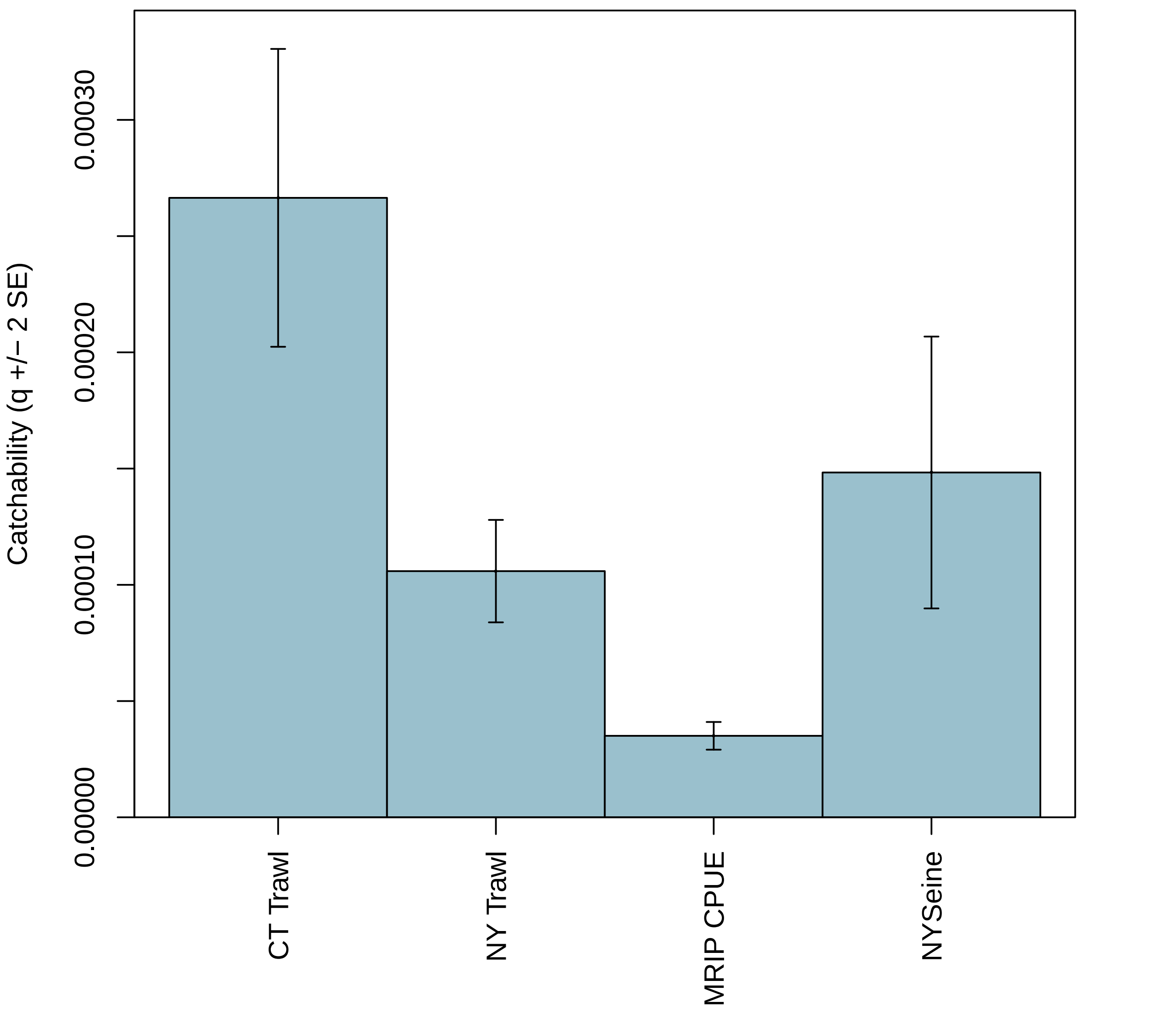


Index 3 (MRIP CPUE) Observed

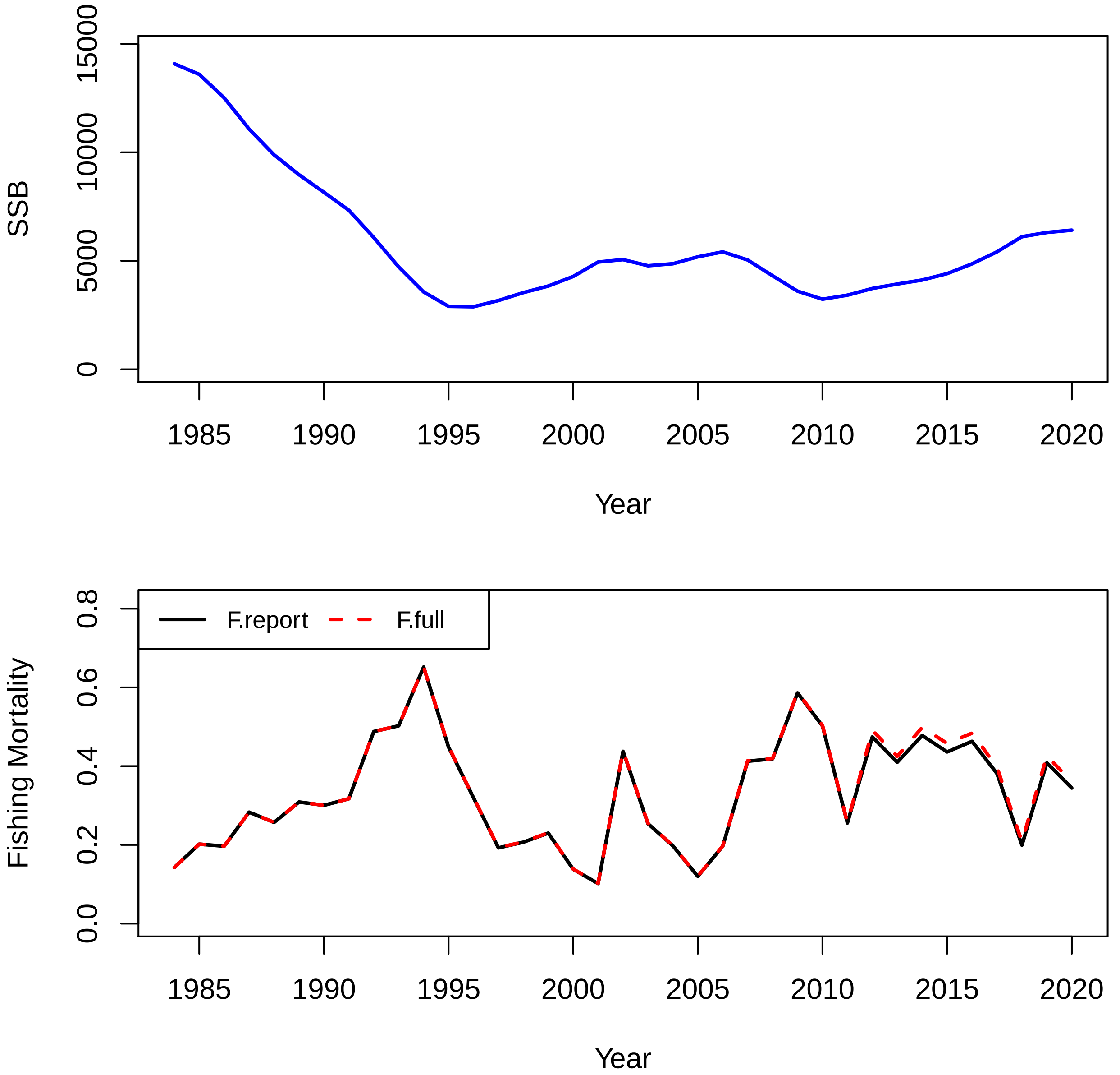


Index 3 (MRIP CPUE) Predicted

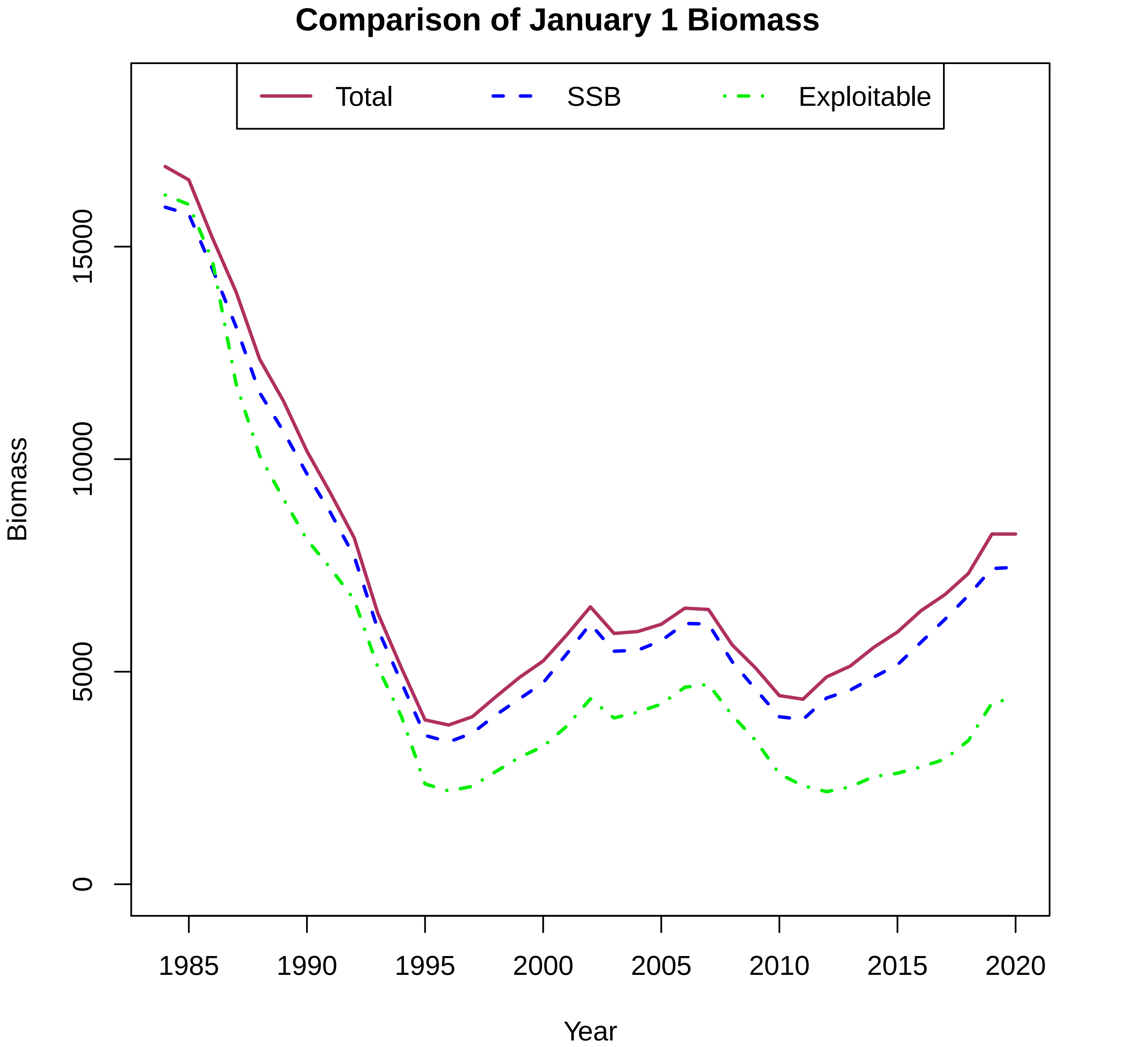




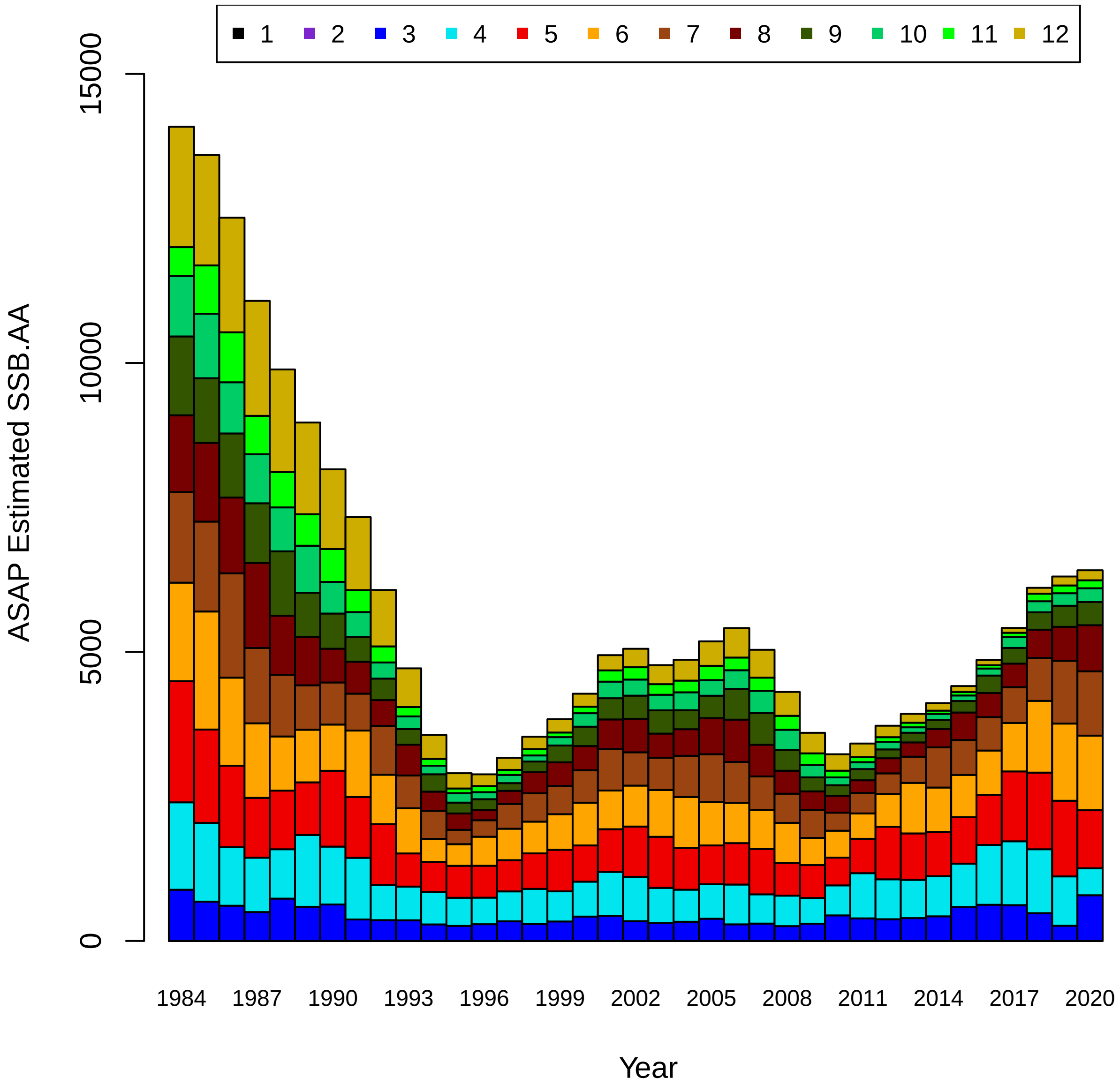
Catchability (q +/− 2 SE)
0.00000
0.00010
0.00020
0.00030
CT Trawl
NY Trawl
MRIP CPUE
NYSeine



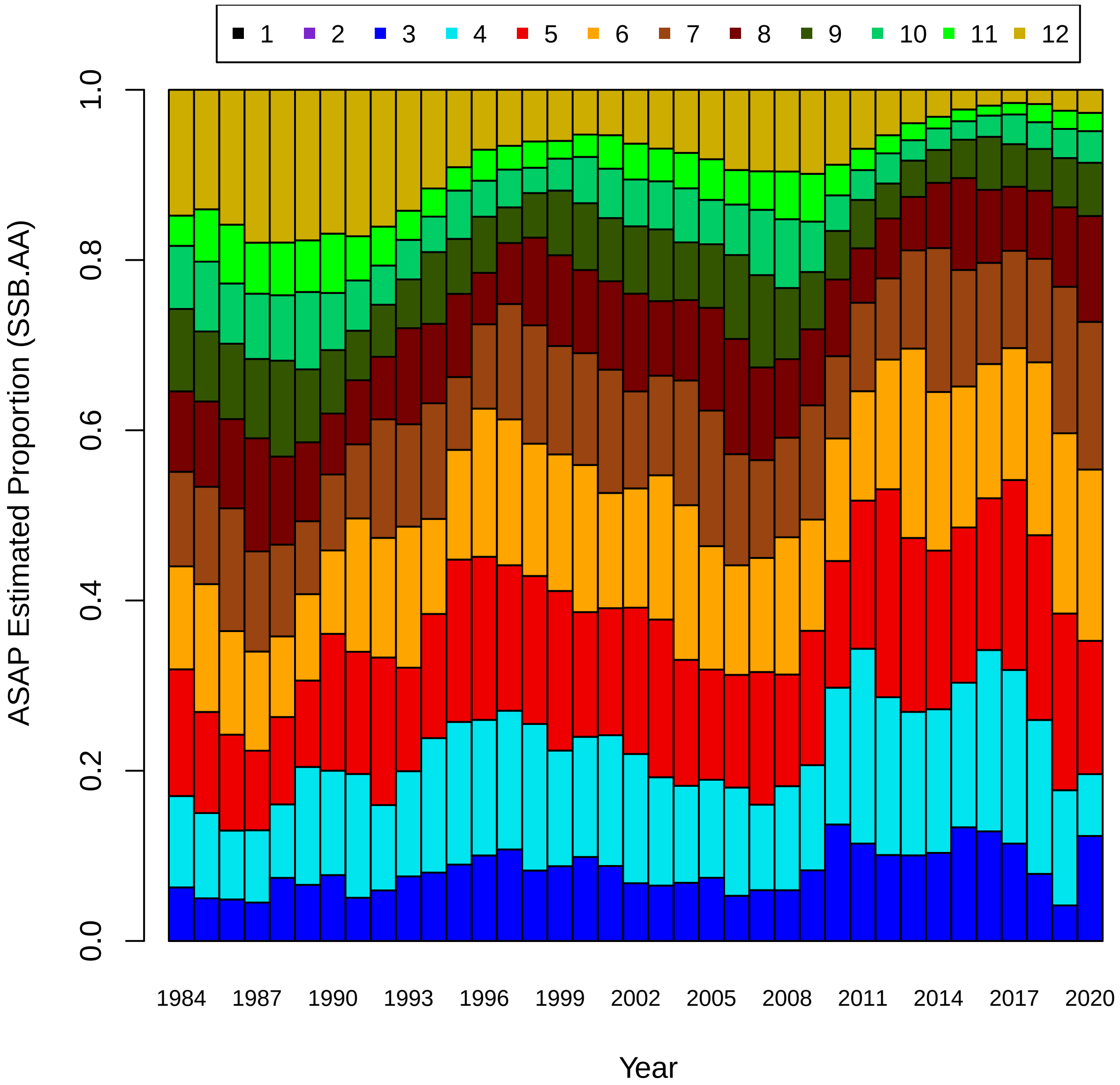
SSB
0
5000
10000
15000
1985
1990
1995
2000
2005
2010
2015
2020
Year
Fishing Mortality
0.0
0.2
0.4
0.6
0.8
F.report
F.full
1985
1990
1995
2000
2005
2010
2015
2020
Year

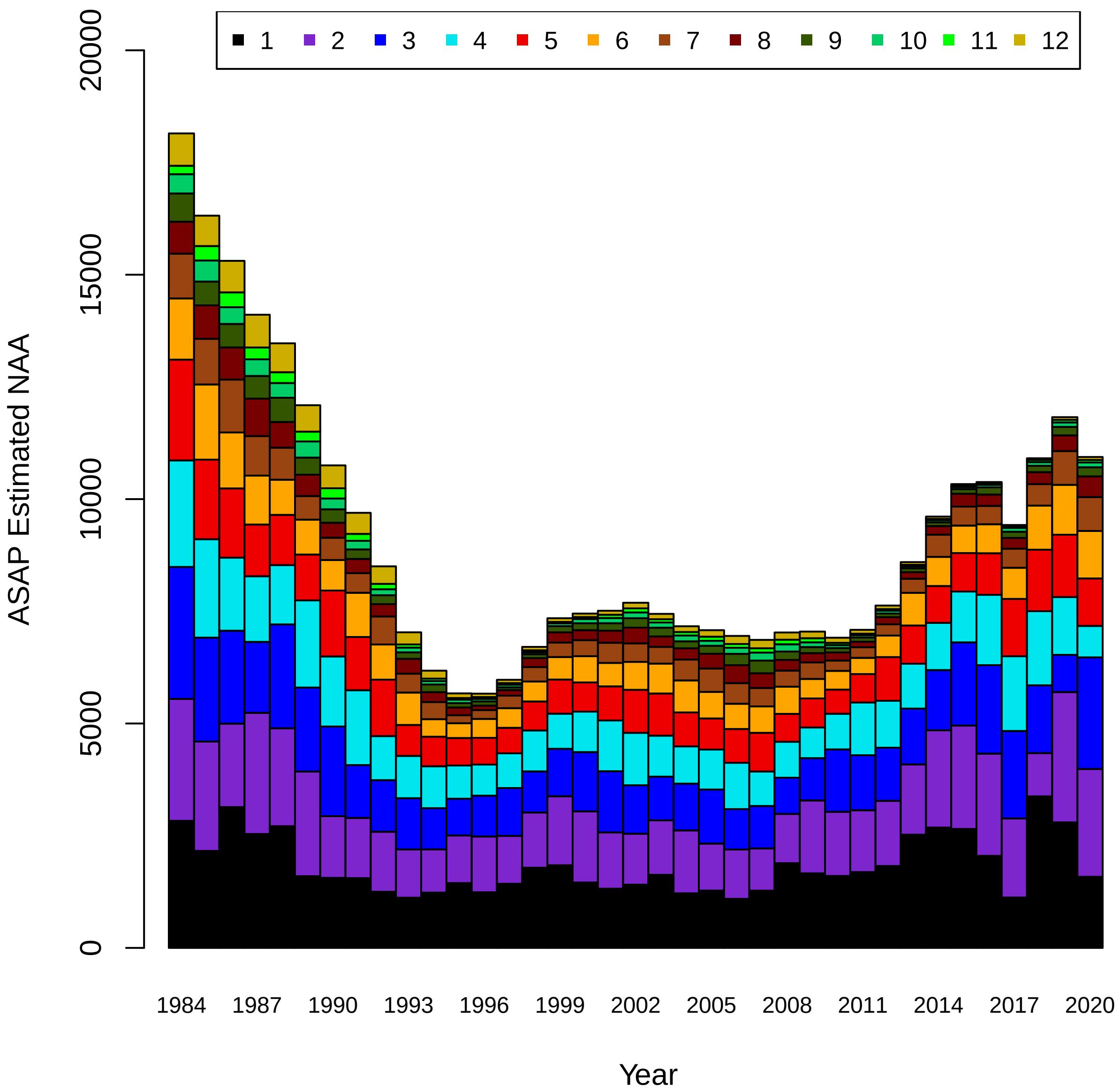


Comparison of January 1 Biomass
Total
SSB
Exploitable
Biomass
0
5000
10000
15000
1985
1990
1995
2000
2005
2010
2015
2020
Year

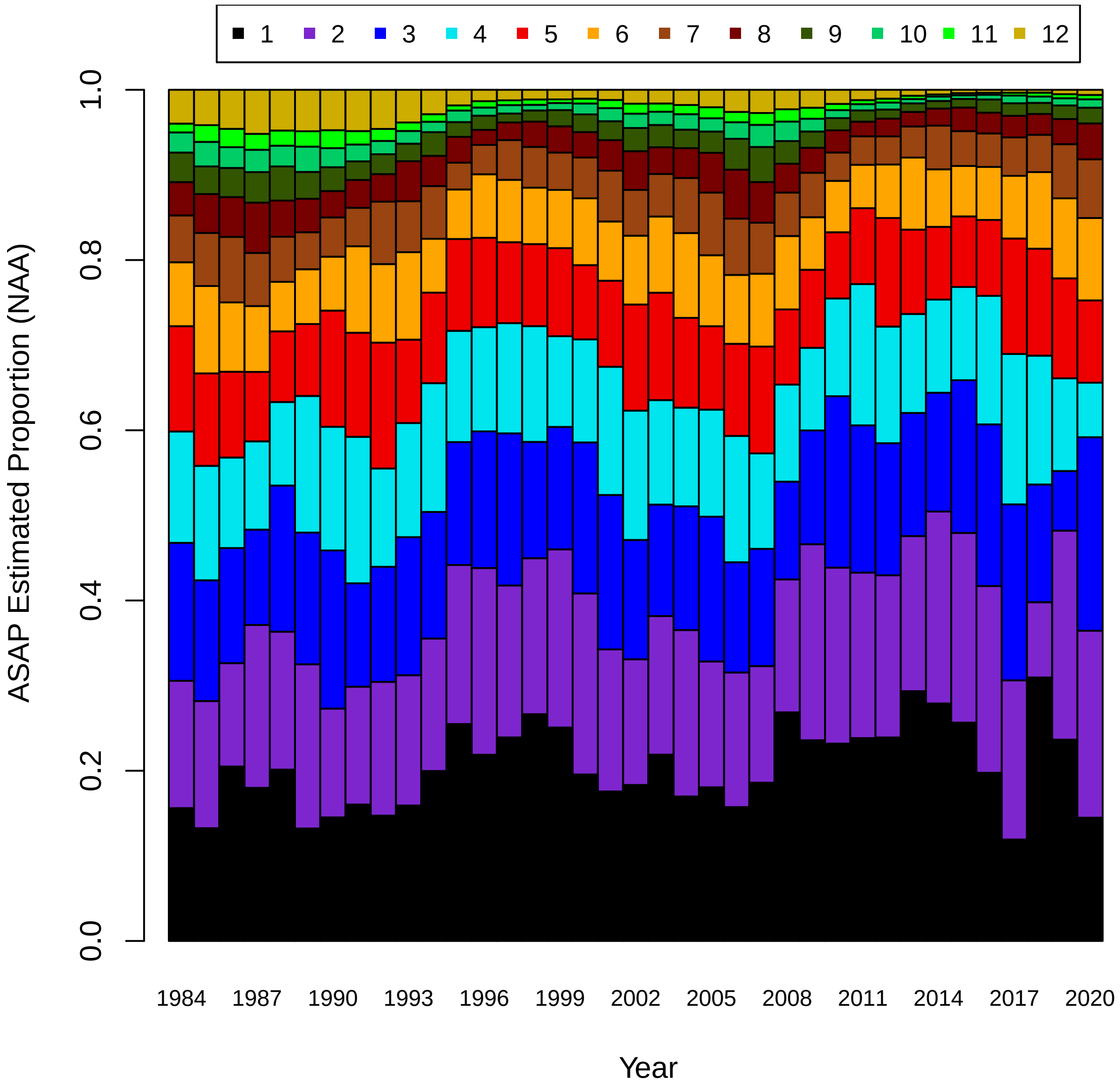


1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated SSB.AA
0
5000
10000
15000
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year

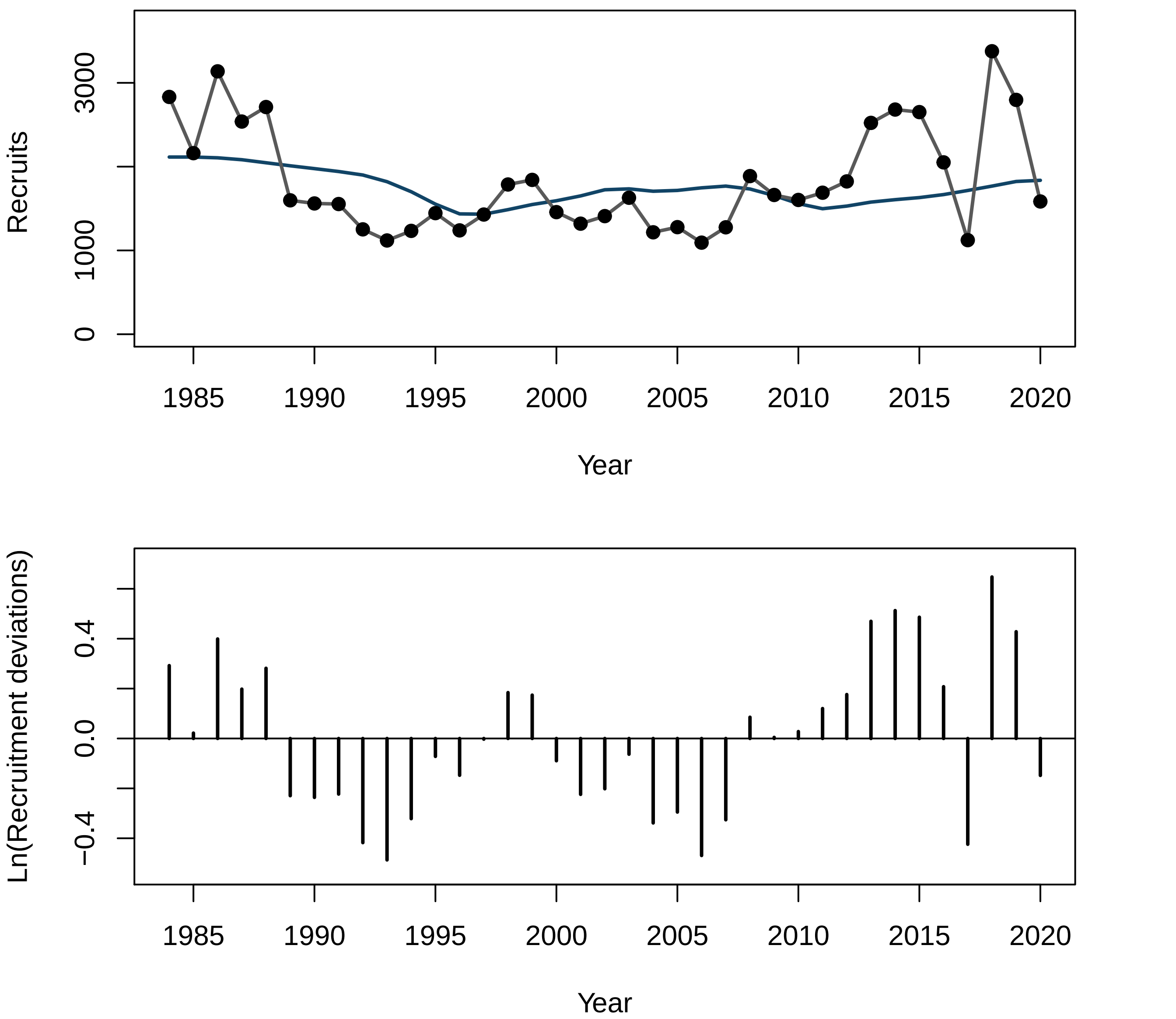

1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (SSB.AA)
0.0
0.2
0.4
0.6
0.8
1.0
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year

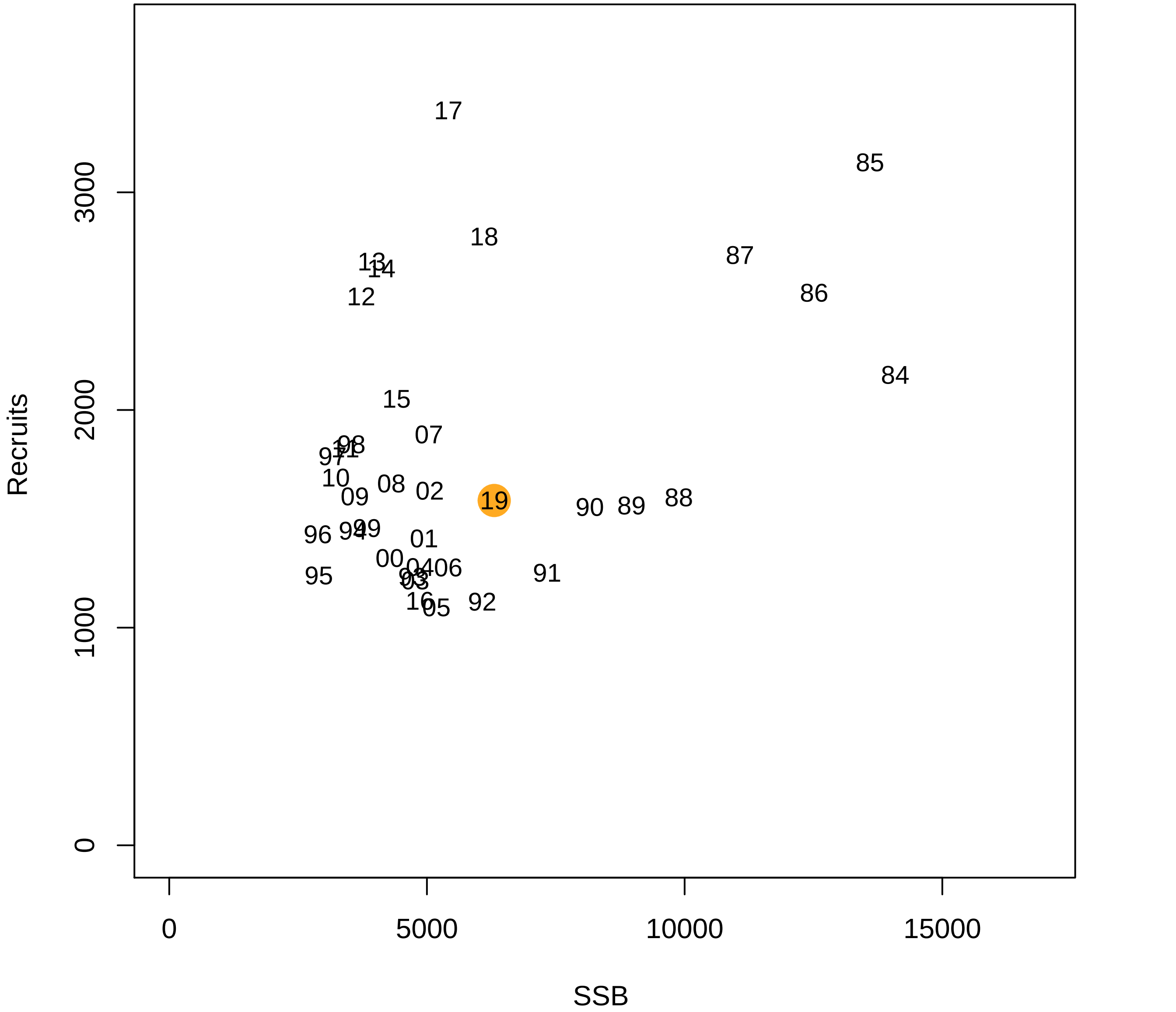


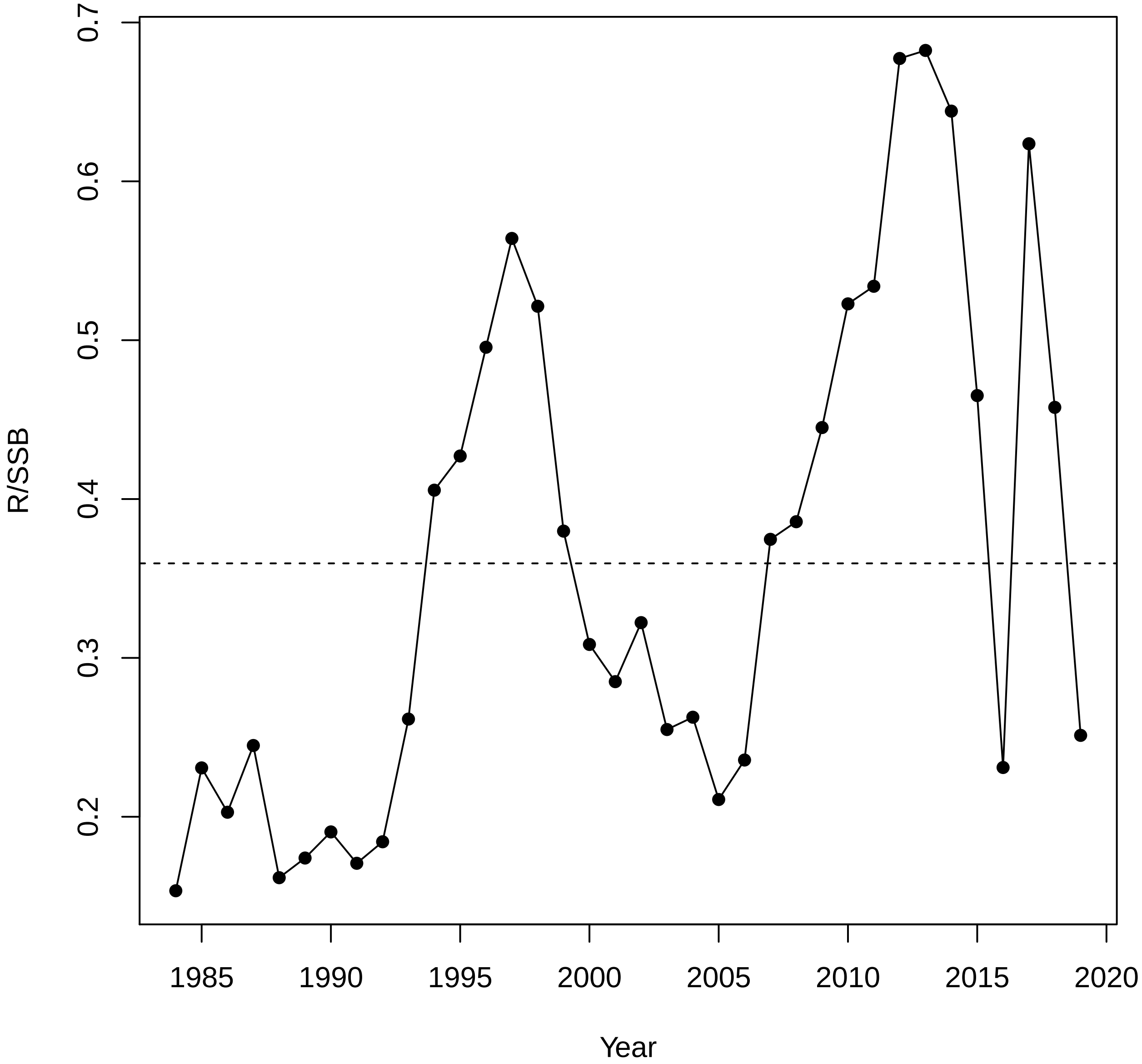
1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated NAA
0
5000
10000
15000
20000
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year



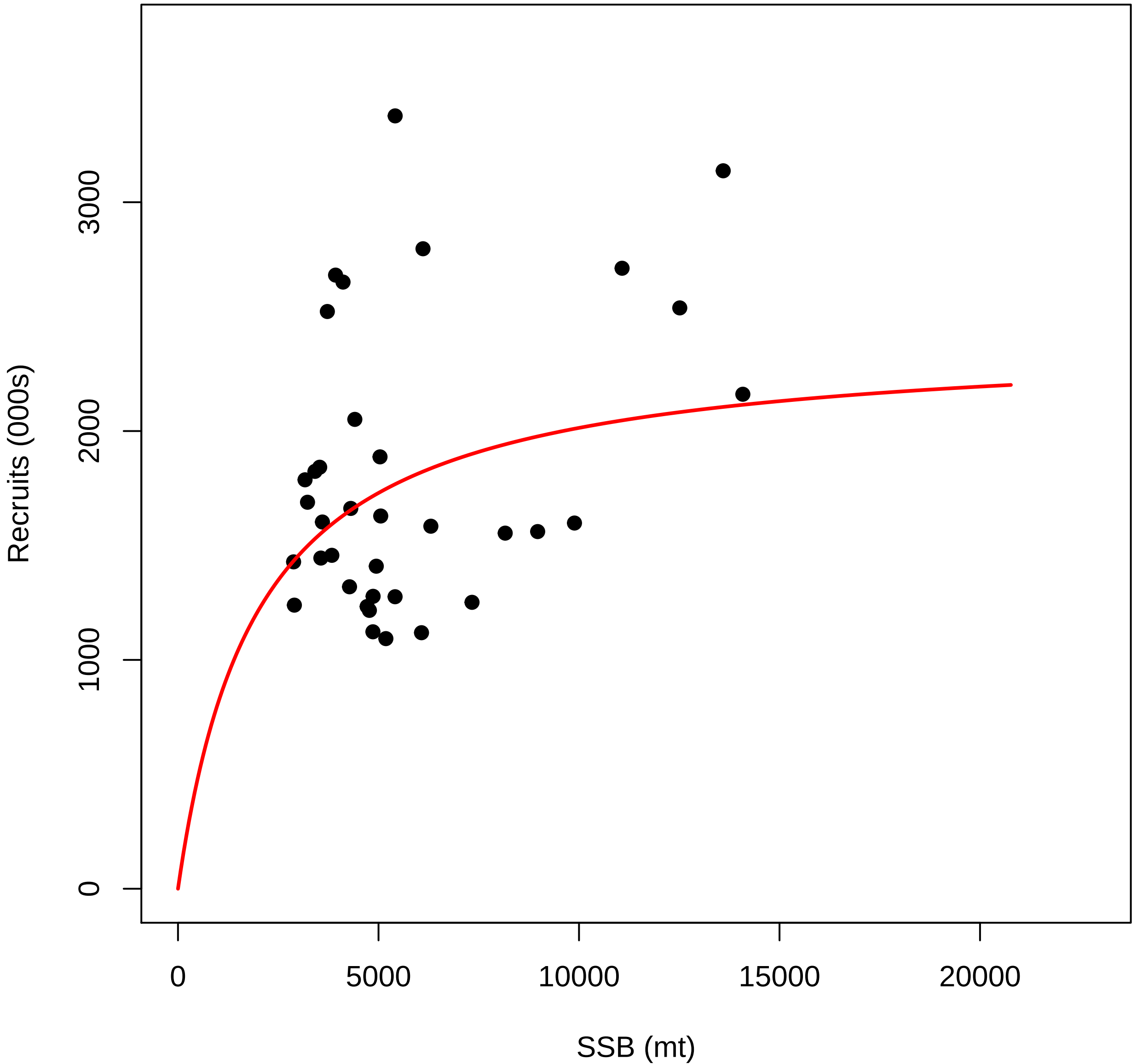
1 2 3 4 5 6 7 8 9 10 11 12
ASAP Estimated Proportion (NAA)
0.0
0.2
0.4
0.6
0.8
1.0
1984 1987 1990 1993 1996 1999 2002 2005 2008 2011 2014 2017 2020
Year


Recruits
0
1000
3000
1985
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Recruitment deviations)
−0.4
0.0
0.4
1985
1990
1995
2000
2005
2010
2015
2020
Year

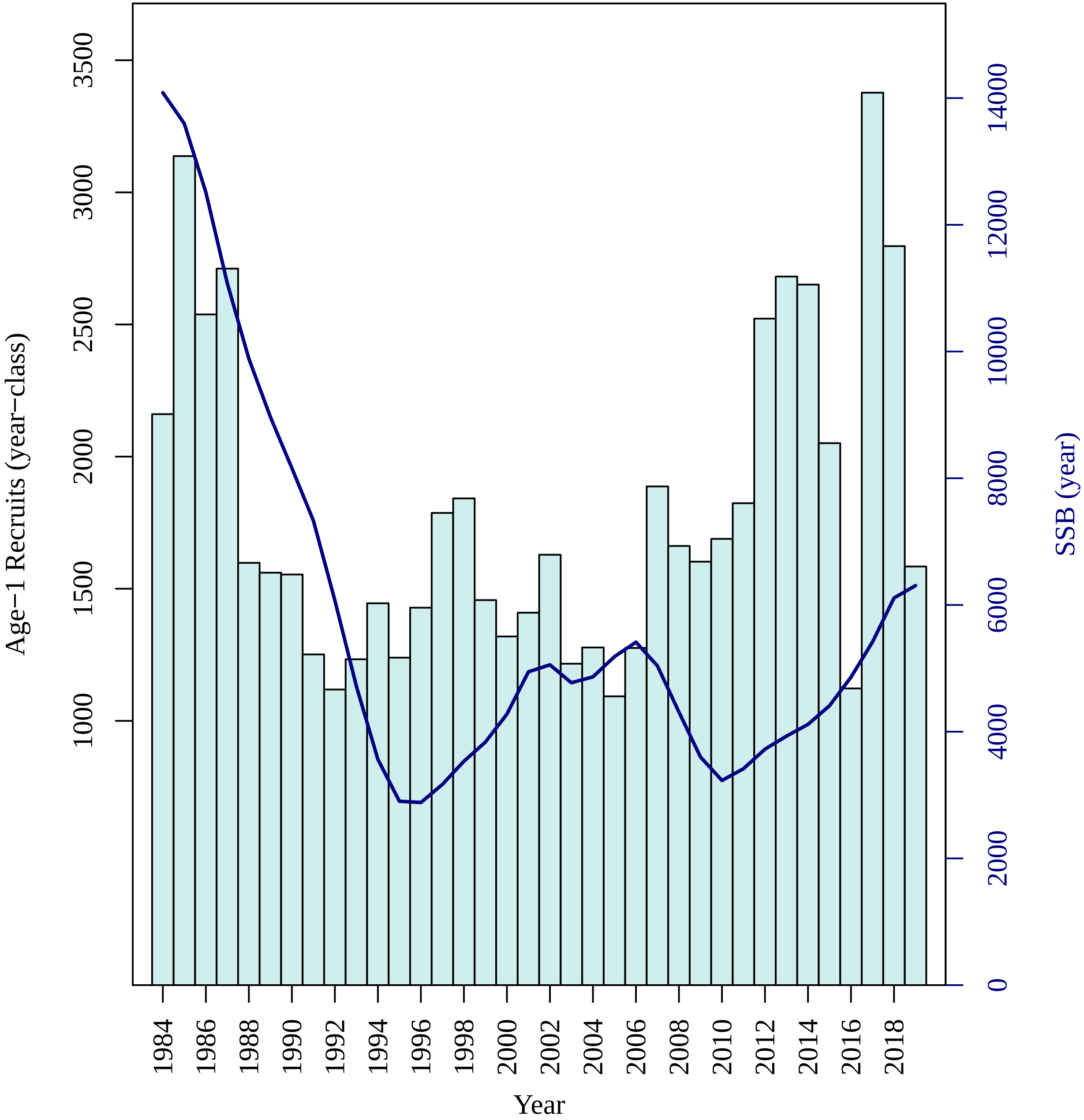

Recruits
SSB
0
1000
2000
3000
0
5000
10000
15000
17
85
18
87
13
14
12
86
84
15
07
98
97
10
08
02
19
09
90
89
88
96
99
01
00
06
91
95
03
16
05
92

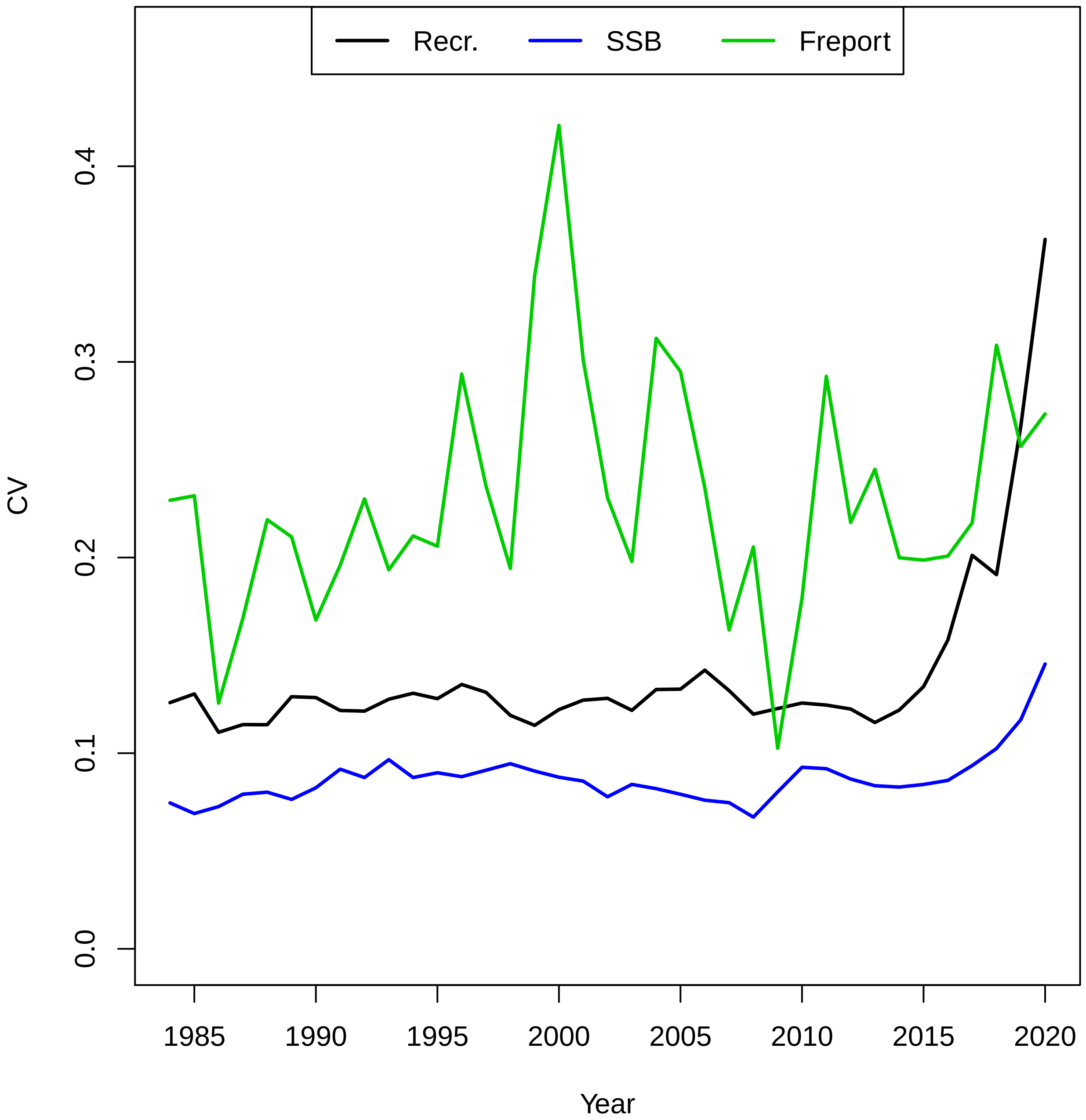


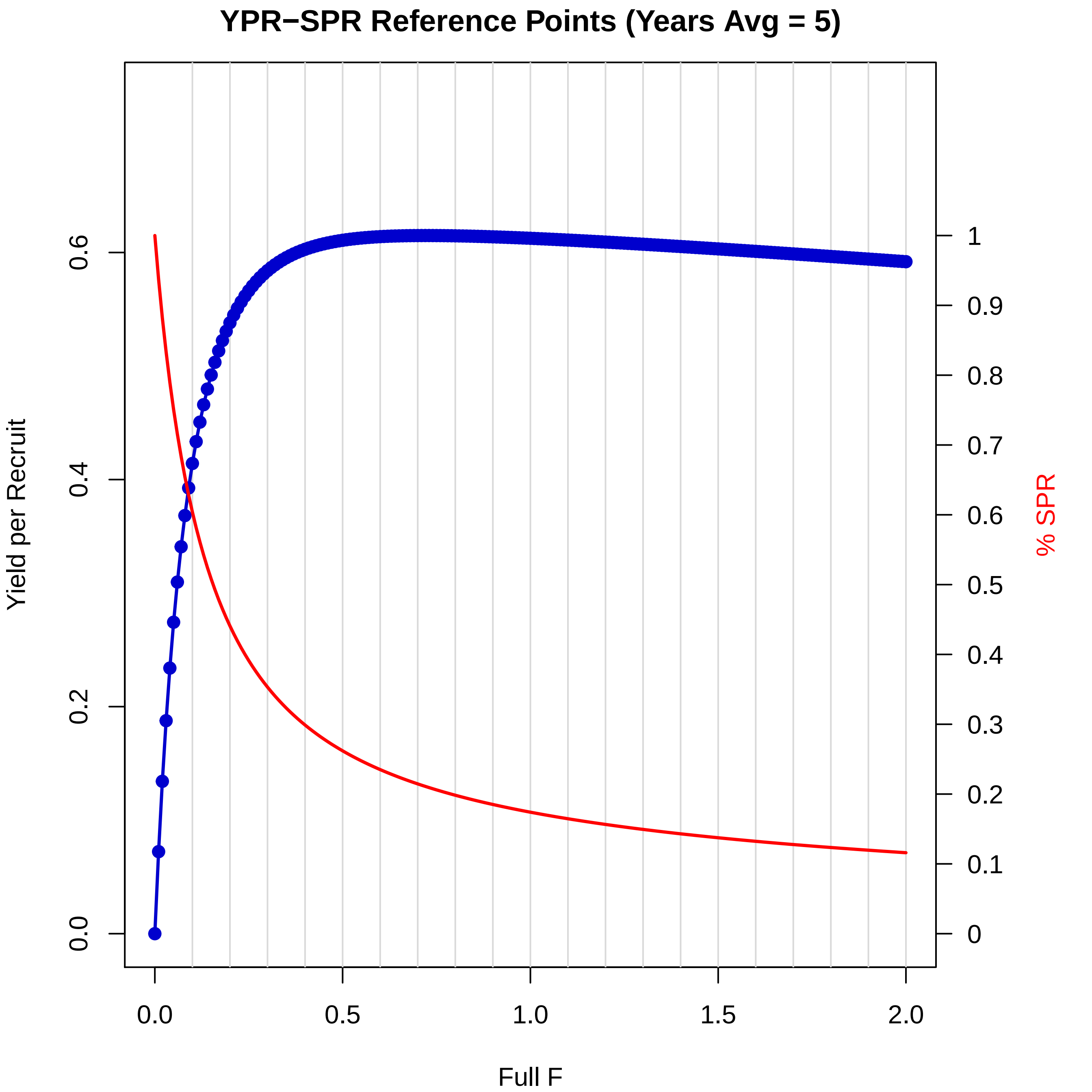
R/SSB
0.2
0.3
0.4
0.5
0.6
0.7
1985
1990
1995
2000
2005
2010
2015
2020
Year



Recruits (000s)
0
1000
2000
3000
0
5000
10000
15000
20000
SSB (mt)

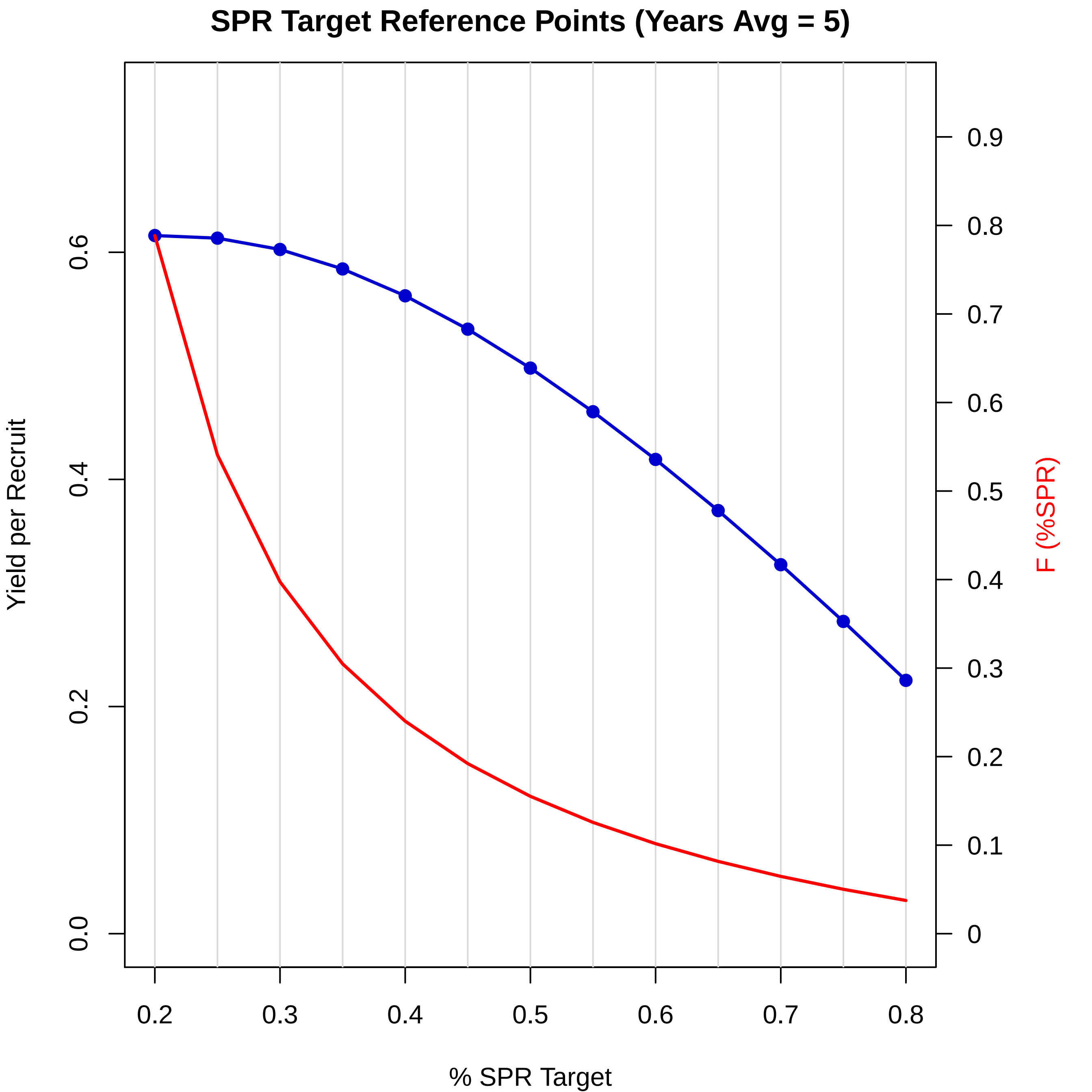

Age−1 Recruits (year−class)
SSB (year)
Year
1000
1500
2000
2500
3000
3500
0
2000
4000
6000
8000
10000
12000
14000
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018


Recr.
SSB
Freport
CV
0.0
0.1
0.2
0.3
0.4
1985
1990
1995
2000
2005
2010
2015
2020
Year


YPR−SPR Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.2
0.4
0.6
% SPR
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.0
0.5
1.0
1.5
2.0
Full F

YPR−SPR Reference Points (Years Avg = 5)

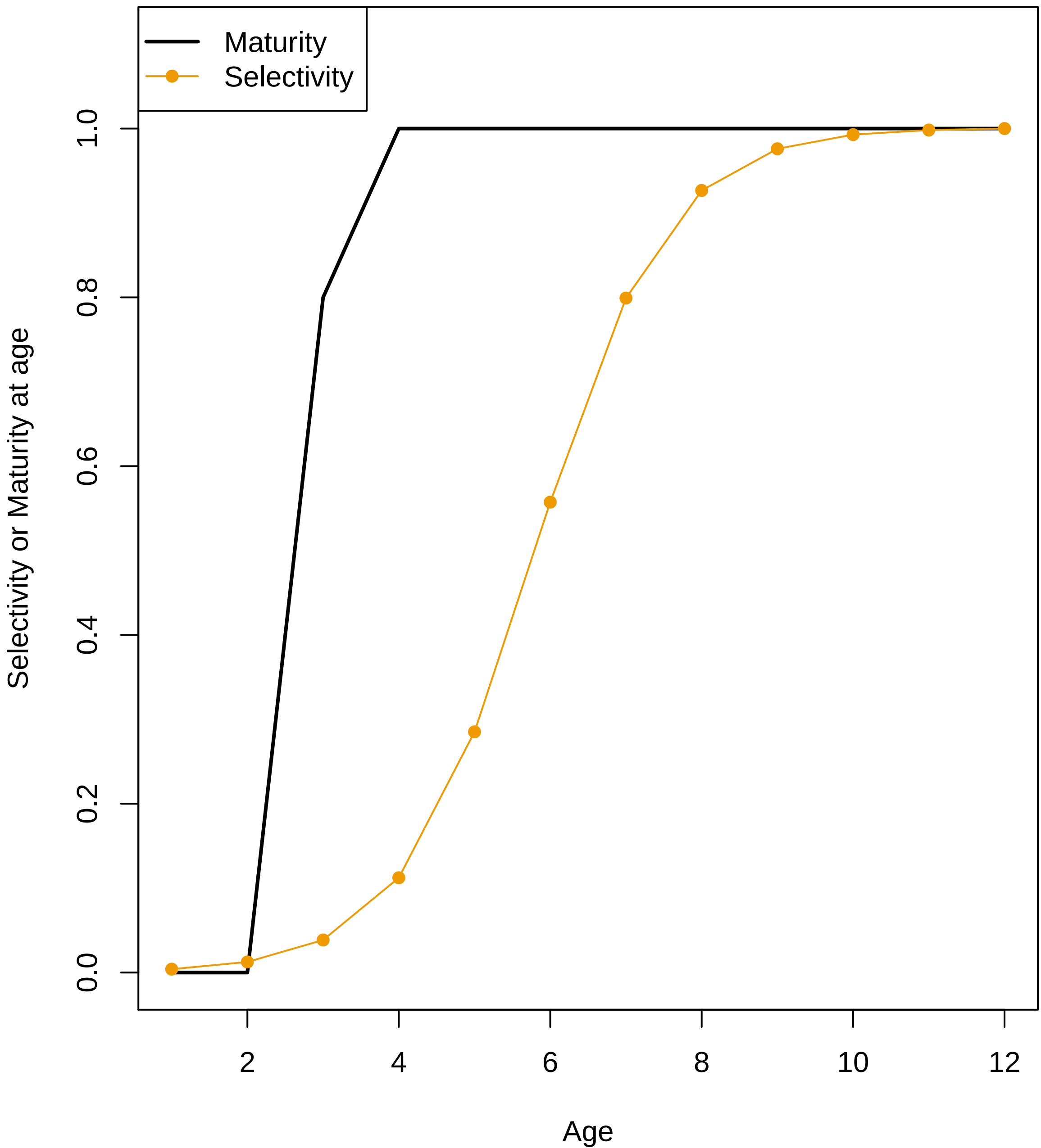
F	YPR	SPR	F	YPR	SPR	F	YPR	SPR
0	0	1	0.35	0.5954	0.3232	0.7	0.6149	0.2145
0.01	0.0723	0.9372	0.36	0.5972	0.3179	0.71	0.6149	0.2128
0.02	0.1342	0.8821	0.37	0.5987	0.3129	0.72	0.6149	0.211
0.03	0.1876	0.8332	0.38	0.6002	0.308	0.73	0.6149	0.2093
0.04	0.2339	0.7897	0.39	0.6016	0.3034	0.74	0.6149	0.2076
0.05	0.2743	0.7506	0.4	0.6028	0.2989	0.75	0.6149	0.206
0.06	0.3097	0.7154	0.41	0.6039	0.2946	0.76	0.6149	0.2044
0.07	0.3408	0.6836	0.42	0.605	0.2904	0.77	0.6148	0.2028
0.08	0.3683	0.6546	0.43	0.6059	0.2864	0.78	0.6148	0.2013
0.09	0.3926	0.6282	0.44	0.6068	0.2825	0.79	0.6147	0.1998
0.1	0.4142	0.6039	0.45	0.6076	0.2788	0.8	0.6147	0.1983
0.11	0.4334	0.5816	0.46	0.6084	0.2752	0.81	0.6146	0.1969
0.12	0.4506	0.5611	0.47	0.609	0.2717	0.82	0.6146	0.1955
0.13	0.466	0.5421	0.48	0.6097	0.2683	0.83	0.6145	0.1941
0.14	0.4797	0.5244	0.49	0.6102	0.2651	0.84	0.6144	0.1927
0.15	0.4921	0.508	0.5	0.6108	0.2619	0.85	0.6143	0.1914
0.16	0.5033	0.4927	0.51	0.6112	0.2588	0.86	0.6142	0.1901
0.17	0.5133	0.4785	0.52	0.6117	0.2559	0.87	0.6141	0.1888
0.18	0.5224	0.4651	0.53	0.6121	0.253	0.88	0.614	0.1875
0.19	0.5307	0.4526	0.54	0.6124	0.2502	0.89	0.6139	0.1863
0.2	0.5381	0.4408	0.55	0.6128	0.2475	0.9	0.6138	0.1851
0.21	0.5449	0.4297	0.56	0.613	0.2449	0.91	0.6137	0.1839
0.22	0.551	0.4192	0.57	0.6133	0.2423	0.92	0.6136	0.1827
0.23	0.5566	0.4094	0.58	0.6136	0.2398	0.93	0.6134	0.1816
0.24	0.5617	0.4	0.59	0.6138	0.2374	0.94	0.6133	0.1804
0.25	0.5663	0.3912	0.6	0.614	0.235	0.95	0.6132	0.1793
0.26	0.5705	0.3828	0.61	0.6141	0.2327	0.96	0.6131	0.1782
0.27	0.5743	0.3748	0.62	0.6143	0.2305	0.97	0.6129	0.1772
0.28	0.5779	0.3673	0.63	0.6144	0.2283	0.98	0.6128	0.1761
0.29	0.5811	0.3601	0.64	0.6145	0.2262	0.99	0.6127	0.1751
0.3	0.584	0.3532	0.65	0.6146	0.2242	1	0.6125	0.174
0.31	0.5867	0.3466	0.66	0.6147	0.2221	1.01	0.6124	0.173
0.32	0.5892	0.3404	0.67	0.6148	0.2202	1.02	0.6122	0.172
0.33	0.5914	0.3344	0.68	0.6148	0.2183	1.03	0.6121	0.1711
0.34	0.5935	0.3287	0.69	0.6149	0.2164	1.04	0.6119	0.1701

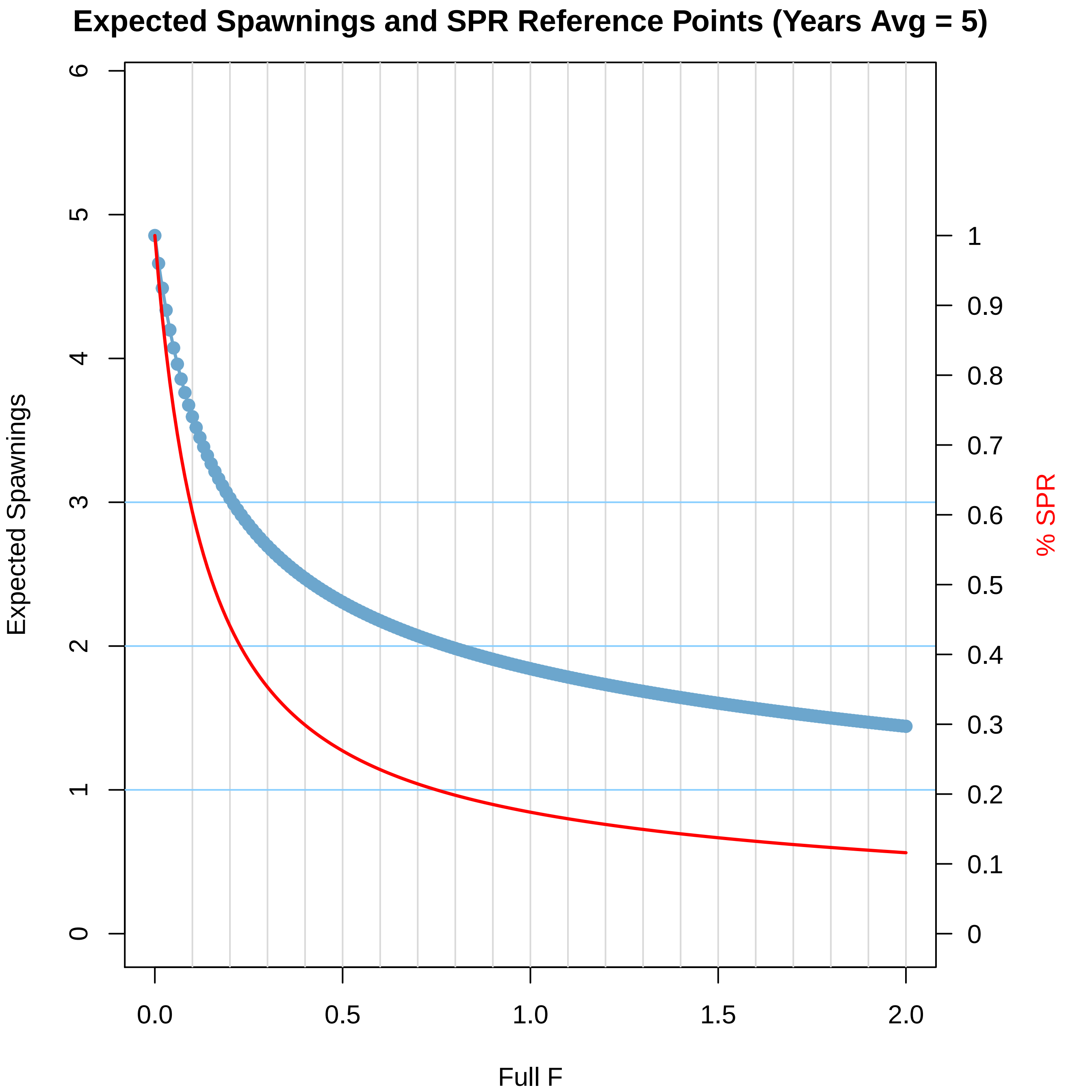


SPR Target Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.2
0.4
0.6
F (%SPR)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.2
0.3
0.4
0.5
0.6
0.7
0.8
% SPR Target

SPR Target Reference Points (Years Avg = 5)

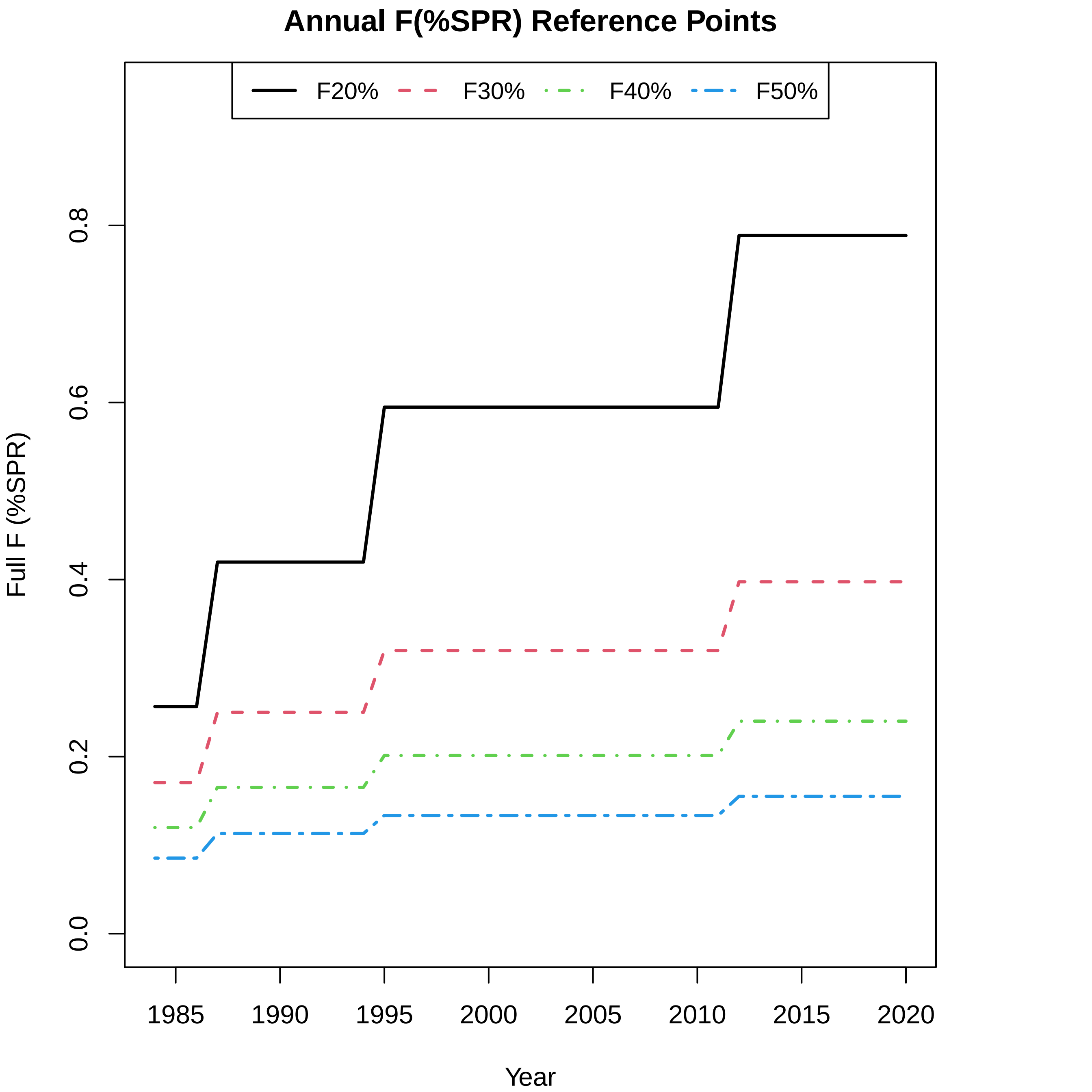
% SPR	F(%SPR)	YPR
0.2	0.7886	0.6148
0.25	0.5407	0.6124
0.3	0.3974	0.6025
0.35	0.3048	0.5853
0.4	0.24	0.5617
0.45	0.1921	0.5323
0.5	0.1552	0.498
0.55	0.1257	0.4596
0.6	0.1017	0.4176
0.65	0.0817	0.3726
0.7	0.0647	0.3249
0.75	0.0502	0.275
0.8	0.0375	0.2231

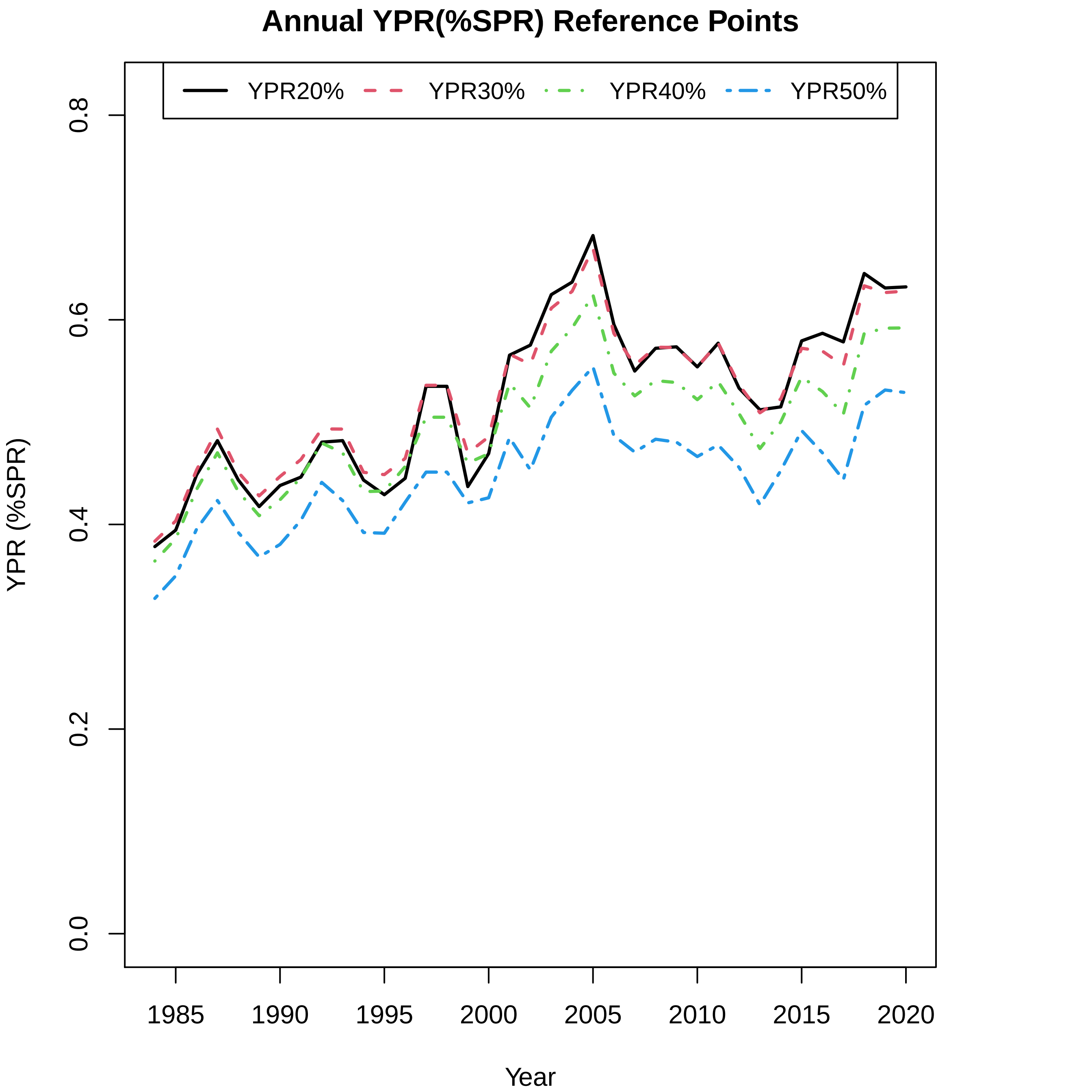

Maturity
Selectivity
Selectivity or Maturity at age
Age
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12


Expected Spawnings and SPR Reference Points (Years Avg = 5)
Expected Spawnings
% SPR
Full F
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

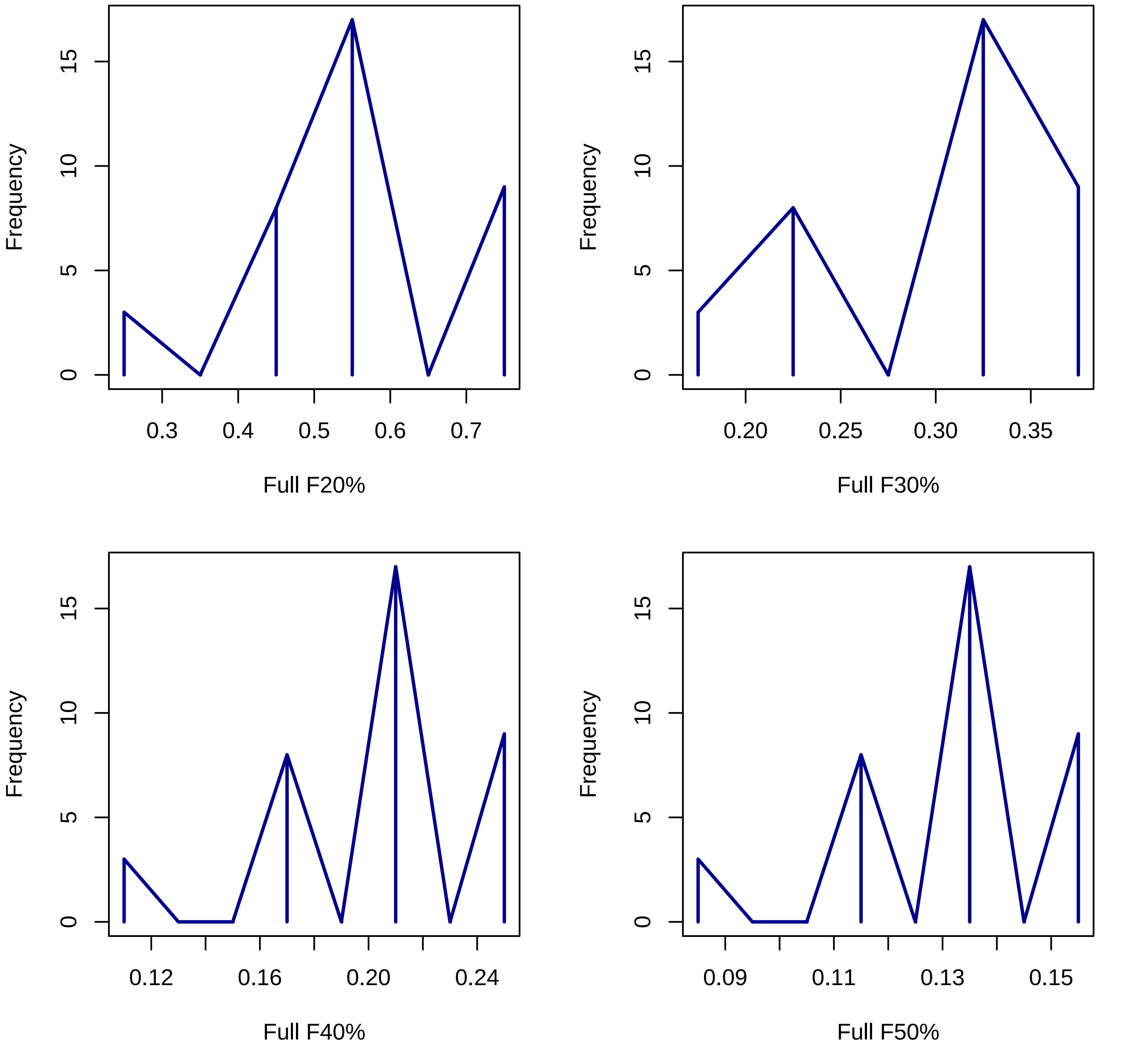
Expected Spawnings & SPR Reference Points (Years Avg = 5)

F	E[Sp]	SPR	F	E[Sp]	SPR	F	E[Sp]	SPR
0	4.8546	1	0.35	2.5731	0.3232	0.7	2.0711	0.2145
0.01	4.6606	0.9372	0.36	2.5512	0.3179	0.71	2.0617	0.2128
0.02	4.4887	0.8821	0.37	2.53	0.3129	0.72	2.0524	0.211
0.03	4.3354	0.8332	0.38	2.5095	0.308	0.73	2.0432	0.2093
0.04	4.1977	0.7897	0.39	2.4896	0.3034	0.74	2.0343	0.2076
0.05	4.0732	0.7506	0.4	2.4703	0.2989	0.75	2.0254	0.206
0.06	3.9602	0.7154	0.41	2.4516	0.2946	0.76	2.0168	0.2044
0.07	3.8569	0.6836	0.42	2.4334	0.2904	0.77	2.0082	0.2028
0.08	3.7622	0.6546	0.43	2.4158	0.2864	0.78	1.9998	0.2013
0.09	3.675	0.6282	0.44	2.3986	0.2825	0.79	1.9915	0.1998
0.1	3.5944	0.6039	0.45	2.3819	0.2788	0.8	1.9834	0.1983
0.11	3.5197	0.5816	0.46	2.3657	0.2752	0.81	1.9754	0.1969
0.12	3.4501	0.5611	0.47	2.3499	0.2717	0.82	1.9675	0.1955
0.13	3.3852	0.5421	0.48	2.3345	0.2683	0.83	1.9597	0.1941
0.14	3.3245	0.5244	0.49	2.3195	0.2651	0.84	1.952	0.1927
0.15	3.2675	0.508	0.5	2.3049	0.2619	0.85	1.9444	0.1914
0.16	3.214	0.4927	0.51	2.2906	0.2588	0.86	1.937	0.1901
0.17	3.1635	0.4785	0.52	2.2766	0.2559	0.87	1.9296	0.1888
0.18	3.1158	0.4651	0.53	2.263	0.253	0.88	1.9224	0.1875
0.19	3.0706	0.4526	0.54	2.2497	0.2502	0.89	1.9152	0.1863
0.2	3.0279	0.4408	0.55	2.2367	0.2475	0.9	1.9082	0.1851
0.21	2.9872	0.4297	0.56	2.224	0.2449	0.91	1.9012	0.1839
0.22	2.9486	0.4192	0.57	2.2116	0.2423	0.92	1.8944	0.1827
0.23	2.9117	0.4094	0.58	2.1994	0.2398	0.93	1.8876	0.1816
0.24	2.8766	0.4	0.59	2.1875	0.2374	0.94	1.8809	0.1804
0.25	2.843	0.3912	0.6	2.1759	0.235	0.95	1.8743	0.1793
0.26	2.8109	0.3828	0.61	2.1645	0.2327	0.96	1.8678	0.1782
0.27	2.7802	0.3748	0.62	2.1533	0.2305	0.97	1.8614	0.1772
0.28	2.7506	0.3673	0.63	2.1423	0.2283	0.98	1.855	0.1761
0.29	2.7223	0.3601	0.64	2.1315	0.2262	0.99	1.8488	0.1751
0.3	2.6951	0.3532	0.65	2.121	0.2242	1	1.8426	0.174
0.31	2.6689	0.3466	0.66	2.1106	0.2221	1.01	1.8365	0.173
0.32	2.6436	0.3404	0.67	2.1005	0.2202	1.02	1.8304	0.172
0.33	2.6193	0.3344	0.68	2.0905	0.2183	1.03	1.8244	0.1711
0.34	2.5958	0.3287	0.69	2.0807	0.2164	1.04	1.8185	0.1701

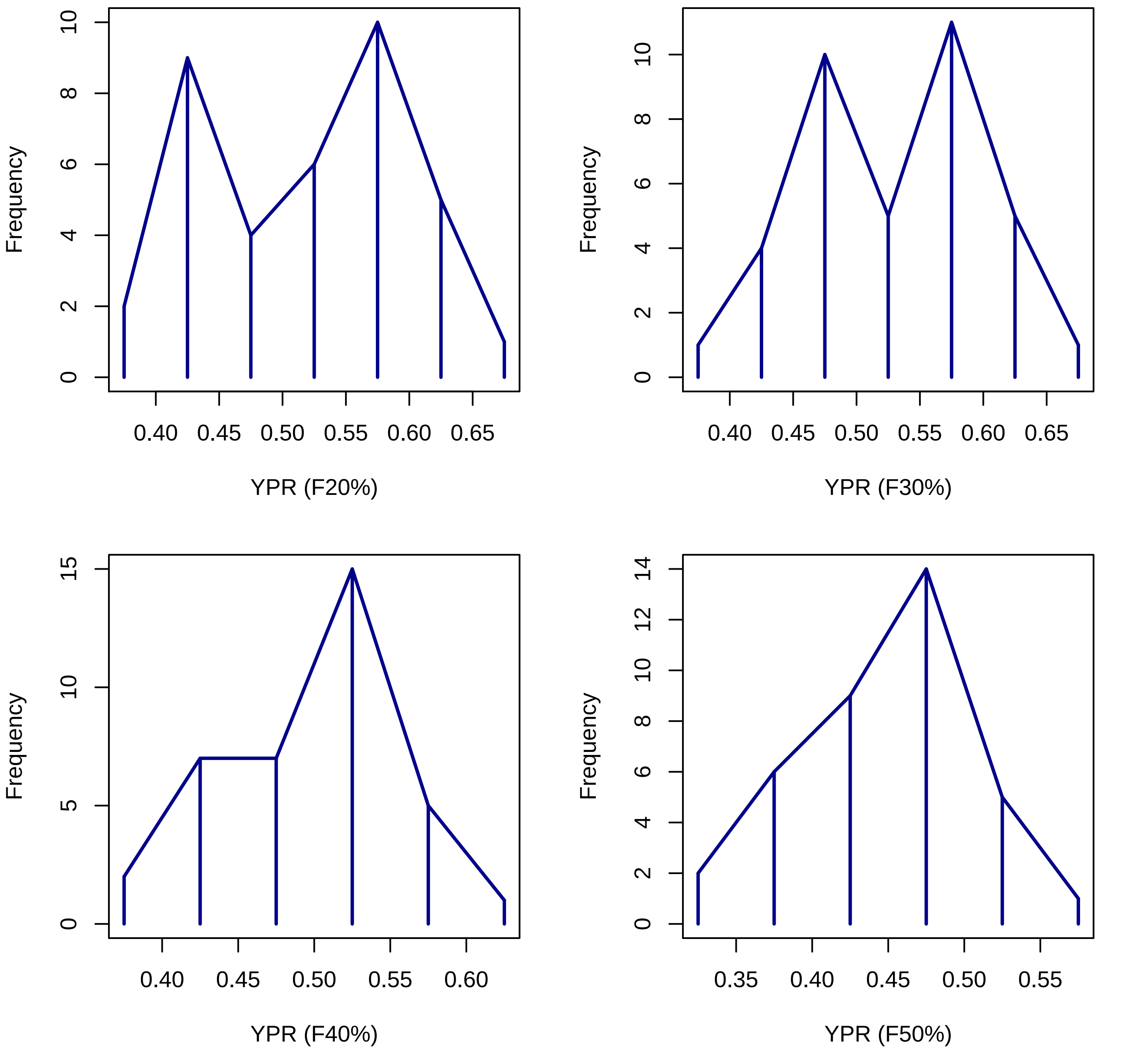

Annual F(%SPR) Reference Points
F20%
F30%
F40%
F50%
Full F (%SPR)
0.0
0.2
0.4
0.6
0.8
1985
1990
1995
2000
2005
2010
2015
2020
Year

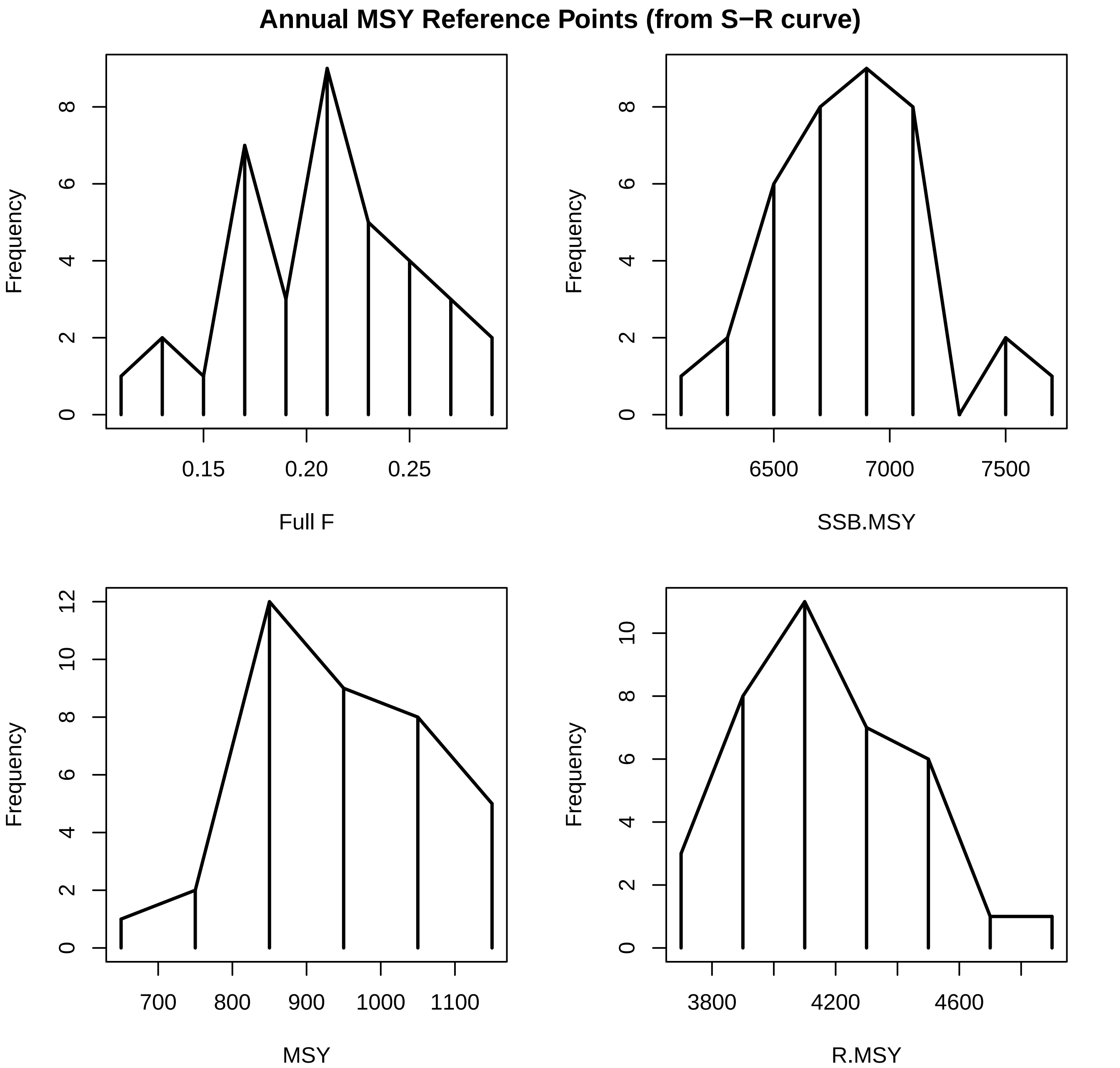

Annual YPR(%SPR) Reference Points
YPR20%
YPR30%
YPR40%
YPR50%
0.0
0.2
0.4
0.6
0.8
YPR (%SPR)
1985
1990
1995
2000
2005
2010
2015
2020
Year

Annual F (%SPR) Reference Points

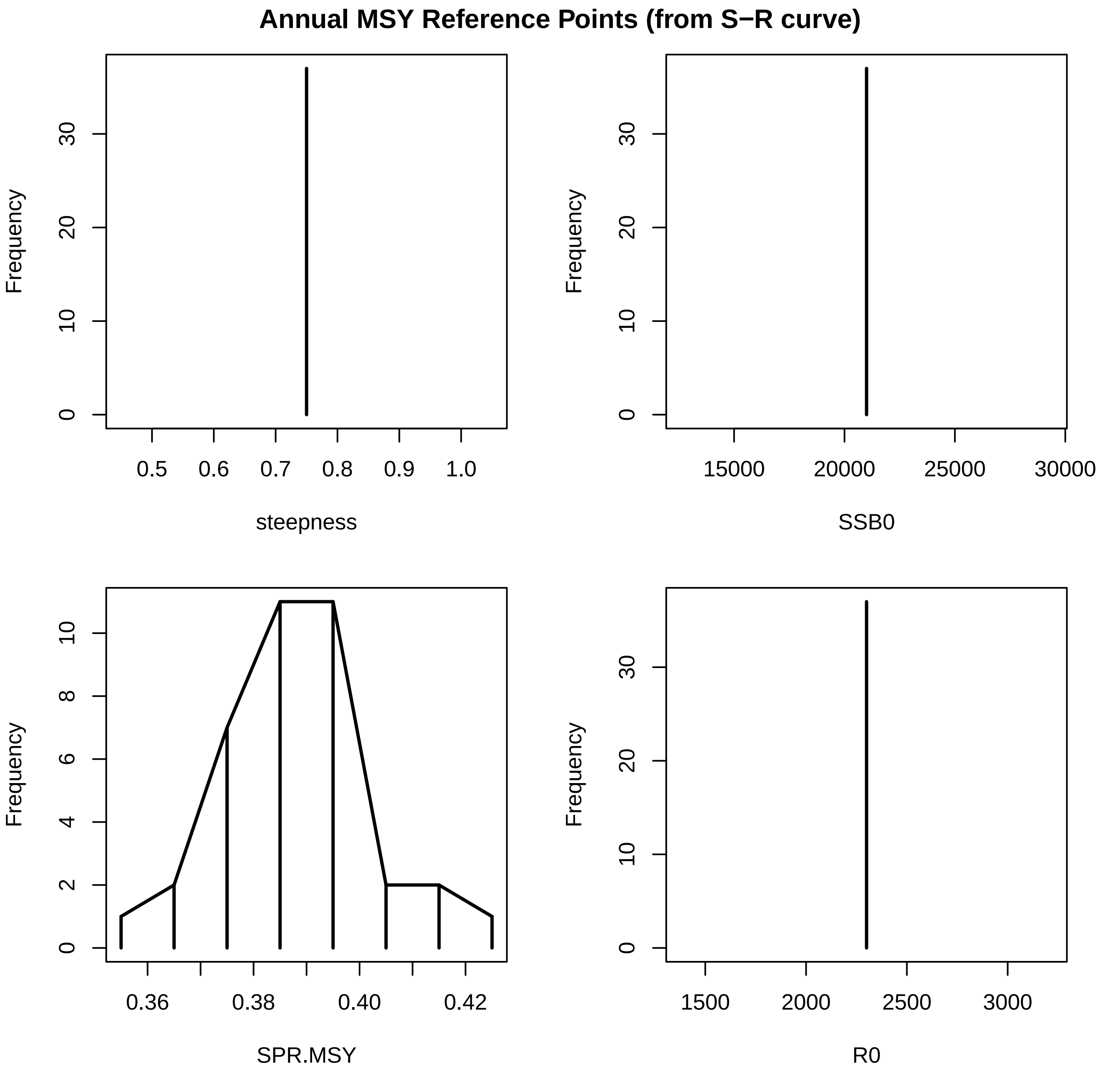


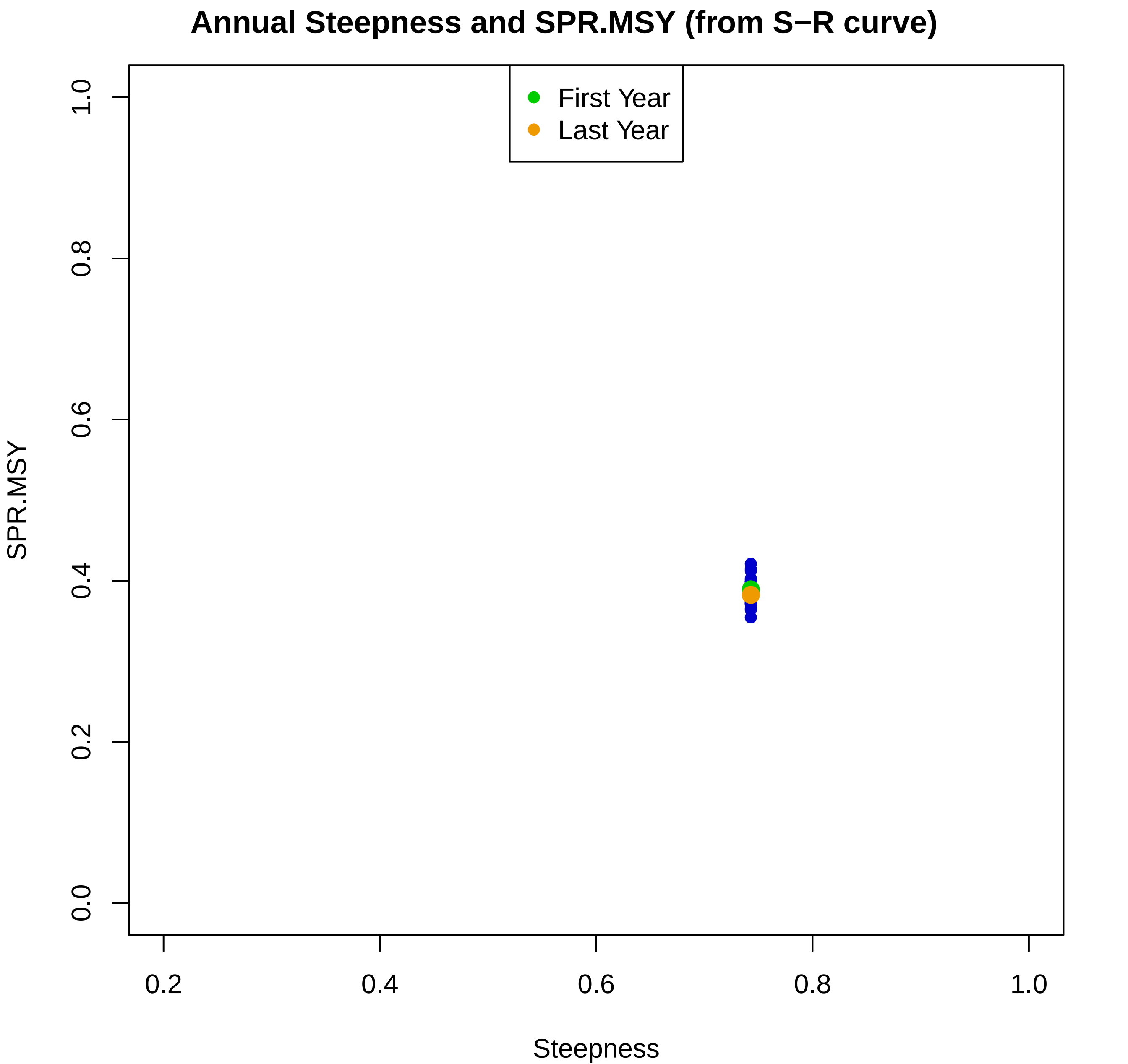
Annual YPR (%SPR) Reference Points



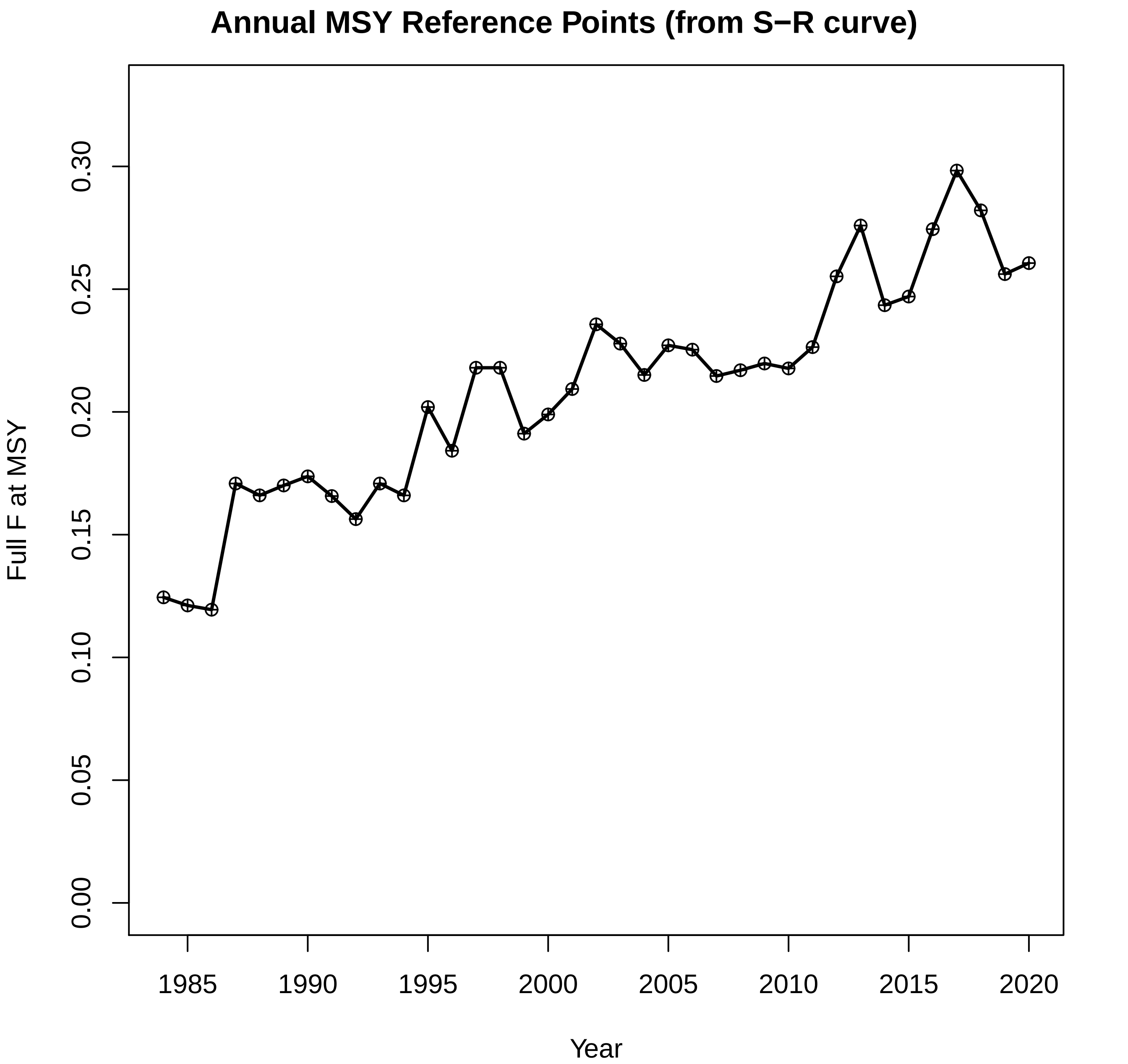


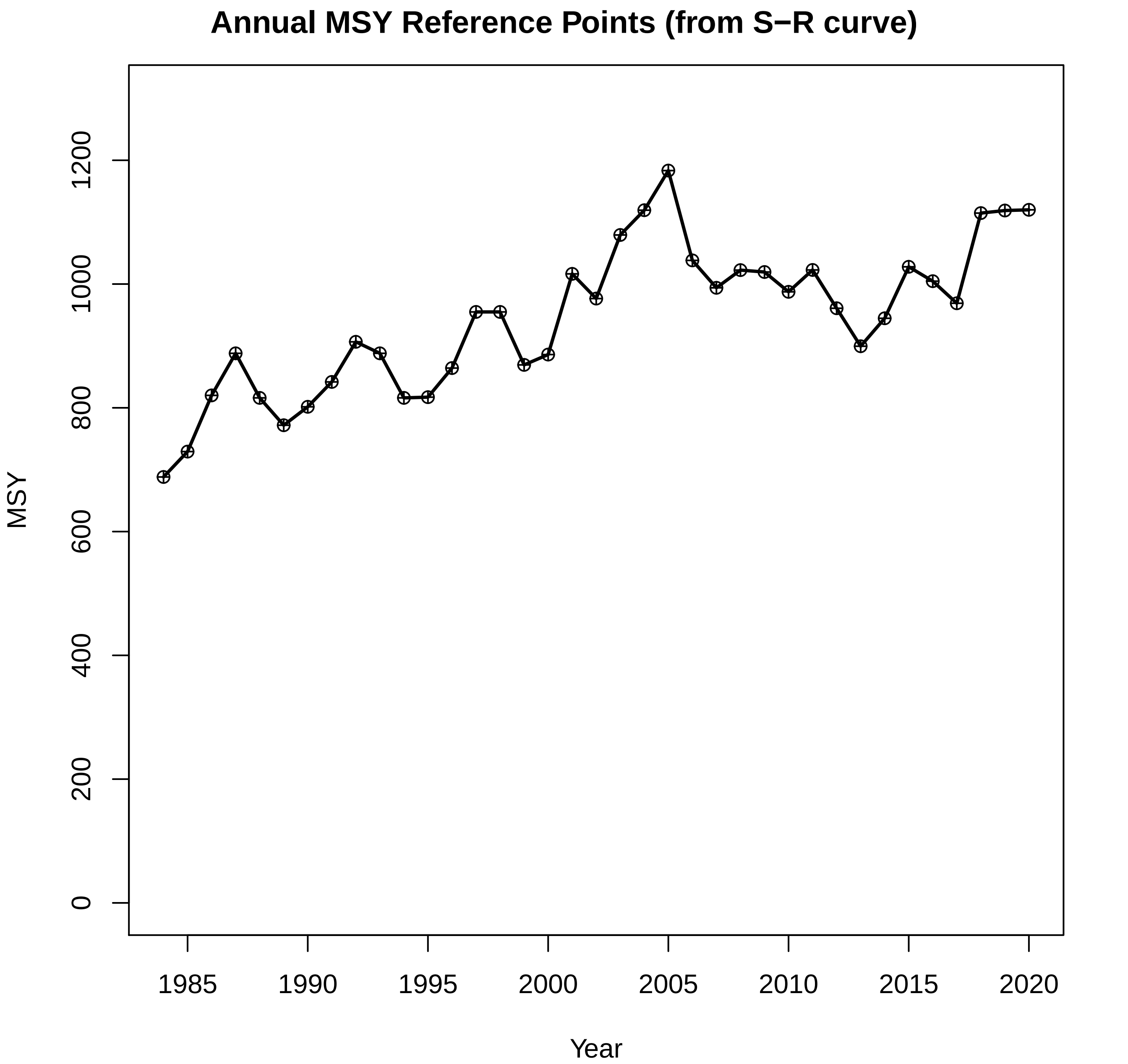
Annual MSY Reference Points (from S−R curve)
Frequency
Full F
0.15
0.20
0.25
0
2
4
6
8
SSB.MSY
6500
7000
7500
MSY
700
800
900
1000
1100
10
12
R.MSY
3800
4200
4600

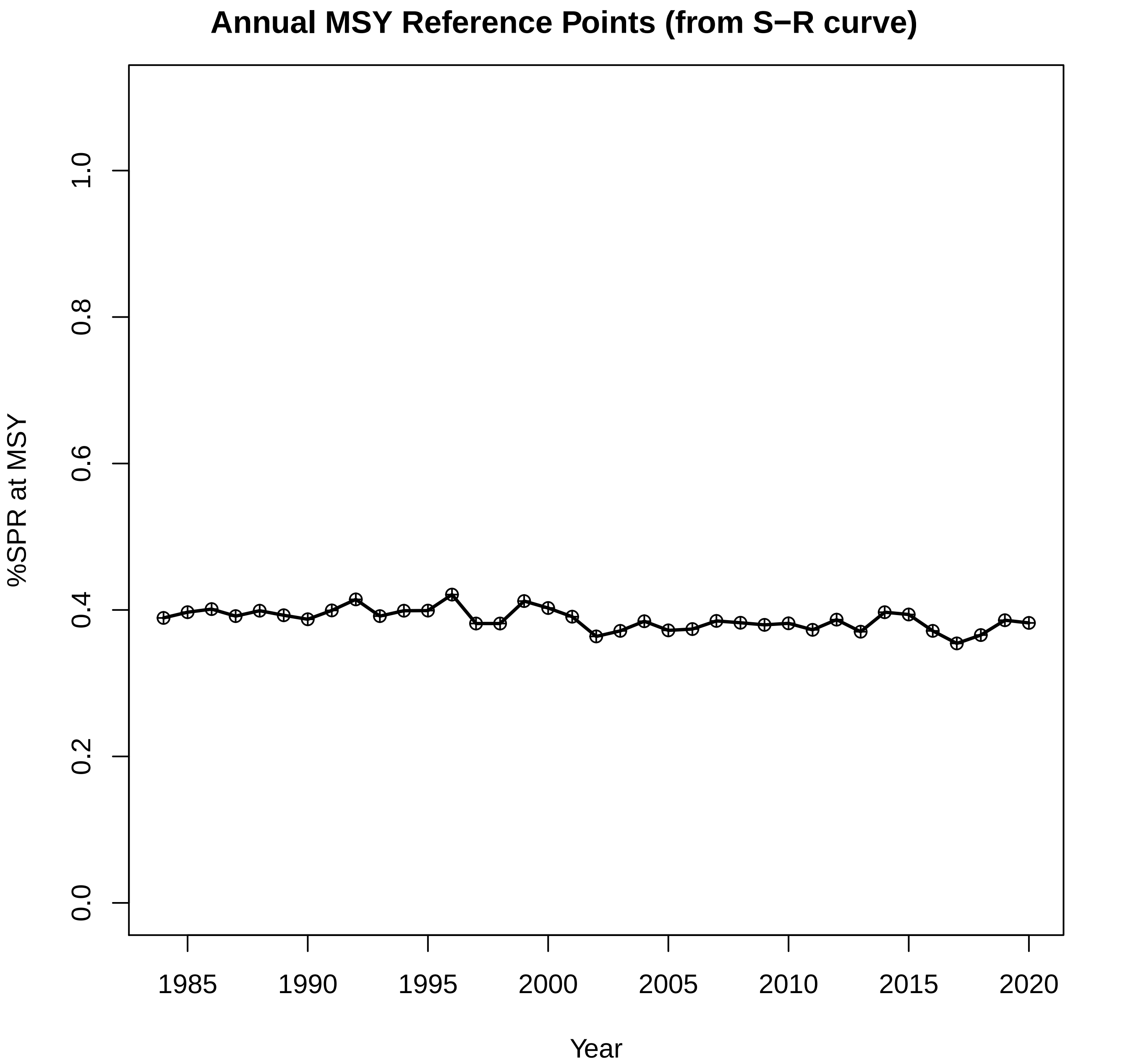

Annual MSY Reference Points (from S−R curve)
Frequency
steepness
0.5
0.6
0.7
0.8
0.9
1.0
0
10
20
30
SSB0
15000
20000
25000
30000
SPR.MSY
0.36
0.38
0.40
0.42
0
2
4
6
8
10
R0
1500
2000
2500
3000



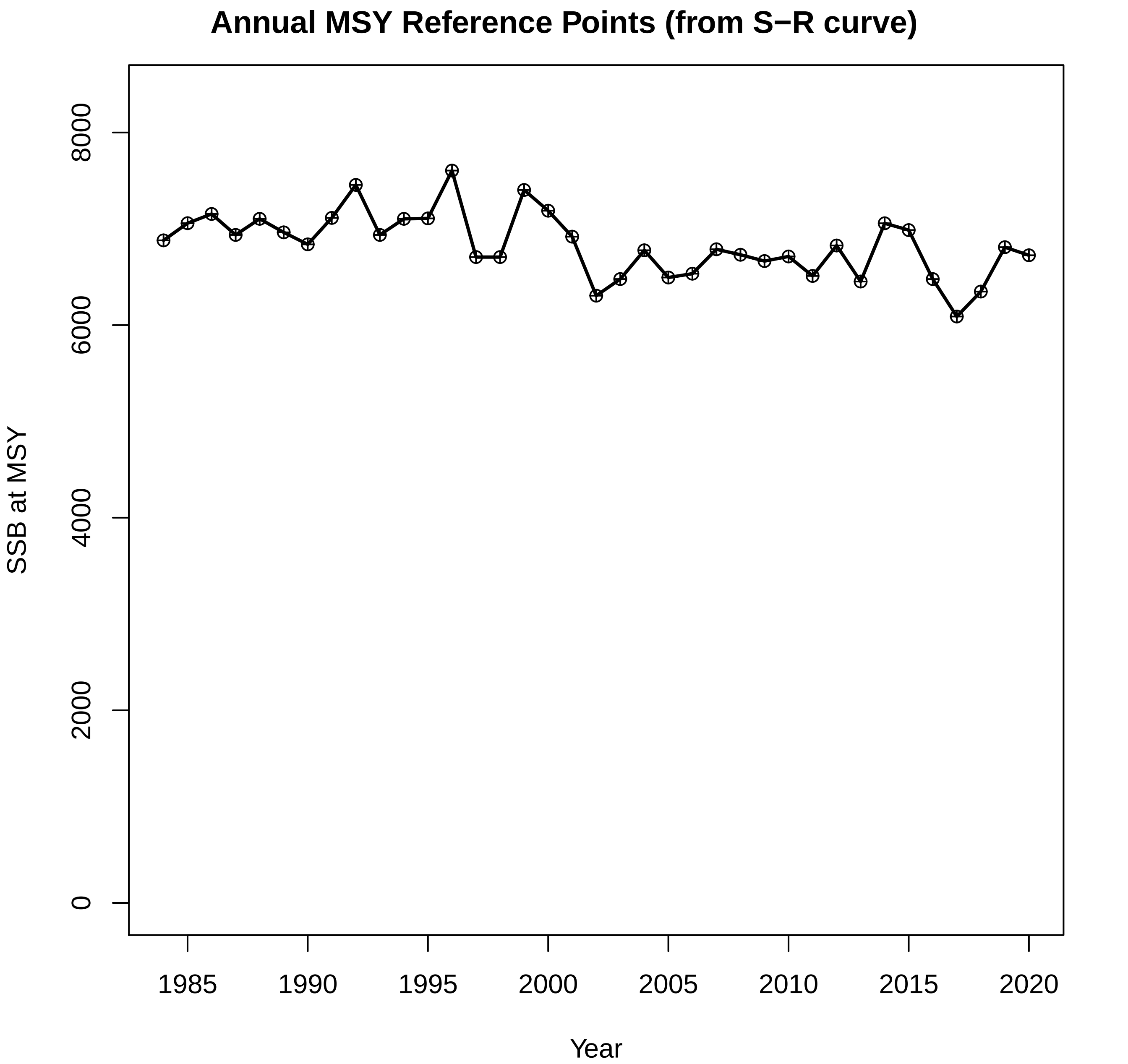
Annual Steepness and SPR.MSY (from S−R curve)
First Year
Last Year
SPR.MSY
Steepness
0.0
0.2
0.4
0.6
0.8
1.0
0.2
0.4
0.6
0.8
1.0

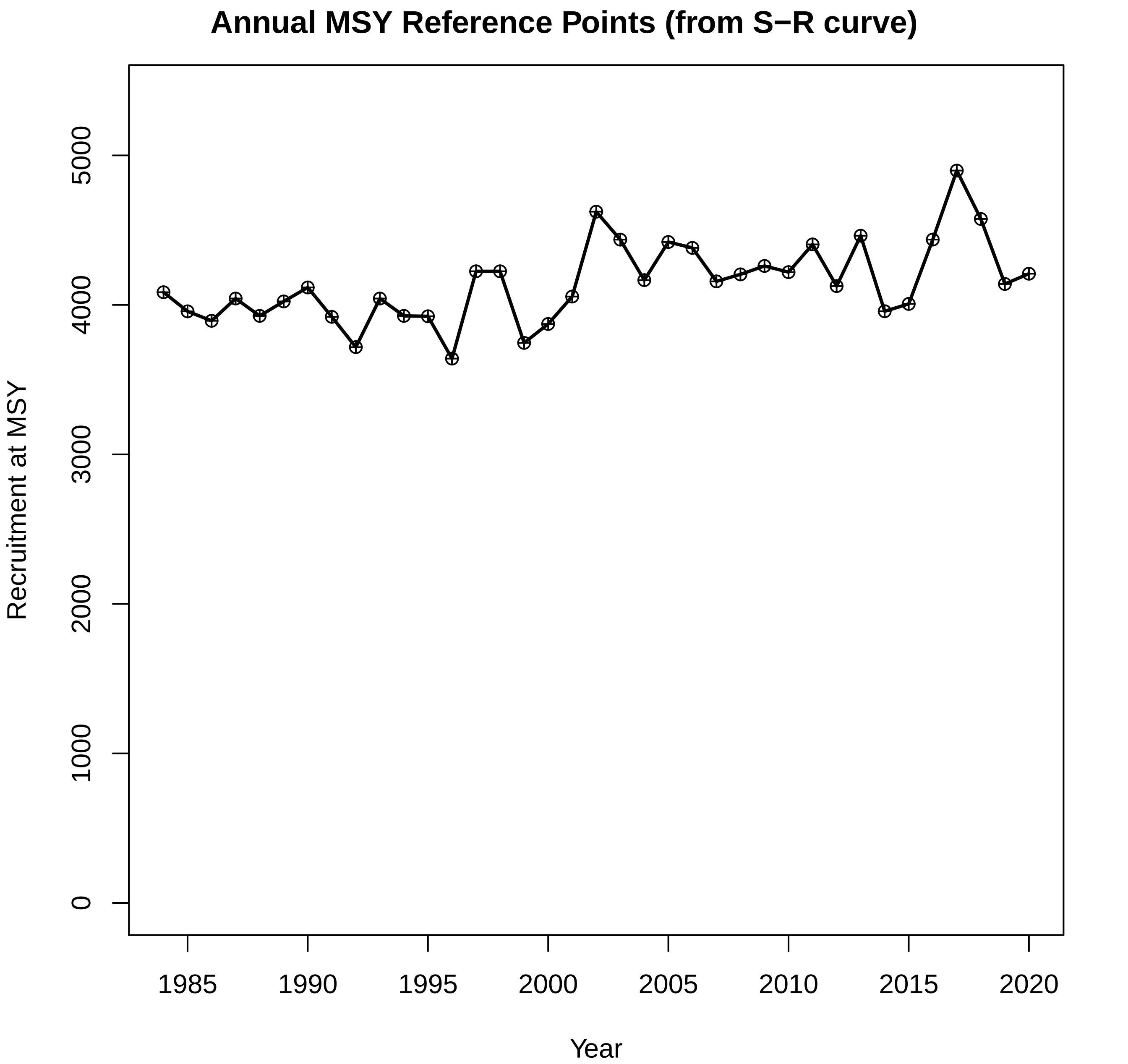

Annual MSY Reference Points (from S−R curve)
Full F at MSY
Year
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1985
1990
1995
2000
2005
2010
2015
2020

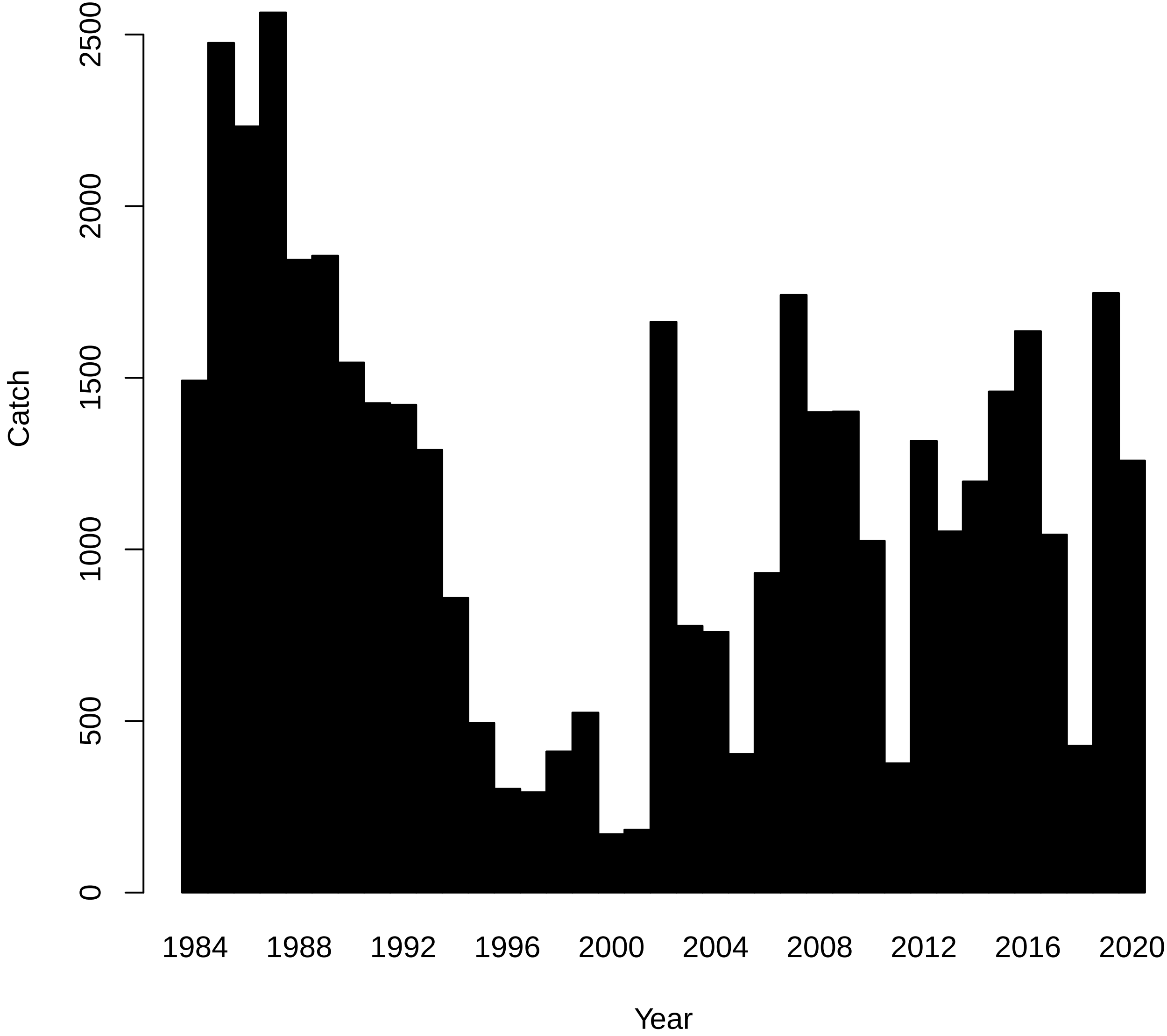

Annual MSY Reference Points (from S−R curve)
MSY
0
200
400
600
800
1000
1200
1985
1990
1995
2000
2005
2010
2015
2020
Year



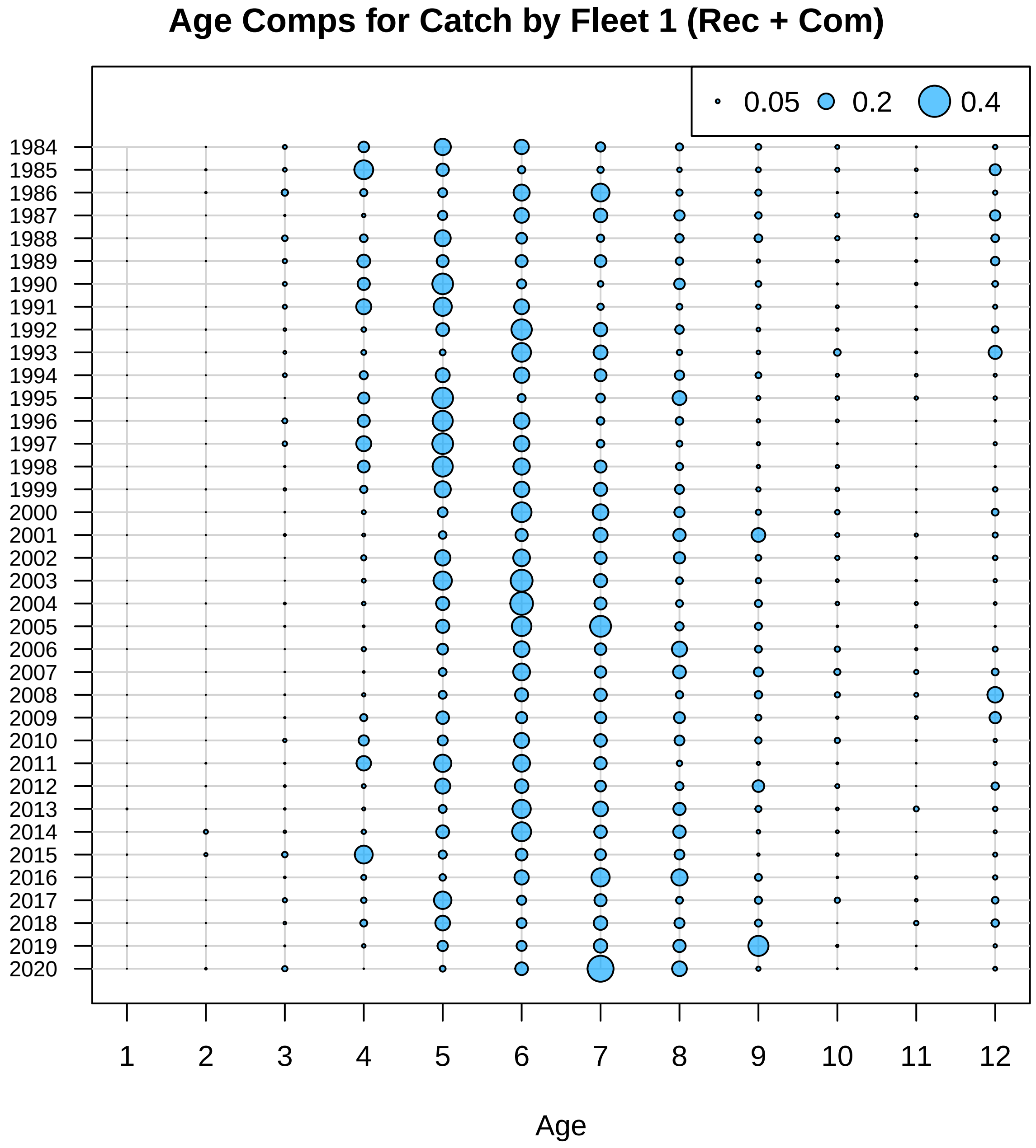
Annual MSY Reference Points (from S−R curve)
%SPR at MSY
0.0
0.2
0.4
0.6
0.8
1.0
1985
1990
1995
2000
2005
2010
2015
2020
Year


Annual MSY Reference Points (from S−R curve)
SSB at MSY
0
2000
4000
6000
8000
1985
1990
1995
2000
2005
2010
2015
2020
Year

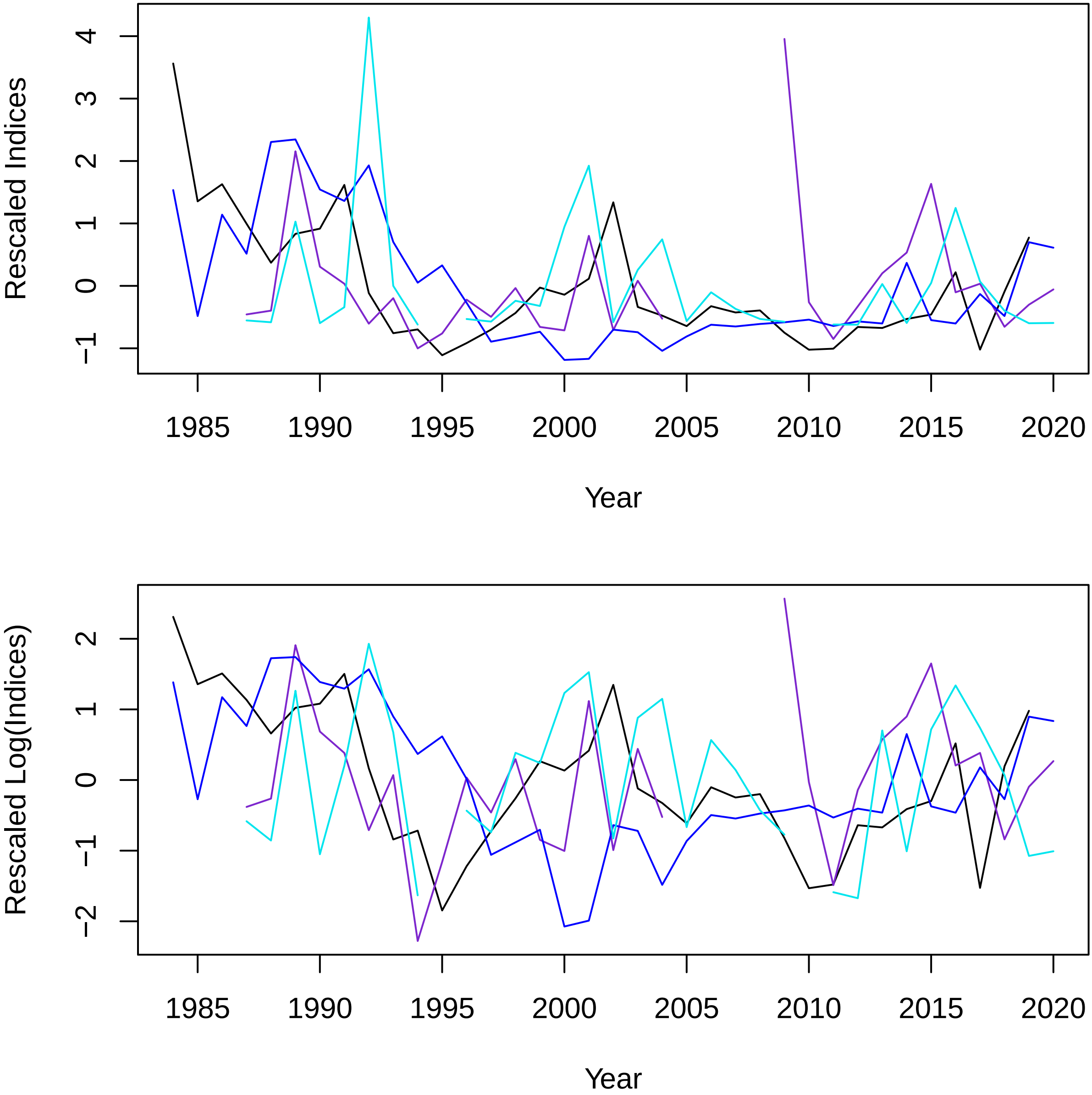

Annual MSY Reference Points (from S−R curve)
Recruitment at MSY
0
1000
2000
3000
4000
5000
1985
1990
1995
2000
2005
2010
2015
2020
Year

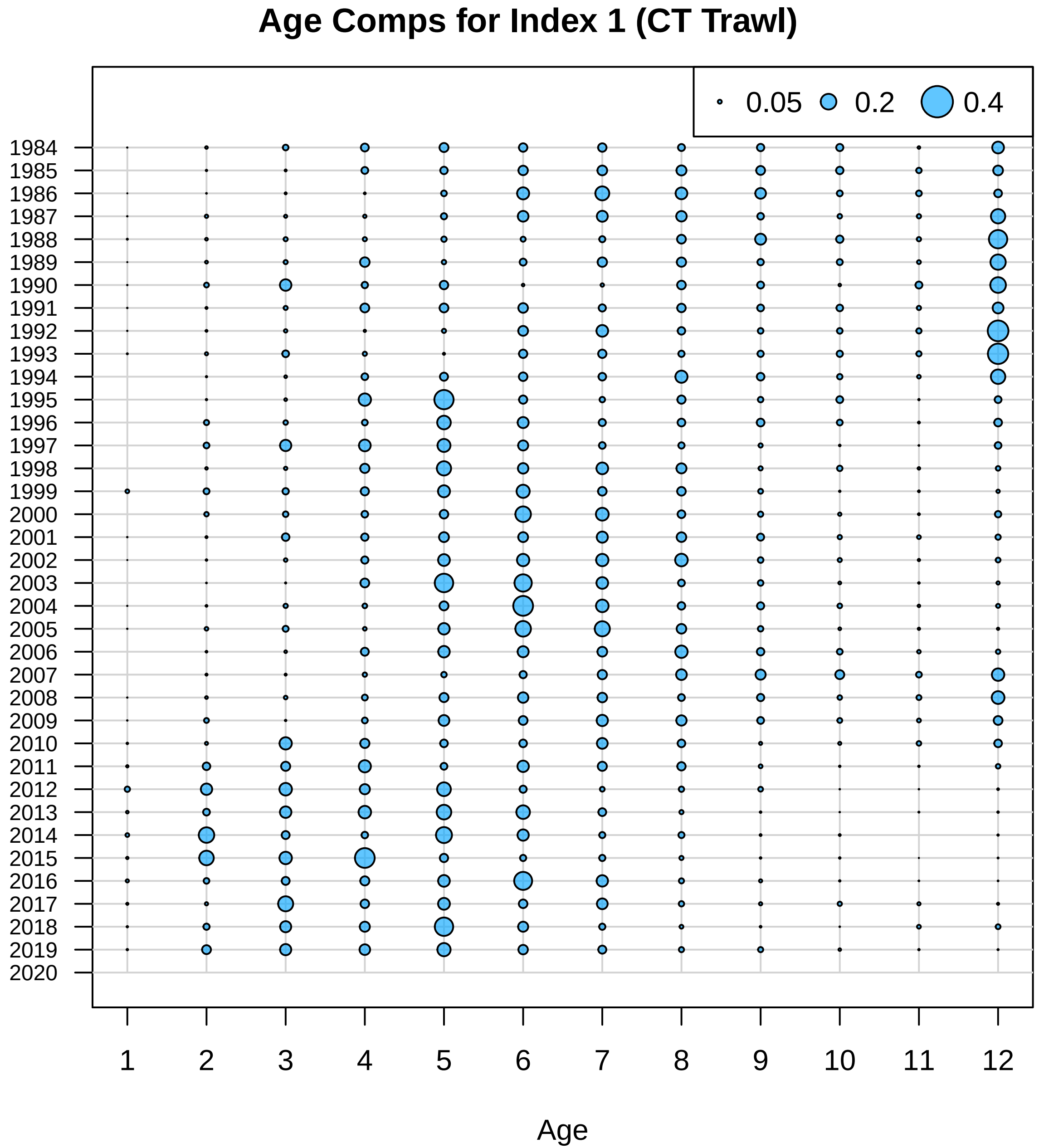


Catch
0
500
1000
1500
2000
2500
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
Year

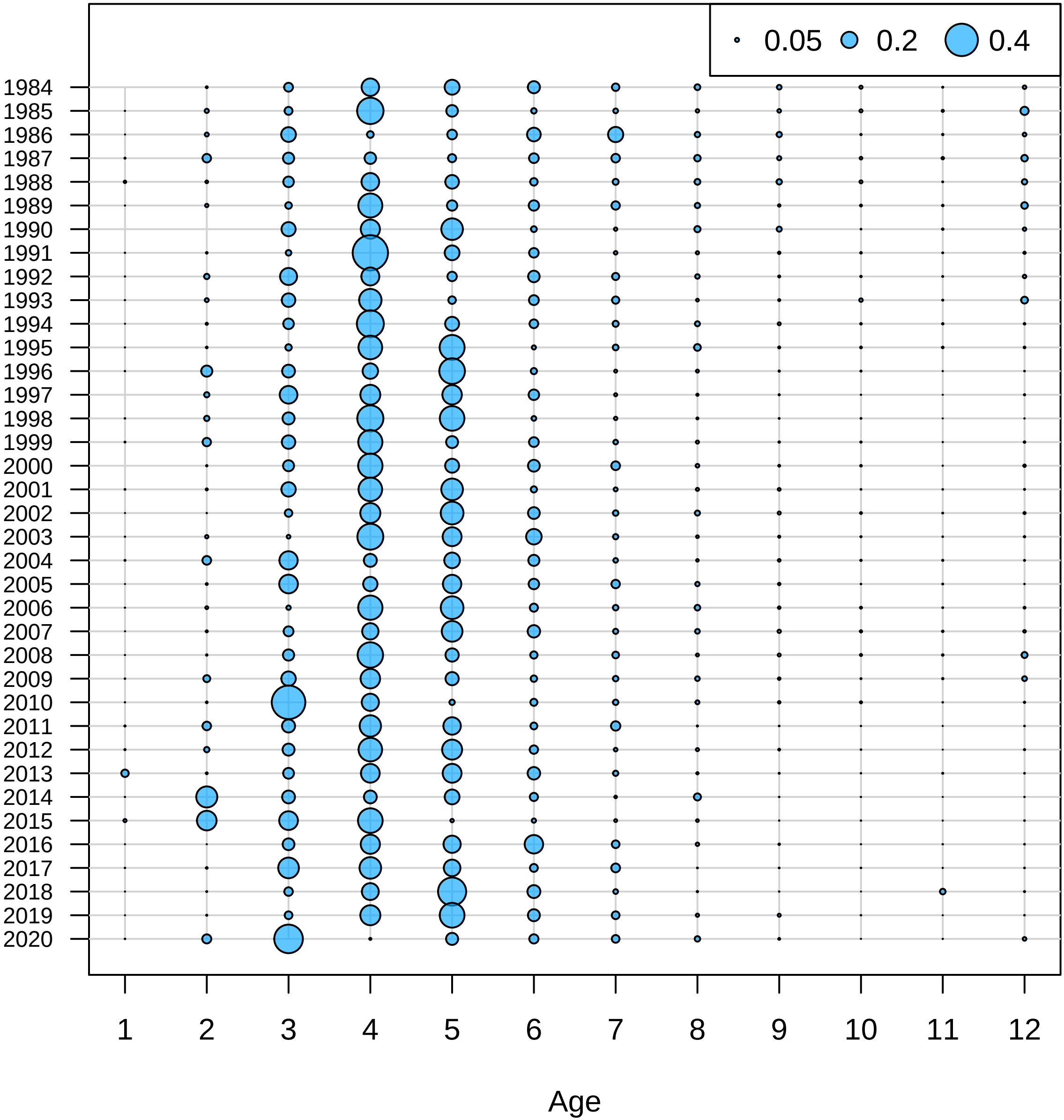


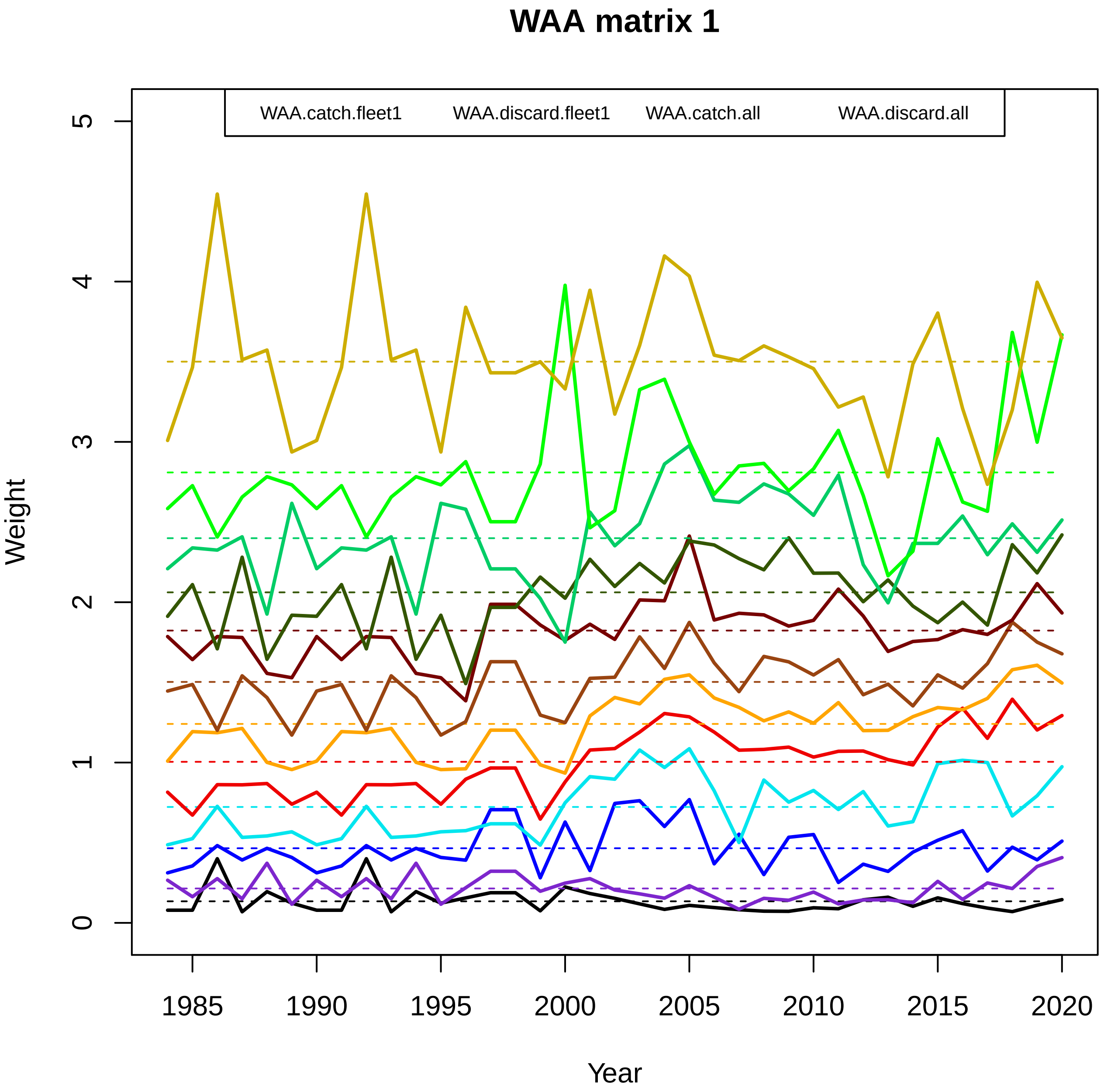
Age Comps for Catch by Fleet 1 (Rec + Com)
0.05
0.2
0.4
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age


Rescaled Indices
4
3
2
1
0
−1
1985
1990
1995
2000
2005
2010
2015
2020
Year
Rescaled Log(Indices)
2
1
0
−1
−2
1985
1990
1995
2000
2005
2010
2015
2020
Year

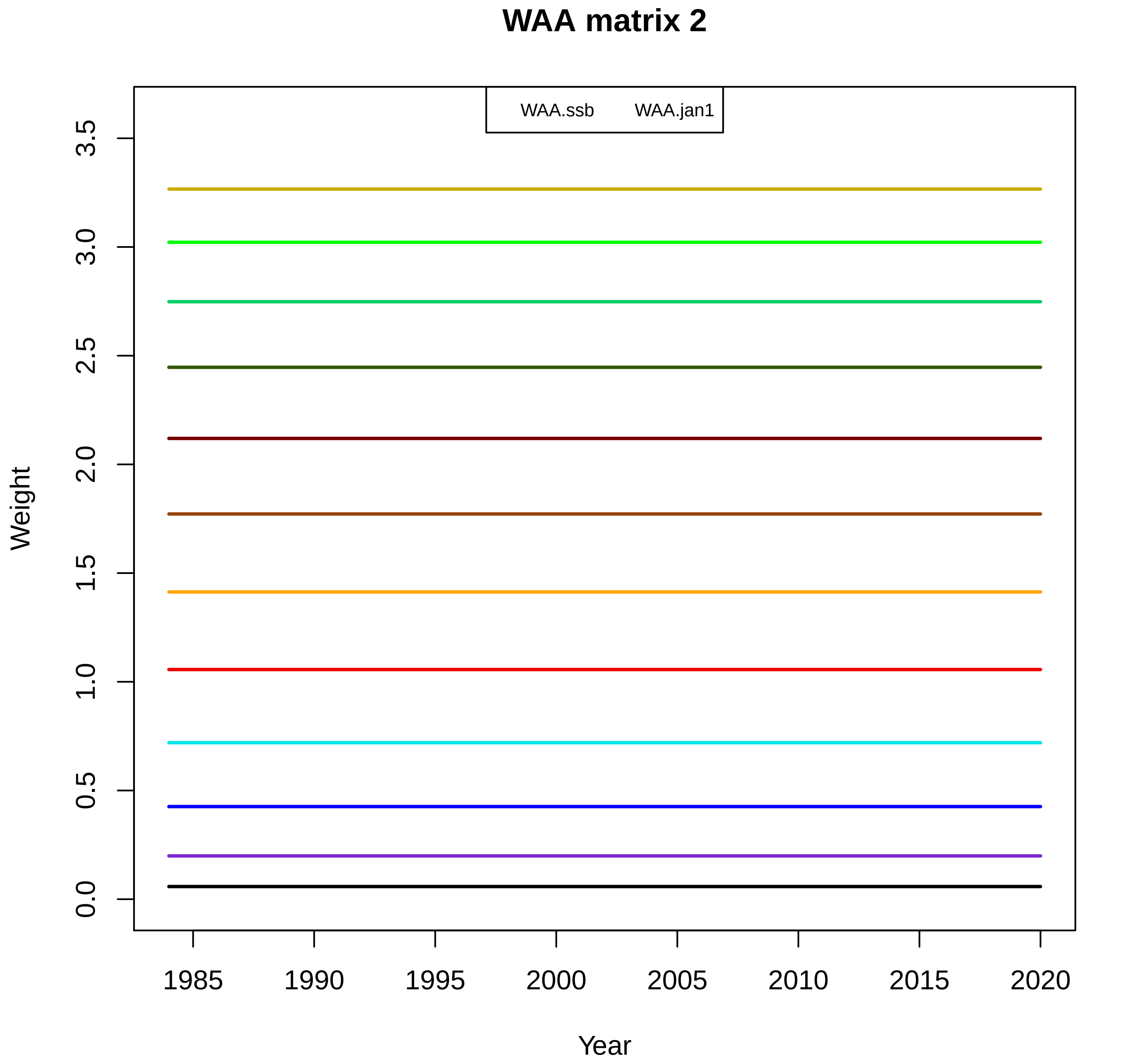

Age Comps for Index 1 (CT Trawl)
0.05
0.2
0.4
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age

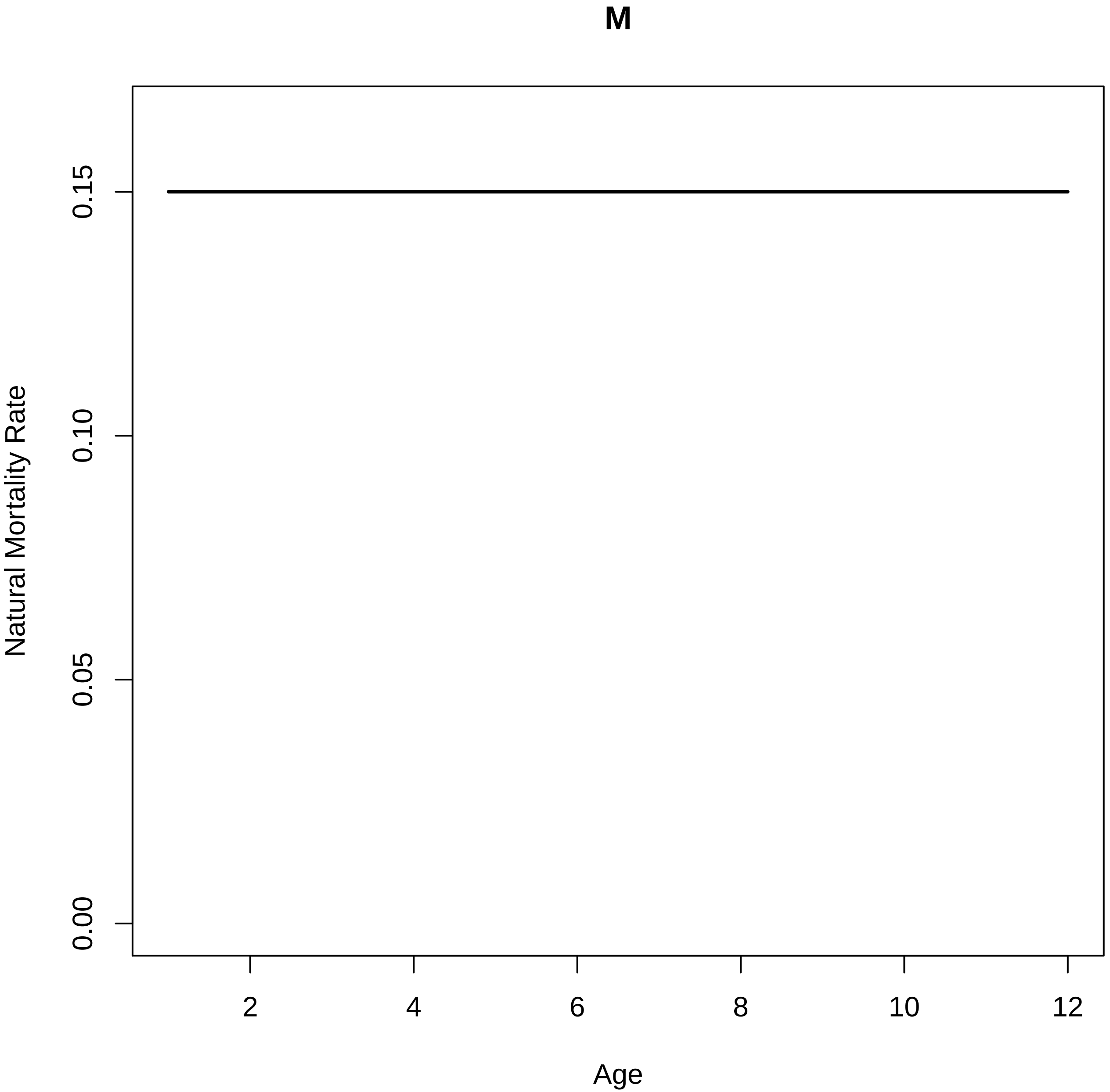
Age Comps for Index 3 (MRIP CPUE)

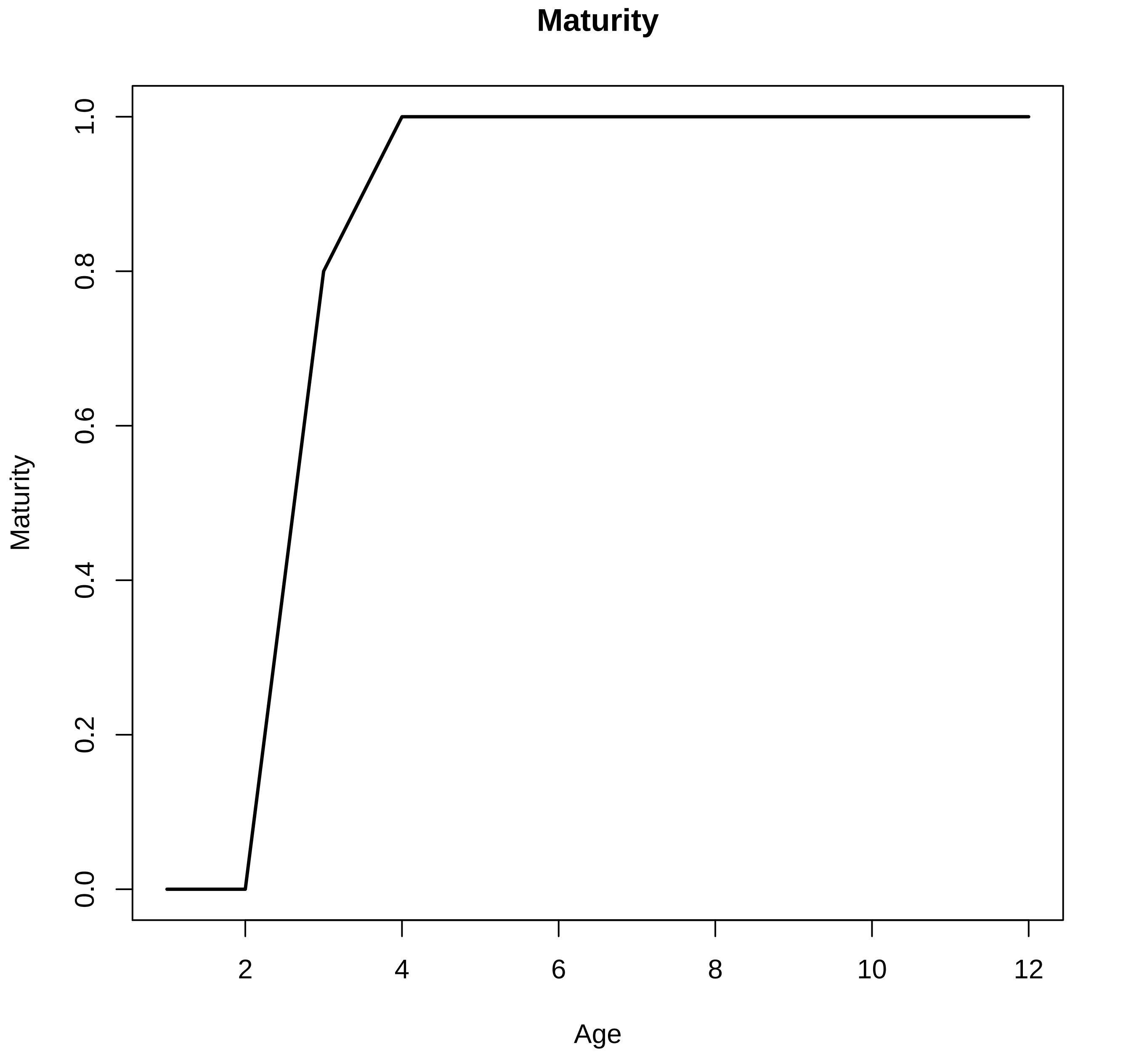




WAA matrix 1
WAA.catch.fleet1
WAA.discard.fleet1
WAA.catch.all
WAA.discard.all
Weight
0
1
2
3
4
5
Year
1985
1990
1995
2000
2005
2010
2015
2020


WAA matrix 2
WAA.ssb
WAA.jan1
Weight
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1985
1990
1995
2000
2005
2010
2015
2020
Year


M
Natural Mortality Rate
0.00
0.05
0.10
0.15
2
4
6
8
10
12
Age



Maturity
Maturity
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
Age

Tautog Stock Assessment Update
LIS Region 2021

LIS **Appendix 2: Sensitivity Runs and Retrospective Adjustment**

Table A2.1. SSB and F reference points from 2016 and 2021 updates for the LIS region

	SSB		F	
	Target	Threshold	Target	Threshold
2016 Update	2,865	2,148	0.28	0.49
2016 Bridge Model	4,892	3,669	0.27	0.47
2021 Update	6,725	5,044	0.26	0.38
2021 Update Sensitivity	6,673	5,005	0.26	0.38

Table A2.2. Stock status for the LIS region.

	SSB		F	
	Target	Threshold	Target	Threshold
2016 Bridge Estimate	2,252		0.81	
2016 Bridge Status	overfished		overfishing	
2020 Estimate	6,413		0.3	
2020 Status	not overfished		not overfishing	
2020 Estimate Sensitivity	6,122		0.34	
2020 Status Sensitivity	not overfished		not overfishing	

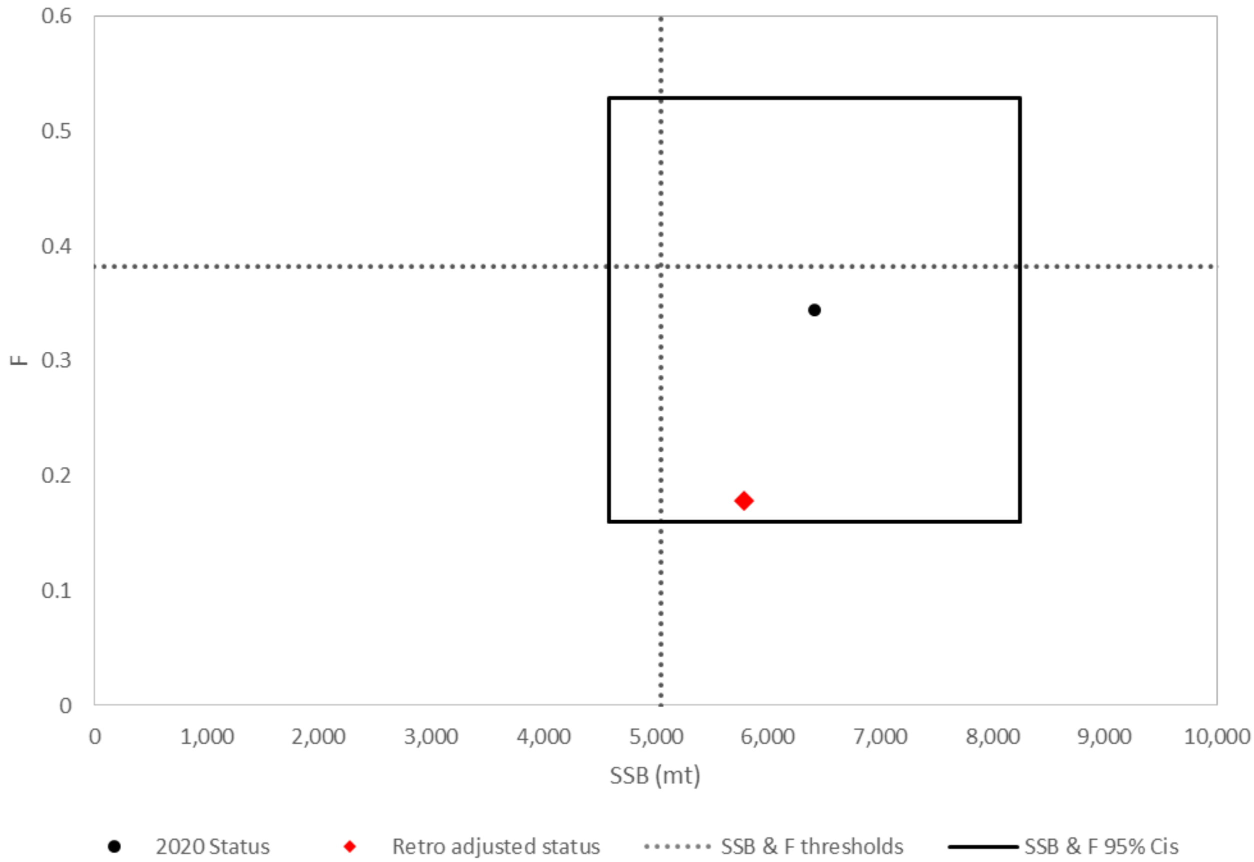


Figure A2.1. Comparison of retrospective adjusted status in 2020 with the base model status. Solid black lines indicate the 95% confidence intervals of the estimates of SSB and *F*.

Tautog Stock Assessment Update
NJ-NYB Region 2021

Appendix 1: ASAP Input, Diagnostic, and Results Plots for the Base Run

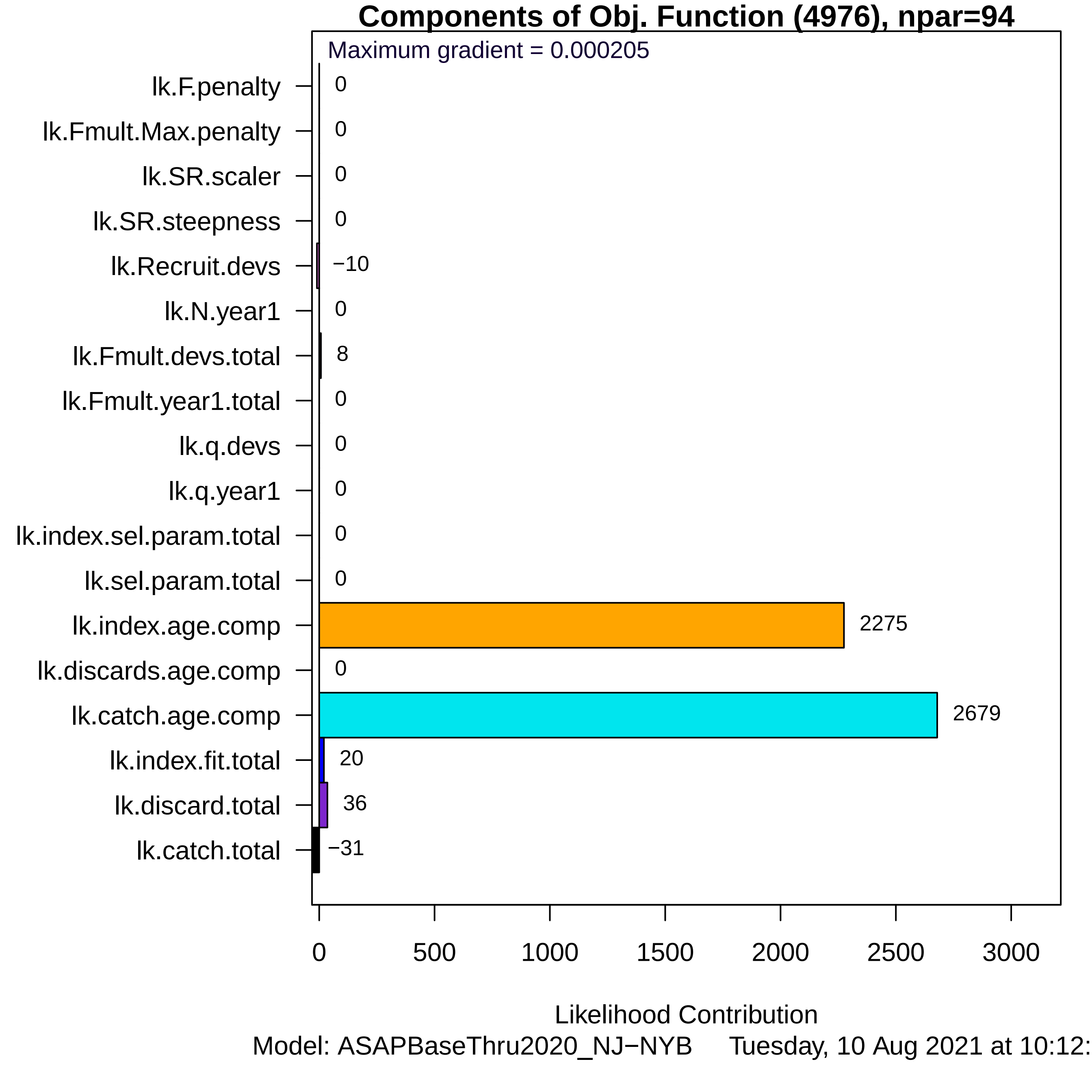
File = ASAPBaseThru2020_NJ−NYB.dat

ASAP3 run on Tuesday, 10 Aug 2021 at 10:12:08

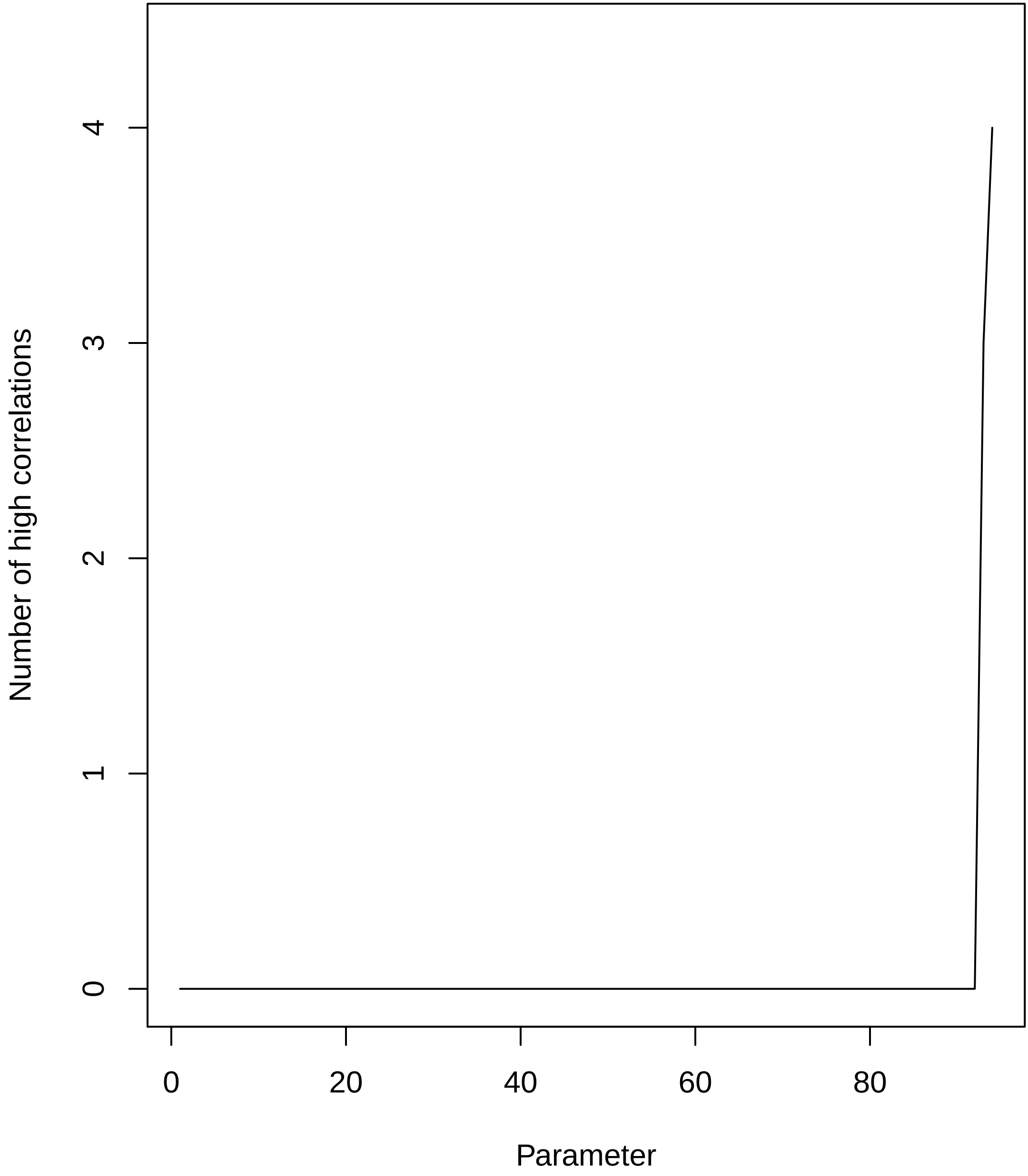
indy\Documents\Tautog\ASMFC\Update 2021 Assessment\ASAP\ASAPThroug

ASAPplots version = 0.2.17

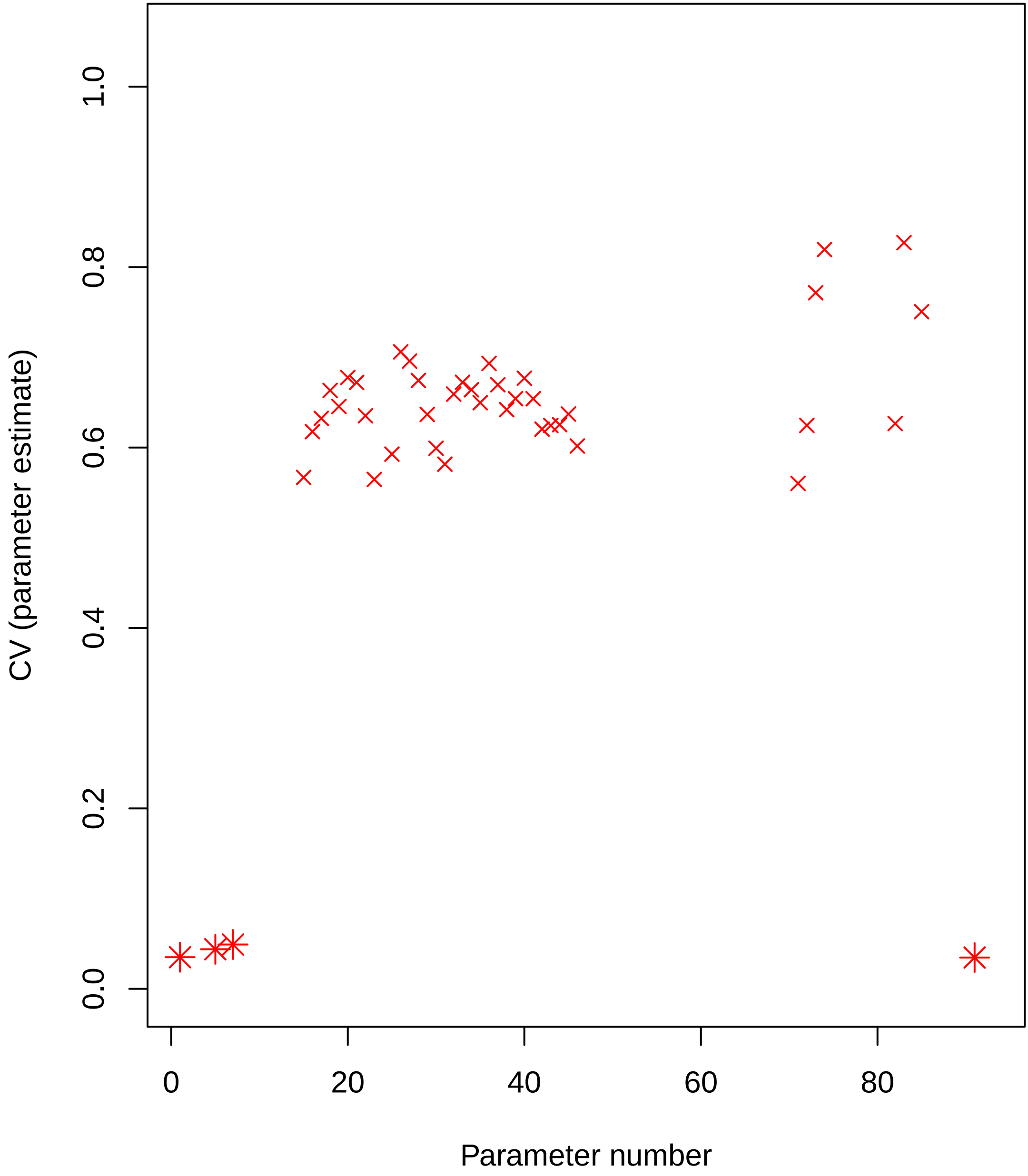
npar = 94, maximum gradient = 0.000204728



Components of Obj. Function (4976), npar=94
Maximum gradient = 0.000205
lk.F.penalty
lk.Fmult.Max.penalty
lk.SR.scaler
lk.SR.steepness
lk.Recruit.devs
lk.N.year1
lk.Fmult.devs.total
lk.Fmult.year1.total
lk.q.devs
lk.q.year1
lk.index.sel.param.total
lk.sel.param.total
lk.index.age.comp
lk.discards.age.comp
lk.catch.age.comp
lk.index.fit.total
lk.discard.total
lk.catch.total
0
0
0
0
−10
0
8
0
0
0
0
0
2275
0
2679
20
36
−31
0
500
1000
1500
2000
2500
3000
Likelihood Contribution
Model: ASAPBaseThru2020_NJ−NYB
Tuesday, 10 Aug 2021 at 10:12:

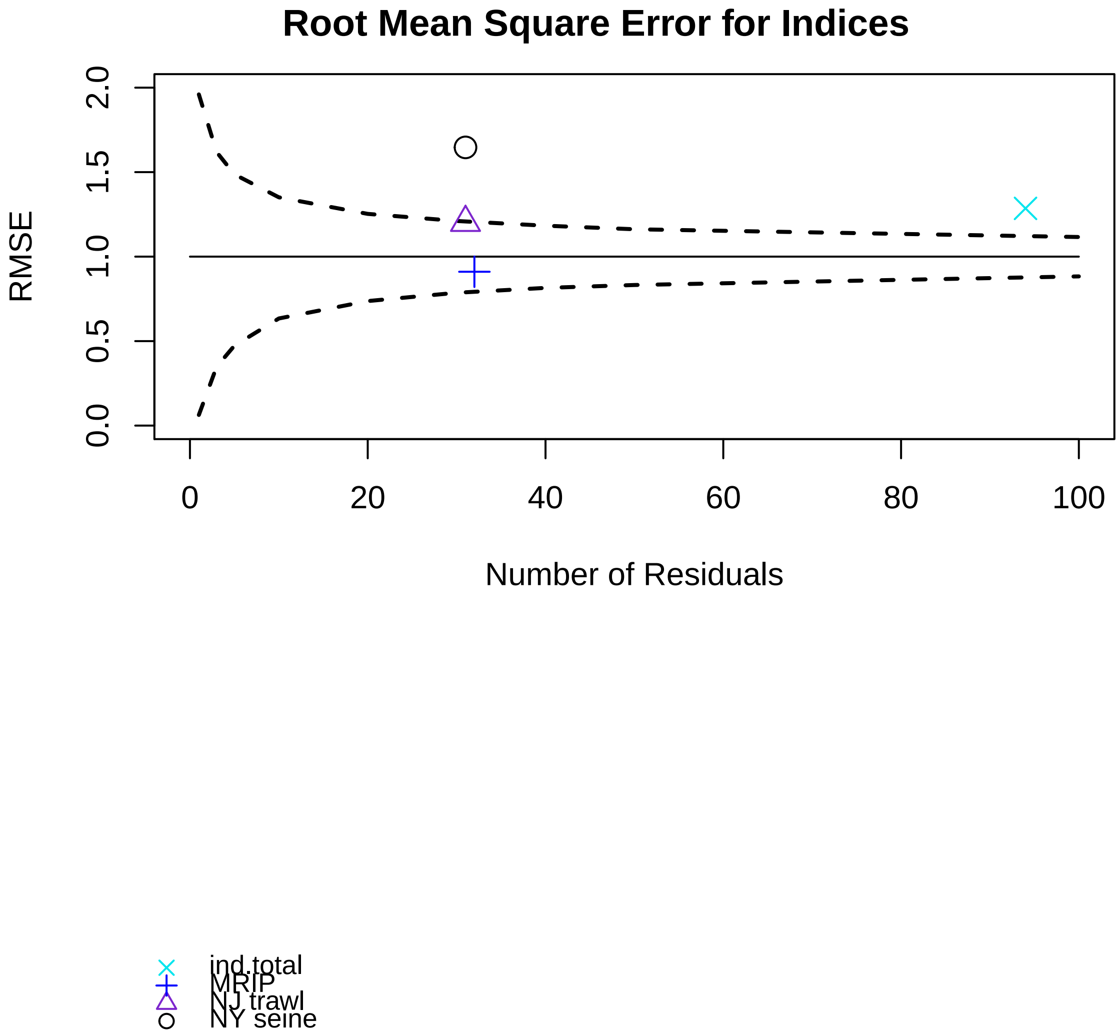


Number of high correlations
0
1
2
3
4
0
20
40
60
80
Parameter

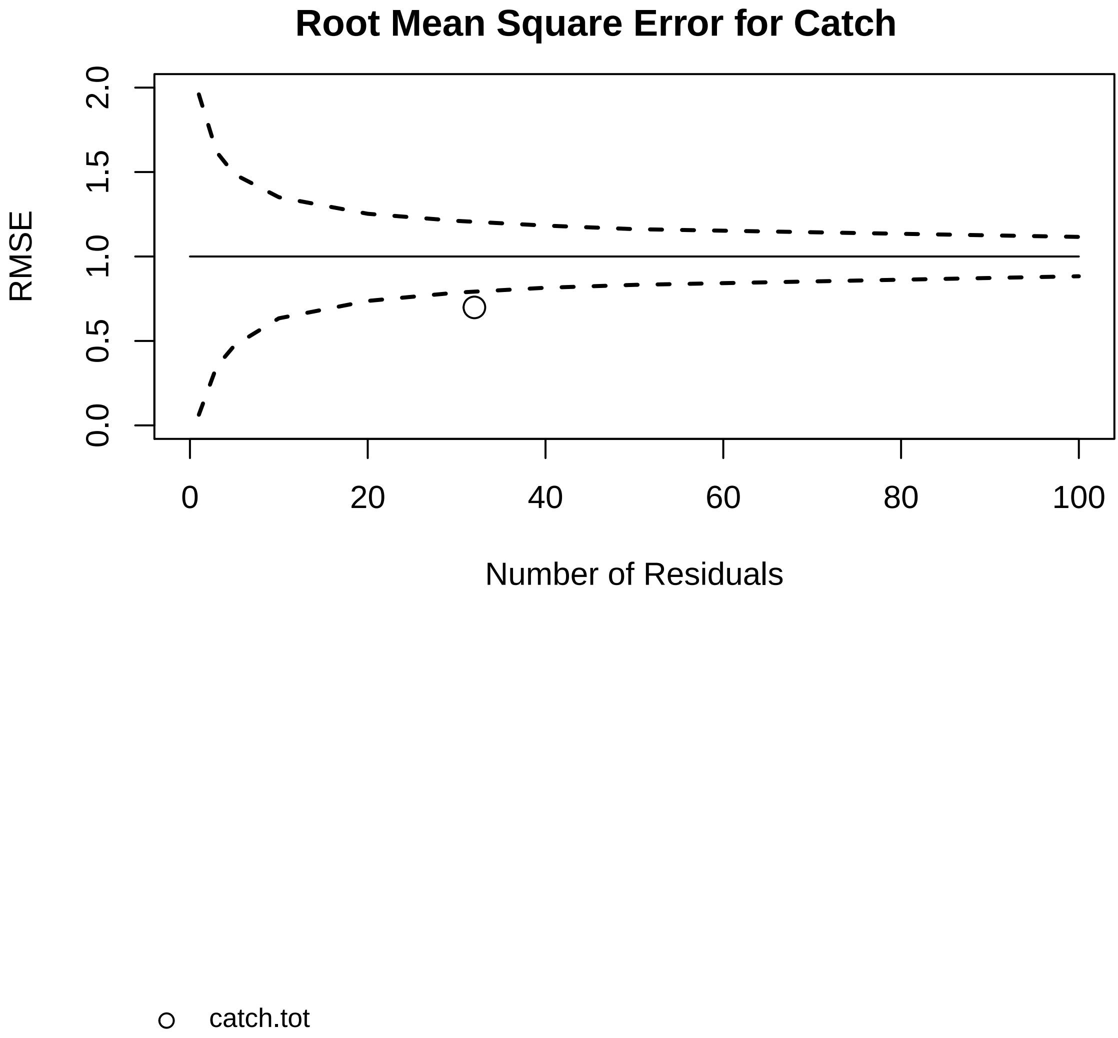

CV (parameter estimate)
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Parameter number

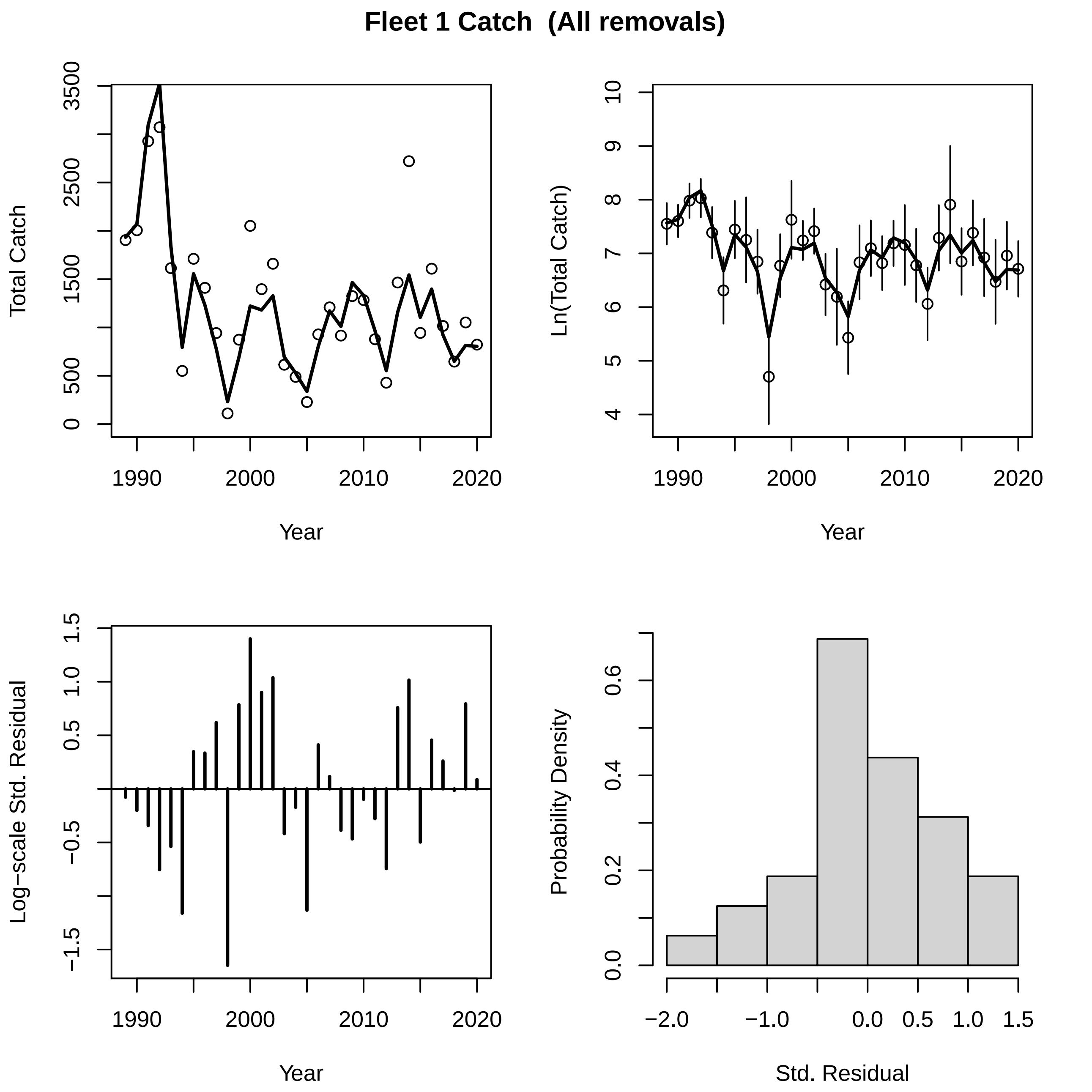
Root Mean Square Error computed from Standardized Residuals

Component	# resids	RMSE
catch.tot	32	0.699
discard.tot	0	0
ind01	31	1.65
ind02	31	1.2
ind03	32	0.911
ind.total	94	1.29
N.year1	0	0
Fmult.year1	0	0
Fmult.devs.total	31	0.992
recruit.devs	32	0.503
fleet.sel.params	0	0
index.sel.params	0	0
q.year1	0	0
q.devs	0	0
SR.steepness	0	0
SR.scaler	0	0

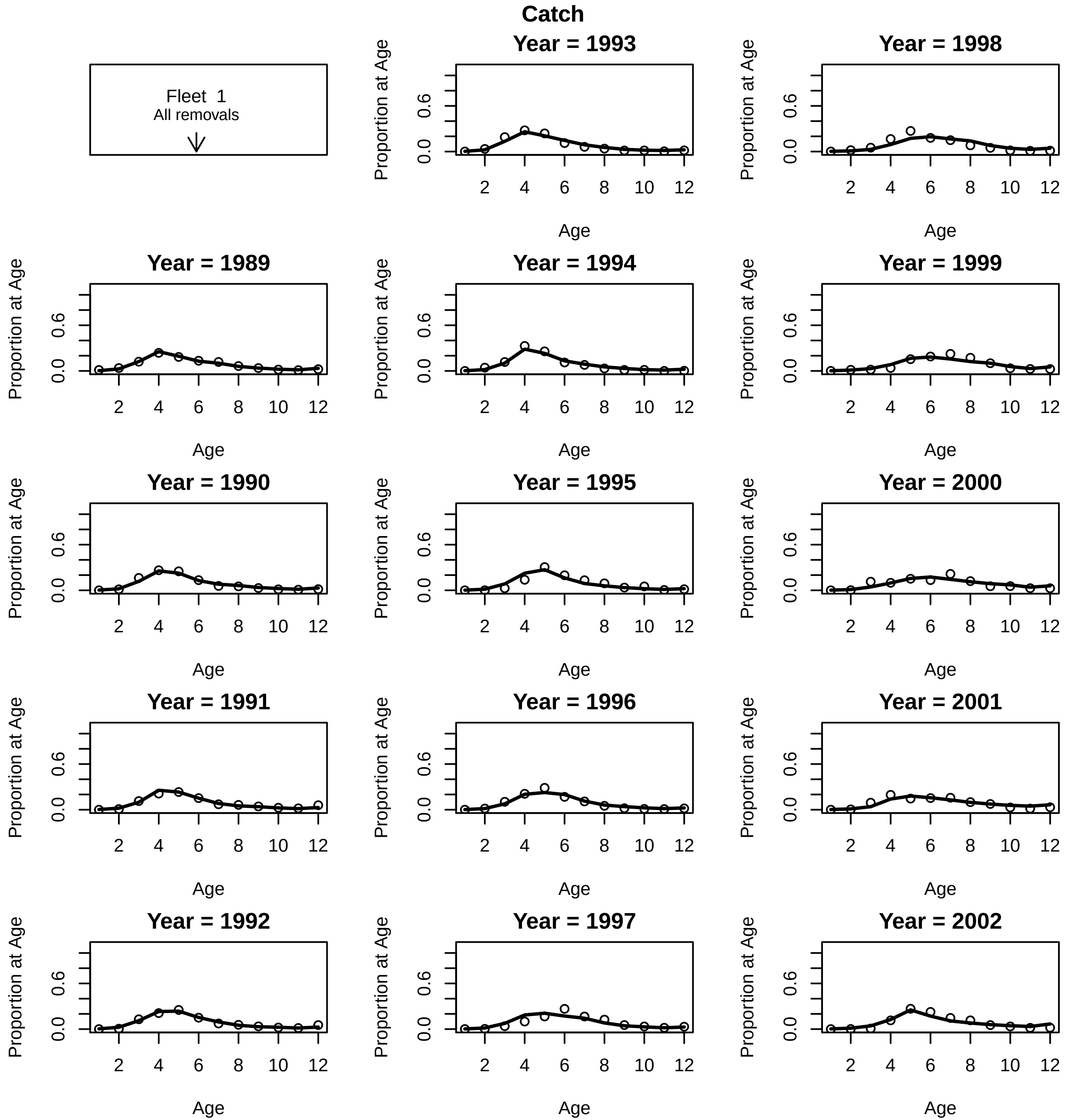


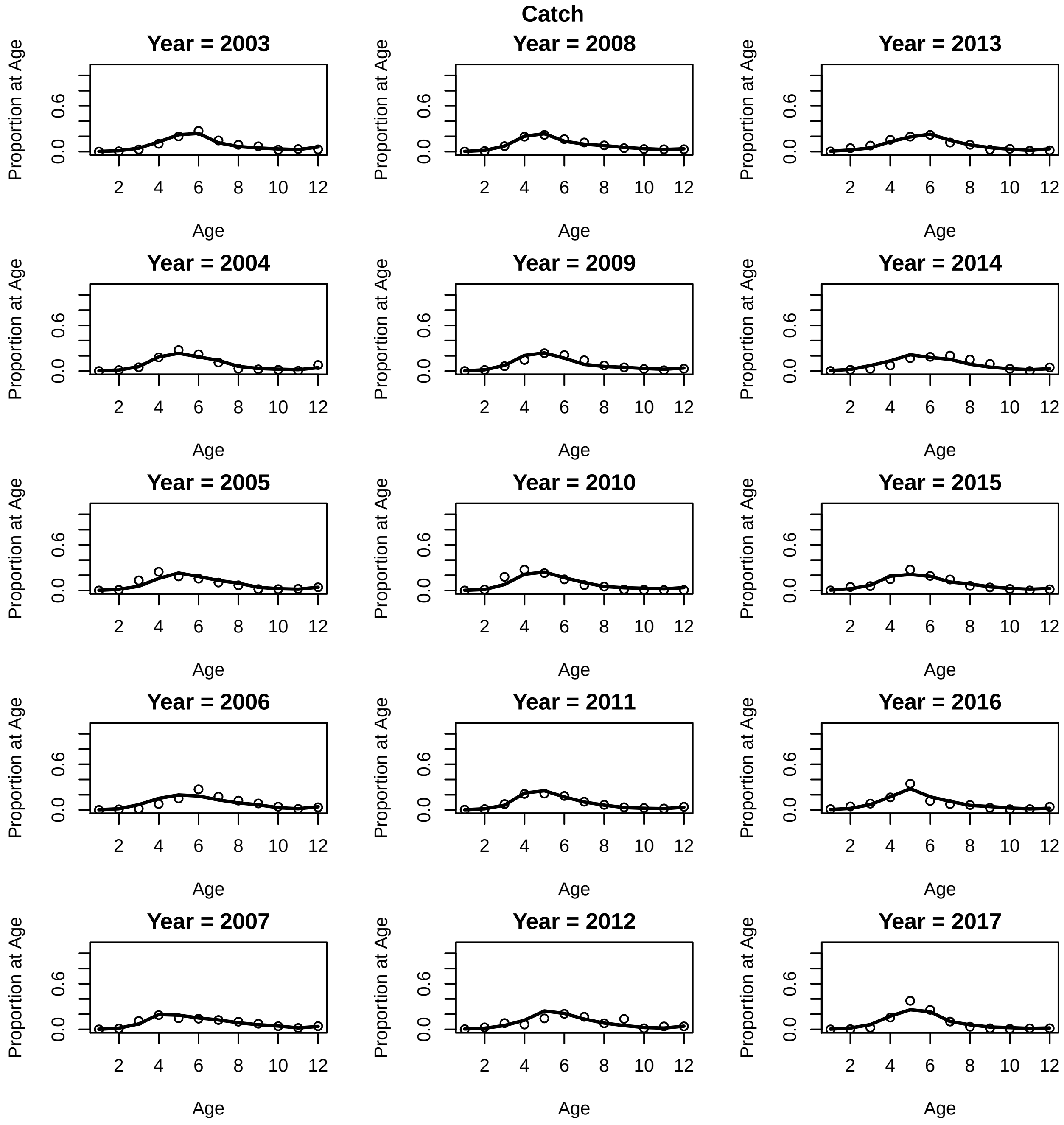
Root Mean Square Error for Indices
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
ind.total
MRIP
NJ trawl
NY seine


Root Mean Square Error for Catch
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
catch.tot

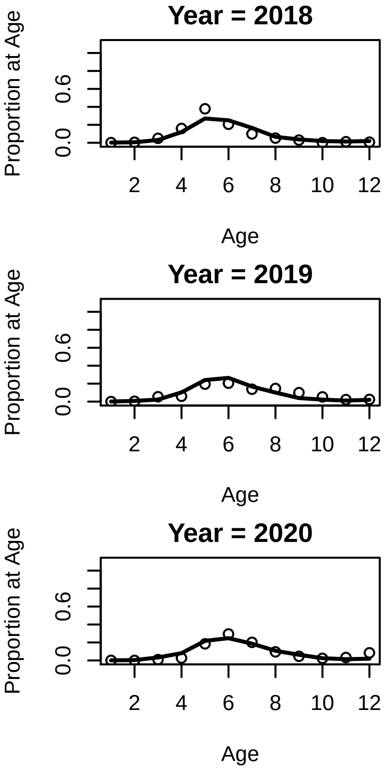


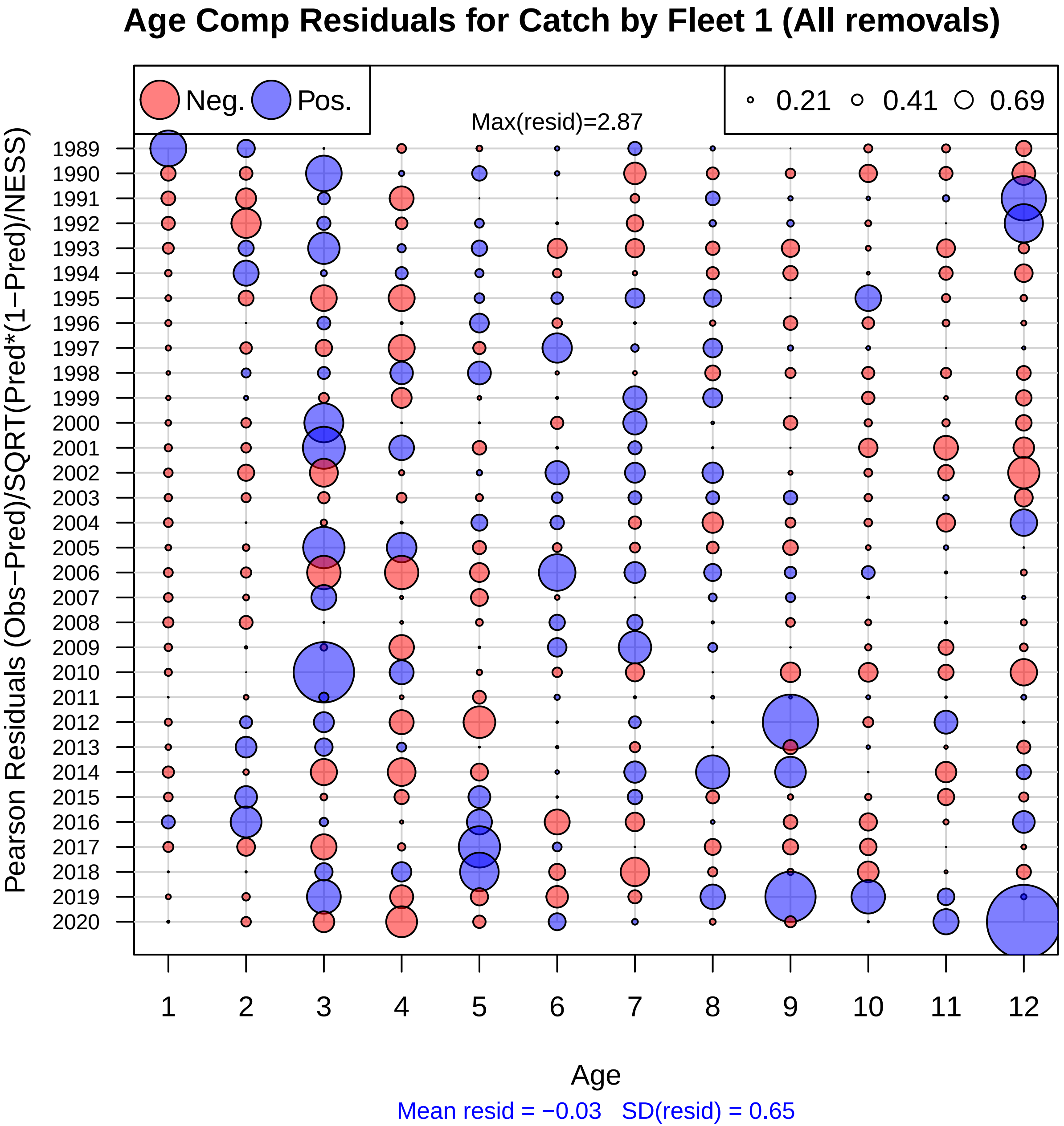
Fleet 1 Catch (All removals)
Total Catch
0
500
1500
2500
3500
1990
2000
2010
2020
Year
Ln(Total Catch)
4
5
6
7
8
9
10
Log−scale Std. Residual
−1.5
−0.5
0.5
1.0
1.5
Probability Density
0.0
0.2
0.4
0.6
−2.0
−1.0
0.0
0.5
1.0
1.5
Std. Residual


Catch
Fleet 1
All removals
Year = 1989
Year = 1990
Year = 1991
Year = 1992
Year = 1993
Year = 1994
Year = 1995
Year = 1996
Year = 1997
Year = 1998
Year = 1999
Year = 2000
Year = 2001
Year = 2002
Proportion at Age
Age
0.0
0.6
2
4
6
8
10
12

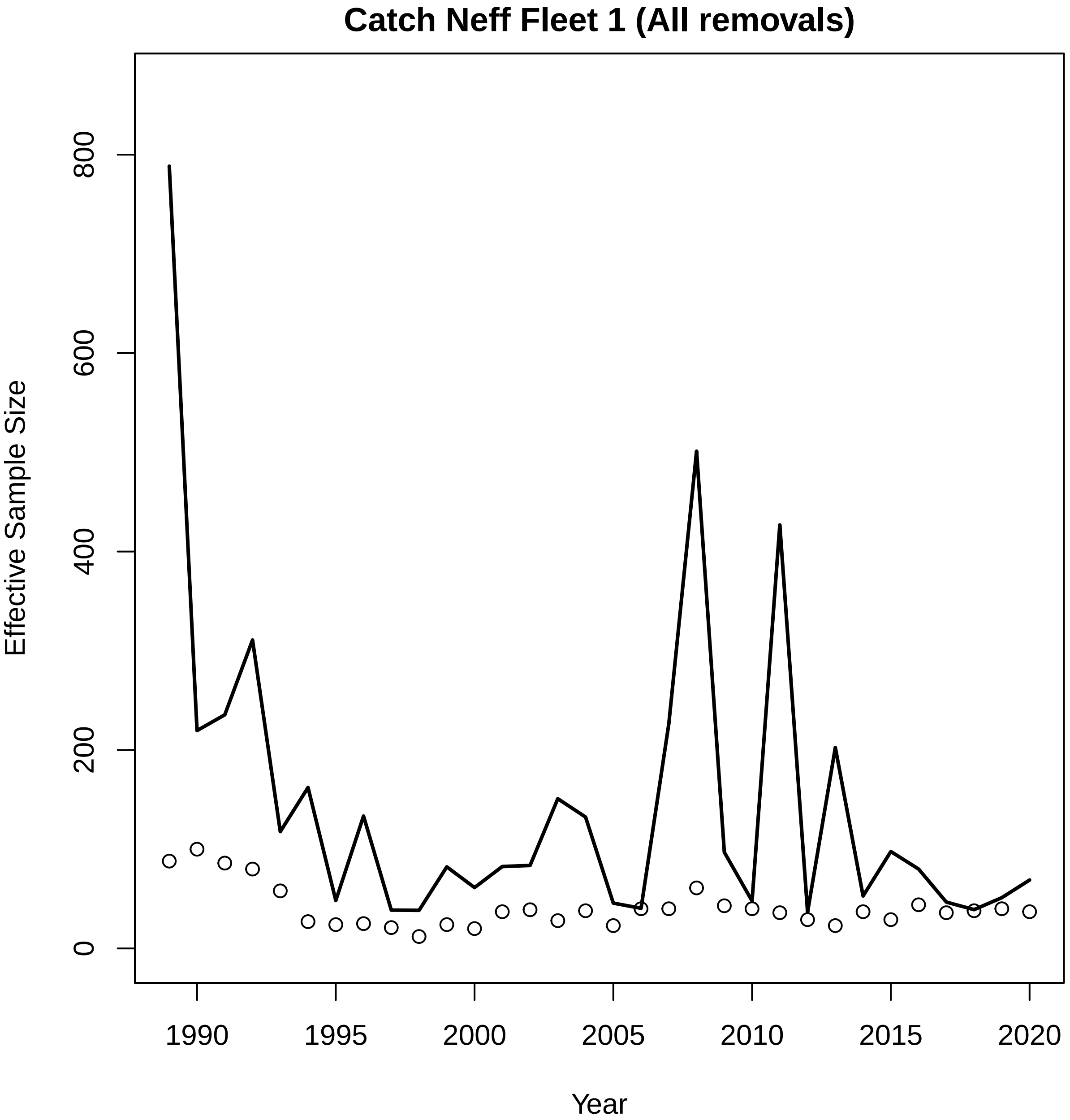

Catch
Year = 2003
Year = 2008
Year = 2013
Year = 2004
Year = 2009
Year = 2014
Year = 2005
Year = 2010
Year = 2015
Year = 2006
Year = 2011
Year = 2016
Year = 2007
Year = 2012
Year = 2017
Proportion at Age
Age
0.0
0.6
2
4
6
8
10
12

Catch

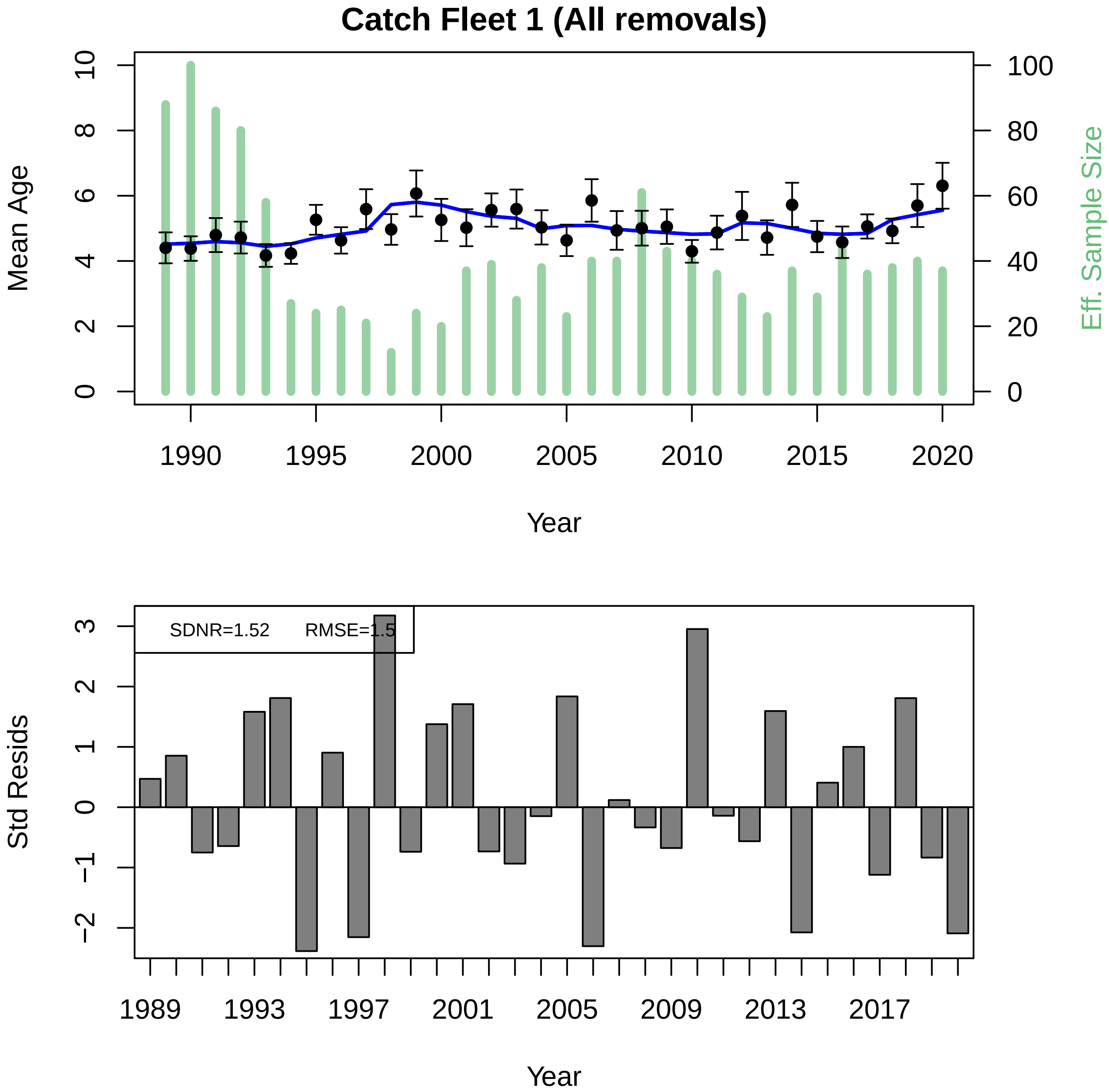

Year = 2018
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age
Year = 2019
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age
Year = 2020
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age

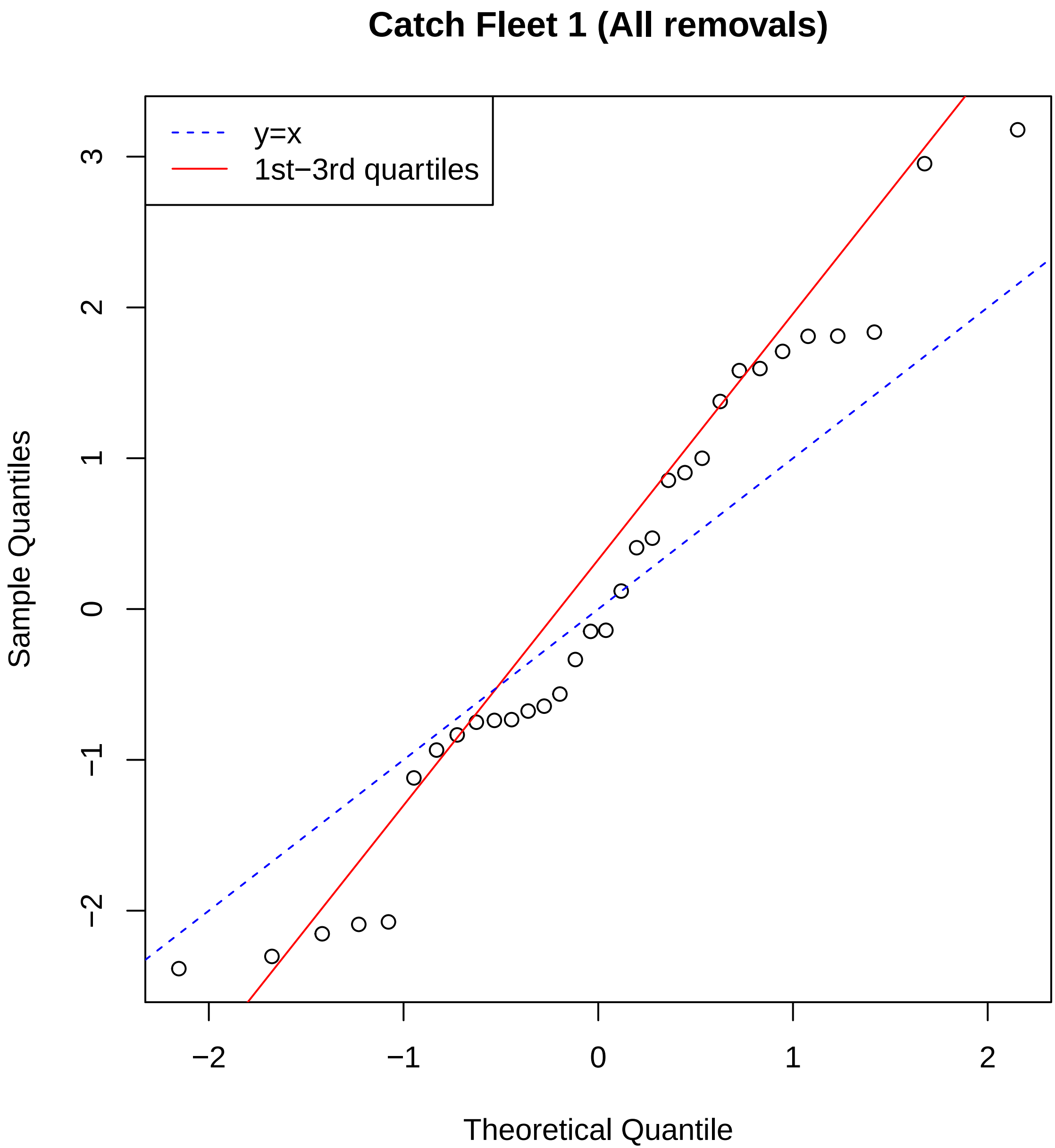


Age Comp Residuals for Catch by Fleet 1 (All removals)
Neg.
Pos.
0.21
0.41
0.69
Max(resid)=2.87
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.03 SD(resid) = 0.65



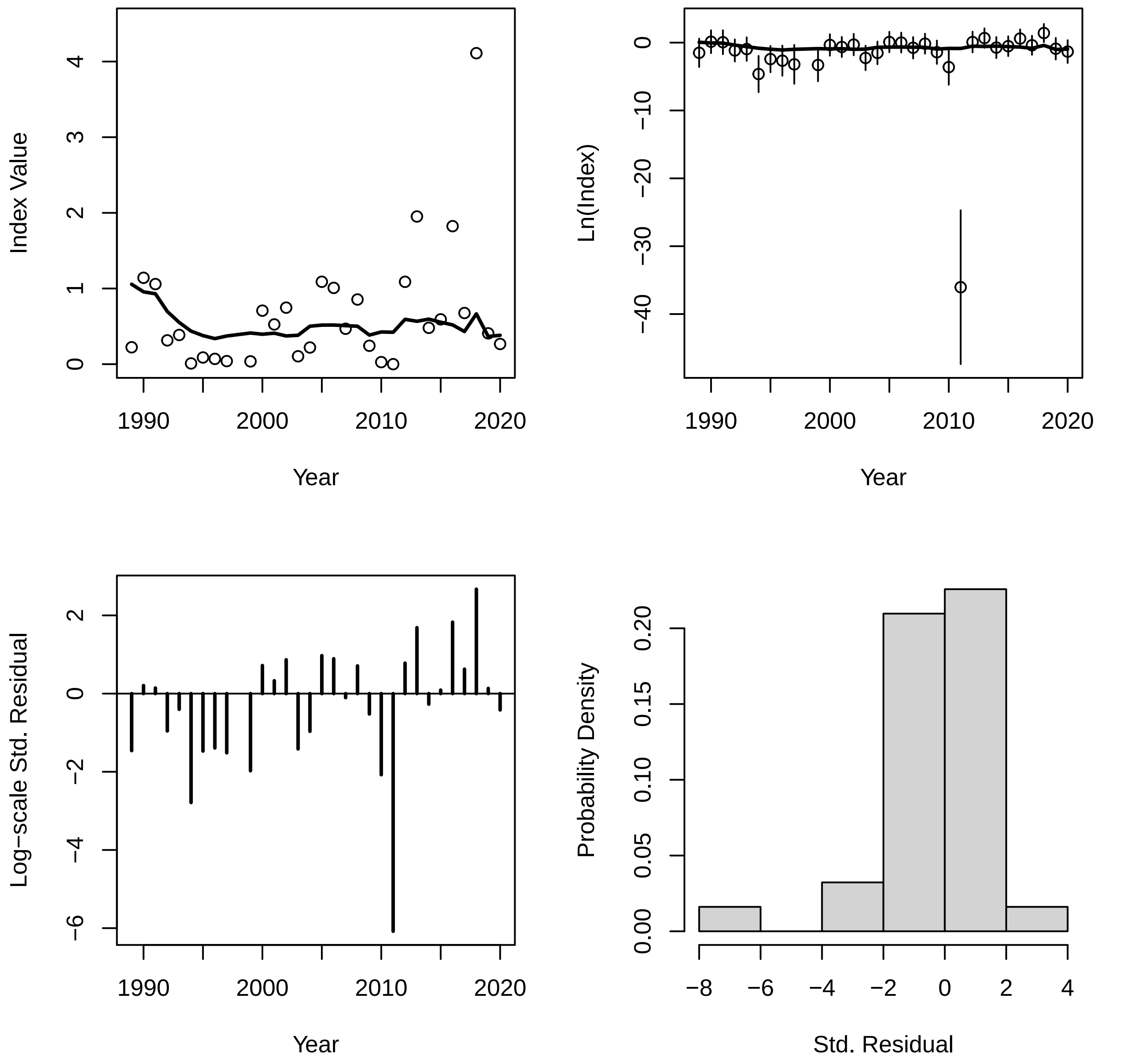
Catch Neff Fleet 1 (All removals)
Effective Sample Size
0
200
400
600
800
1990
1995
2000
2005
2010
2015
2020
Year


Catch Fleet 1 (All removals)
Mean Age
Eff. Sample Size
Year
0
2
4
6
8
10
0
20
40
60
80
100
1990
1995
2000
2005
2010
2015
2020
SDNR=1.52
RMSE=1.5
Std Resids
−2
−1
0
1
2
3
1989
1993
1997
2001
2005
2009
2013
2017
Year

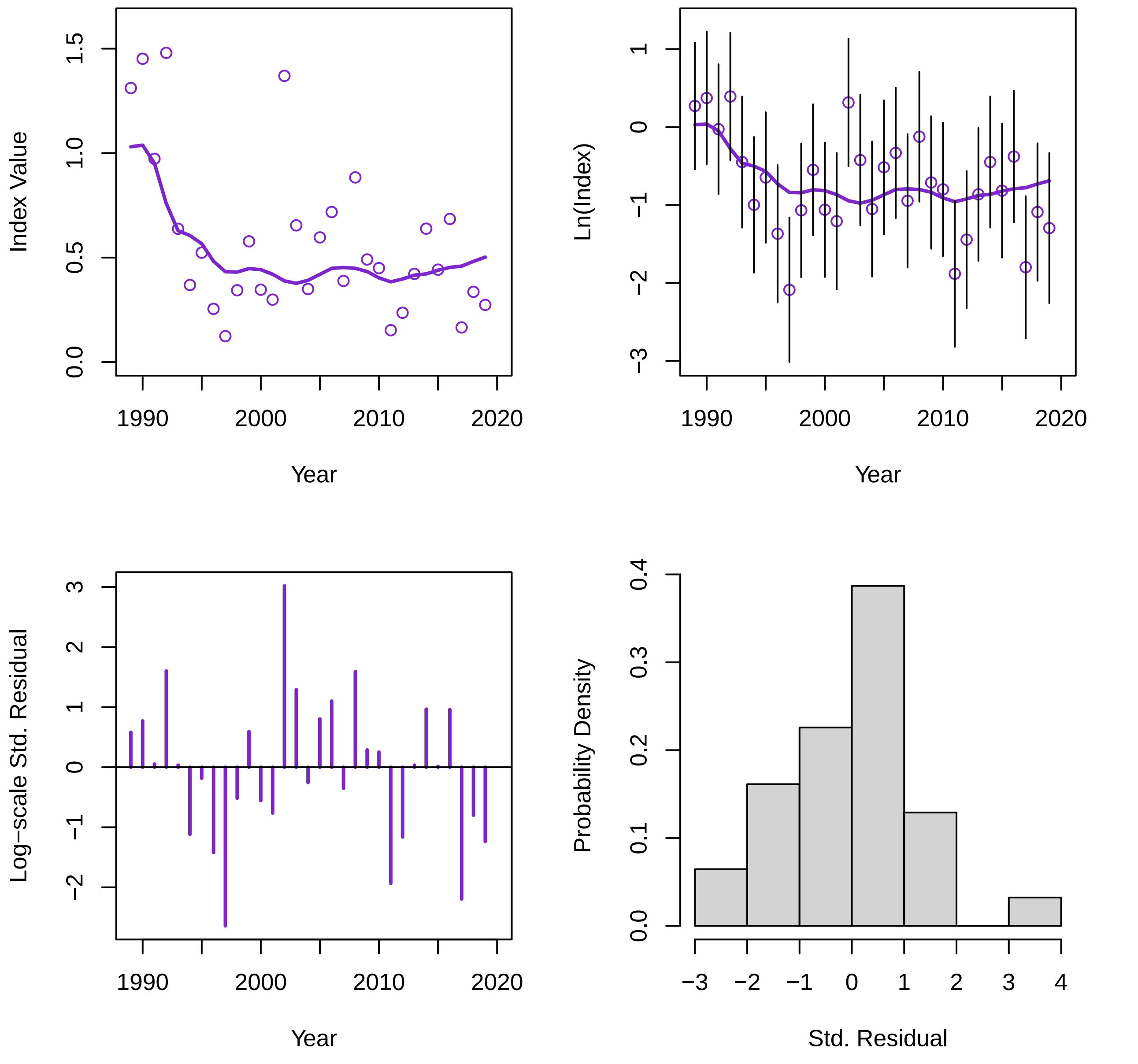


Catch Fleet 1 (All removals)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2
3

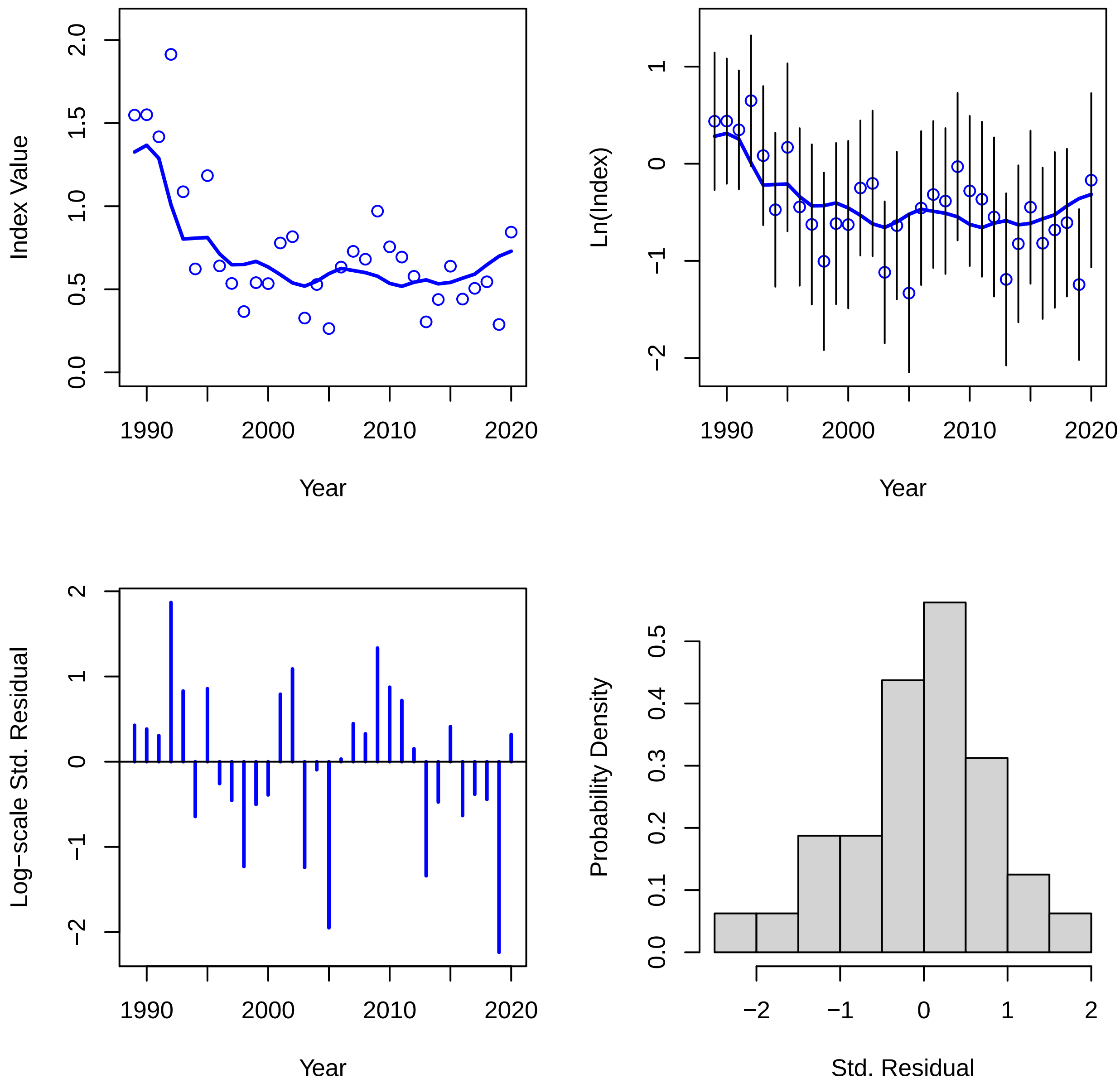
Index 1 (NY seine)

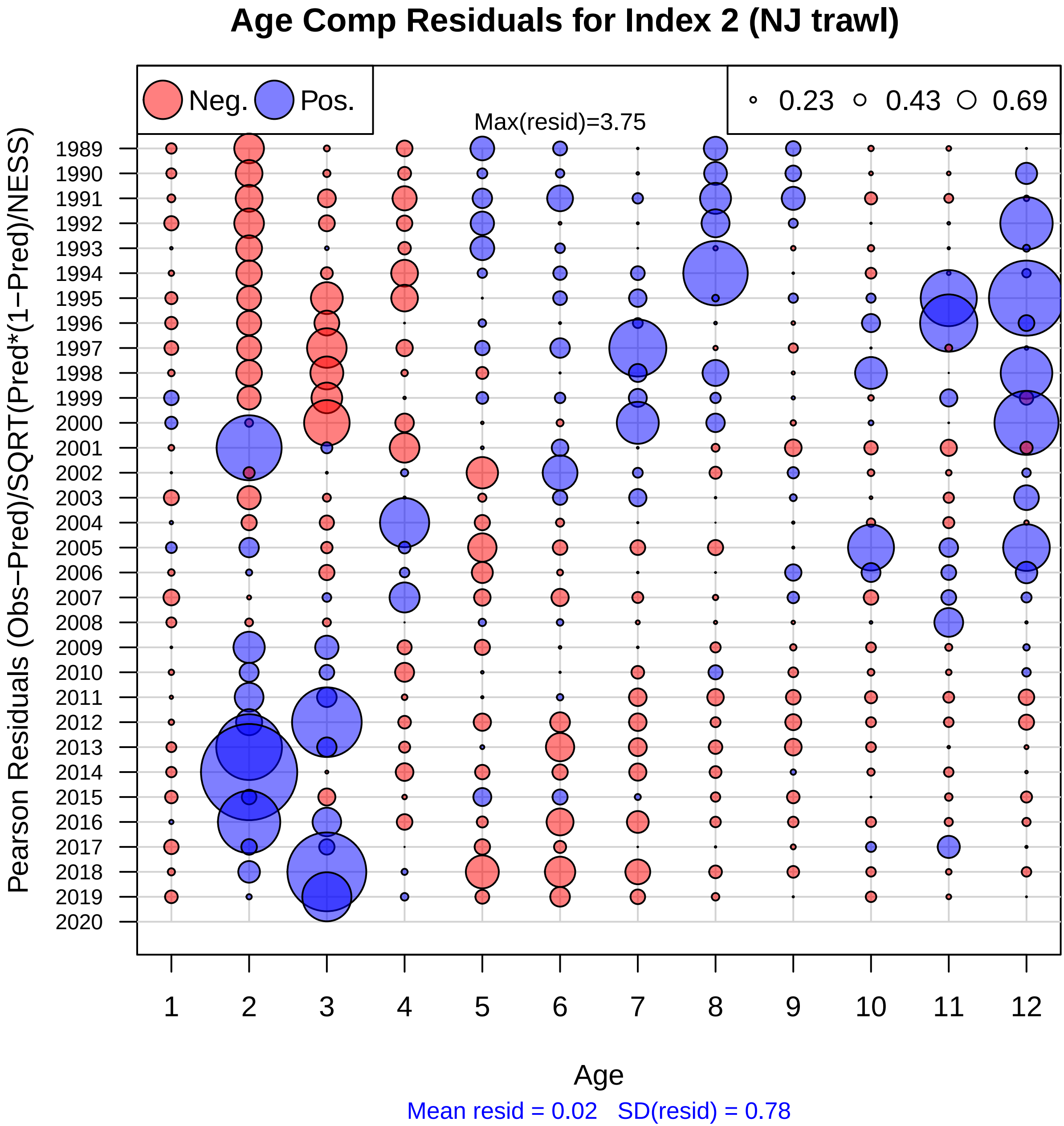


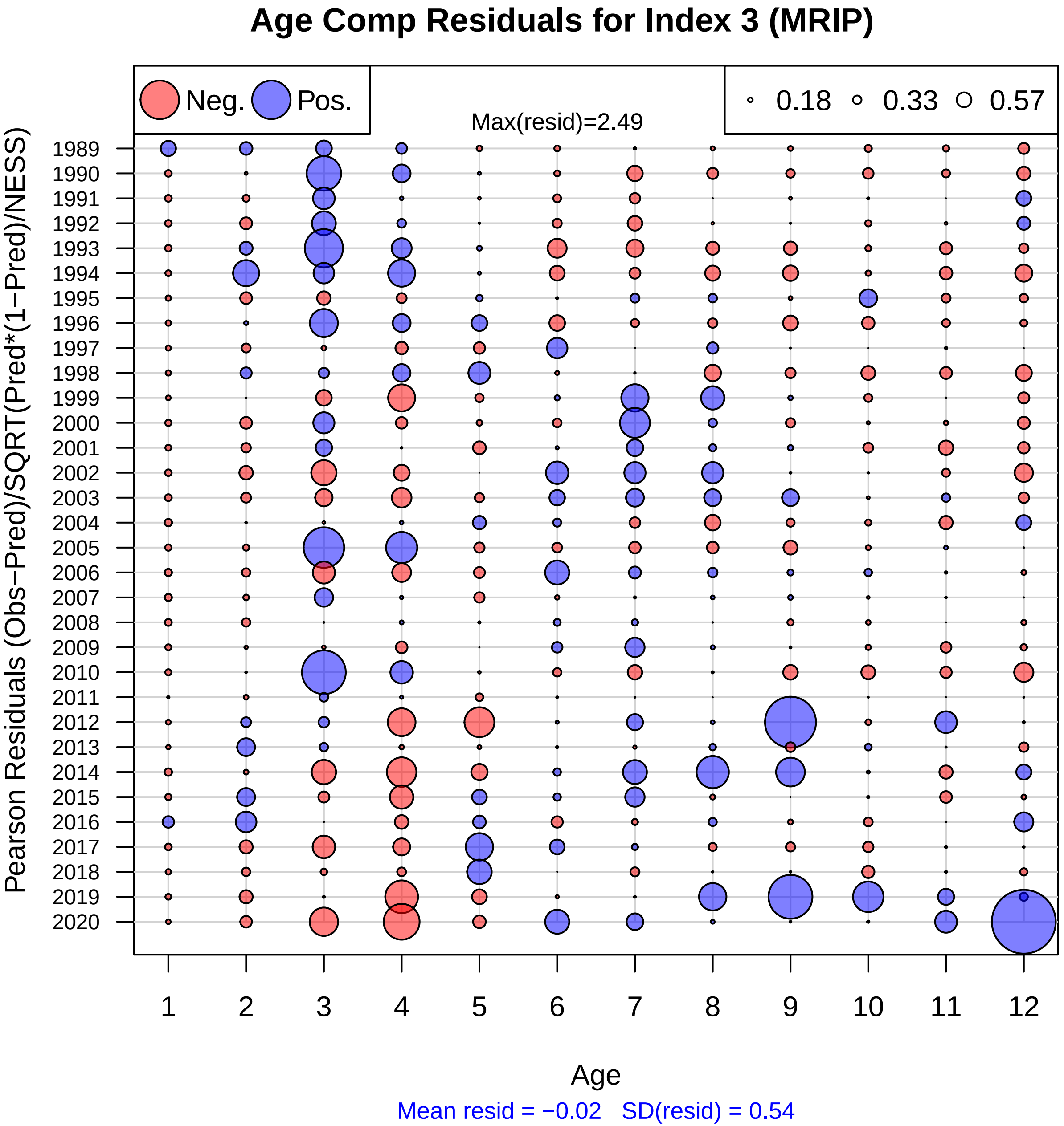
Index 2 (NJ trawl)

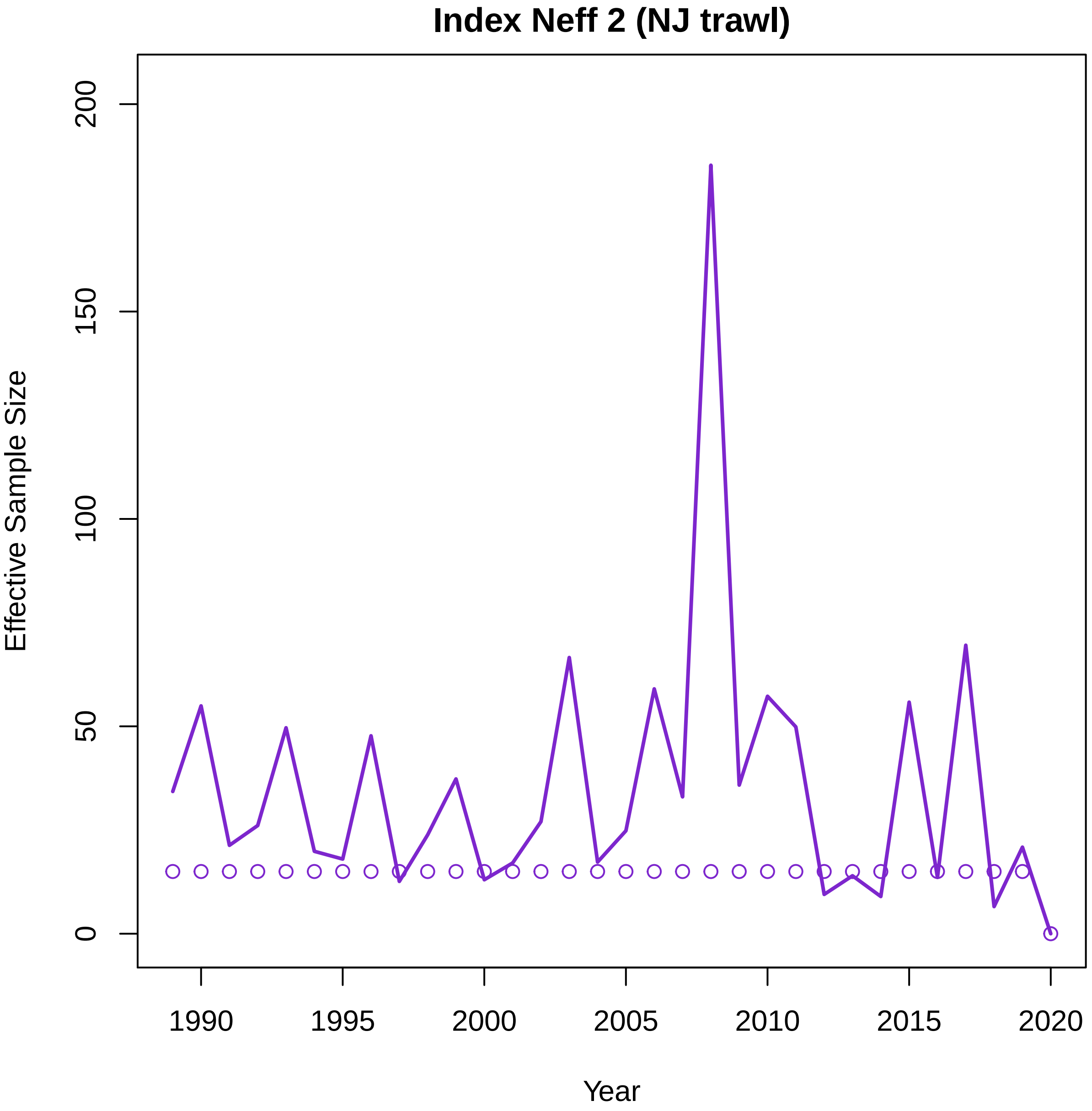


Index 3 (MRIP)

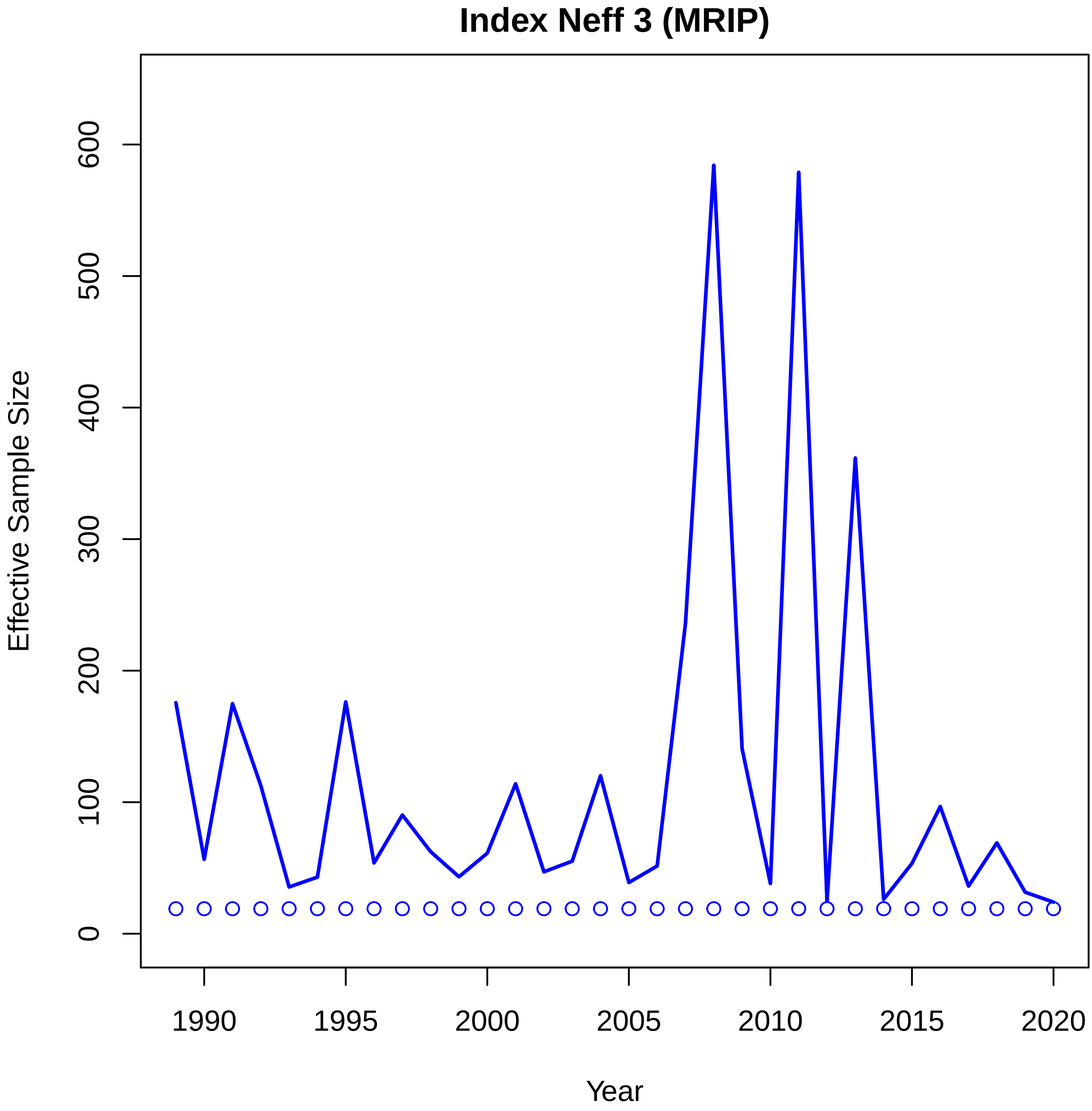

Index Value
Year
Ln(Index)
Year
Log−scale Std. Residual
Year
Probability Density
Std. Residual

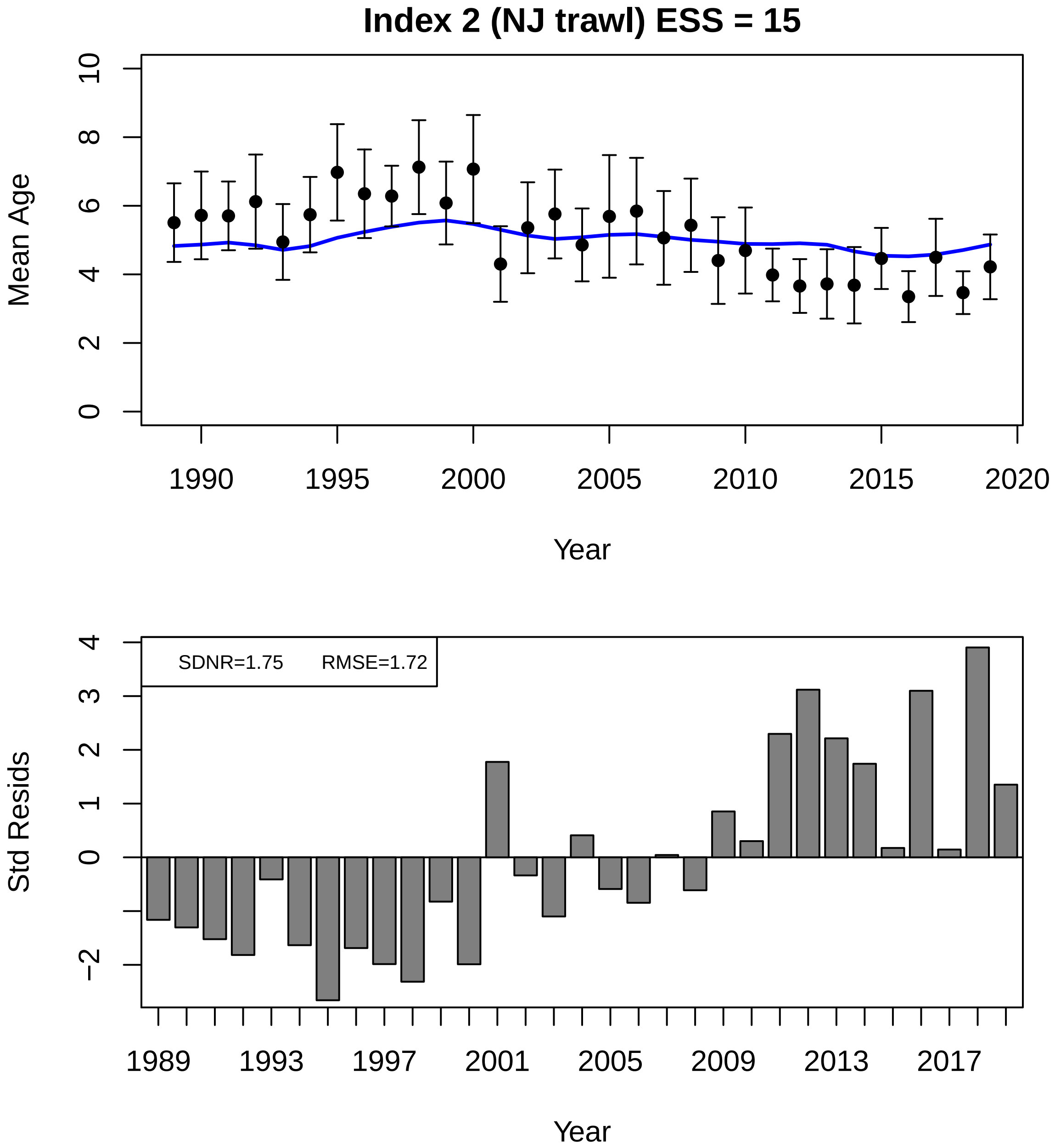

Age Comp Residuals for Index 2 (NJ trawl)
Neg.
Pos.
0.23
0.43
0.69
Max(resid)=3.75
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = 0.02 SD(resid) = 0.78


Age Comp Residuals for Index 3 (MRIP)
Neg.
Pos.
0.18
0.33
0.57
Max(resid)=2.49
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
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
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.02 SD(resid) = 0.54

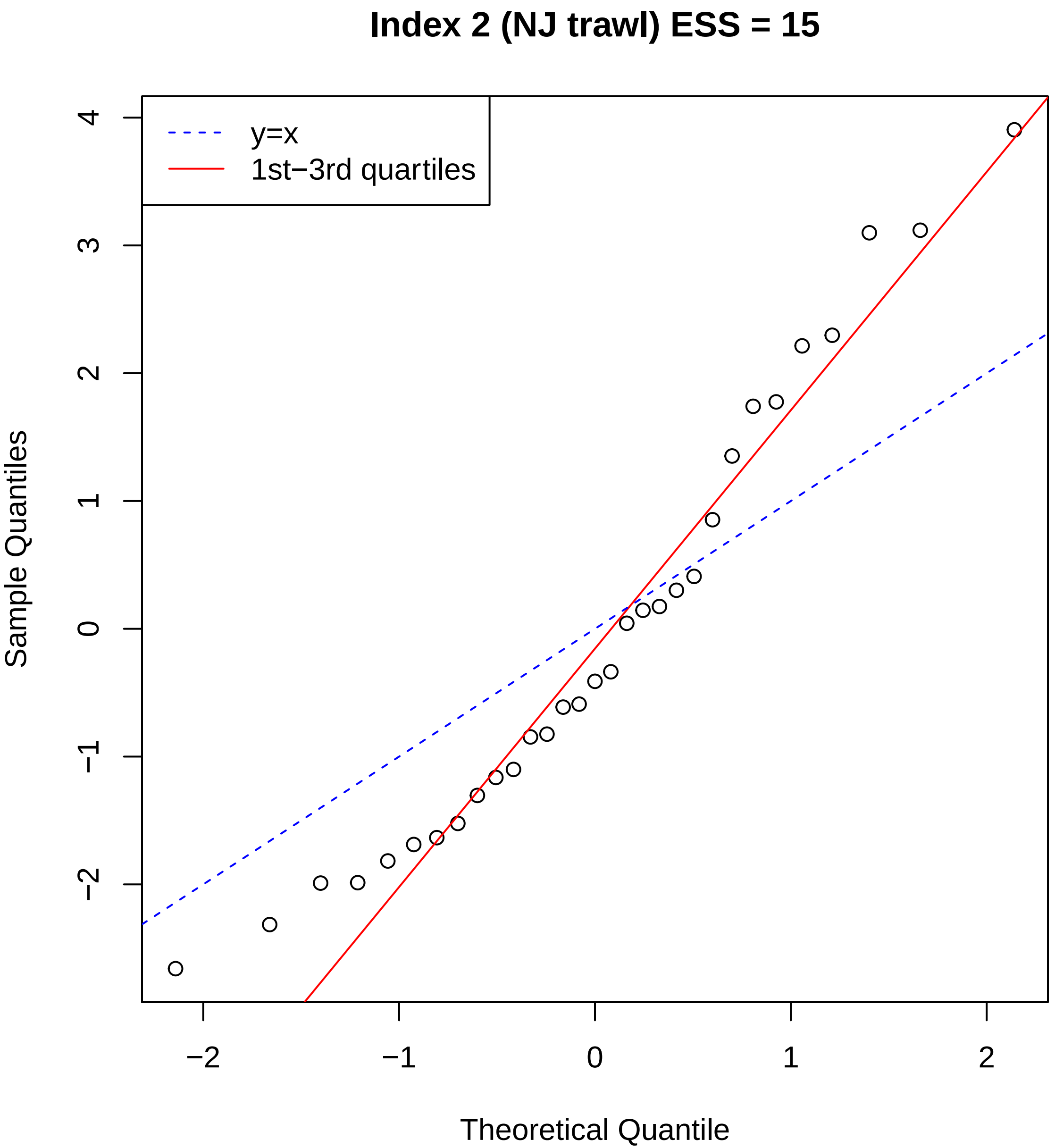


Index Neff 2 (NJ trawl)
Effective Sample Size
0
50
100
150
200
1990
1995
2000
2005
2010
2015
2020
Year

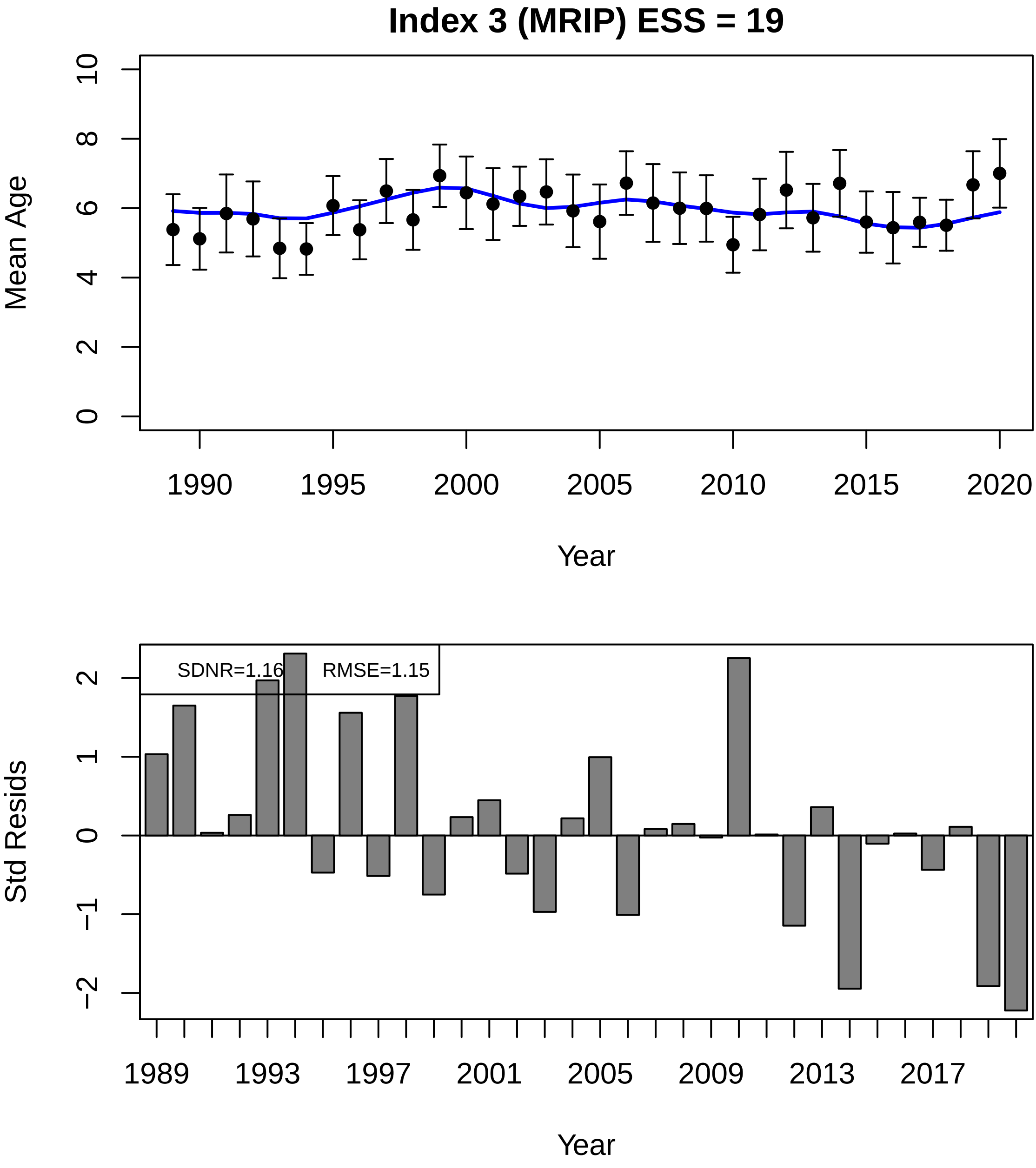

Index Neff 3 (MRIP)
Effective Sample Size
0
100
200
300
400
500
600
1990
1995
2000
2005
2010
2015
2020
Year



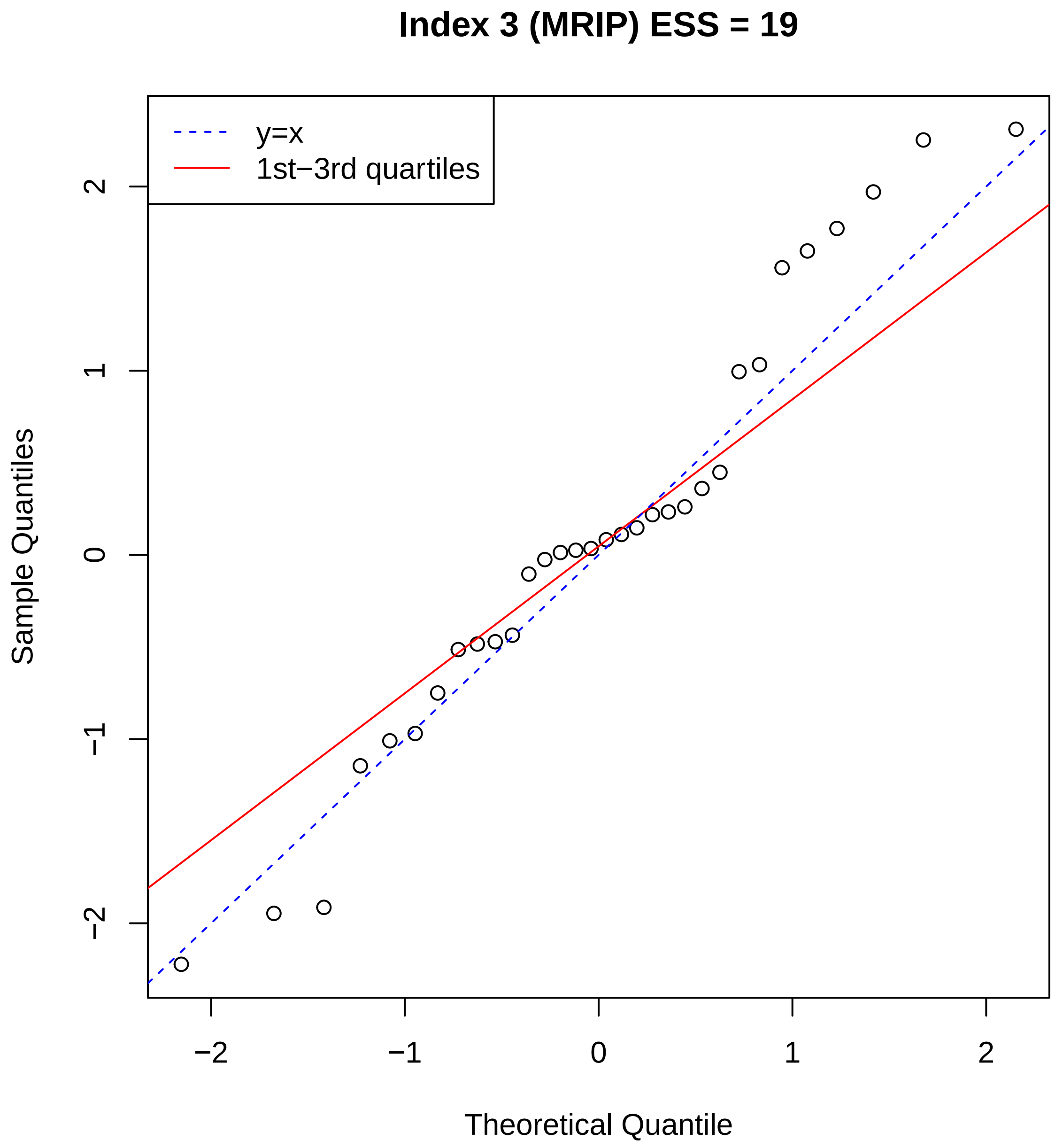
Index 2 (NJ trawl) ESS = 15
Mean Age
0
2
4
6
8
10
1990
1995
2000
2005
2010
2015
2020
Year
SDNR=1.75
RMSE=1.72
Std Resids
−2
0
1
2
3
4
1989
1993
1997
2001
2005
2009
2013
2017
Year



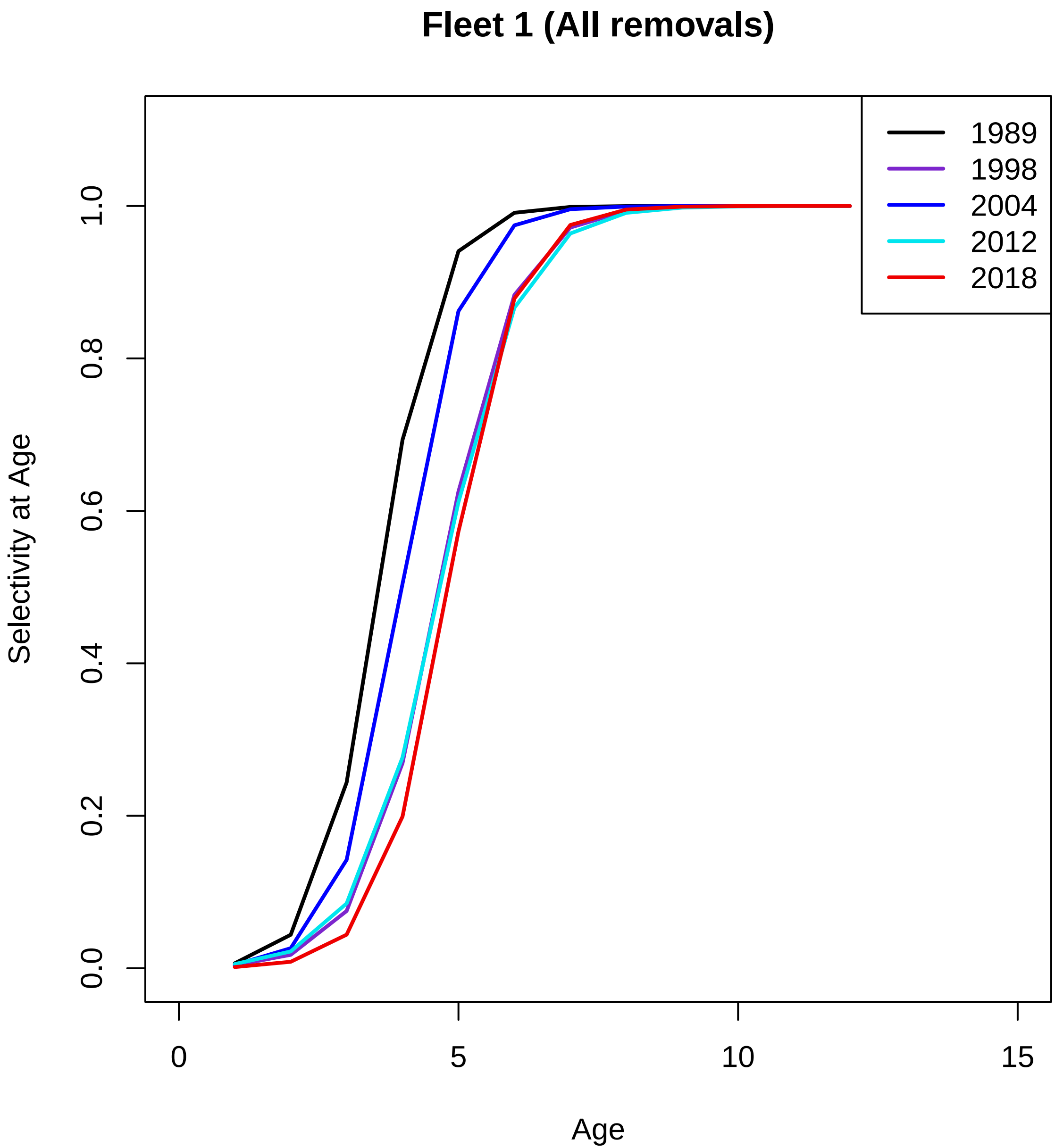
Index 2 (NJ trawl) ESS = 15
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2
3
4



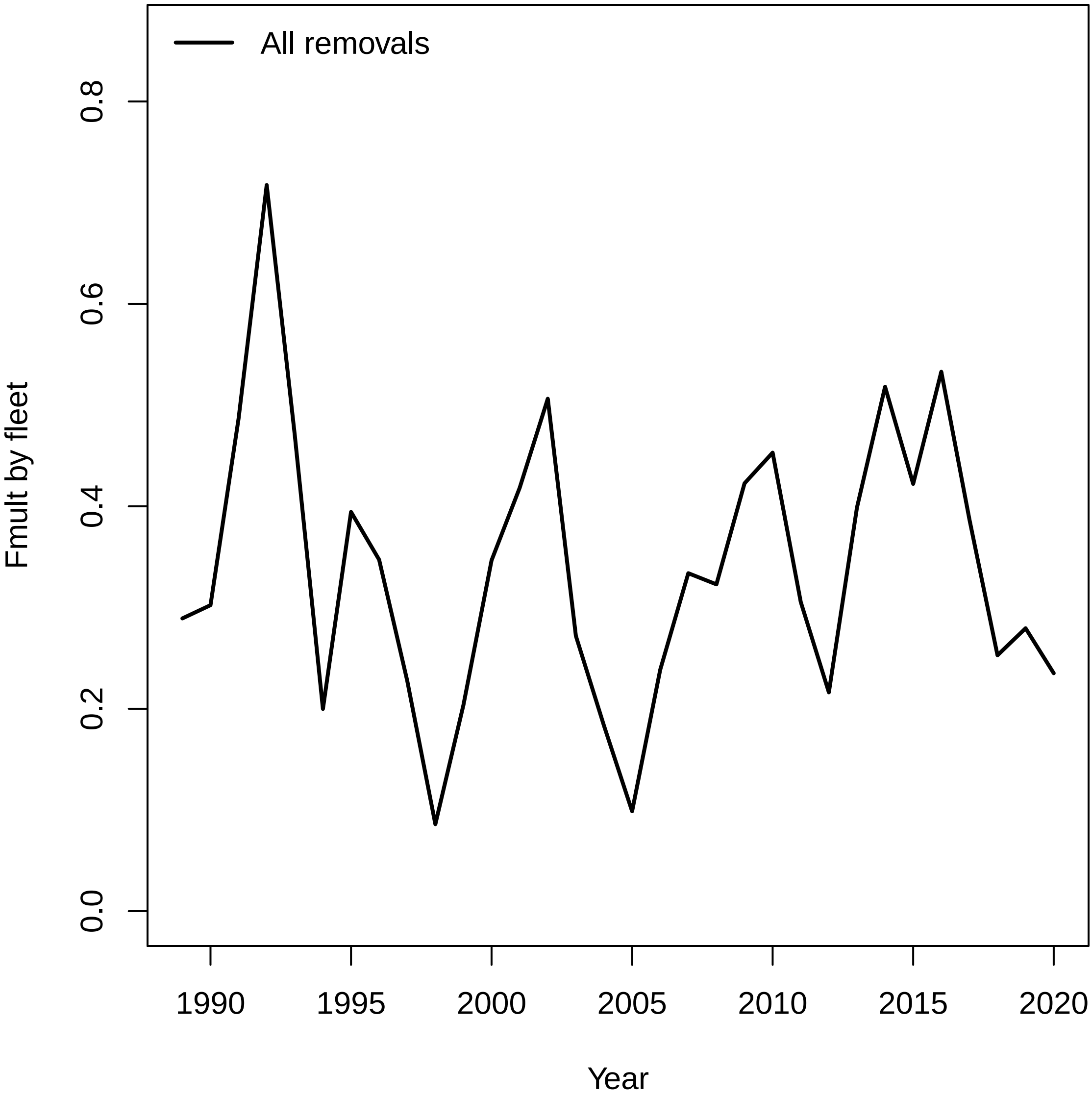
Index 3 (MRIP) ESS = 19
Mean Age
Year
SDNR=1.16
RMSE=1.15
Std Resids
Year

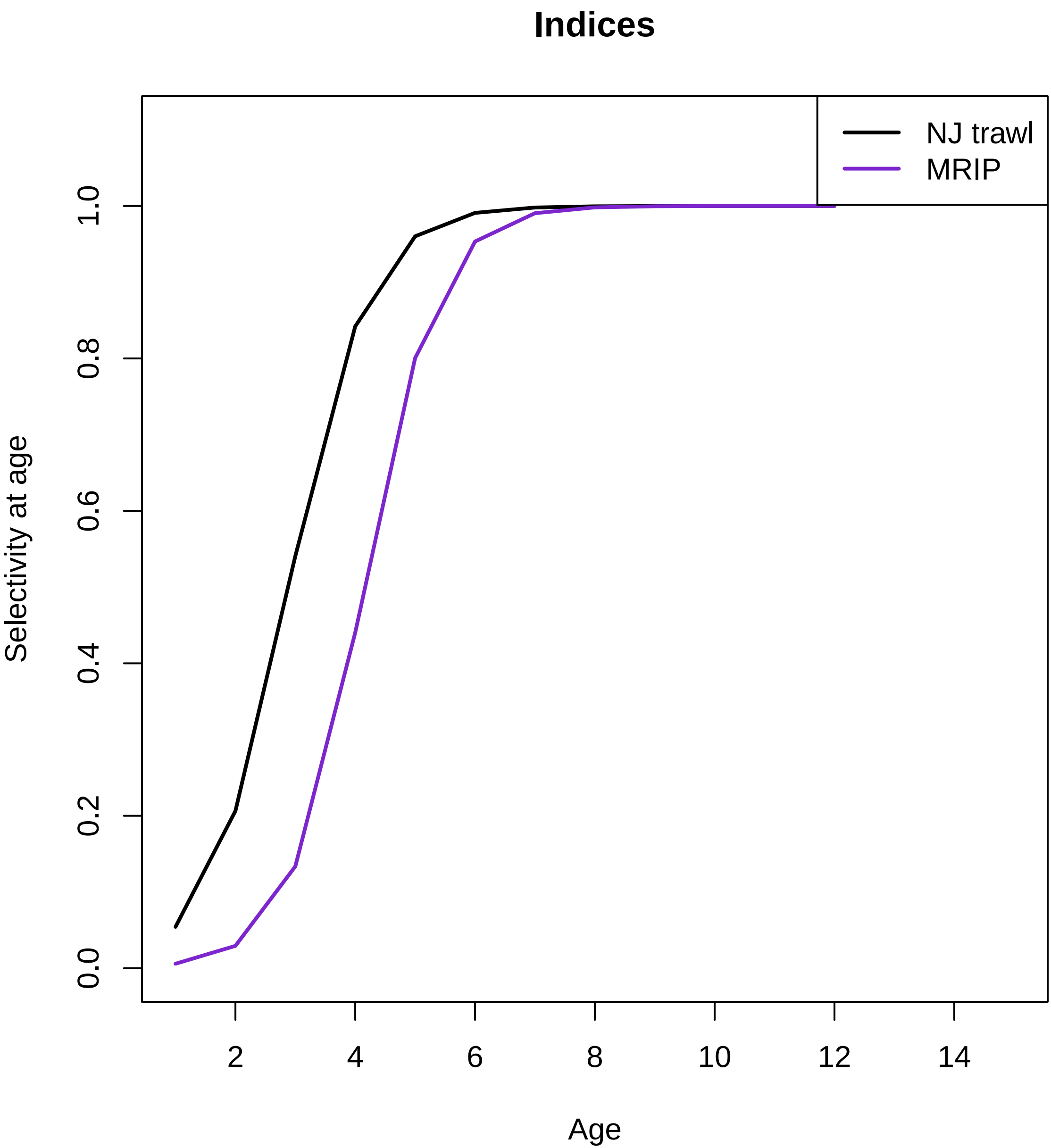


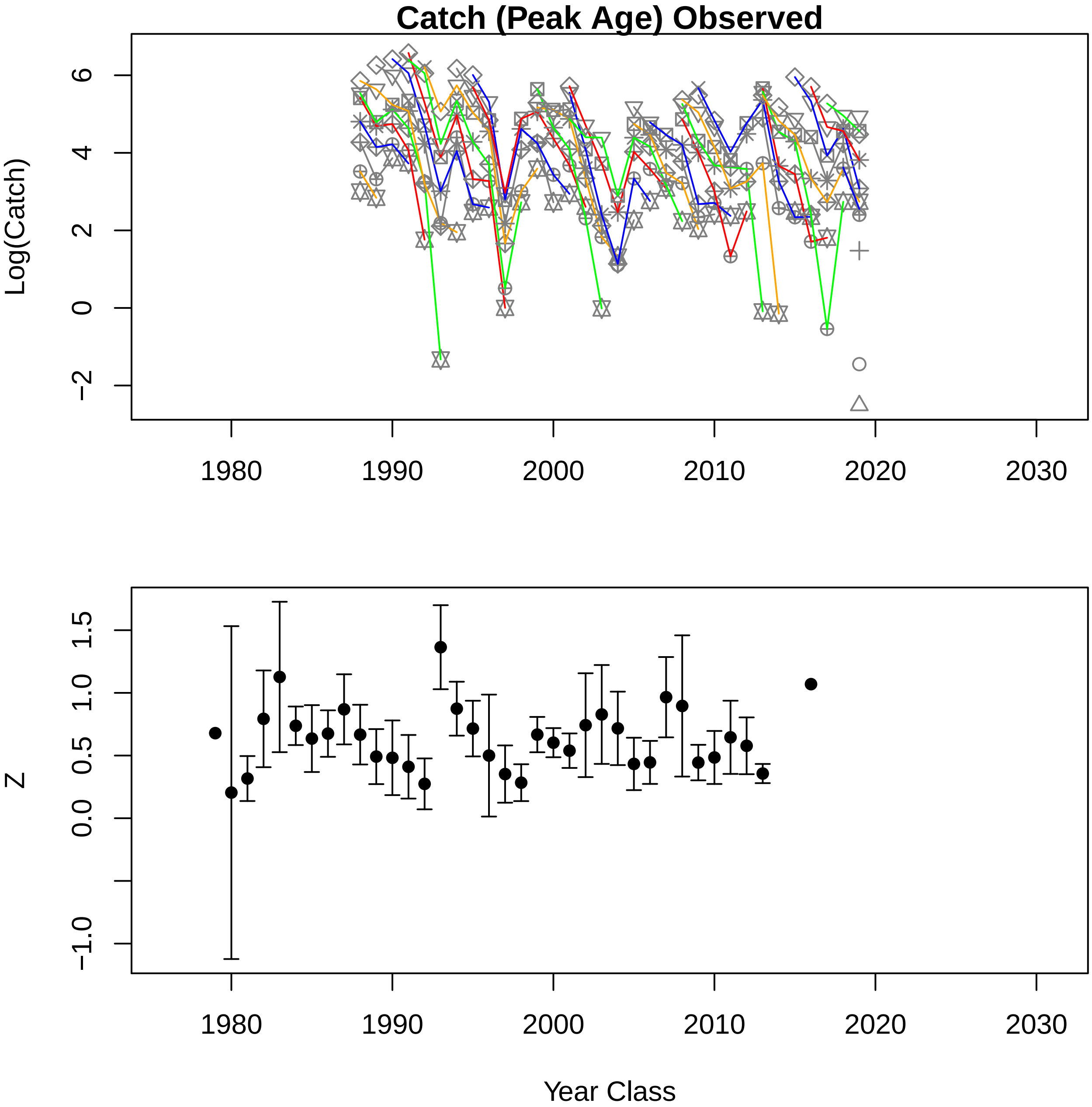
Index 3 (MRIP) ESS = 19
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2

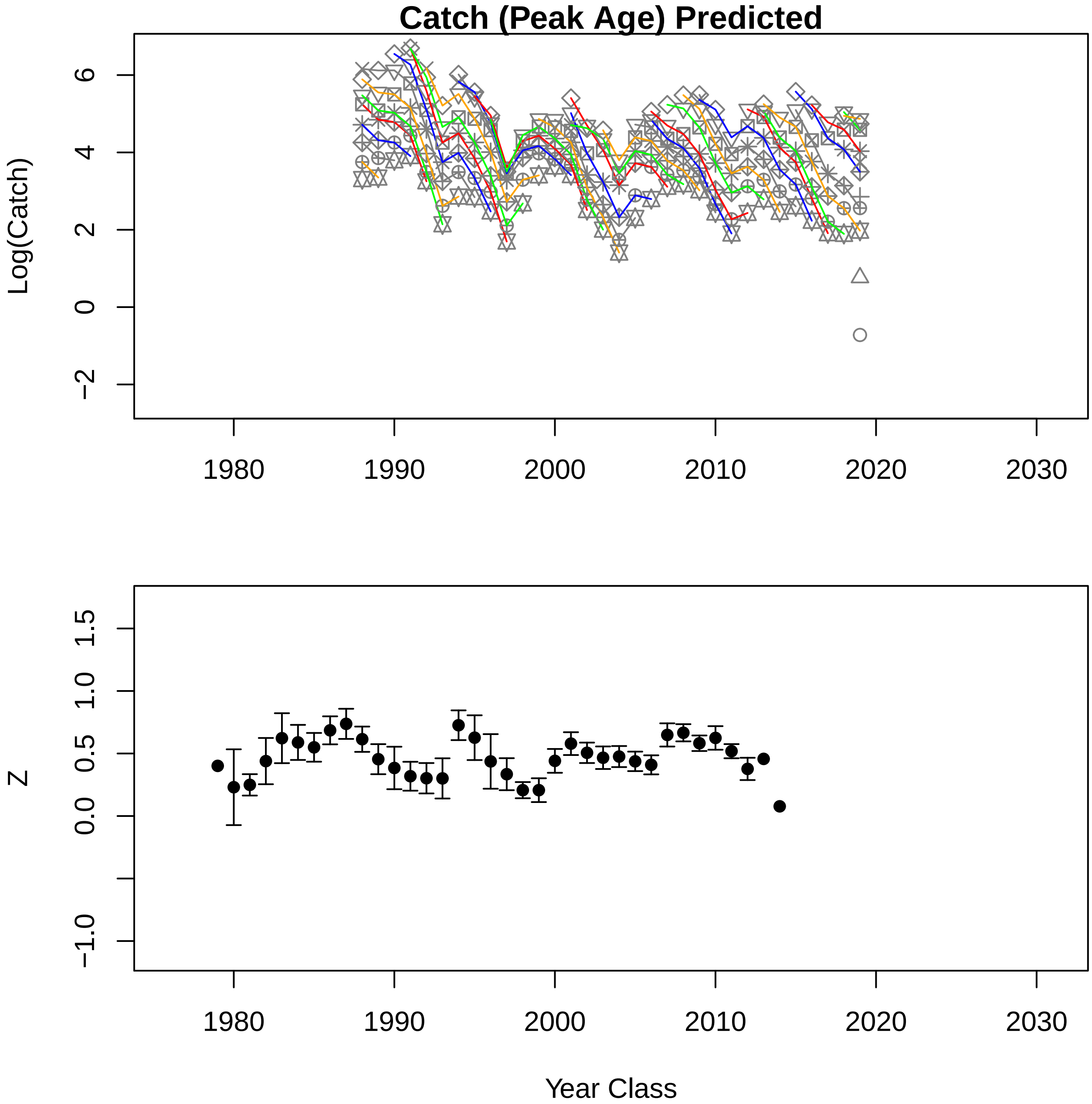


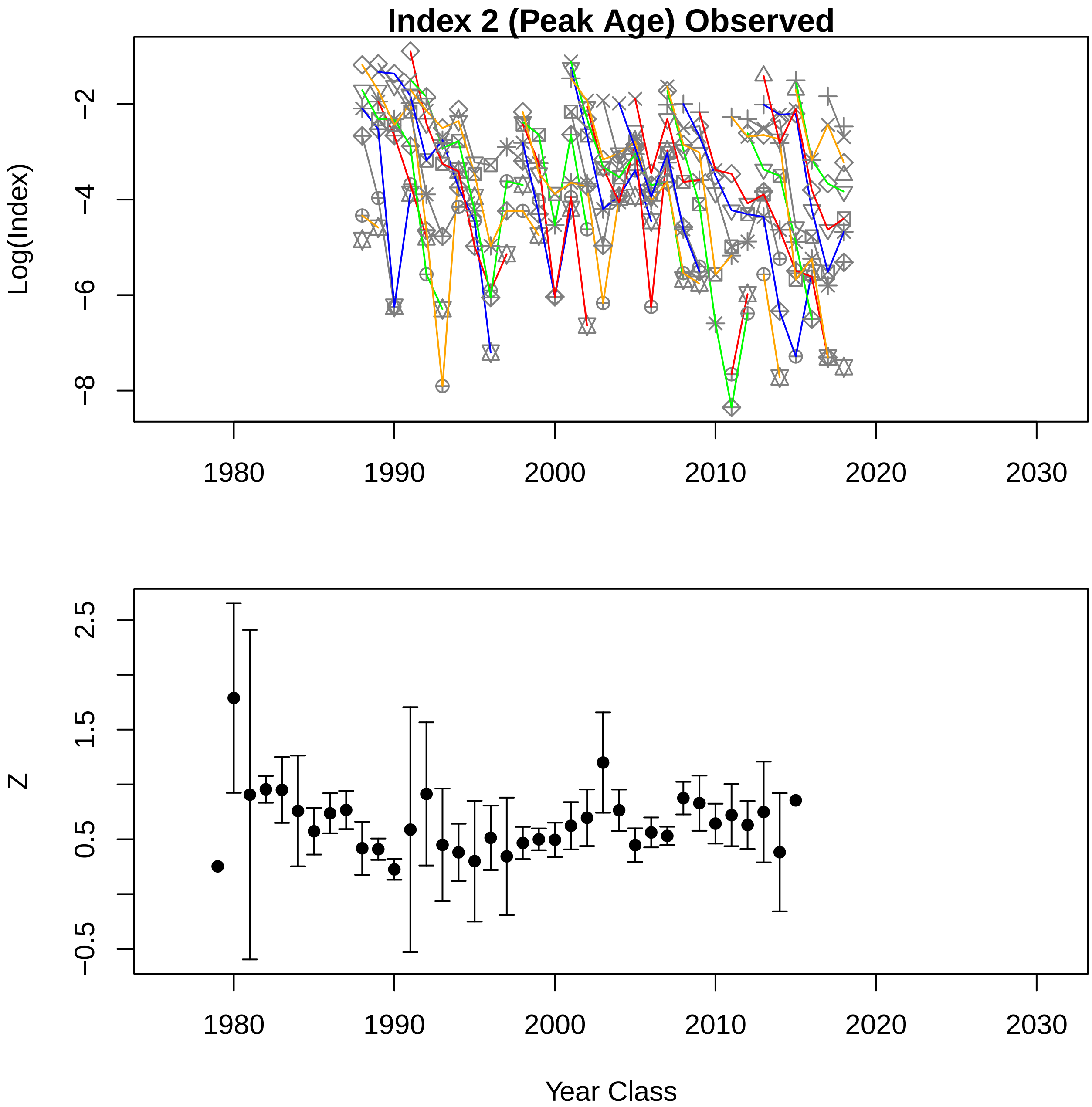
Fleet 1 (All removals)
1989
1998
2004
2012
2018
Selectivity at Age
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
Age


All removals
Fmult by fleet
0.0
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
2020
Year

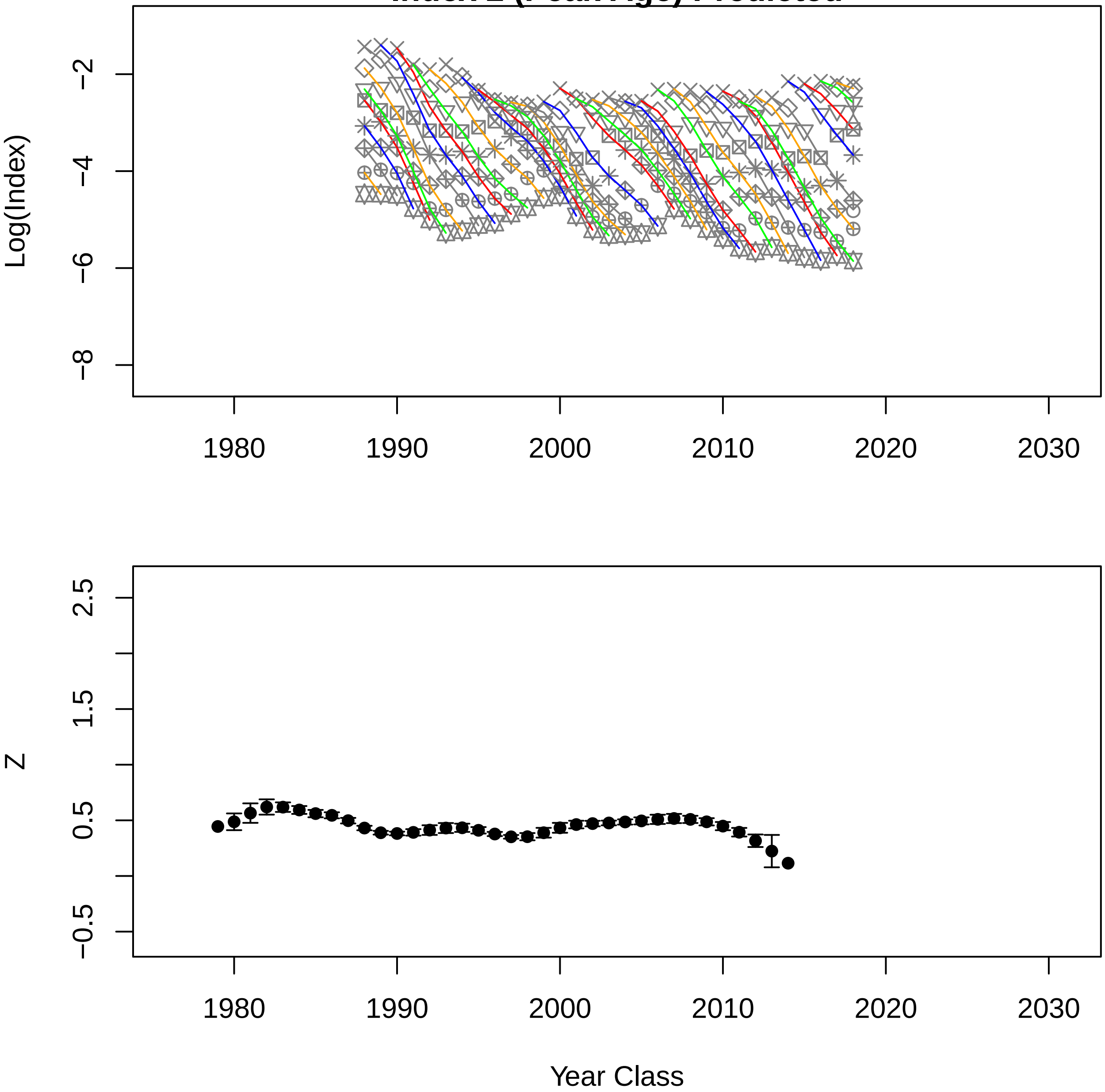

Indices
NJ trawl
MRIP
Selectivity at age
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
14
Age

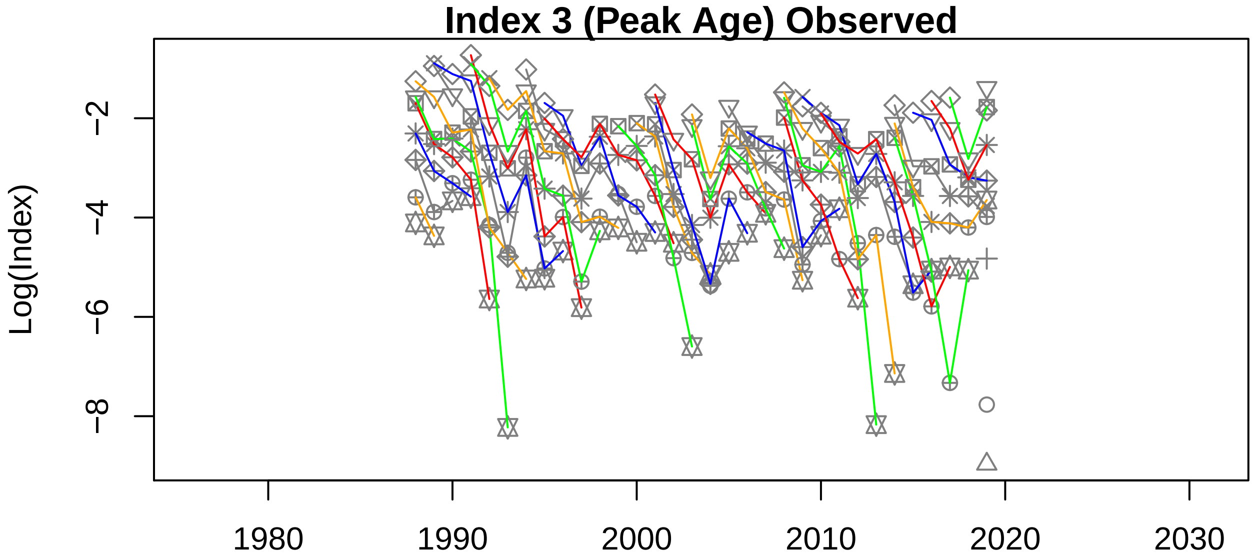

Catch (Peak Age) Observed
Log(Catch)
6
4
2
0
−2
1980
1990
2000
2010
2020
2030
Z
1.5
1.0
0.5
0.0
−1.0
1980
1990
2000
2010
2020
2030
Year Class

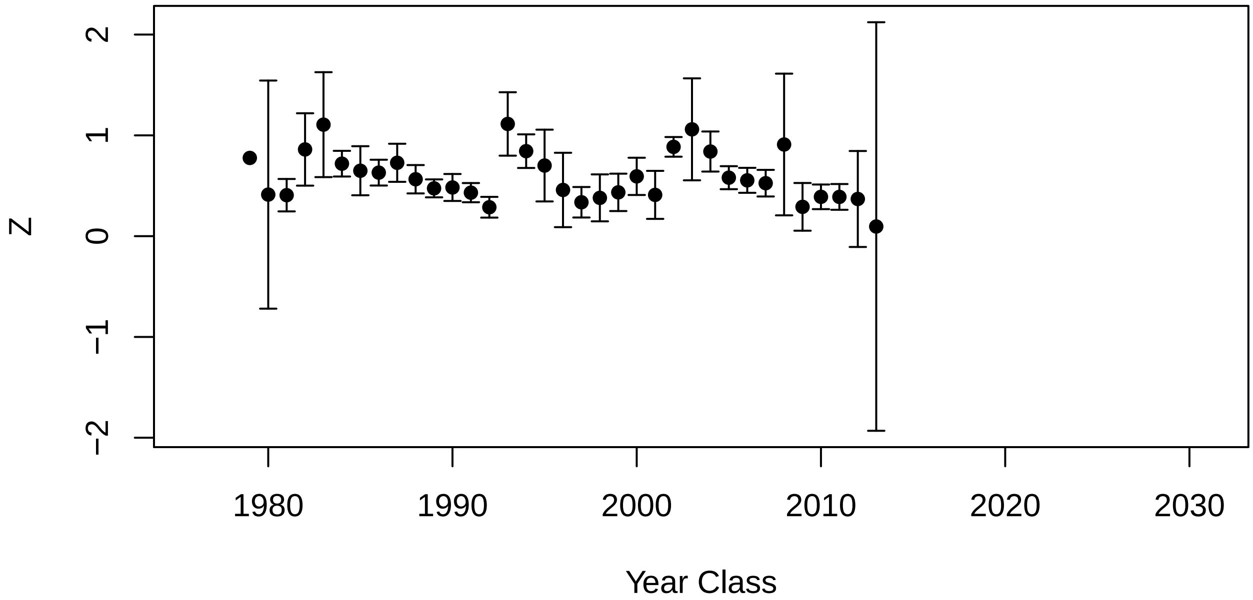

Catch (Peak Age) Predicted
Log(Catch)
−2
0
2
4
6
1980
1990
2000
2010
2020
2030
Z
−1.0
0.0
0.5
1.0
1.5
1980
1990
2000
2010
2020
2030
Year Class

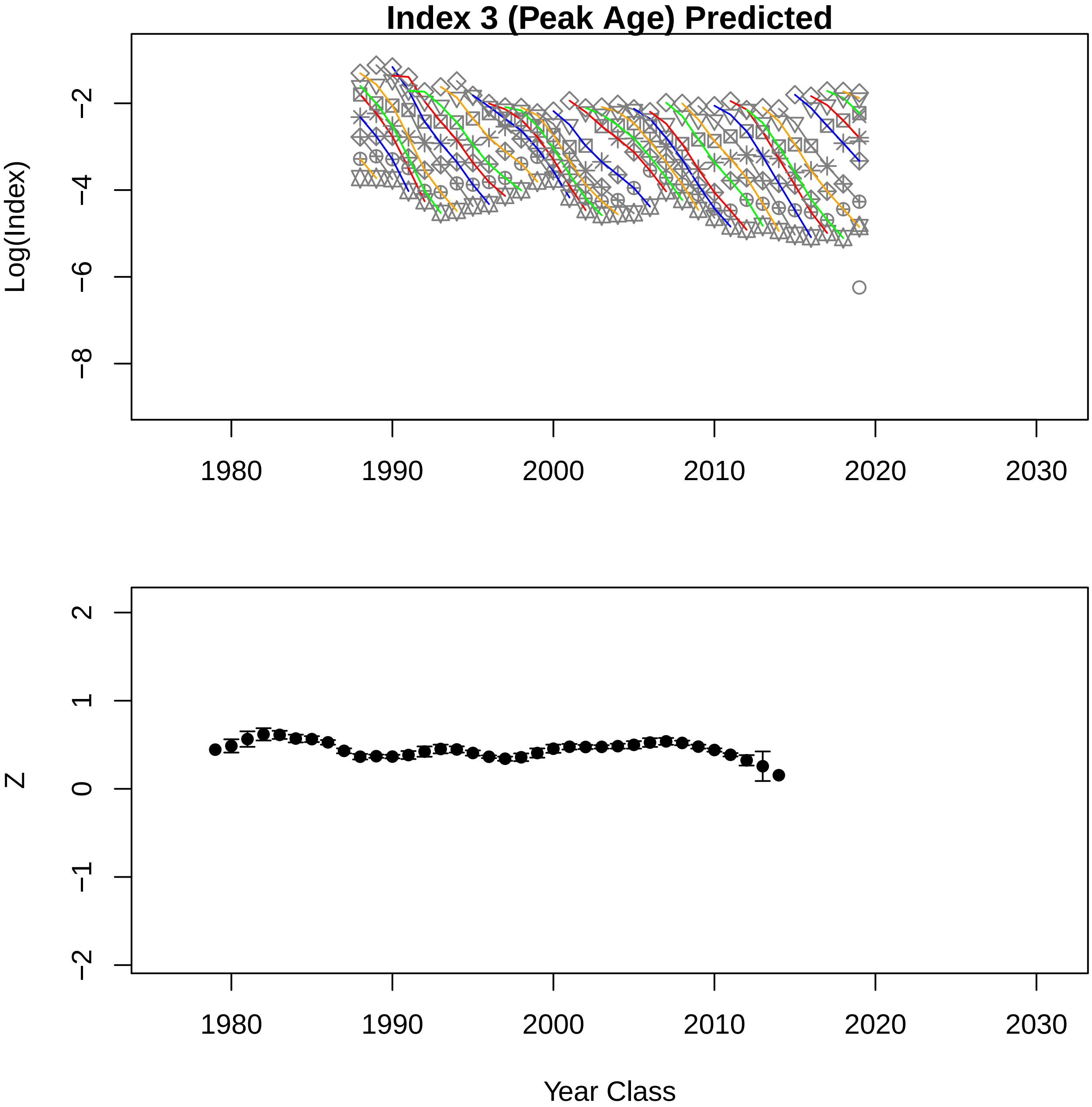

Index 2 (Peak Age) Observed
Log(Index)
−2
−4
−6
−8
1980
1990
2000
2010
2020
2030
Z
2.5
1.5
0.5
−0.5
Year Class

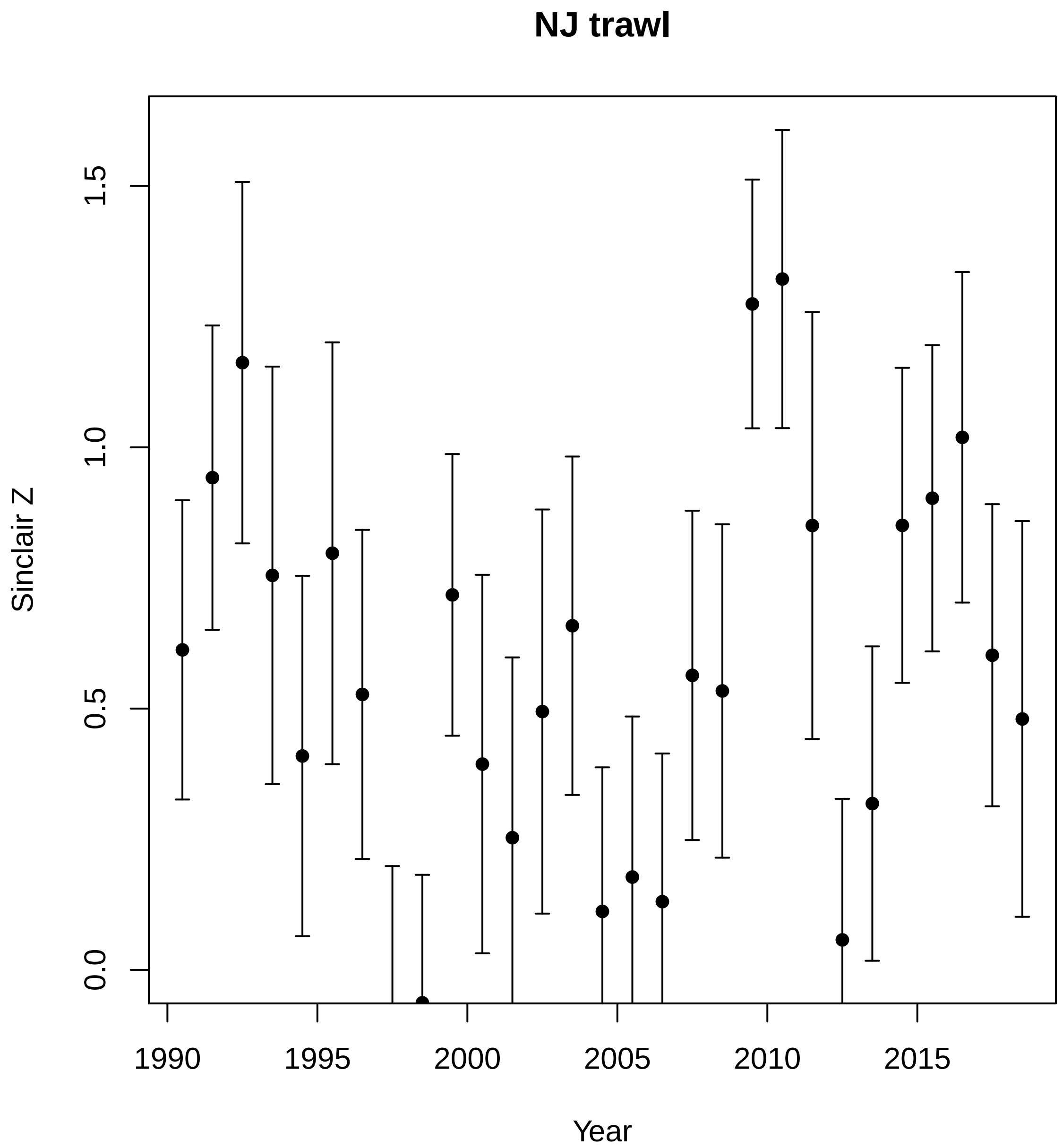
Index 2 (Peak Age) Predicted

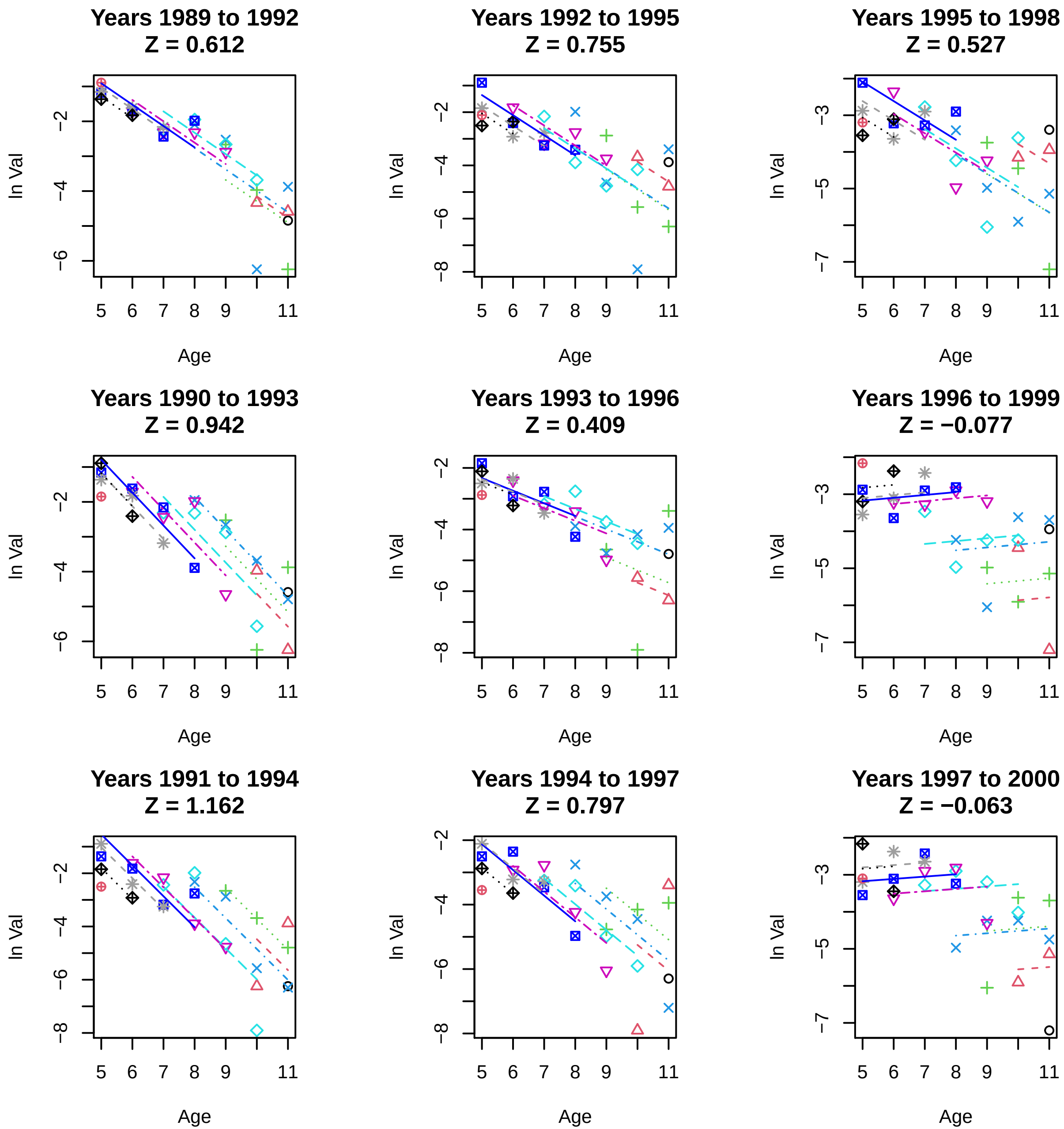


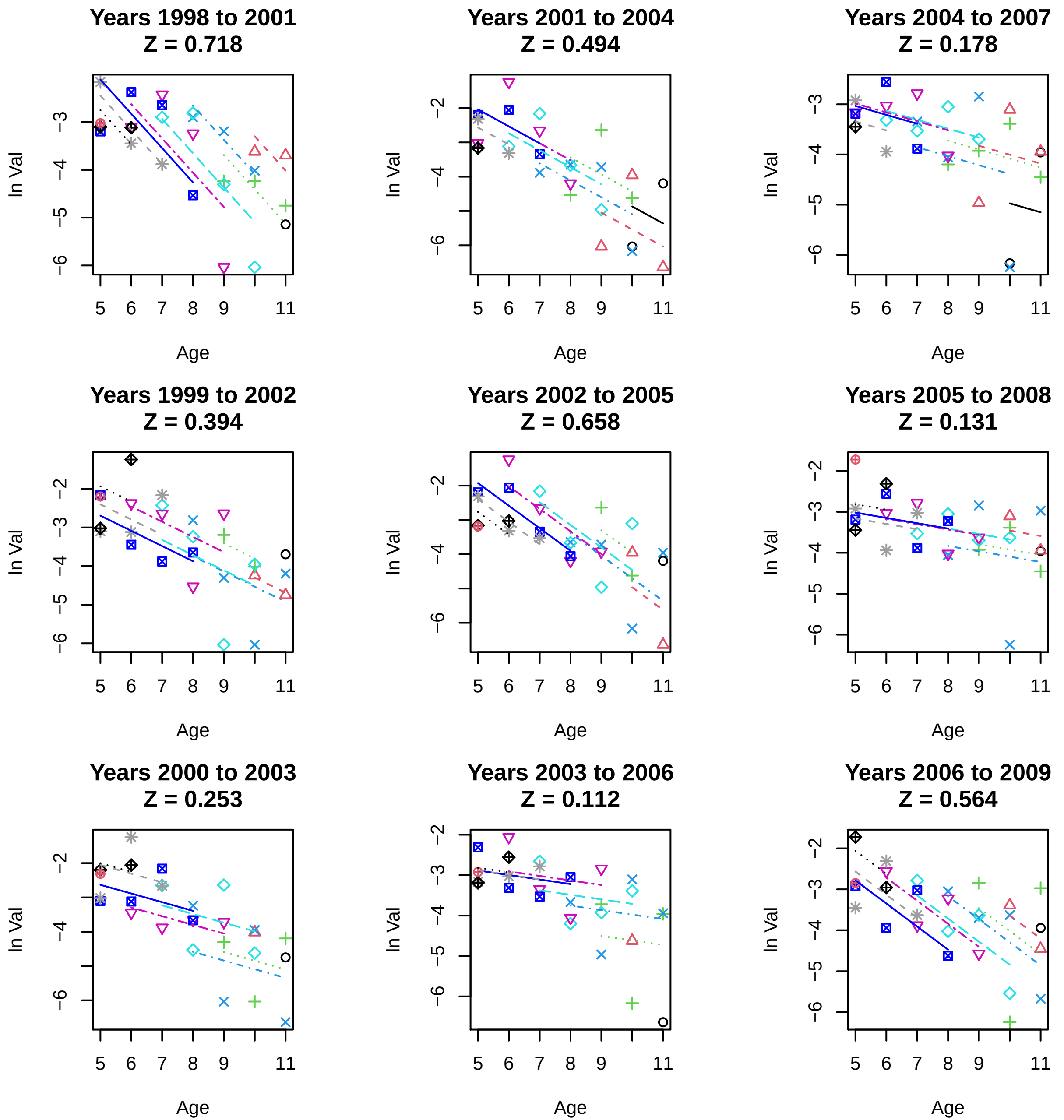

Index 3 (Peak Age) Observed
Log(Index)
−2
−4
−6
−8
1980
1990
2000
2010
2020
2030

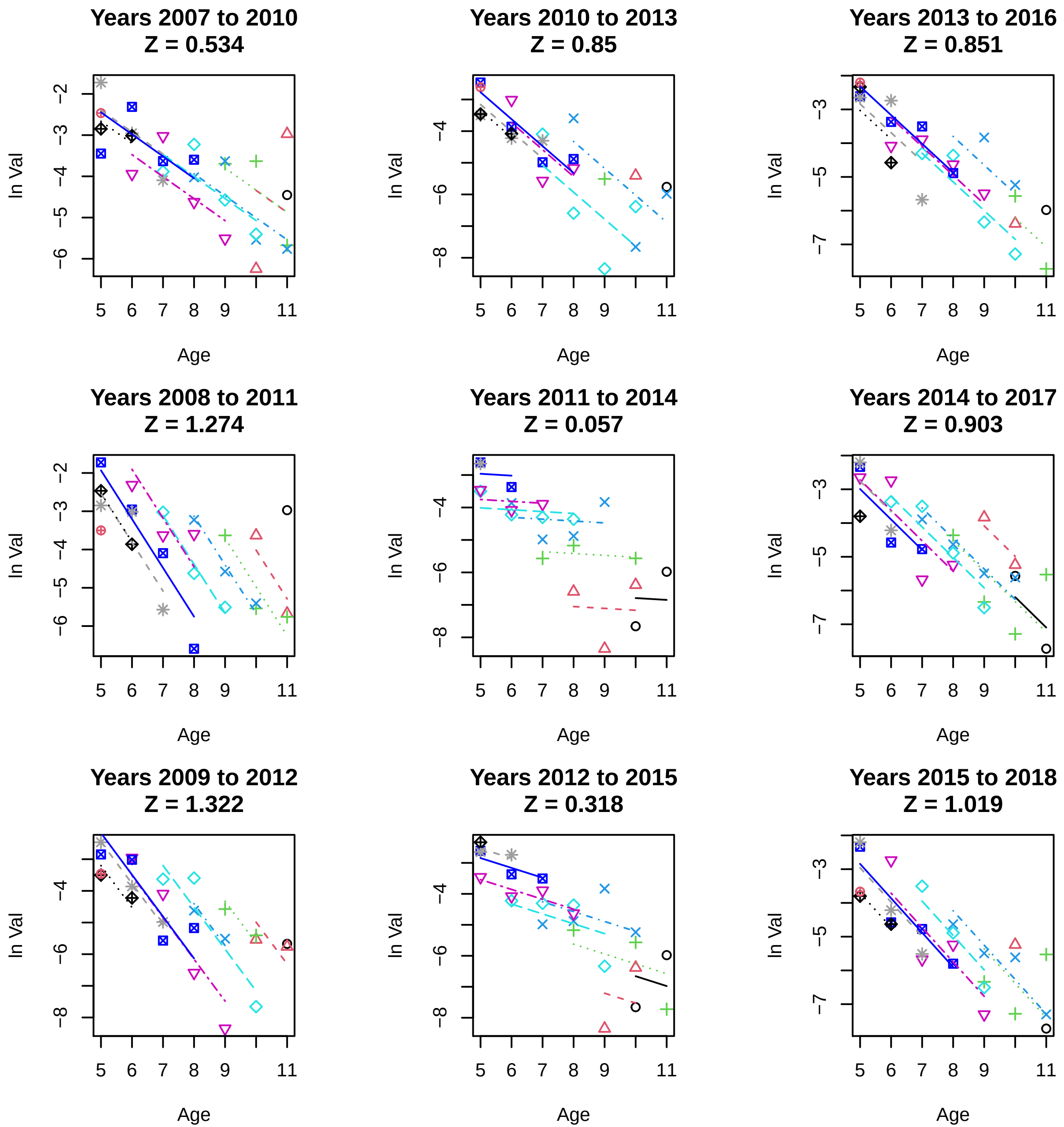

Z
2
1
0
−1
−2
1980
1990
2000
2010
2020
2030
Year Class


Index 3 (Peak Age) Predicted
Log(Index)
−2
−4
−6
−8
1980
1990
2000
2010
2020
2030
Z
2
1
0
−1
−2
Year Class

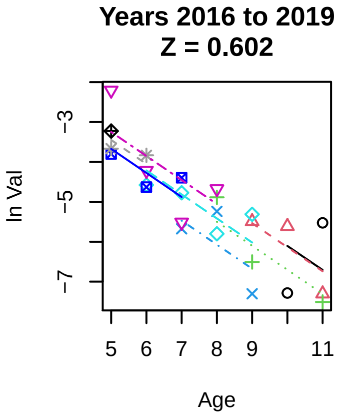

NJ trawl
Sinclair Z
0.0
0.5
1.0
1.5
1990
1995
2000
2005
2010
2015
Year

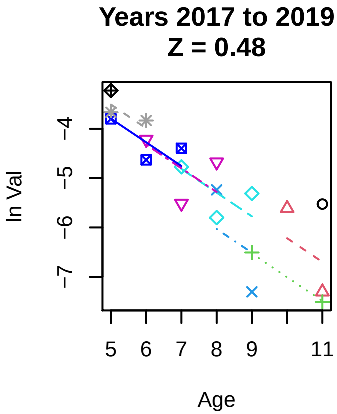

Years 1989 to 1992
Z = 0.612
Years 1992 to 1995
Z = 0.755
Years 1995 to 1998
Z = 0.527
Years 1990 to 1993
Z = 0.942
Years 1993 to 1996
Z = 0.409
Years 1996 to 1999
Z = −0.077
Years 1991 to 1994
Z = 1.162
Years 1994 to 1997
Z = 0.797
Years 1997 to 2000
Z = −0.063
ln Val
Age

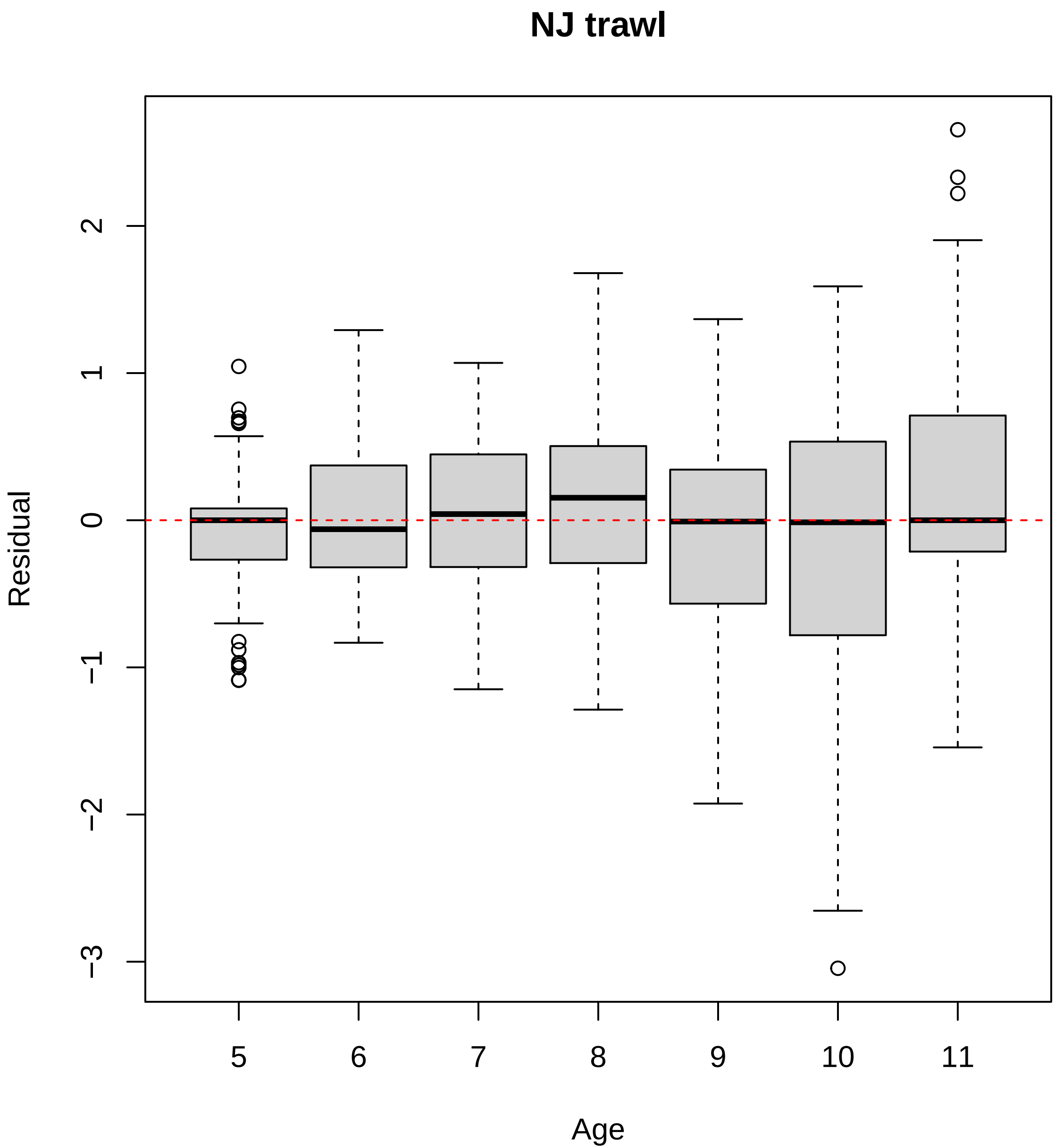

Years 1998 to 2001
Z = 0.718
Years 2001 to 2004
Z = 0.494
Years 2004 to 2007
Z = 0.178
Years 1999 to 2002
Z = 0.394
Years 2002 to 2005
Z = 0.658
Years 2005 to 2008
Z = 0.131
Years 2000 to 2003
Z = 0.253
Years 2003 to 2006
Z = 0.112
Years 2006 to 2009
Z = 0.564
ln Val
Age
5
6
7
8
9
11
−2
−3
−4
−5
−6

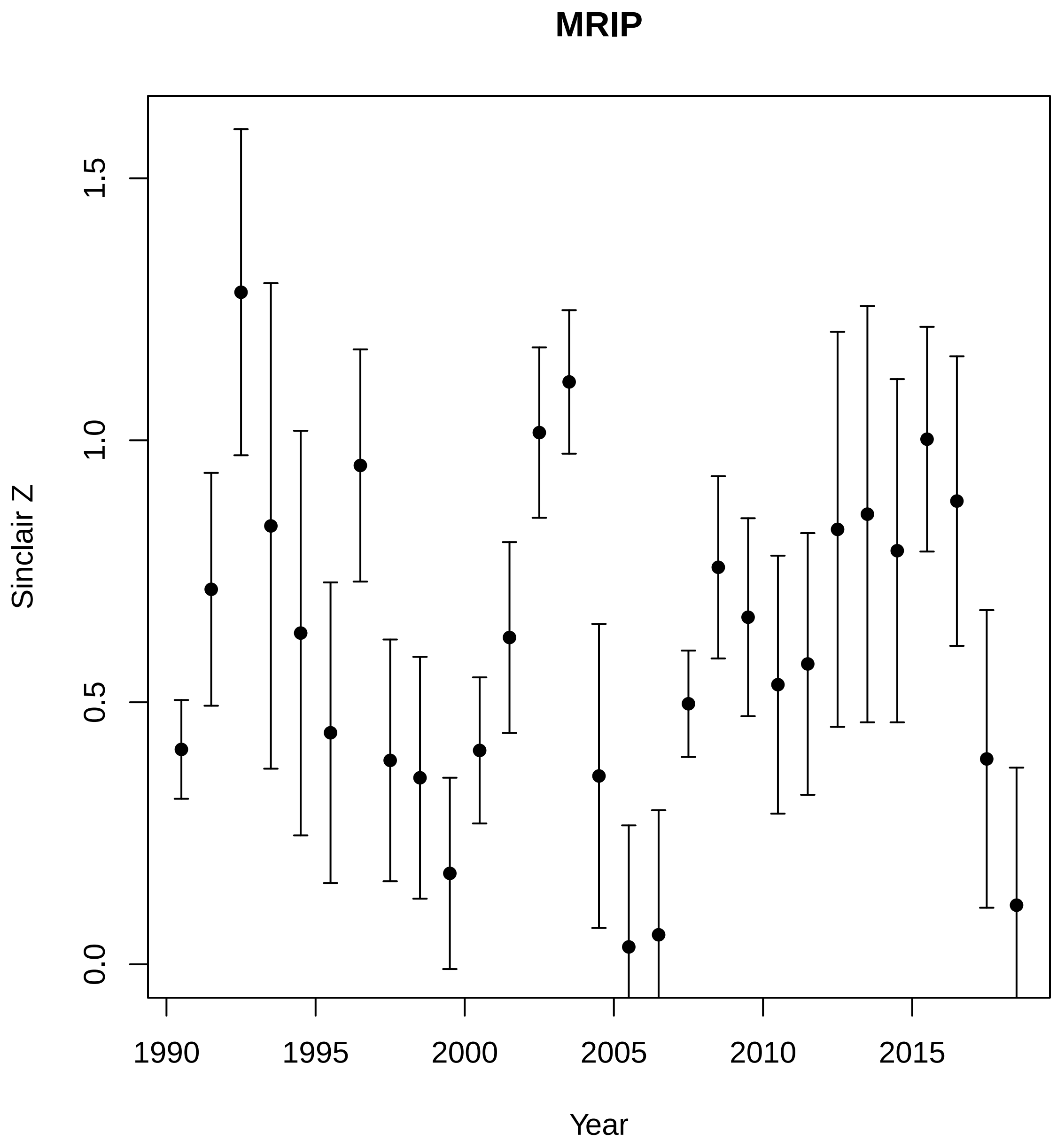


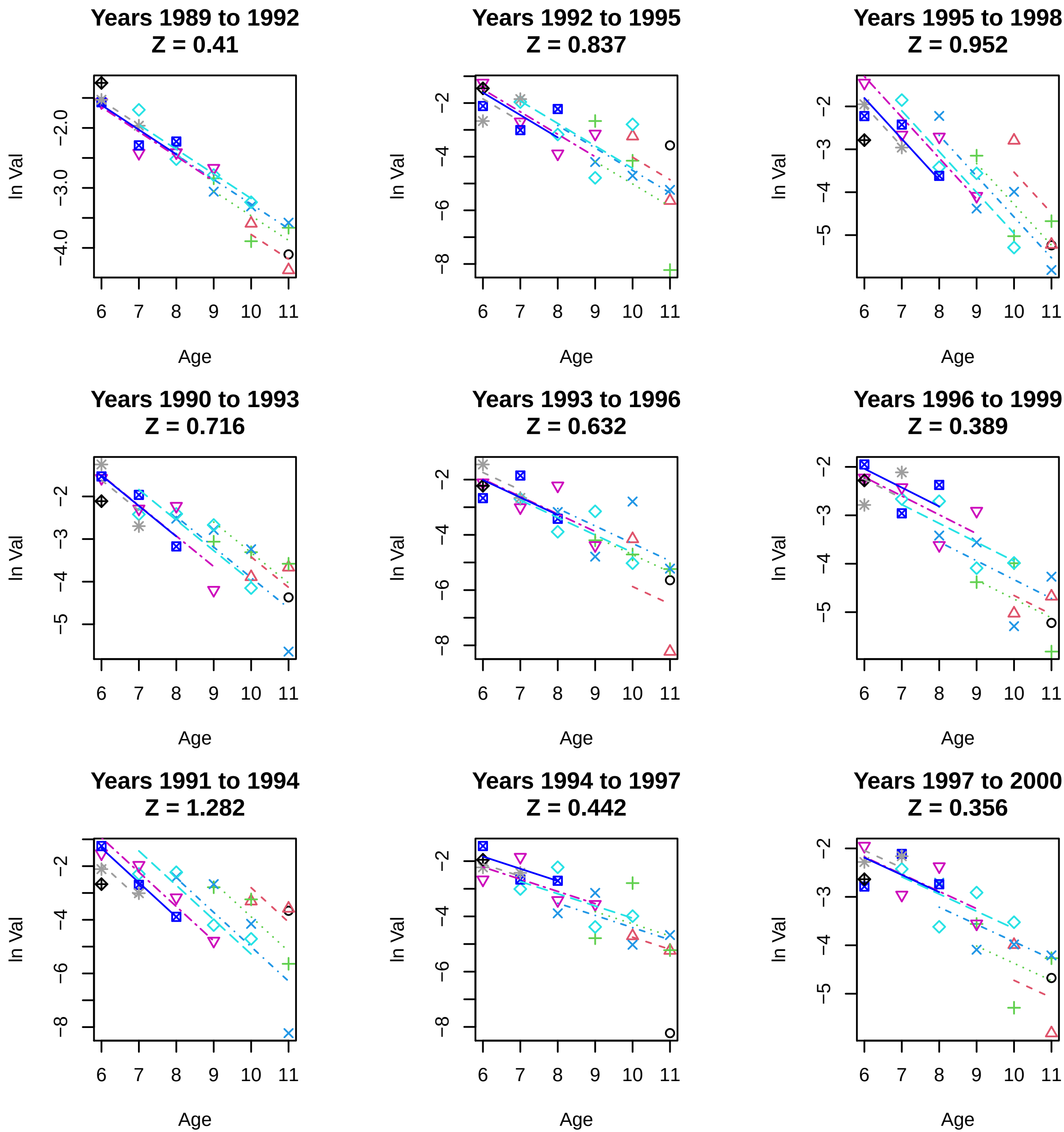
Years 2007 to 2010
Z = 0.534
Years 2010 to 2013
Z = 0.85
Years 2013 to 2016
Z = 0.851
Years 2008 to 2011
Z = 1.274
Years 2011 to 2014
Z = 0.057
Years 2014 to 2017
Z = 0.903
Years 2009 to 2012
Z = 1.322
Years 2012 to 2015
Z = 0.318
Years 2015 to 2018
Z = 1.019
ln Val
Age

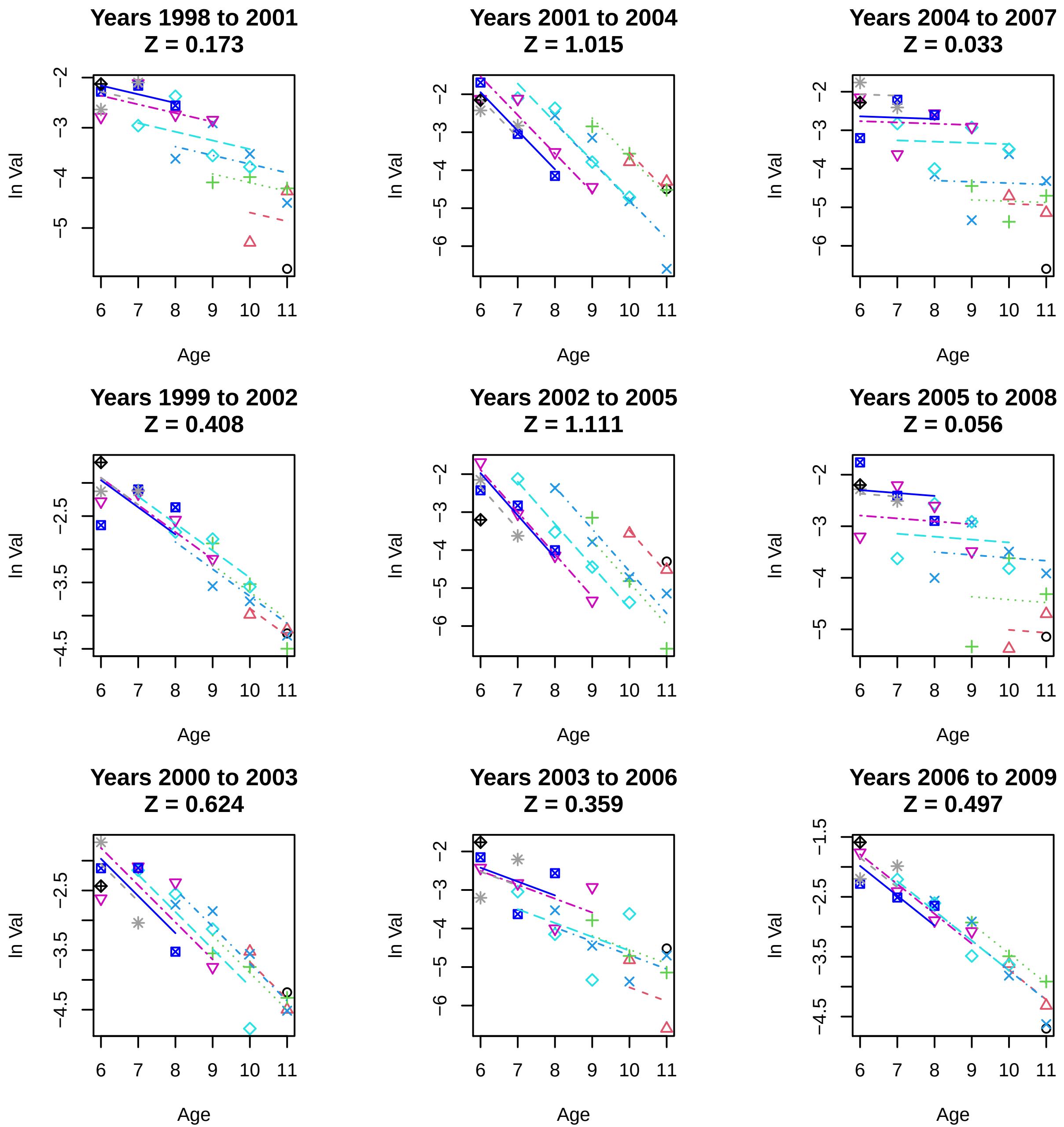

Years 2016 to 2019
Z = 0.602
ln Val
−3
−5
−7
5
6
7
8
9
11
Age

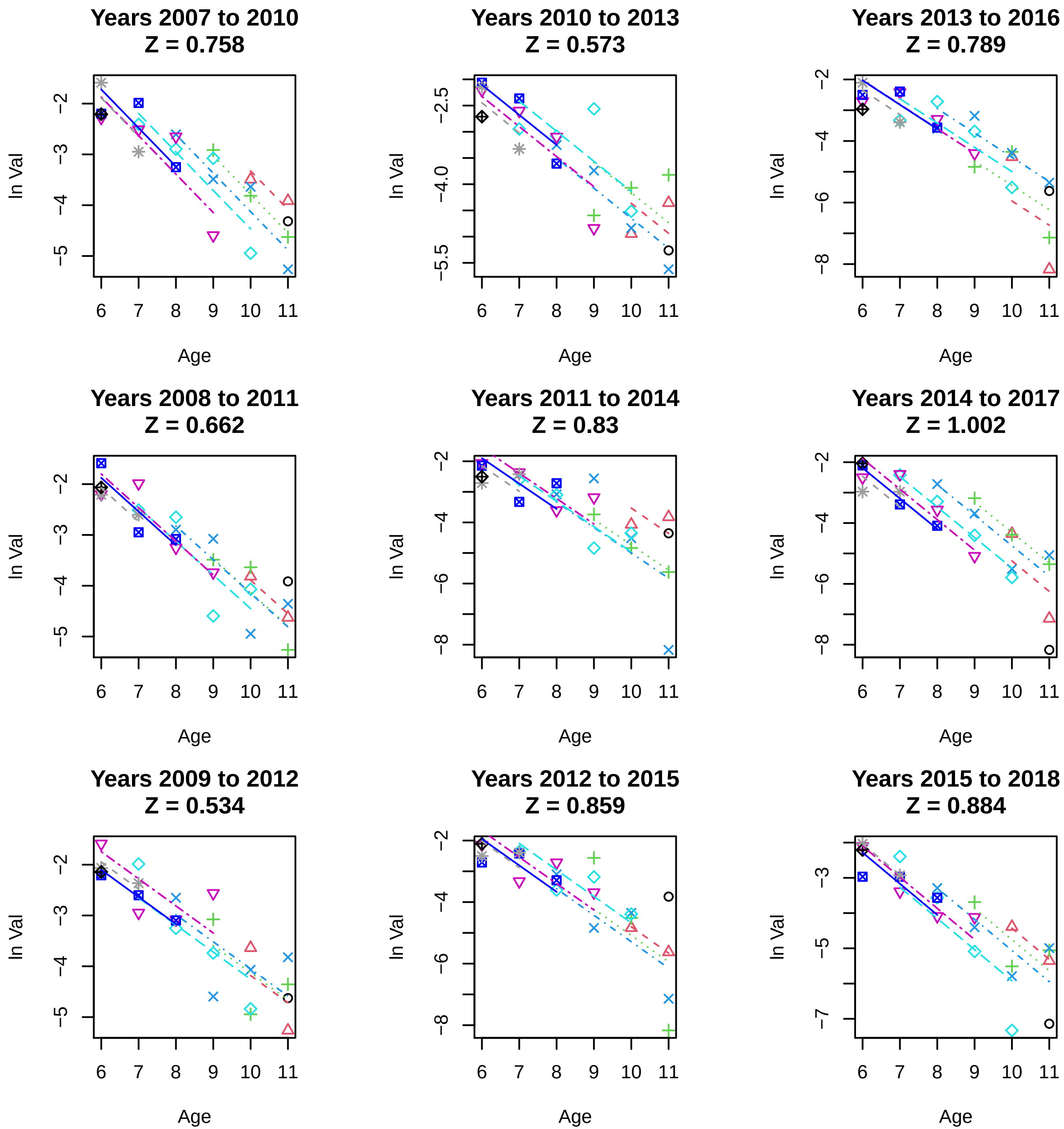

Years 2017 to 2019
Z = 0.48
ln Val
−4
−5
−6
−7
5
6
7
8
9
11
Age

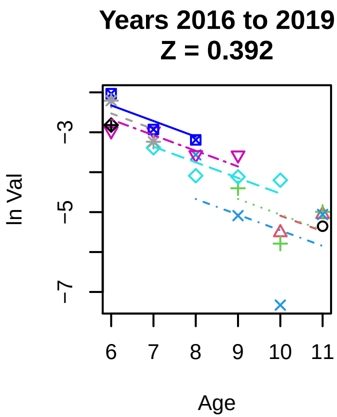

NJ trawl
Residual
Age
2
1
0
−1
−2
−3
5
6
7
8
9
10
11

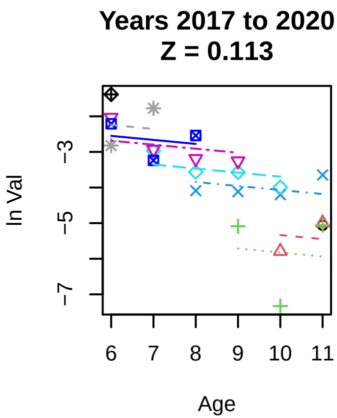

MRIP
Sinclair Z
0.0
0.5
1.0
1.5
1990
1995
2000
2005
2010
2015
Year

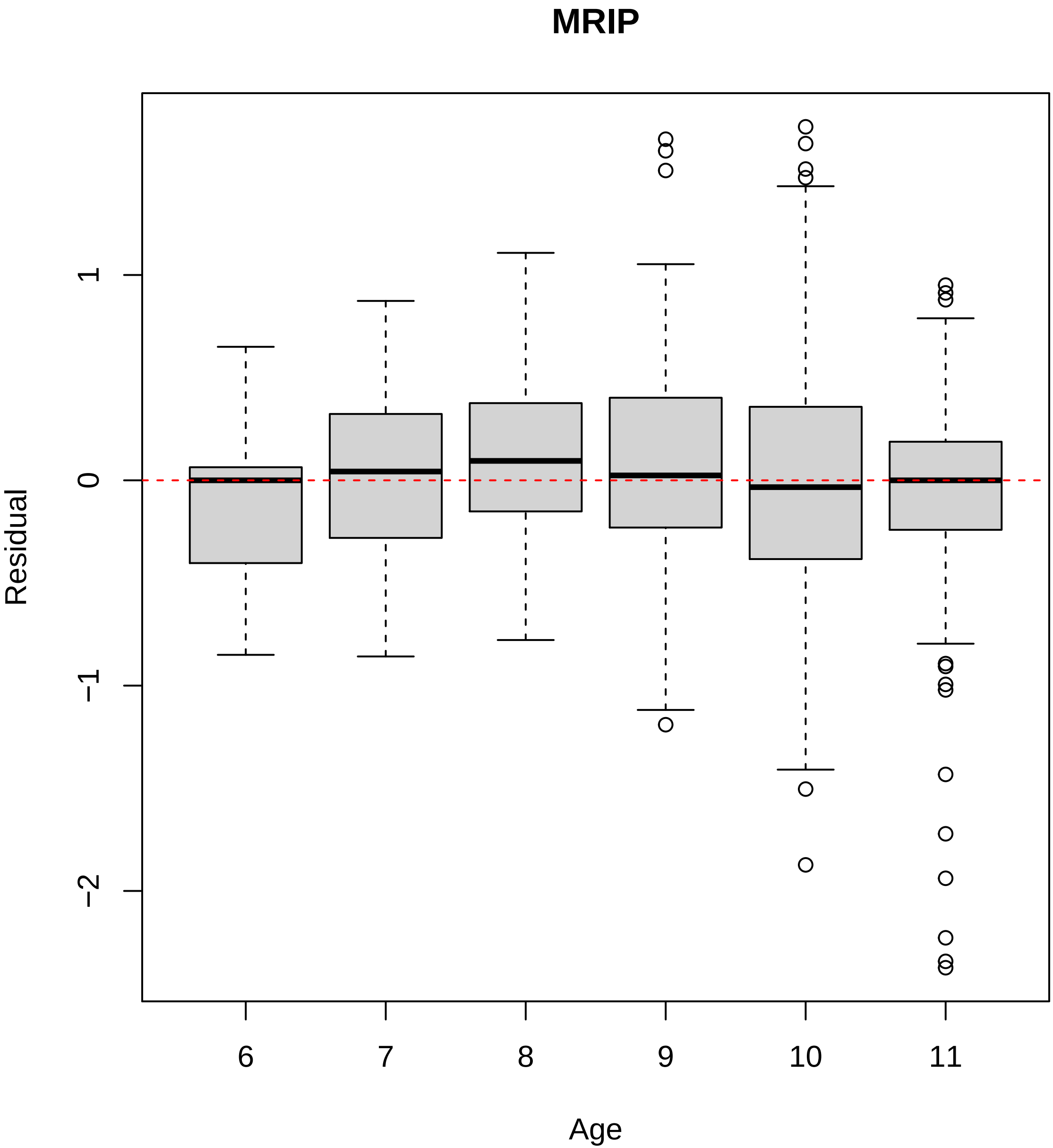

Years 1989 to 1992
Z = 0.41
Years 1992 to 1995
Z = 0.837
Years 1995 to 1998
Z = 0.952
Years 1990 to 1993
Z = 0.716
Years 1993 to 1996
Z = 0.632
Years 1996 to 1999
Z = 0.389
Years 1991 to 1994
Z = 1.282
Years 1994 to 1997
Z = 0.442
Years 1997 to 2000
Z = 0.356
ln Val
Age
6
7
8
9
10
11


Years 1998 to 2001
Z = 0.173
Years 2001 to 2004
Z = 1.015
Years 2004 to 2007
Z = 0.033
Years 1999 to 2002
Z = 0.408
Years 2002 to 2005
Z = 1.111
Years 2005 to 2008
Z = 0.056
Years 2000 to 2003
Z = 0.624
Years 2003 to 2006
Z = 0.359
Years 2006 to 2009
Z = 0.497
ln Val
Age

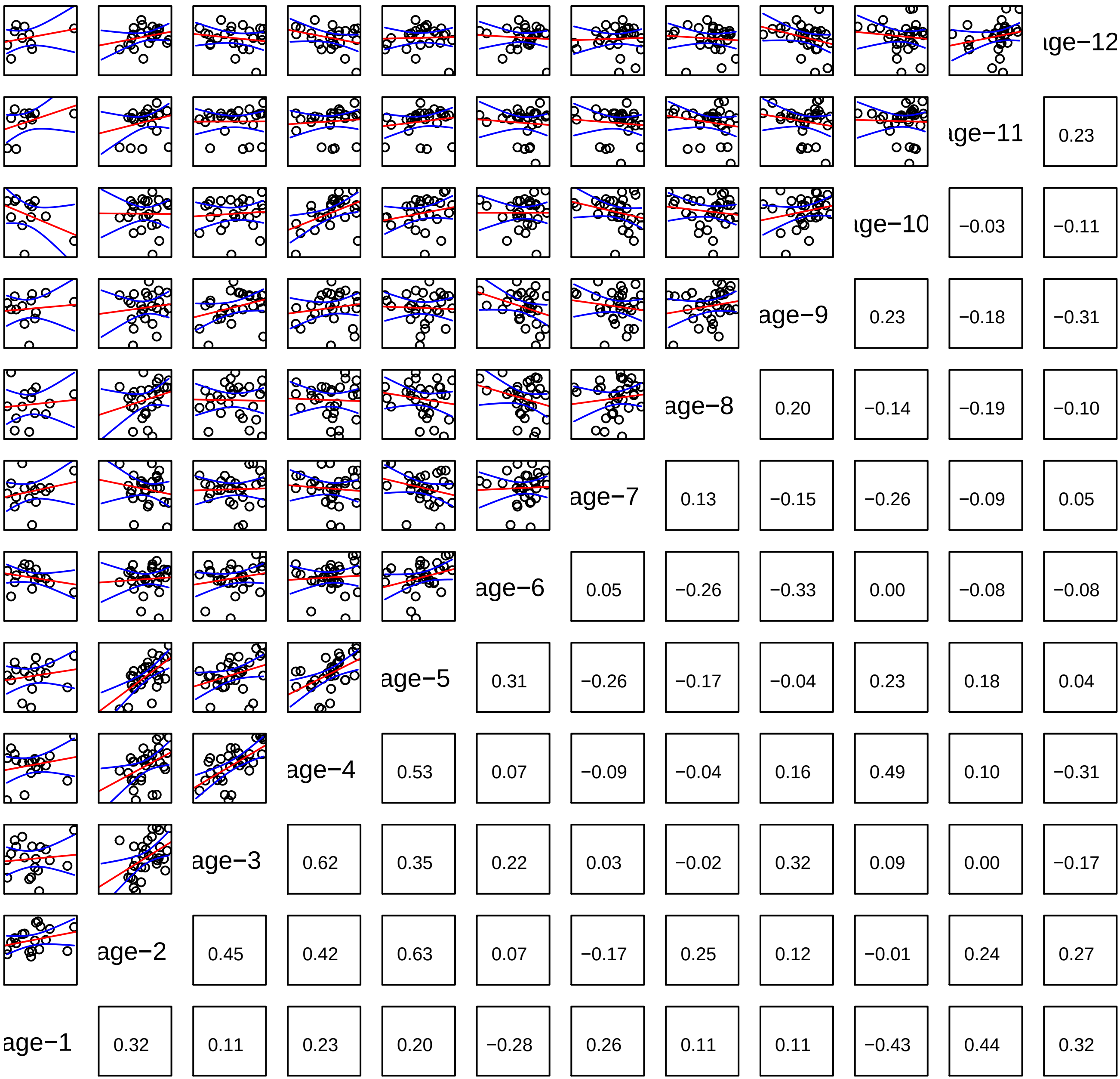

Years 2007 to 2010
Z = 0.758
Years 2010 to 2013
Z = 0.573
Years 2013 to 2016
Z = 0.789
Years 2008 to 2011
Z = 0.662
Years 2011 to 2014
Z = 0.83
Years 2014 to 2017
Z = 1.002
Years 2009 to 2012
Z = 0.534
Years 2012 to 2015
Z = 0.859
Years 2015 to 2018
Z = 0.884
ln Val
Age
6
7
8
9
10
11


Years 2016 to 2019
Z = 0.392
ln Val
−3
−5
−7
6
7
8
9
10
11
Age

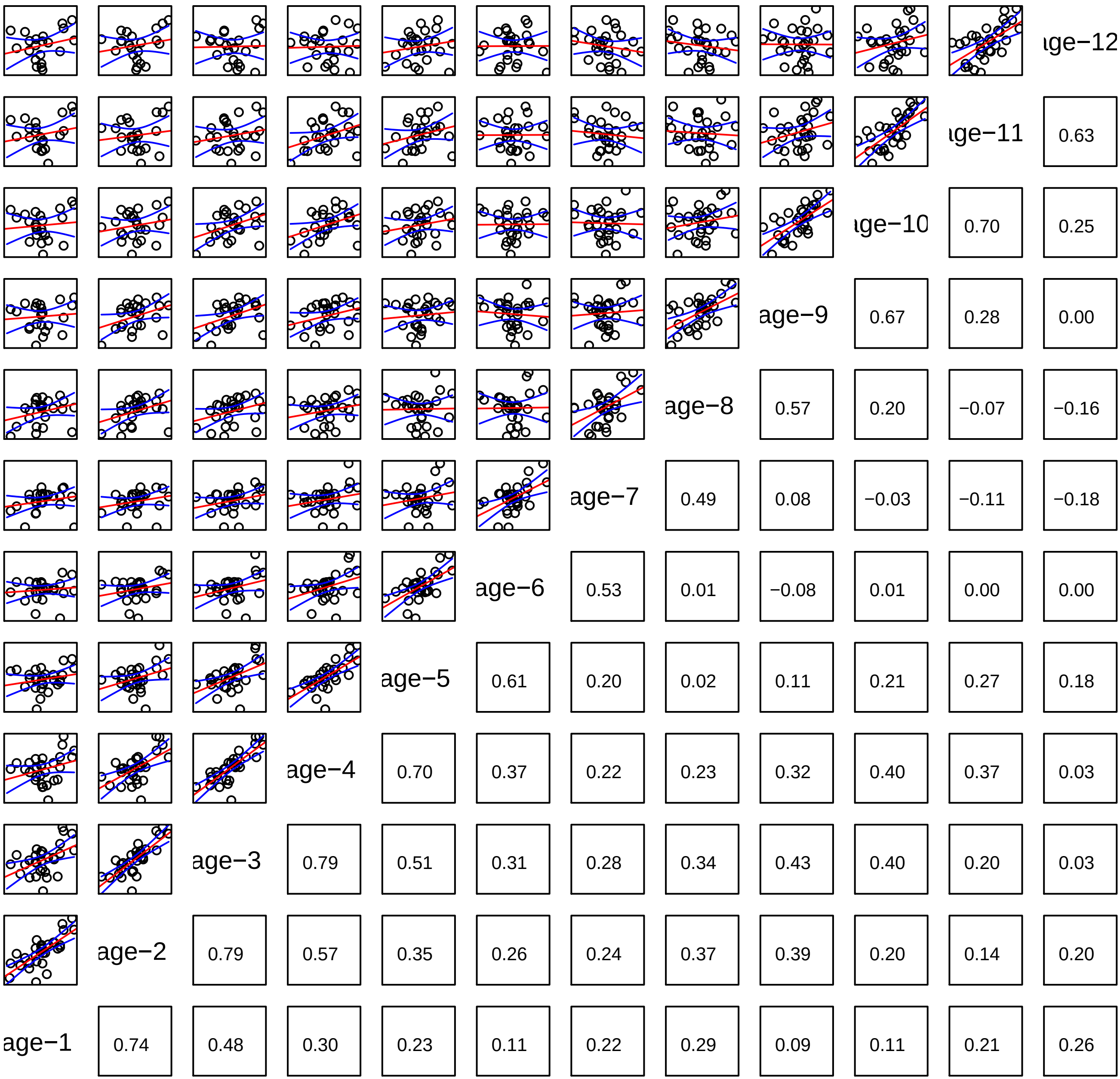

Years 2017 to 2020
Z = 0.113
ln Val
−3
−5
−7
6
7
8
9
10
11
Age


MRIP
Residual
1
0
−1
−2
6
7
8
9
10
11
Age

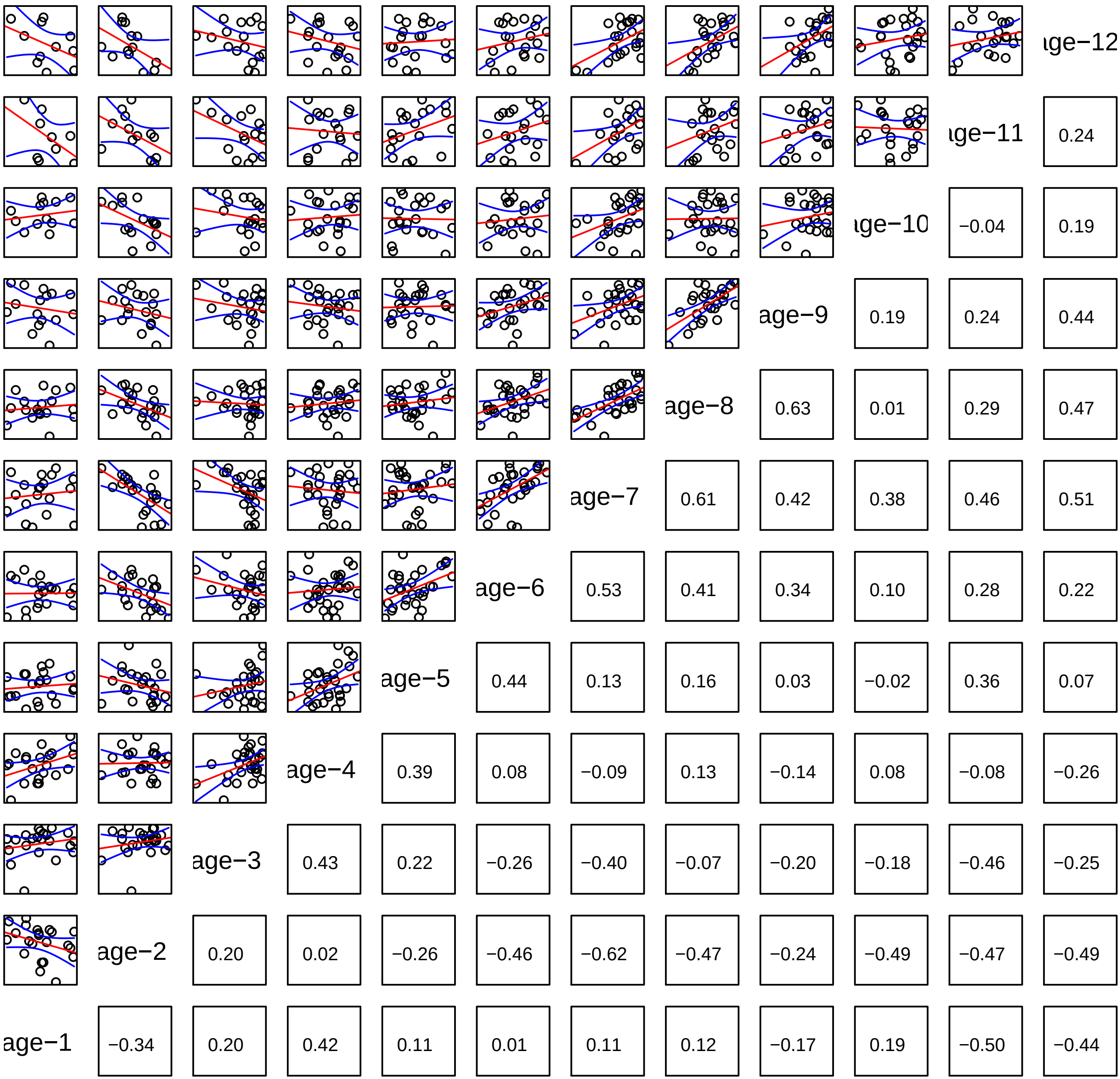
Catch Observed



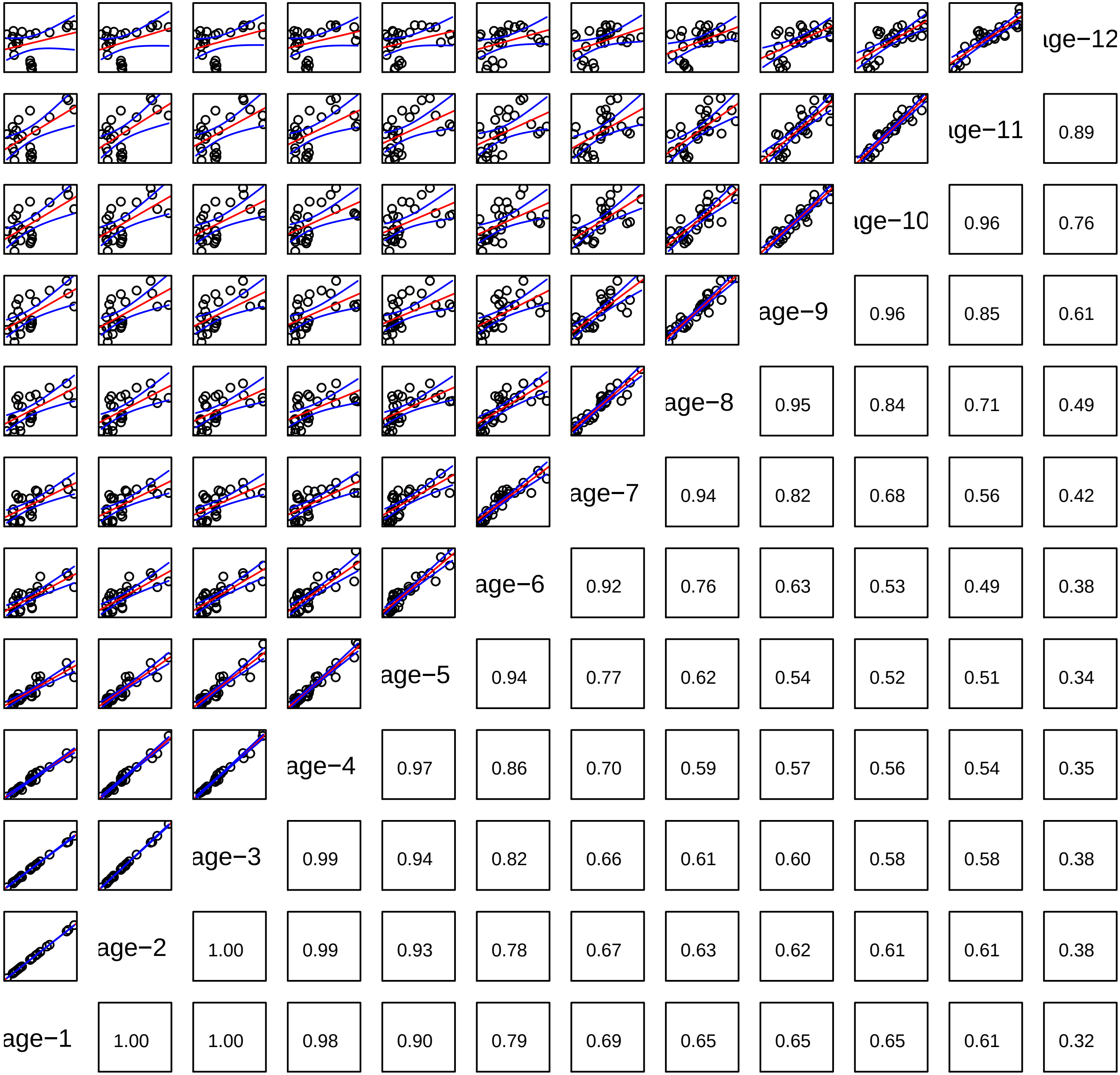
Catch Predicted



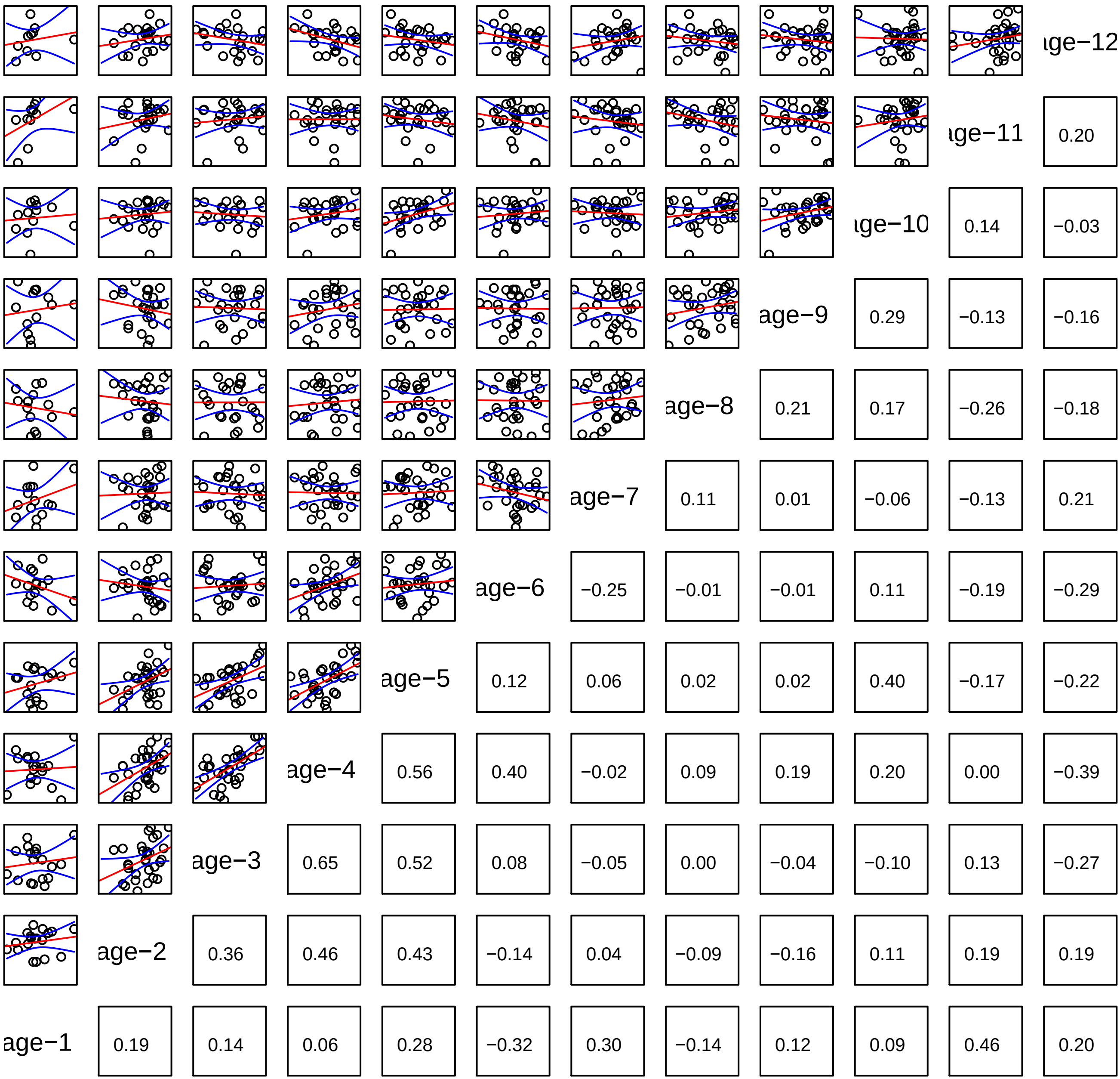
Index 2 (NJ trawl) Observed



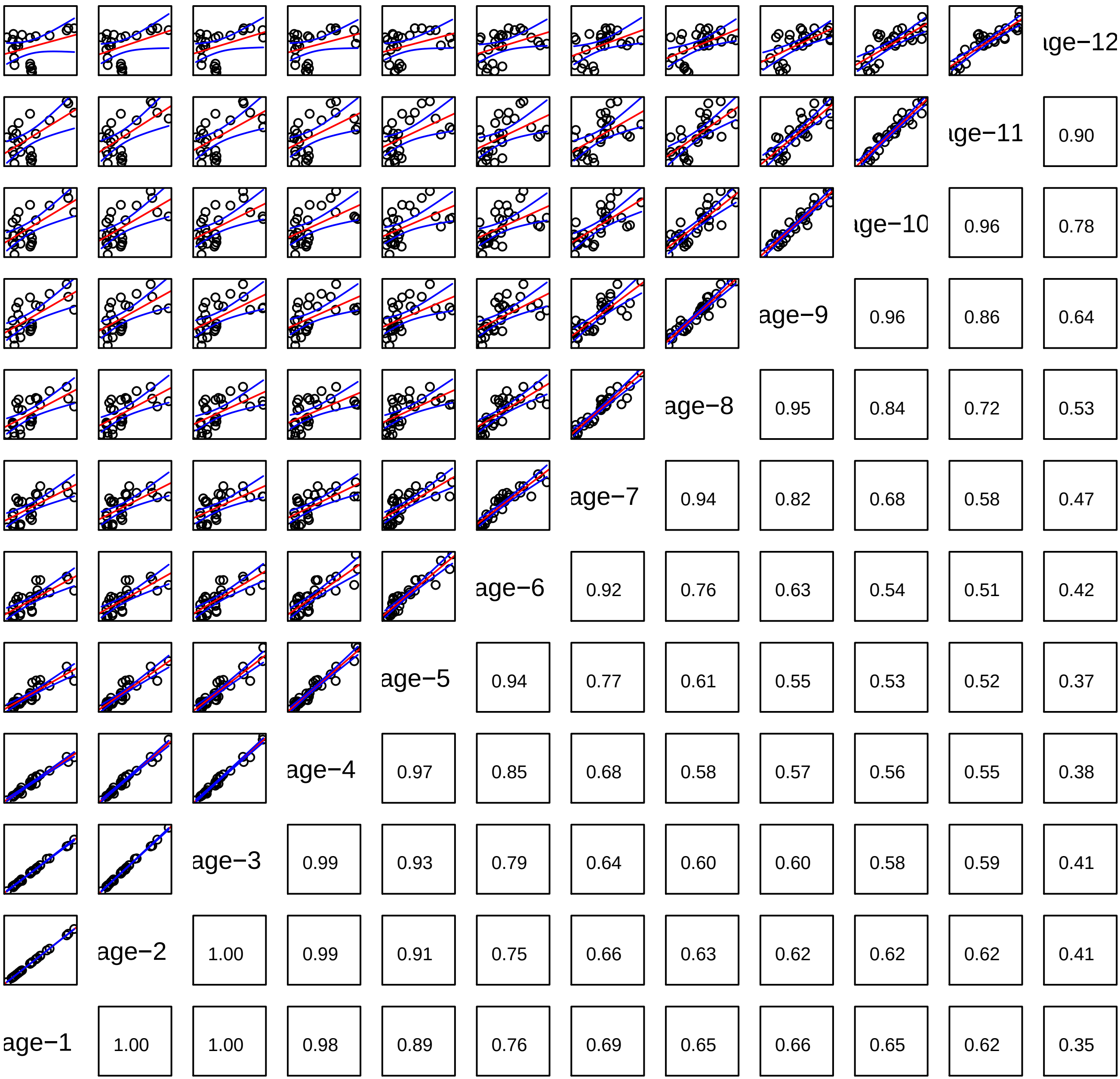
Index 2 (NJ trawl) Predicted

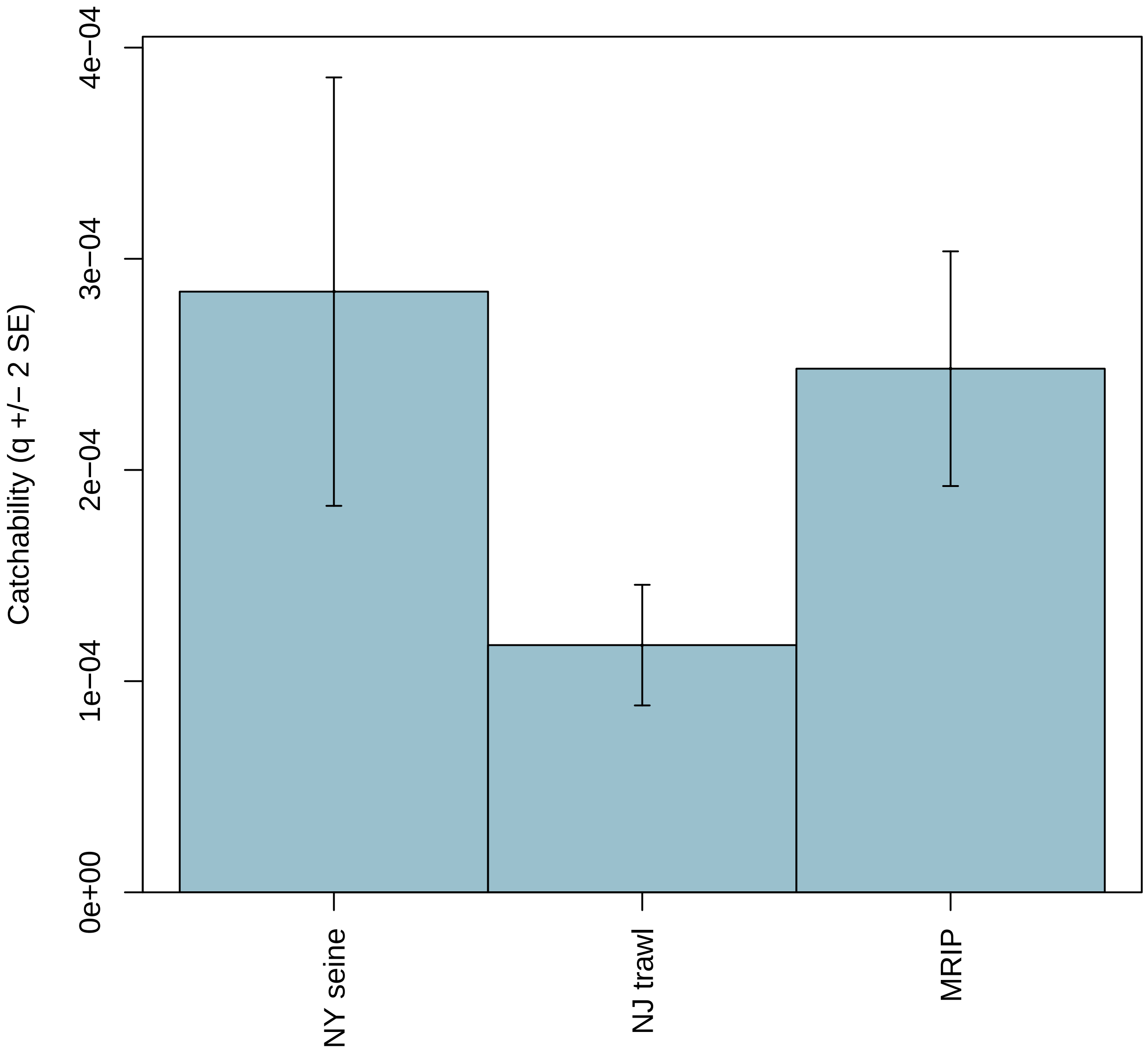


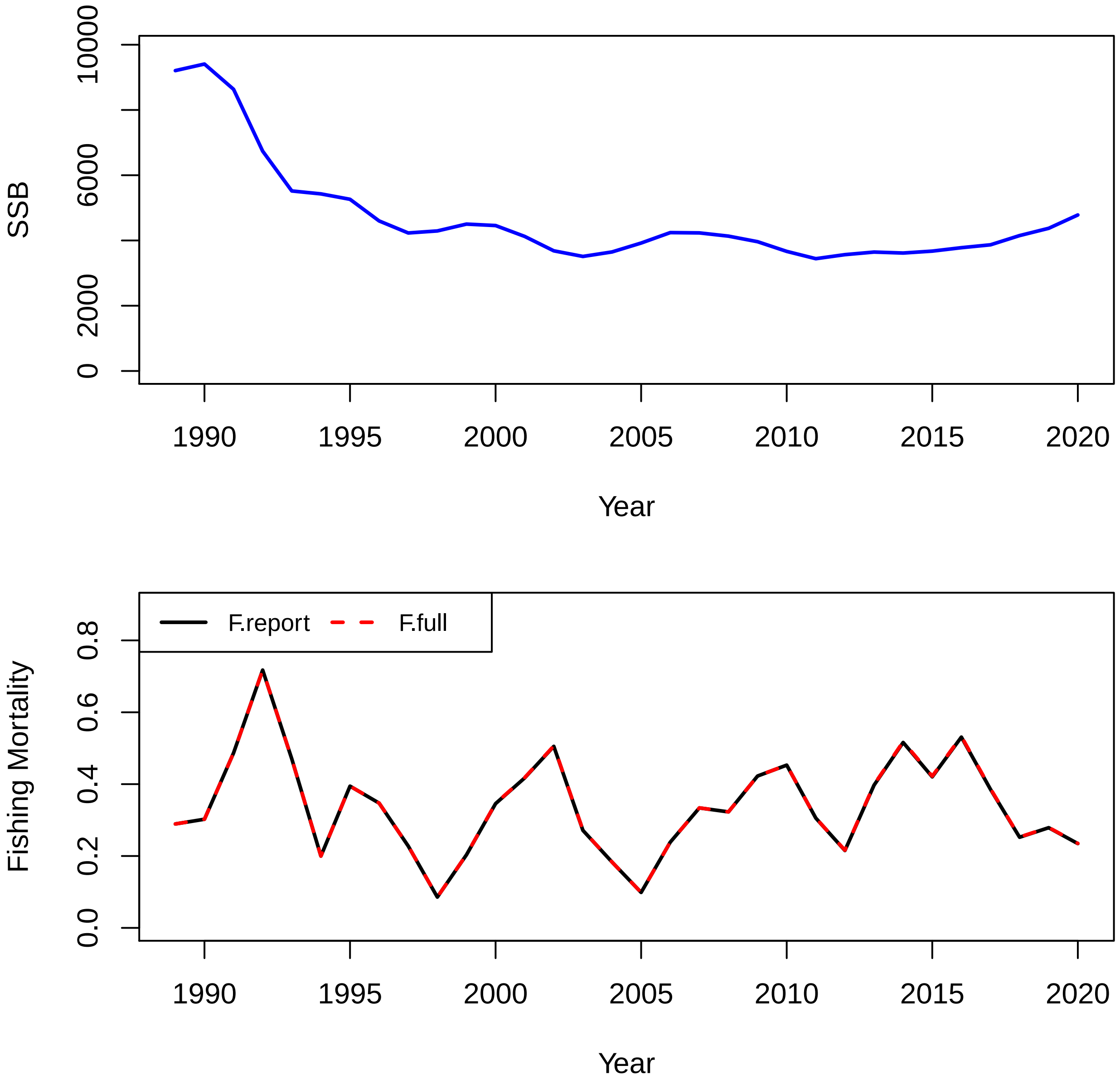
Index 3 (MRIP) Observed



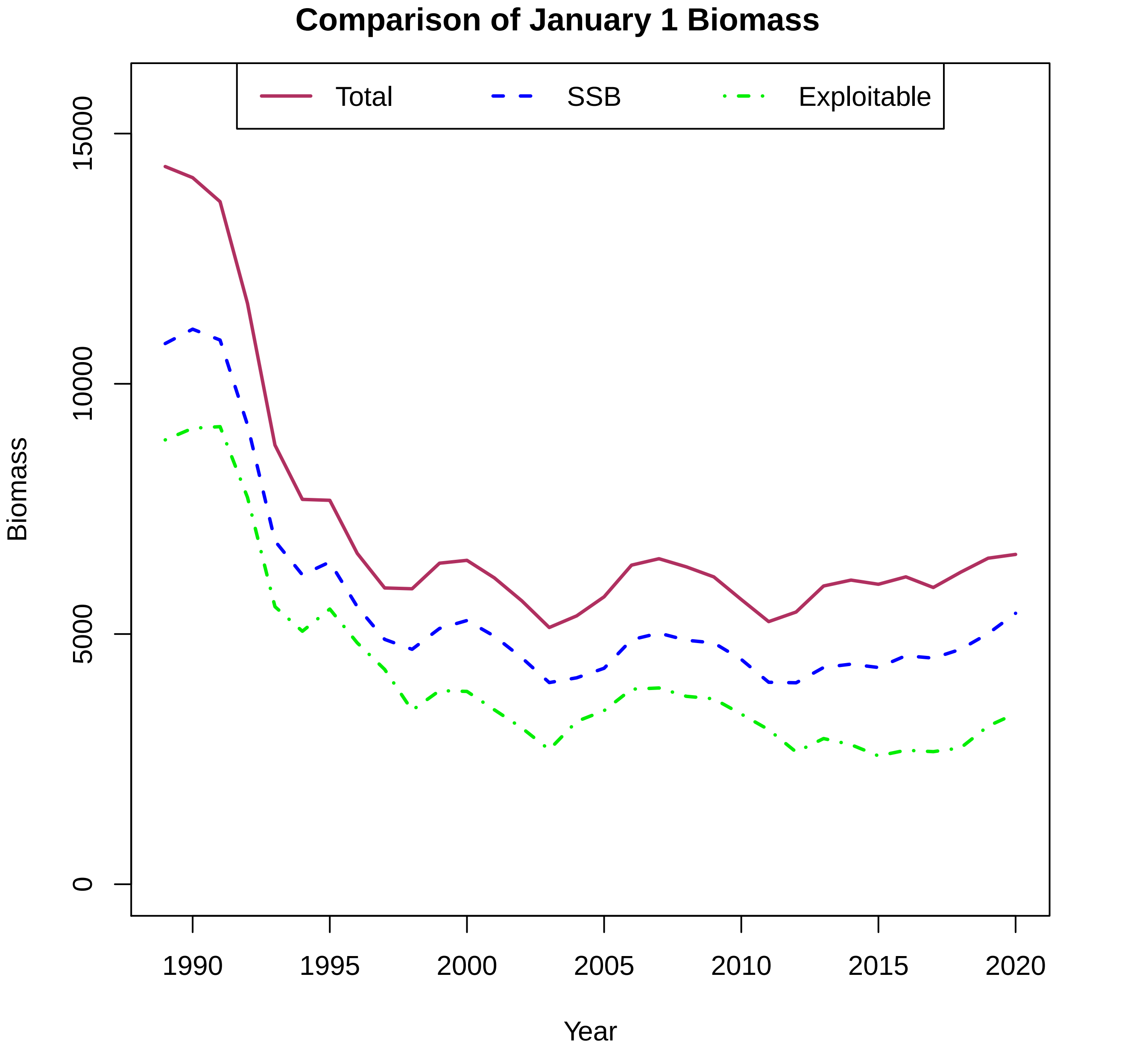
Index 3 (MRIP) Predicted

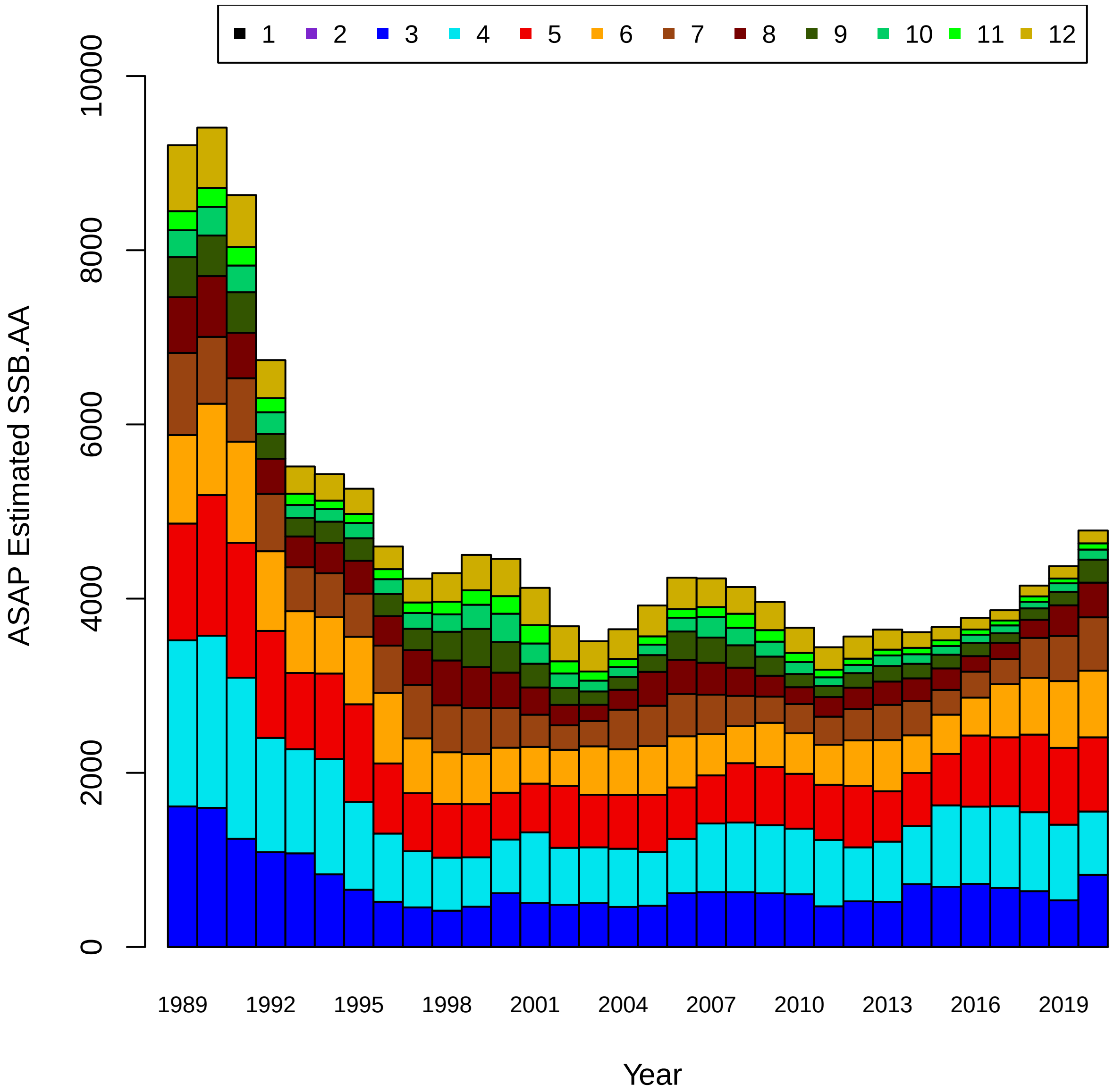


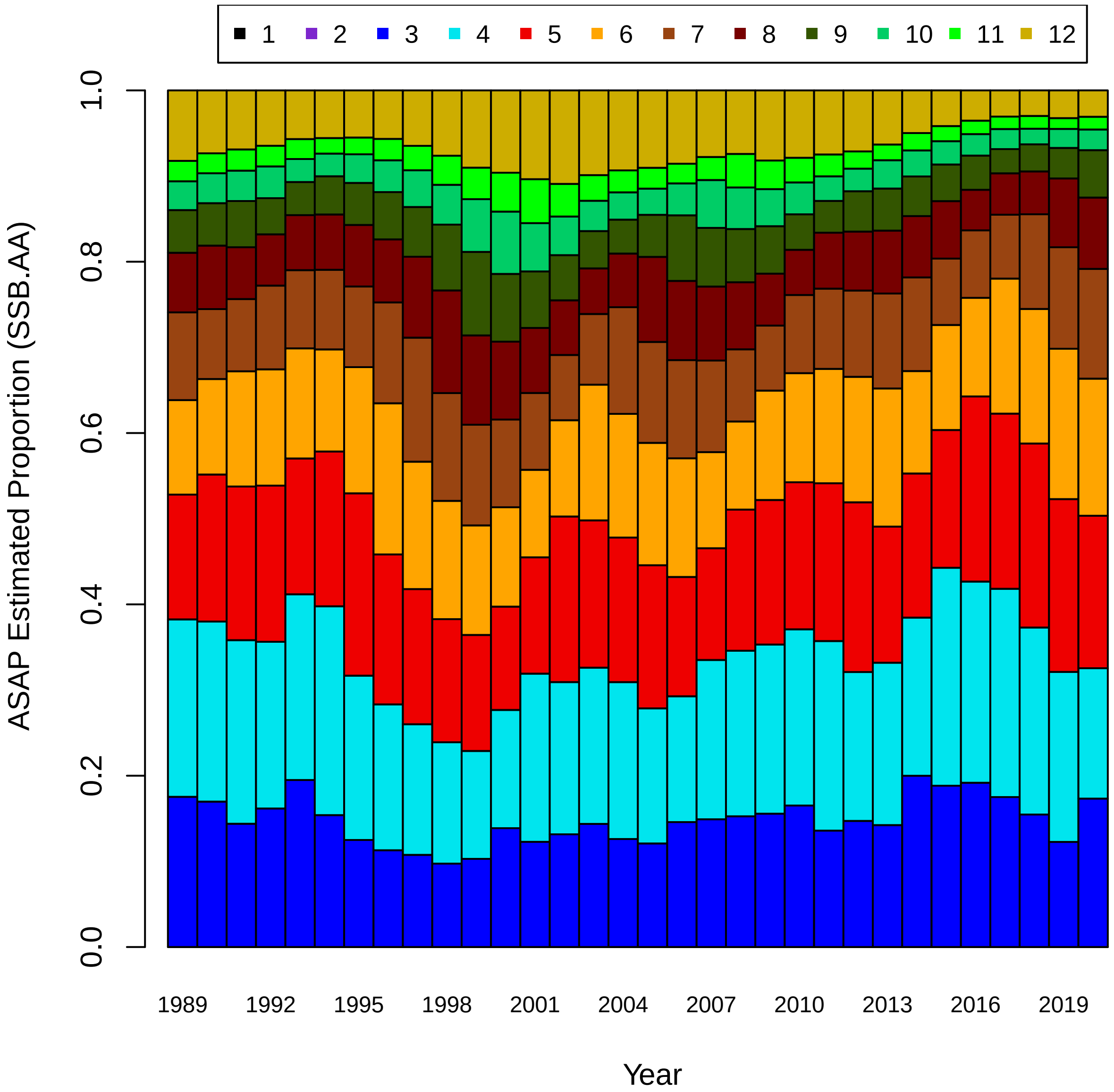

Catchability (q +/− 2 SE)
0e+00
1e−04
2e−04
3e−04
4e−04
NY seine
NJ trawl
MRIP

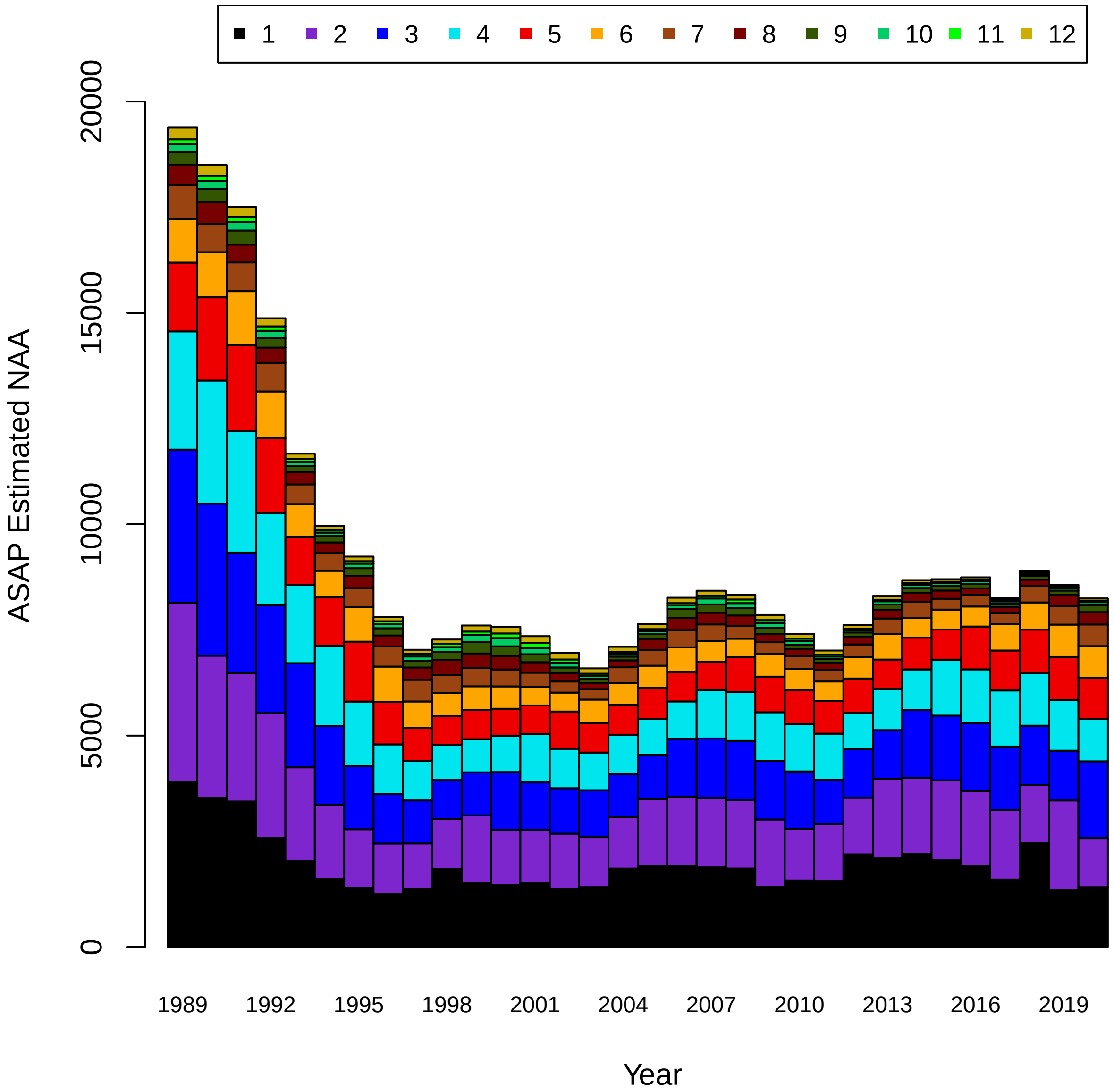


SSB
10000
6000
2000
0
1990
1995
2000
2005
2010
2015
2020
Year
Fishing Mortality
0.8
0.6
0.4
0.2
0.0
F.report
F.full
1990
1995
2000
2005
2010
2015
2020
Year

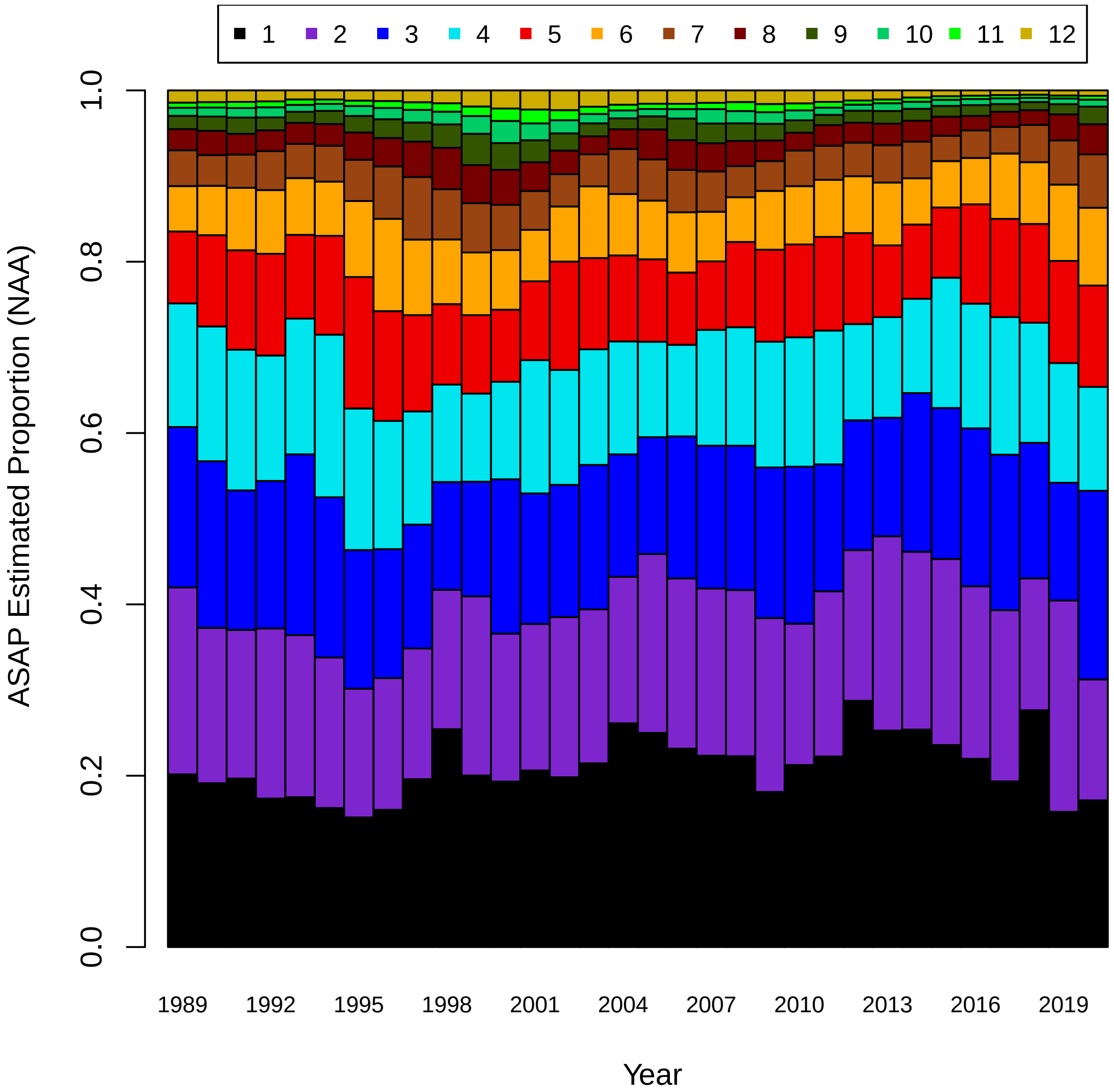

Comparison of January 1 Biomass
Total
SSB
Exploitable
Biomass
0
5000
10000
15000
Year
1990
1995
2000
2005
2010
2015
2020


1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated SSB.AA
0
2000
4000
6000
8000
10000
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Year

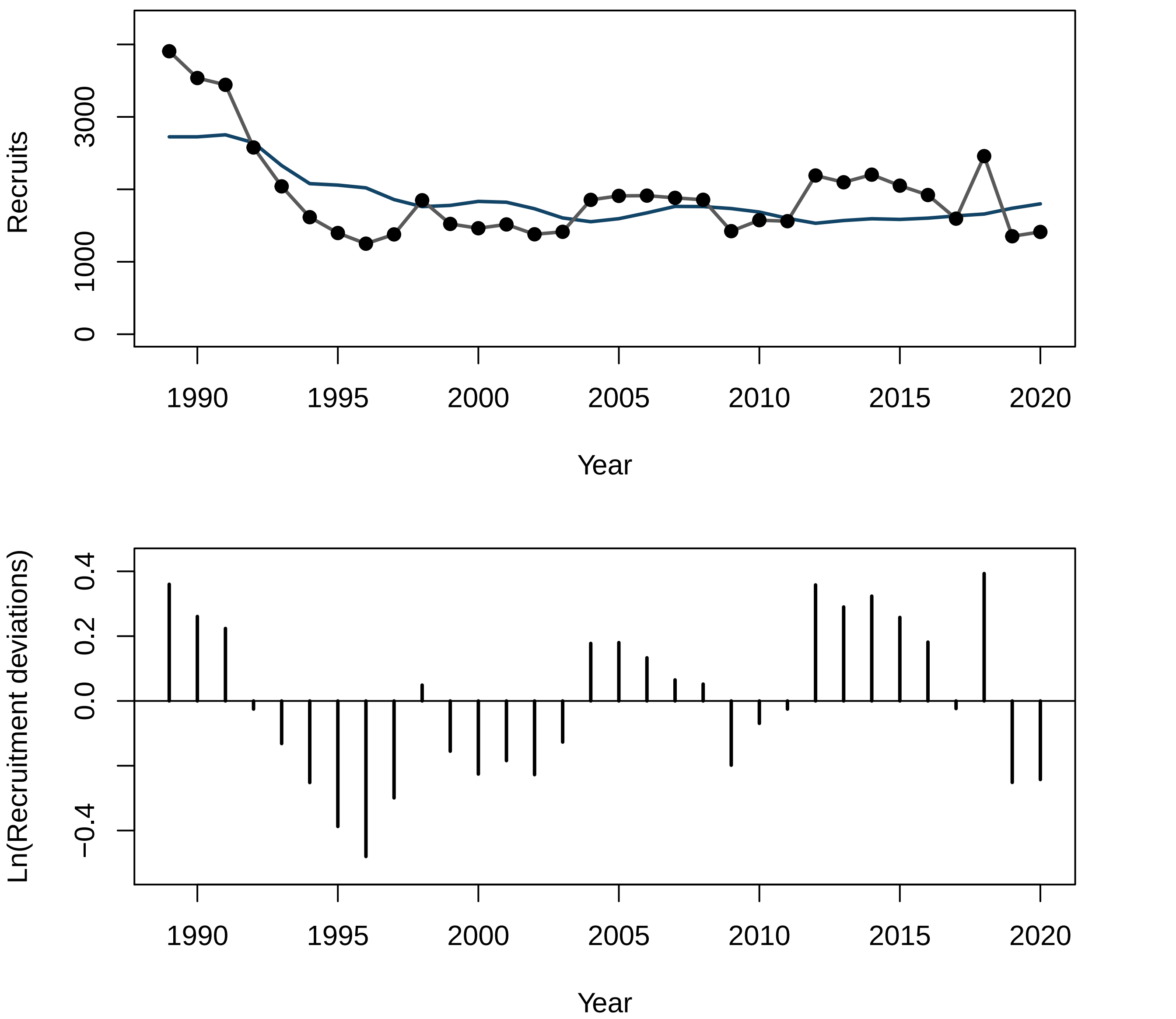

1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (SSB.AA)
0.0
0.2
0.4
0.6
0.8
1.0
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Year



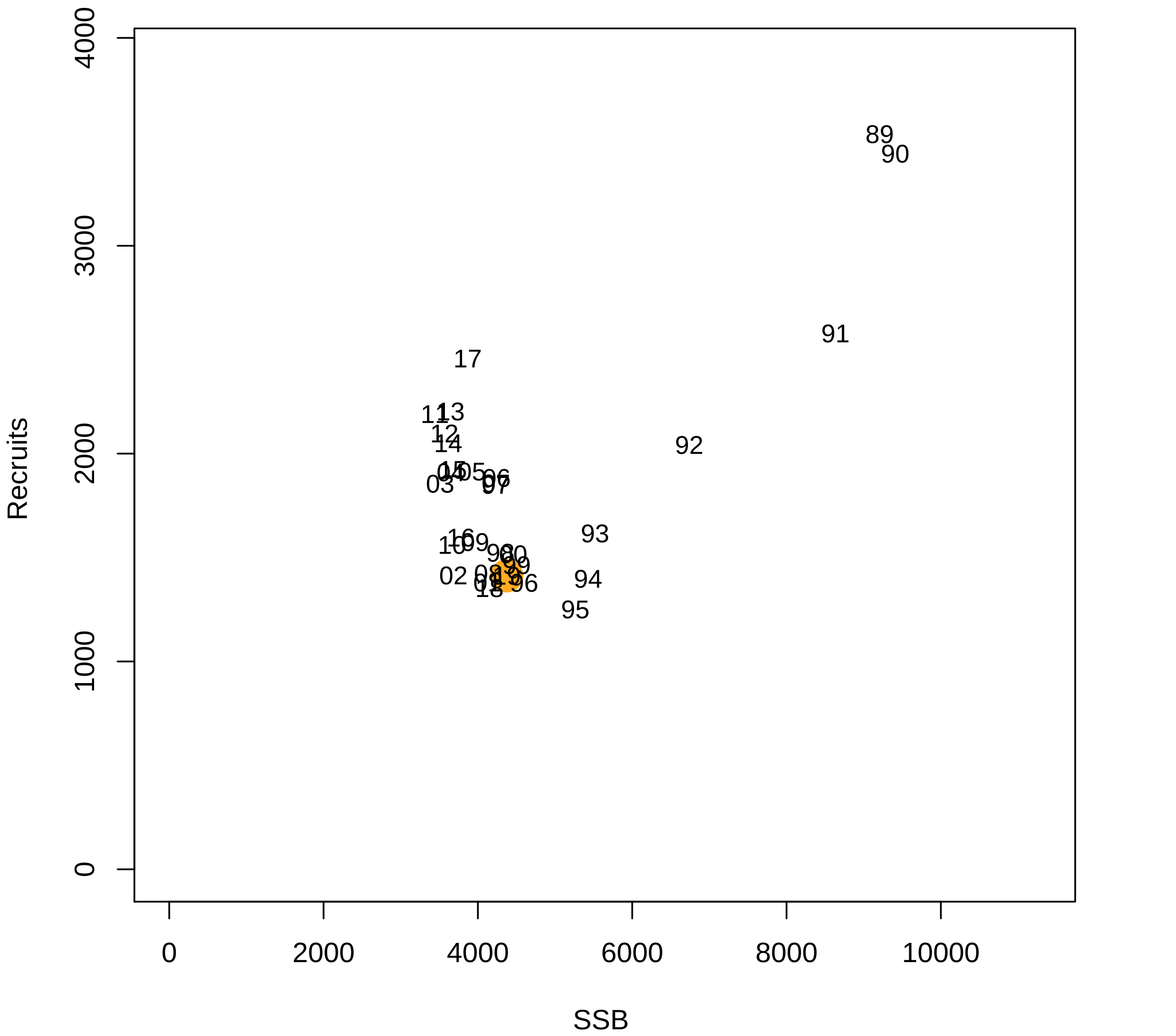
1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated NAA
0
5000
10000
15000
20000
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Year



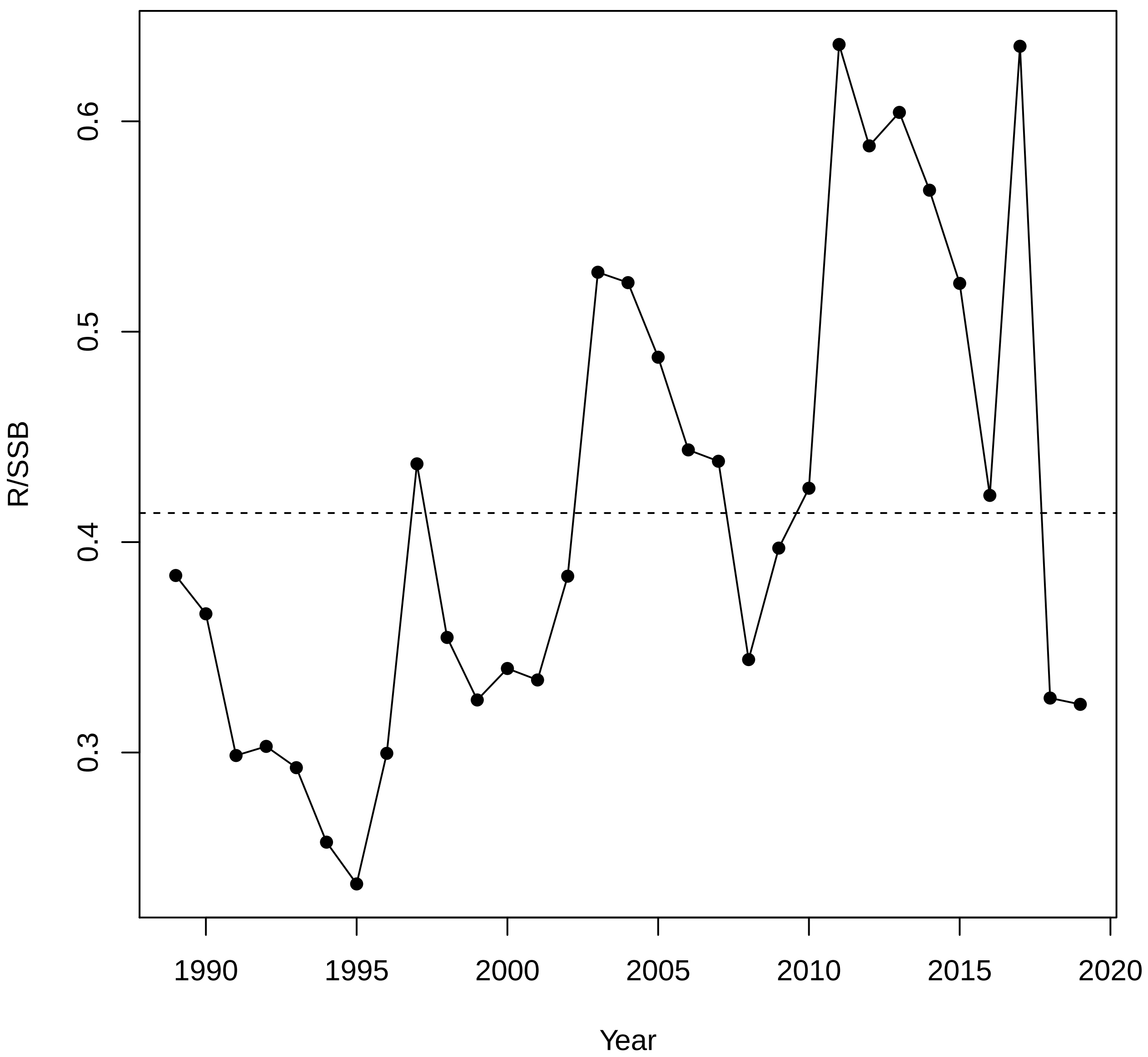
1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (NAA)
0.0
0.2
0.4
0.6
0.8
1.0
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Year

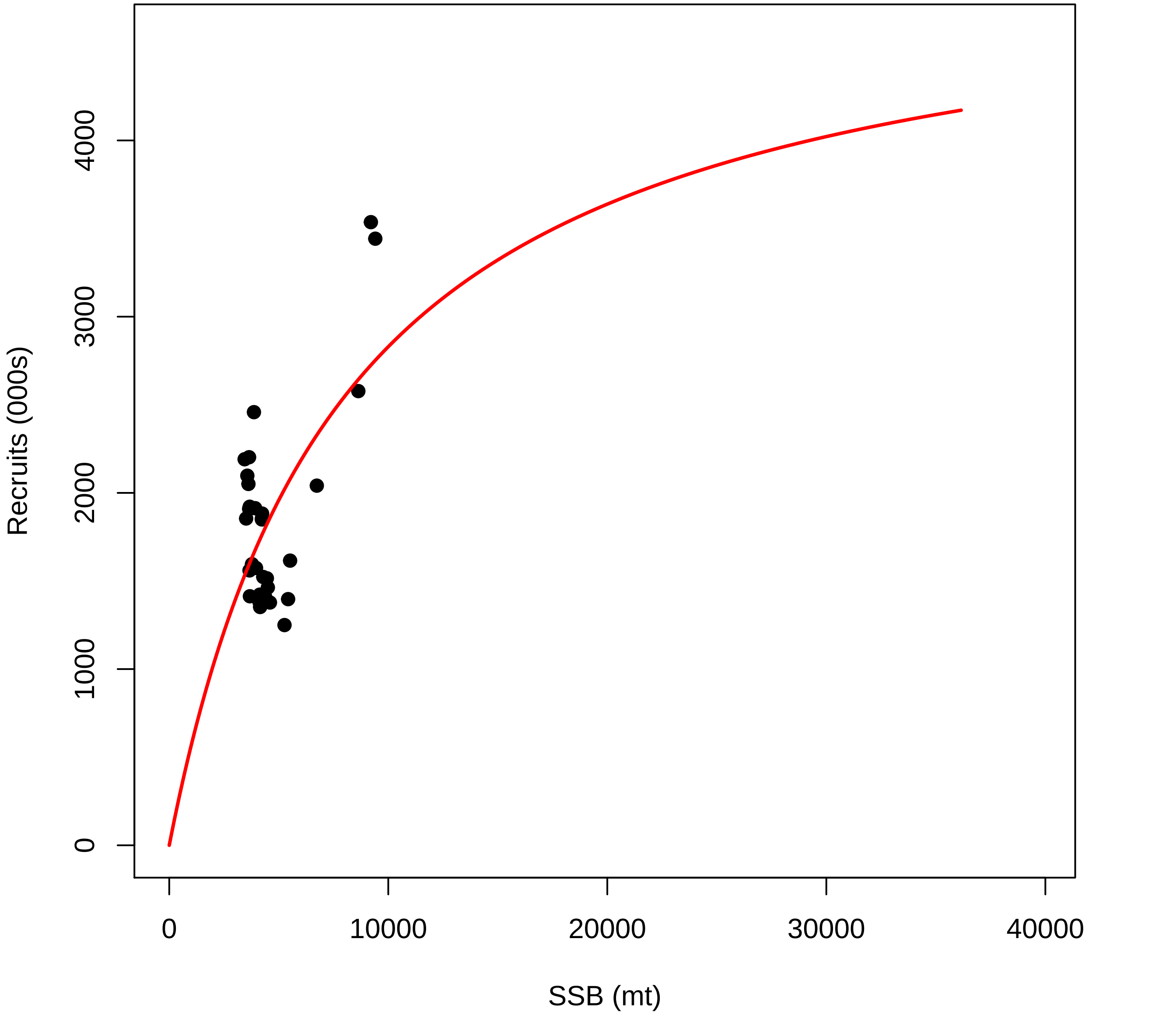


Recruits
0
1000
3000
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Recruitment deviations)
−0.4
0.0
0.2
0.4
1990
1995
2000
2005
2010
2015
2020
Year

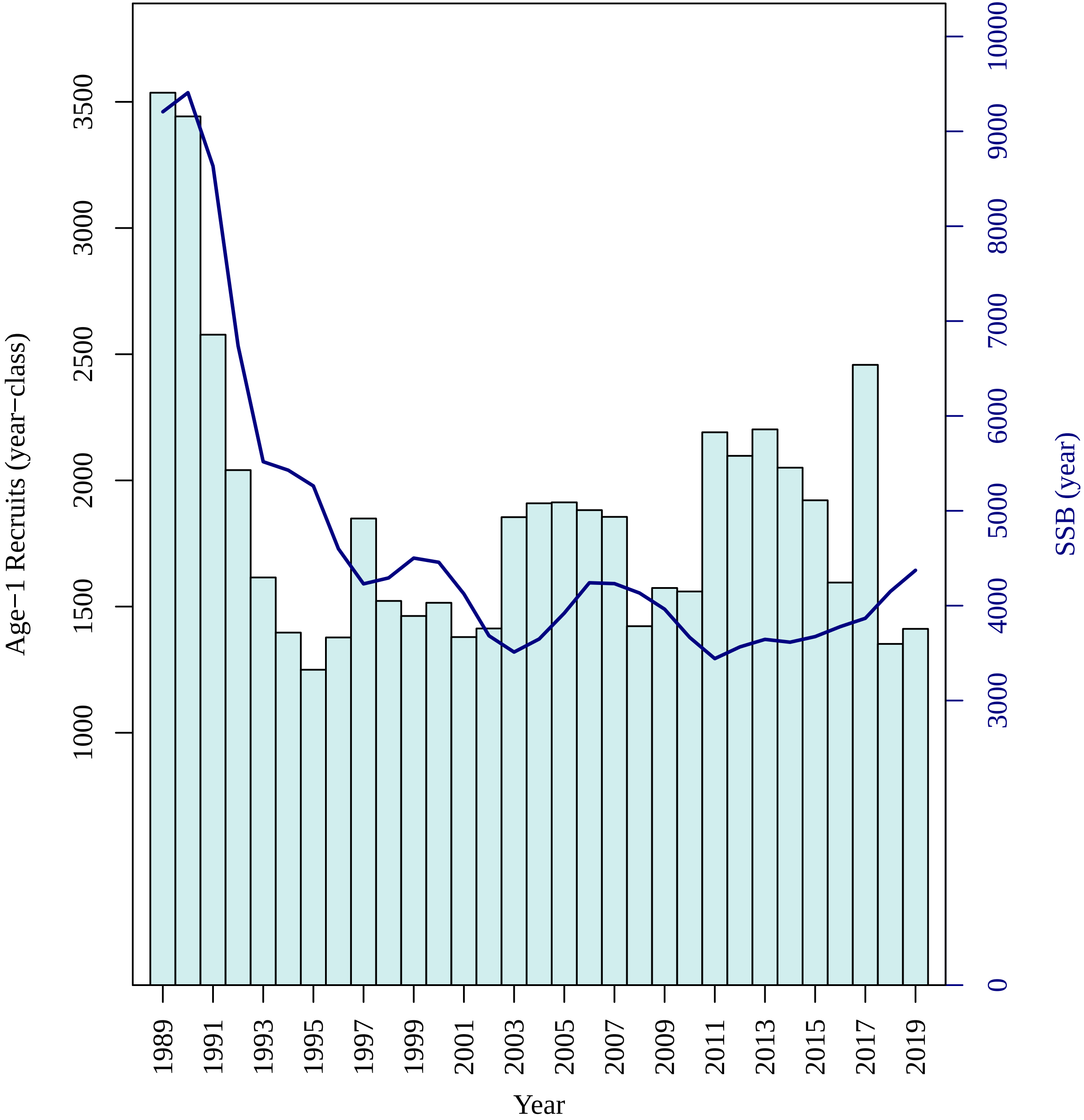


Recruits
0
1000
2000
3000
4000
SSB
0
2000
4000
6000
8000
10000
89
90
91
92
93
94
95
17

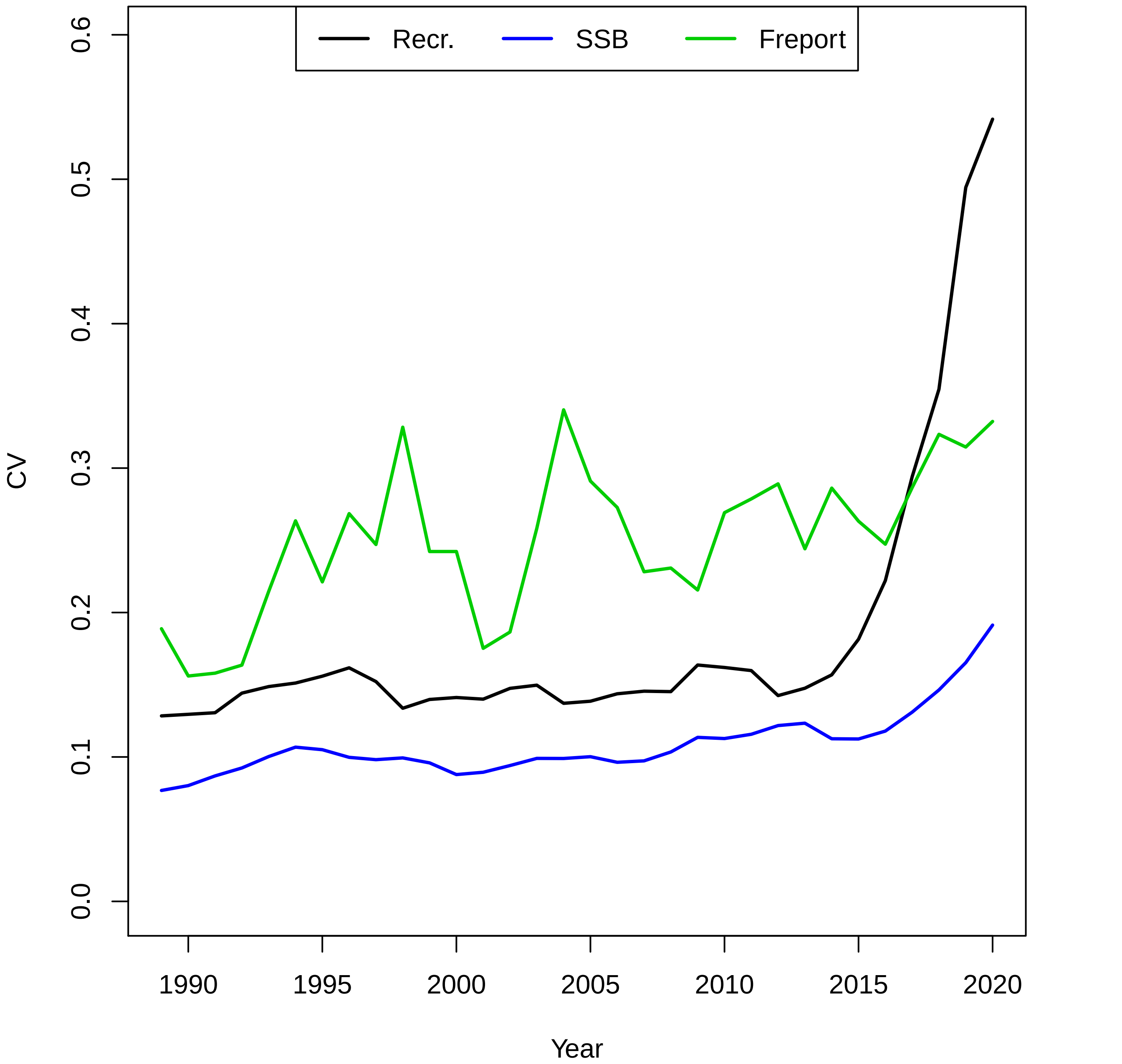

R/SSB
0.3
0.4
0.5
0.6
1990
1995
2000
2005
2010
2015
2020
Year

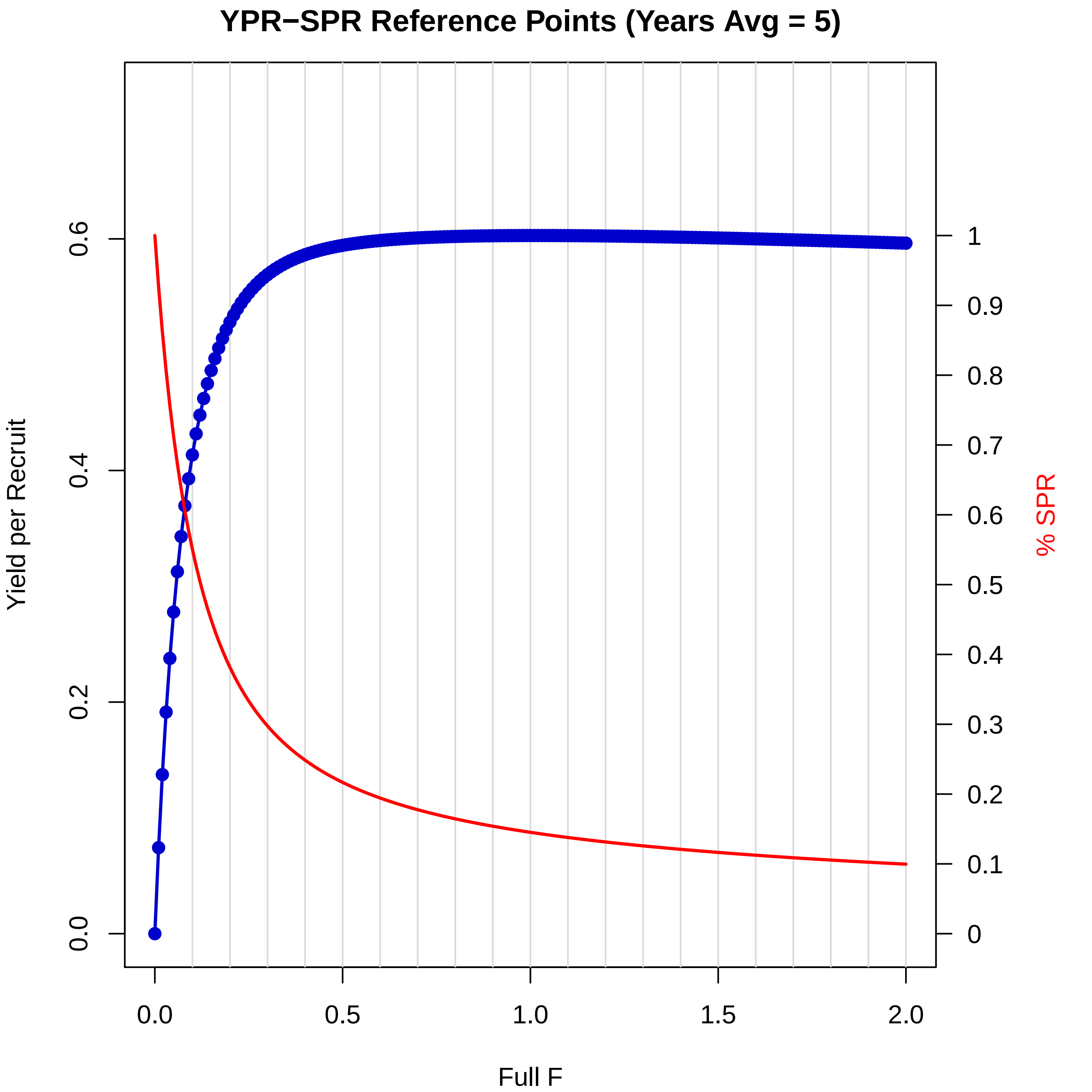


Recruits (000s)
0
1000
2000
3000
4000
SSB (mt)
0
10000
20000
30000
40000



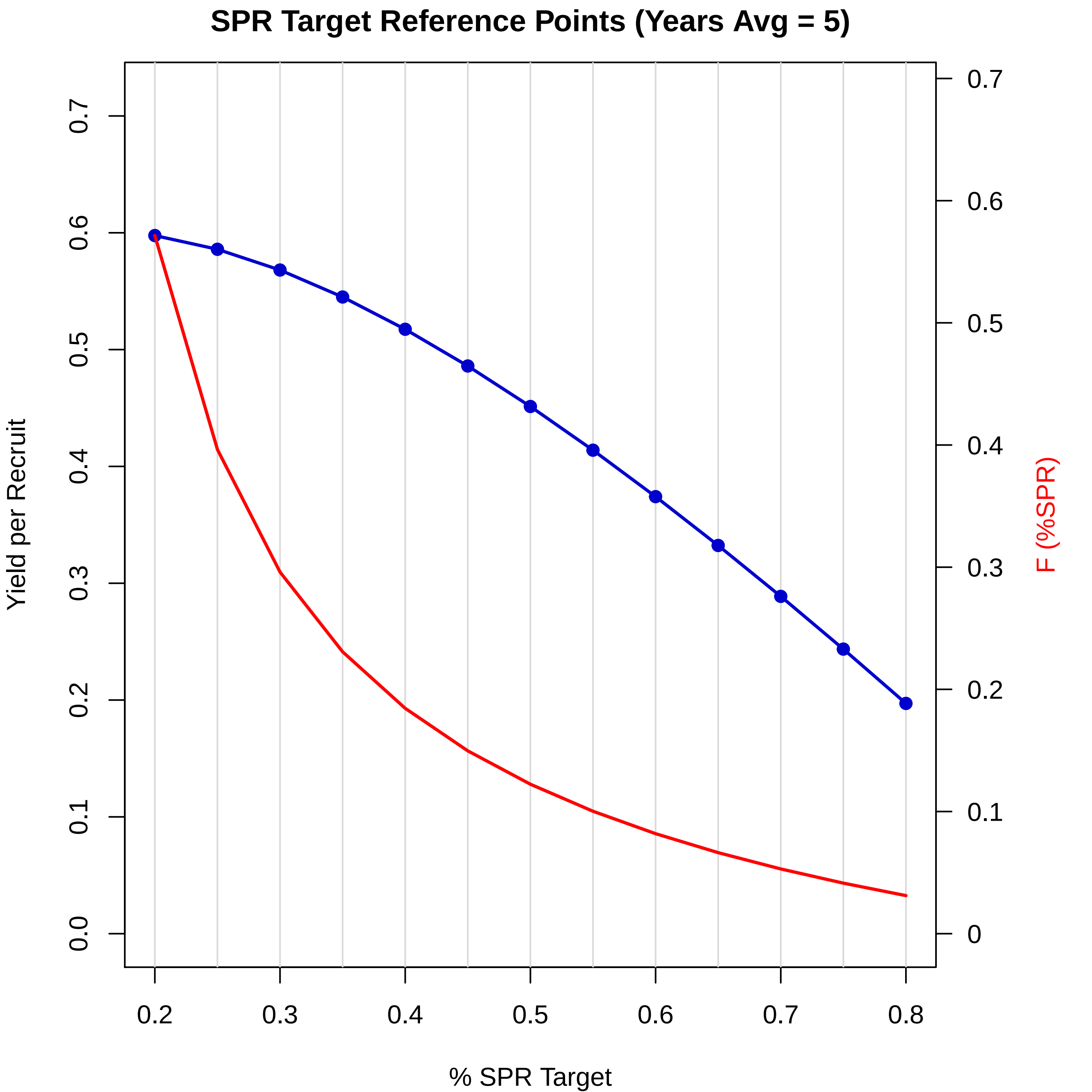
Age−1 Recruits (year−class)
1000
1500
2000
2500
3000
3500
SSB (year)
0
3000
4000
5000
6000
7000
8000
9000
10000
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year


Recr.
SSB
Freport
CV
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1990
1995
2000
2005
2010
2015
2020
Year


YPR−SPR Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.2
0.4
0.6
% SPR
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.0
0.5
1.0
1.5
2.0
Full F

YPR−SPR Reference Points (Years Avg = 5)

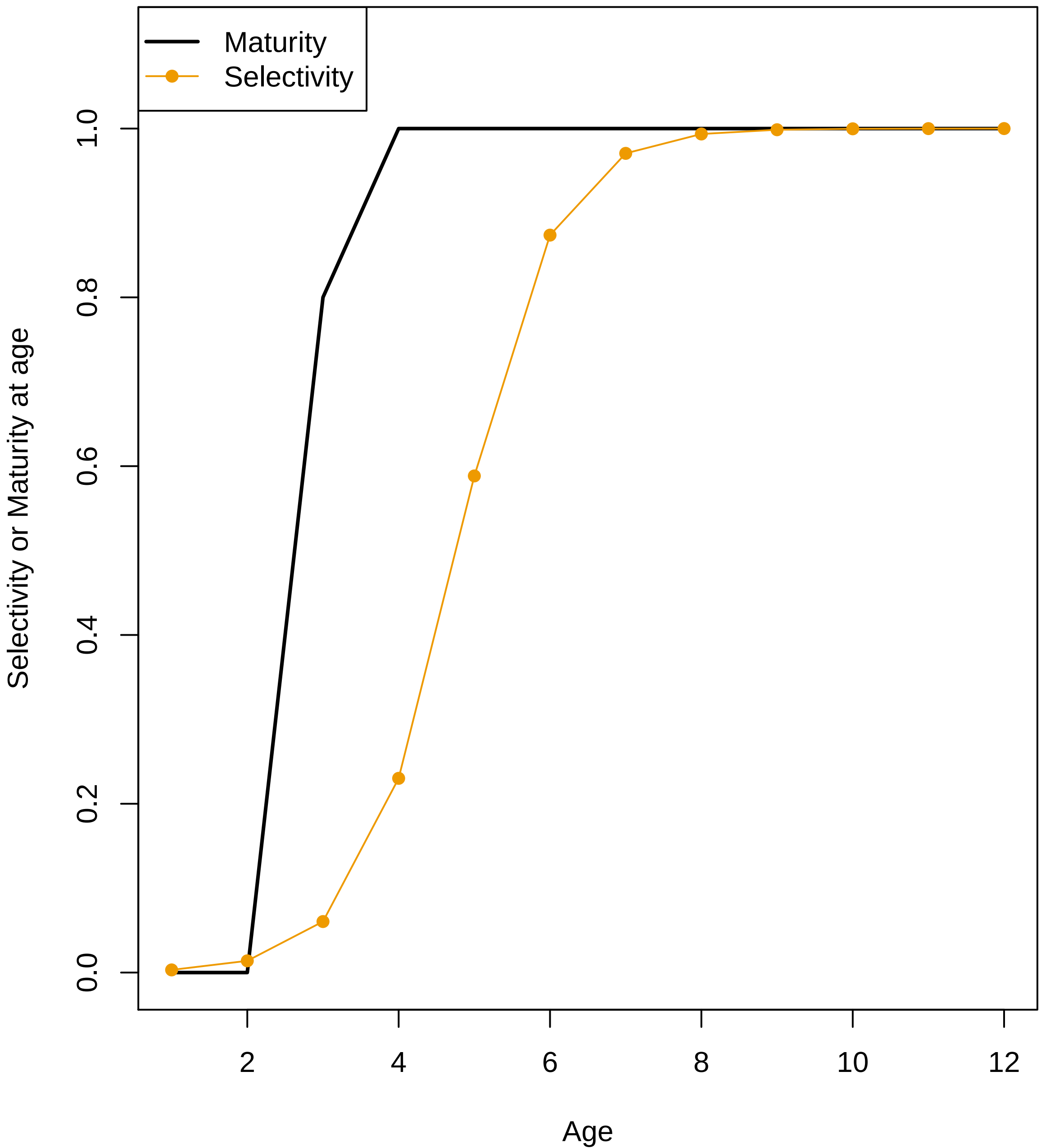
F	YPR	SPR	F	YPR	SPR	F	YPR	SPR
0	0	1	0.35	0.5794	0.2701	0.7	0.6008	0.1776
0.01	0.0743	0.9264	0.36	0.581	0.2654	0.71	0.601	0.1761
0.02	0.1374	0.8624	0.37	0.5825	0.2609	0.72	0.6012	0.1747
0.03	0.1913	0.8061	0.38	0.5838	0.2566	0.73	0.6013	0.1733
0.04	0.2377	0.7564	0.39	0.5851	0.2525	0.74	0.6014	0.172
0.05	0.2778	0.7123	0.4	0.5863	0.2486	0.75	0.6016	0.1707
0.06	0.3126	0.6729	0.41	0.5874	0.2448	0.76	0.6017	0.1694
0.07	0.343	0.6375	0.42	0.5884	0.2412	0.77	0.6018	0.1681
0.08	0.3695	0.6056	0.43	0.5893	0.2377	0.78	0.6019	0.1669
0.09	0.3929	0.5768	0.44	0.5902	0.2343	0.79	0.602	0.1657
0.1	0.4135	0.5505	0.45	0.591	0.2311	0.8	0.6021	0.1645
0.11	0.4317	0.5267	0.46	0.5918	0.228	0.81	0.6022	0.1633
0.12	0.4478	0.5048	0.47	0.5925	0.225	0.82	0.6022	0.1622
0.13	0.4621	0.4848	0.48	0.5932	0.2222	0.83	0.6023	0.1611
0.14	0.4749	0.4664	0.49	0.5938	0.2194	0.84	0.6024	0.16
0.15	0.4863	0.4494	0.5	0.5944	0.2167	0.85	0.6024	0.159
0.16	0.4966	0.4337	0.51	0.5949	0.2141	0.86	0.6025	0.1579
0.17	0.5057	0.4192	0.52	0.5955	0.2116	0.87	0.6025	0.1569
0.18	0.514	0.4057	0.53	0.5959	0.2092	0.88	0.6026	0.1559
0.19	0.5214	0.3932	0.54	0.5964	0.2069	0.89	0.6026	0.1549
0.2	0.5281	0.3815	0.55	0.5968	0.2046	0.9	0.6027	0.154
0.21	0.5342	0.3705	0.56	0.5972	0.2024	0.91	0.6027	0.153
0.22	0.5397	0.3603	0.57	0.5976	0.2003	0.92	0.6027	0.1521
0.23	0.5447	0.3507	0.58	0.5979	0.1982	0.93	0.6028	0.1512
0.24	0.5492	0.3417	0.59	0.5983	0.1962	0.94	0.6028	0.1503
0.25	0.5533	0.3332	0.6	0.5986	0.1943	0.95	0.6028	0.1494
0.26	0.5571	0.3252	0.61	0.5989	0.1924	0.96	0.6028	0.1485
0.27	0.5605	0.3177	0.62	0.5991	0.1906	0.97	0.6029	0.1477
0.28	0.5636	0.3106	0.63	0.5994	0.1888	0.98	0.6029	0.1468
0.29	0.5665	0.3039	0.64	0.5997	0.1871	0.99	0.6029	0.146
0.3	0.5691	0.2975	0.65	0.5999	0.1854	1	0.6029	0.1452
0.31	0.5715	0.2915	0.66	0.6001	0.1837	1.01	0.6029	0.1444
0.32	0.5737	0.2857	0.67	0.6003	0.1821	1.02	0.6029	0.1436
0.33	0.5758	0.2803	0.68	0.6005	0.1806	1.03	0.6029	0.1429
0.34	0.5777	0.2751	0.69	0.6007	0.179	1.04	0.6029	0.1421



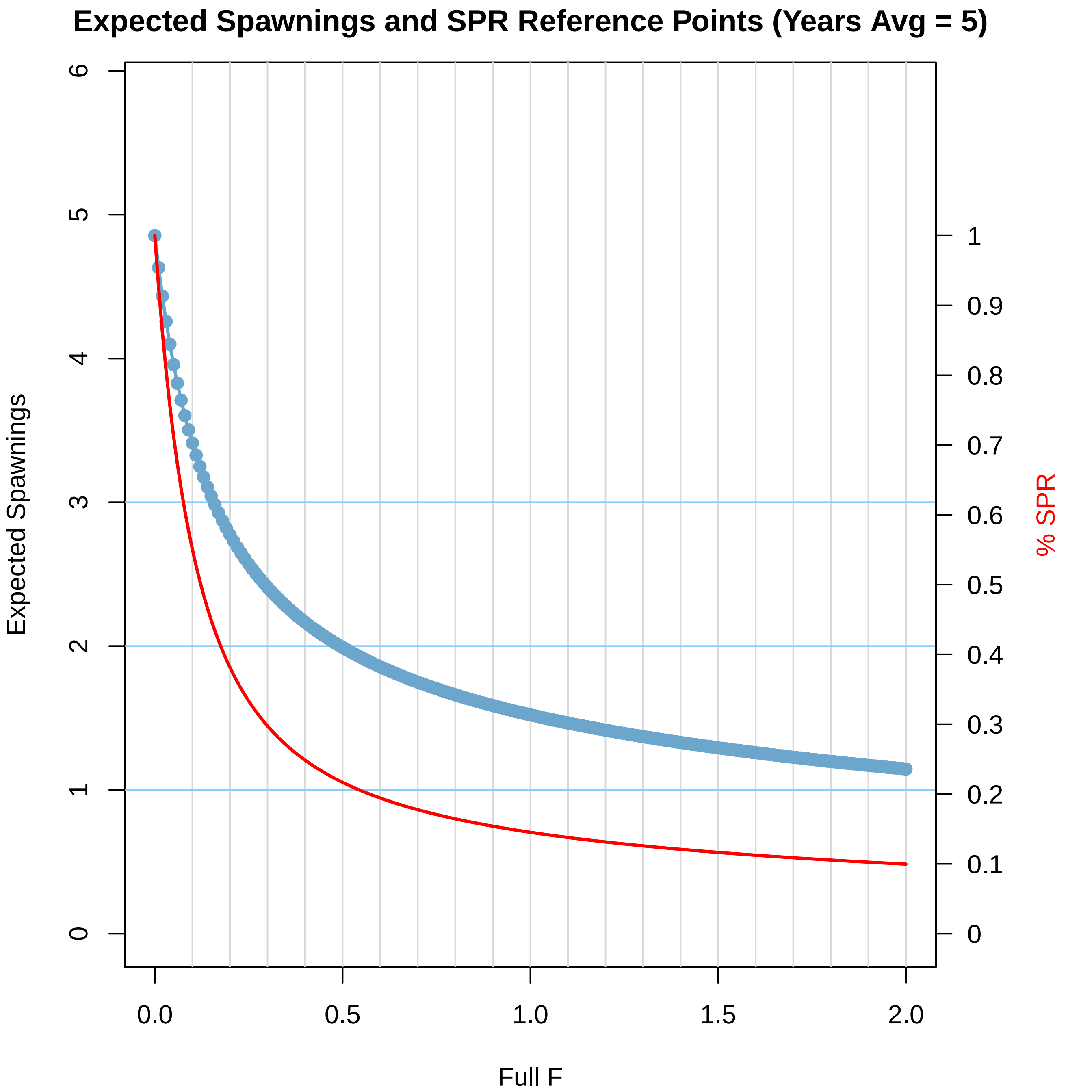
SPR Target Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
F (%SPR)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.2
0.3
0.4
0.5
0.6
0.7
0.8
% SPR Target

SPR Target Reference Points (Years Avg = 5)

% SPR	F(%SPR)	YPR
0.2	0.5715	0.5976
0.25	0.3963	0.5859
0.3	0.296	0.5681
0.35	0.2308	0.545
0.4	0.1845	0.5174
0.45	0.1497	0.486
0.5	0.1223	0.4513
0.55	0.1002	0.4139
0.6	0.0819	0.3741
0.65	0.0663	0.3323
0.7	0.053	0.2887
0.75	0.0414	0.2436
0.8	0.0312	0.1971



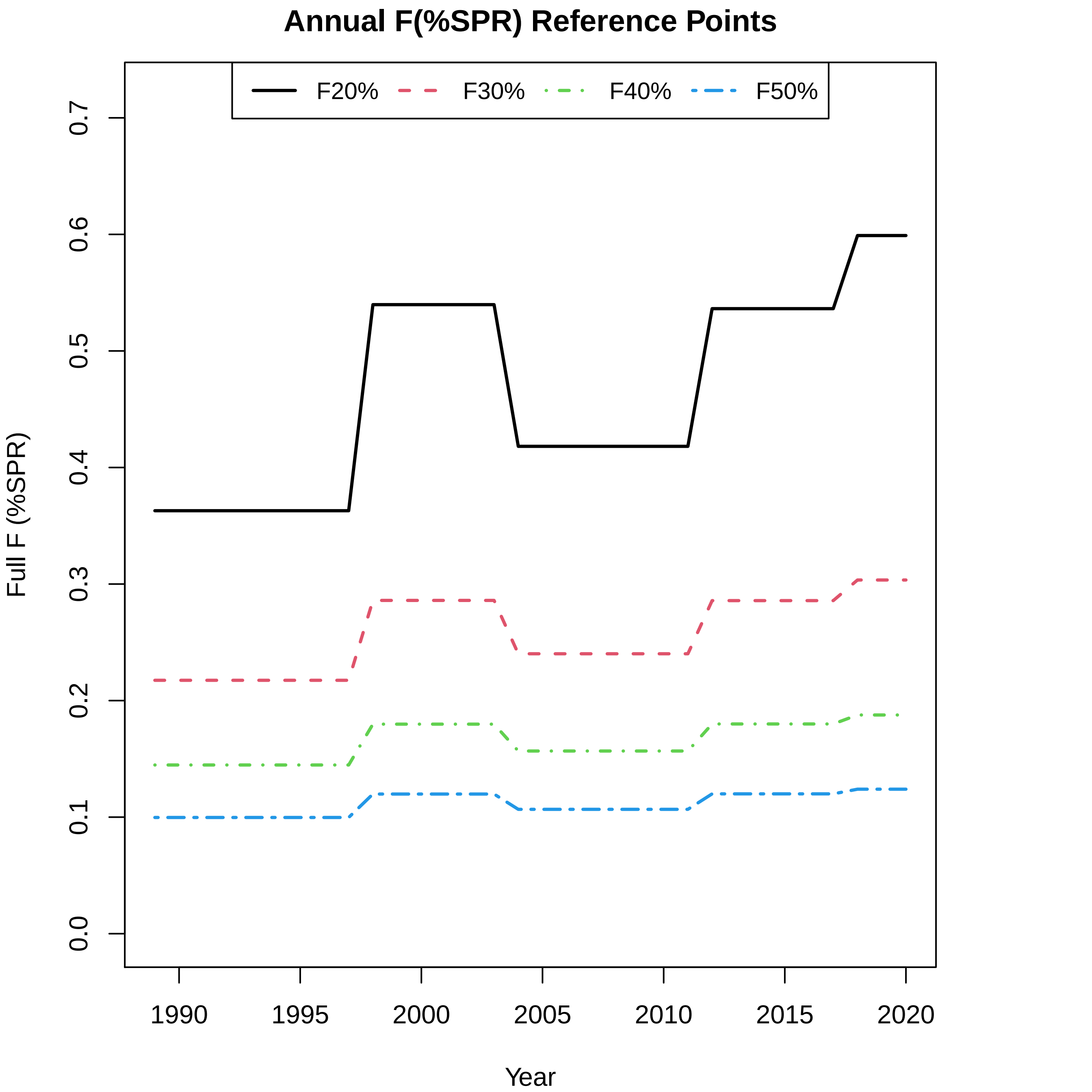
Maturity
Selectivity
0.0
0.2
0.4
0.6
0.8
1.0
Selectivity or Maturity at age
2
4
6
8
10
12
Age

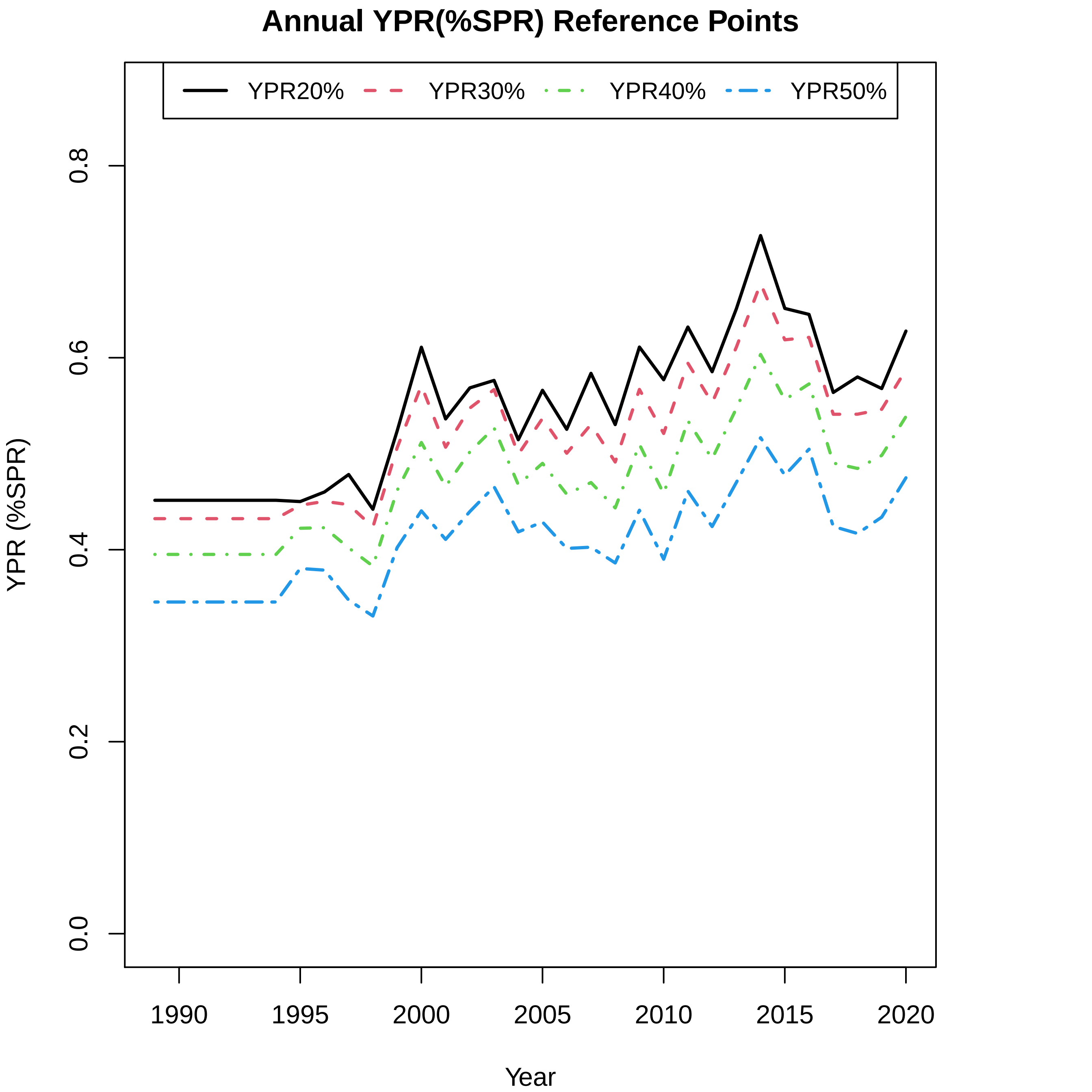


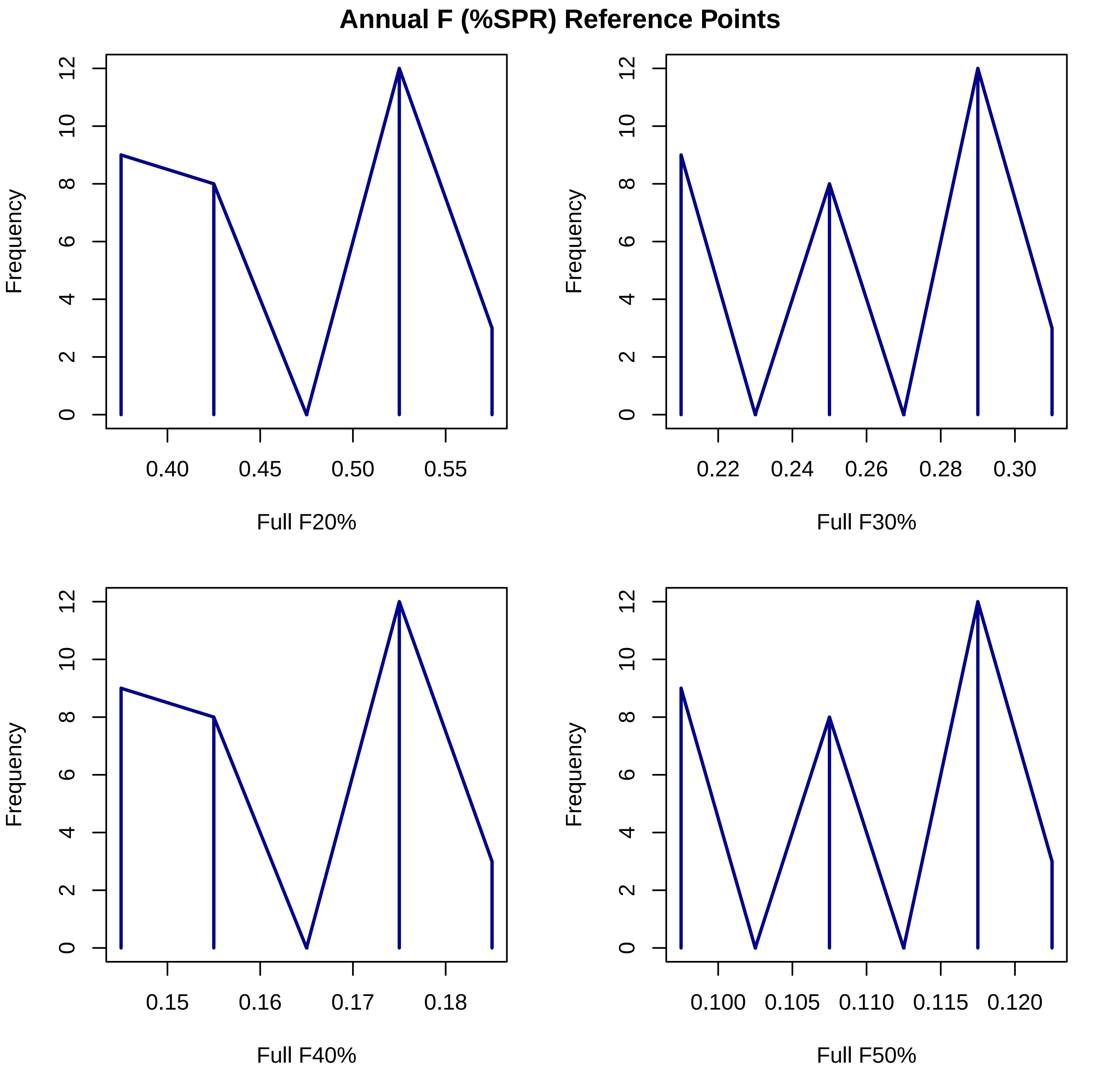
Expected Spawnings and SPR Reference Points (Years Avg = 5)
Expected Spawnings
% SPR
Full F
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Expected Spawnings & SPR Reference Points (Years Avg = 5)

F	E[Sp]	SPR	F	E[Sp]	SPR	F	E[Sp]	SPR
0	4.8546	1	0.35	2.276	0.2701	0.7	1.7491	0.1776
0.01	4.6311	0.9264	0.36	2.2524	0.2654	0.71	1.7395	0.1761
0.02	4.4334	0.8624	0.37	2.2295	0.2609	0.72	1.7301	0.1747
0.03	4.2574	0.8061	0.38	2.2075	0.2566	0.73	1.7208	0.1733
0.04	4.0994	0.7564	0.39	2.1862	0.2525	0.74	1.7118	0.172
0.05	3.957	0.7123	0.4	2.1656	0.2486	0.75	1.7029	0.1707
0.06	3.8277	0.6729	0.41	2.1456	0.2448	0.76	1.6941	0.1694
0.07	3.71	0.6375	0.42	2.1262	0.2412	0.77	1.6855	0.1681
0.08	3.6021	0.6056	0.43	2.1075	0.2377	0.78	1.6771	0.1669
0.09	3.503	0.5768	0.44	2.0893	0.2343	0.79	1.6688	0.1657
0.1	3.4116	0.5505	0.45	2.0716	0.2311	0.8	1.6606	0.1645
0.11	3.3269	0.5267	0.46	2.0544	0.228	0.81	1.6526	0.1633
0.12	3.2483	0.5048	0.47	2.0378	0.225	0.82	1.6447	0.1622
0.13	3.1751	0.4848	0.48	2.0215	0.2222	0.83	1.637	0.1611
0.14	3.1067	0.4664	0.49	2.0058	0.2194	0.84	1.6293	0.16
0.15	3.0426	0.4494	0.5	1.9904	0.2167	0.85	1.6218	0.159
0.16	2.9825	0.4337	0.51	1.9754	0.2141	0.86	1.6144	0.1579
0.17	2.926	0.4192	0.52	1.9608	0.2116	0.87	1.6071	0.1569
0.18	2.8727	0.4057	0.53	1.9466	0.2092	0.88	1.5999	0.1559
0.19	2.8224	0.3932	0.54	1.9328	0.2069	0.89	1.5929	0.1549
0.2	2.7748	0.3815	0.55	1.9192	0.2046	0.9	1.5859	0.154
0.21	2.7296	0.3705	0.56	1.906	0.2024	0.91	1.579	0.153
0.22	2.6868	0.3603	0.57	1.8932	0.2003	0.92	1.5723	0.1521
0.23	2.646	0.3507	0.58	1.8806	0.1982	0.93	1.5656	0.1512
0.24	2.6073	0.3417	0.59	1.8683	0.1962	0.94	1.559	0.1503
0.25	2.5703	0.3332	0.6	1.8562	0.1943	0.95	1.5526	0.1494
0.26	2.535	0.3252	0.61	1.8445	0.1924	0.96	1.5462	0.1485
0.27	2.5012	0.3177	0.62	1.833	0.1906	0.97	1.5399	0.1477
0.28	2.4689	0.3106	0.63	1.8217	0.1888	0.98	1.5337	0.1468
0.29	2.4379	0.3039	0.64	1.8107	0.1871	0.99	1.5275	0.146
0.3	2.4082	0.2975	0.65	1.7999	0.1854	1	1.5215	0.1452
0.31	2.3797	0.2915	0.66	1.7893	0.1837	1.01	1.5155	0.1444
0.32	2.3523	0.2857	0.67	1.7789	0.1821	1.02	1.5096	0.1436
0.33	2.3259	0.2803	0.68	1.7688	0.1806	1.03	1.5038	0.1429
0.34	2.3005	0.2751	0.69	1.7588	0.179	1.04	1.498	0.1421

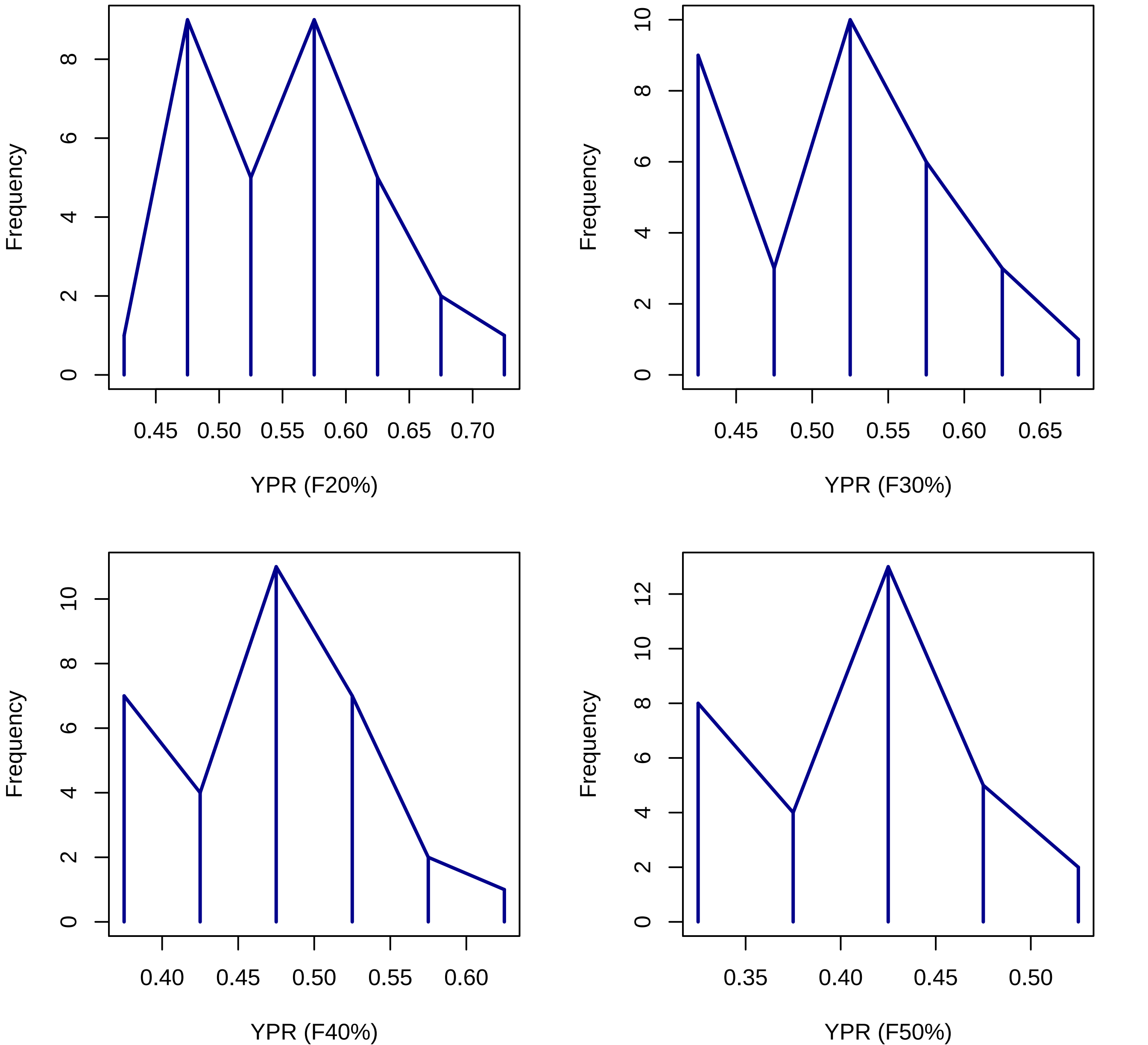

Annual F(%SPR) Reference Points
F20%
F30%
F40%
F50%
Full F (%SPR)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1990
1995
2000
2005
2010
2015
2020
Year

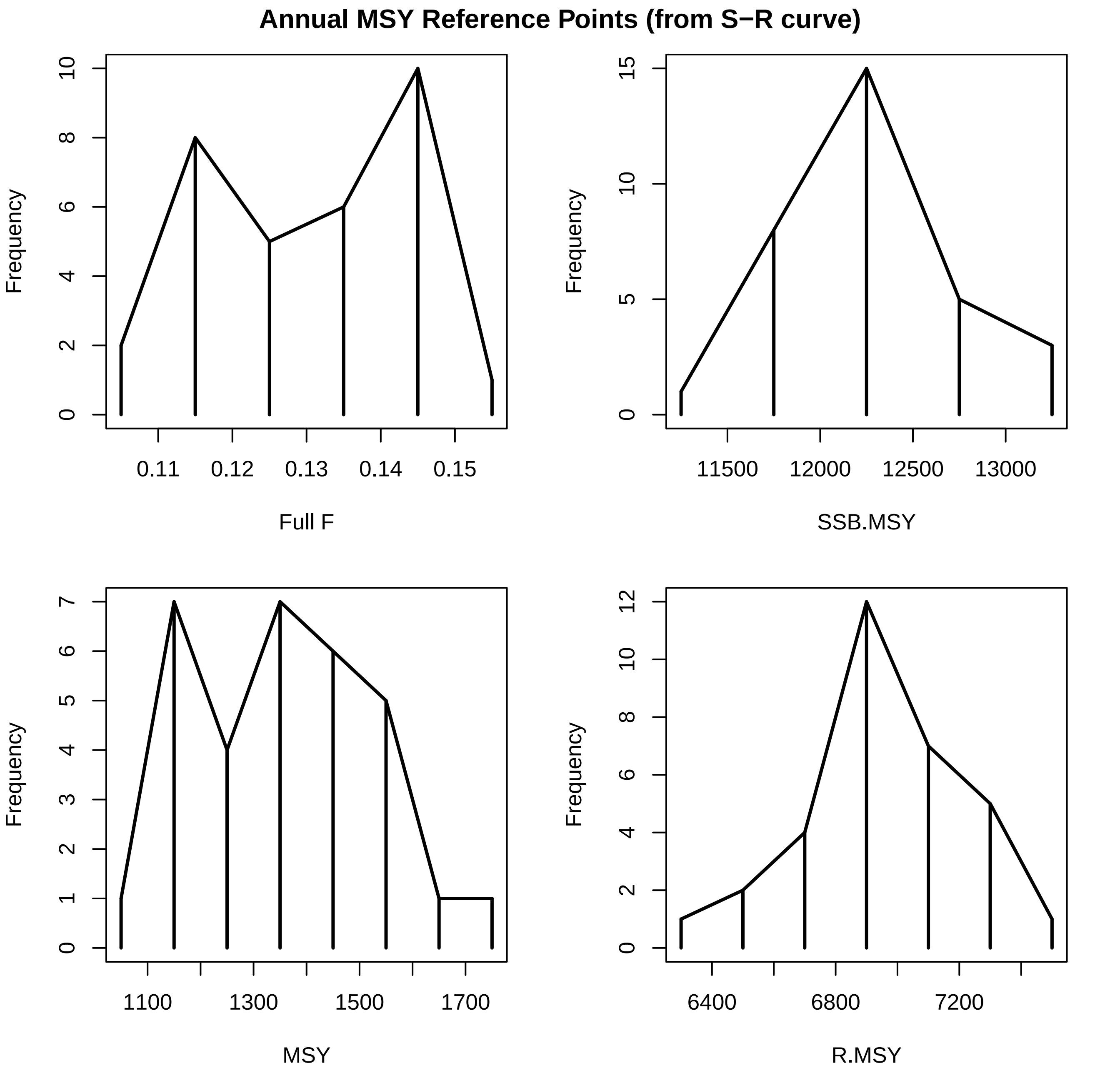

Annual YPR(%SPR) Reference Points
YPR20%
YPR30%
YPR40%
YPR50%
YPR (%SPR)
0.0
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
2020
Year

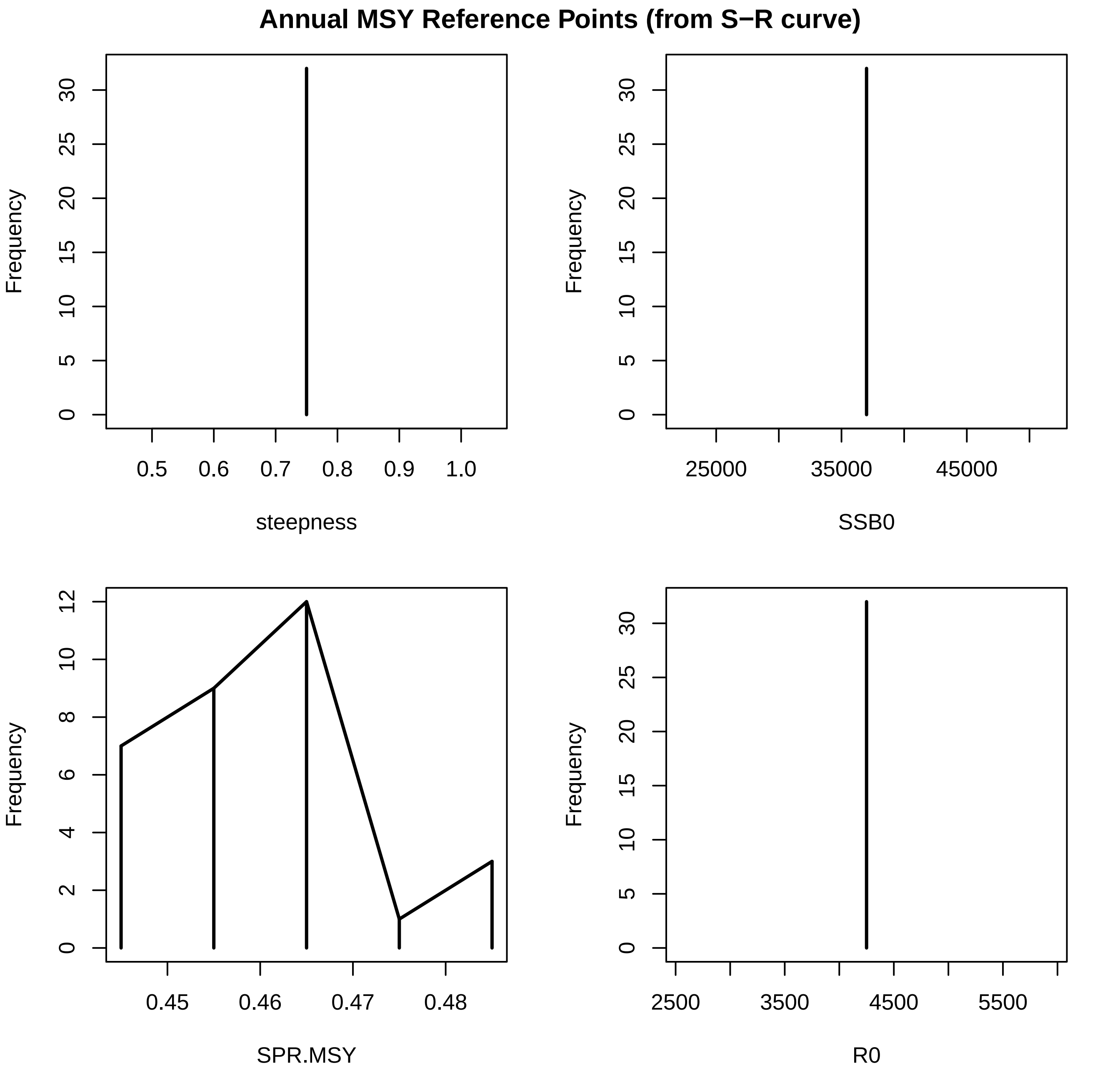


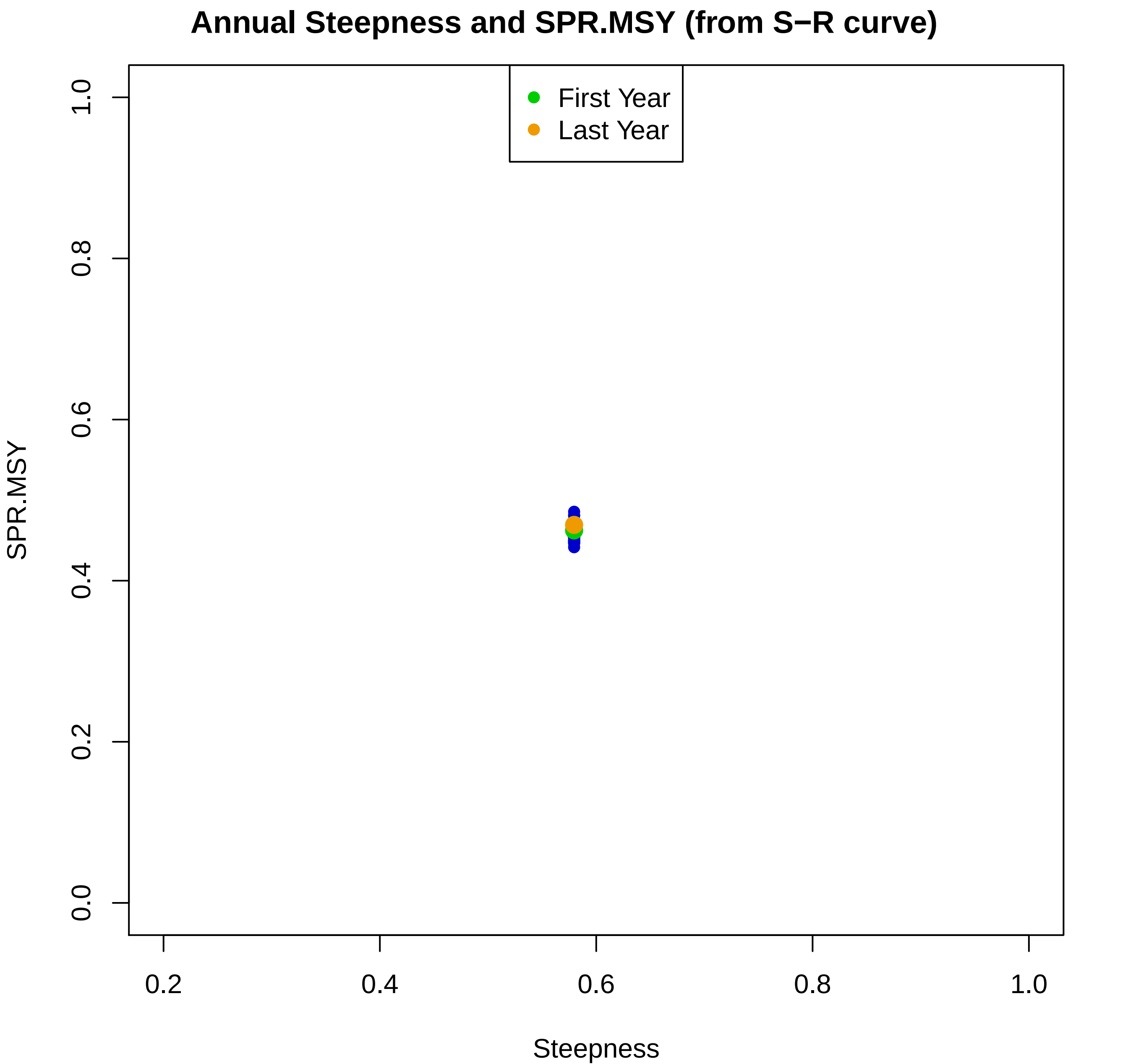
Annual F (%SPR) Reference Points
Frequency
0
2
4
6
8
10
12
0.40
0.45
0.50
0.55
Full F20%
0.22
0.24
0.26
0.28
0.30
Full F30%
0.15
0.16
0.17
0.18
Full F40%
0.100
0.105
0.110
0.115
0.120
Full F50%

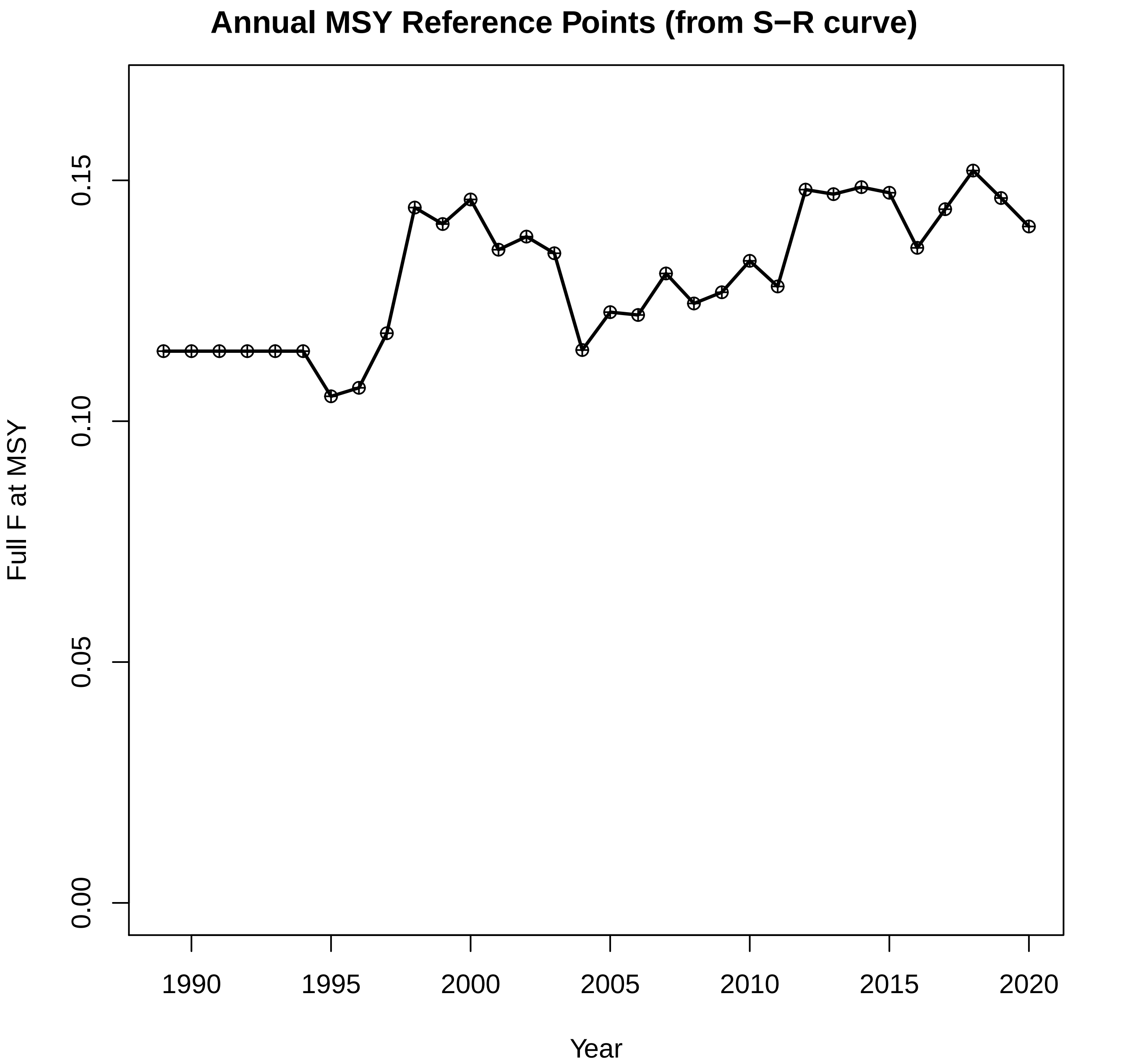
Annual YPR (%SPR) Reference Points

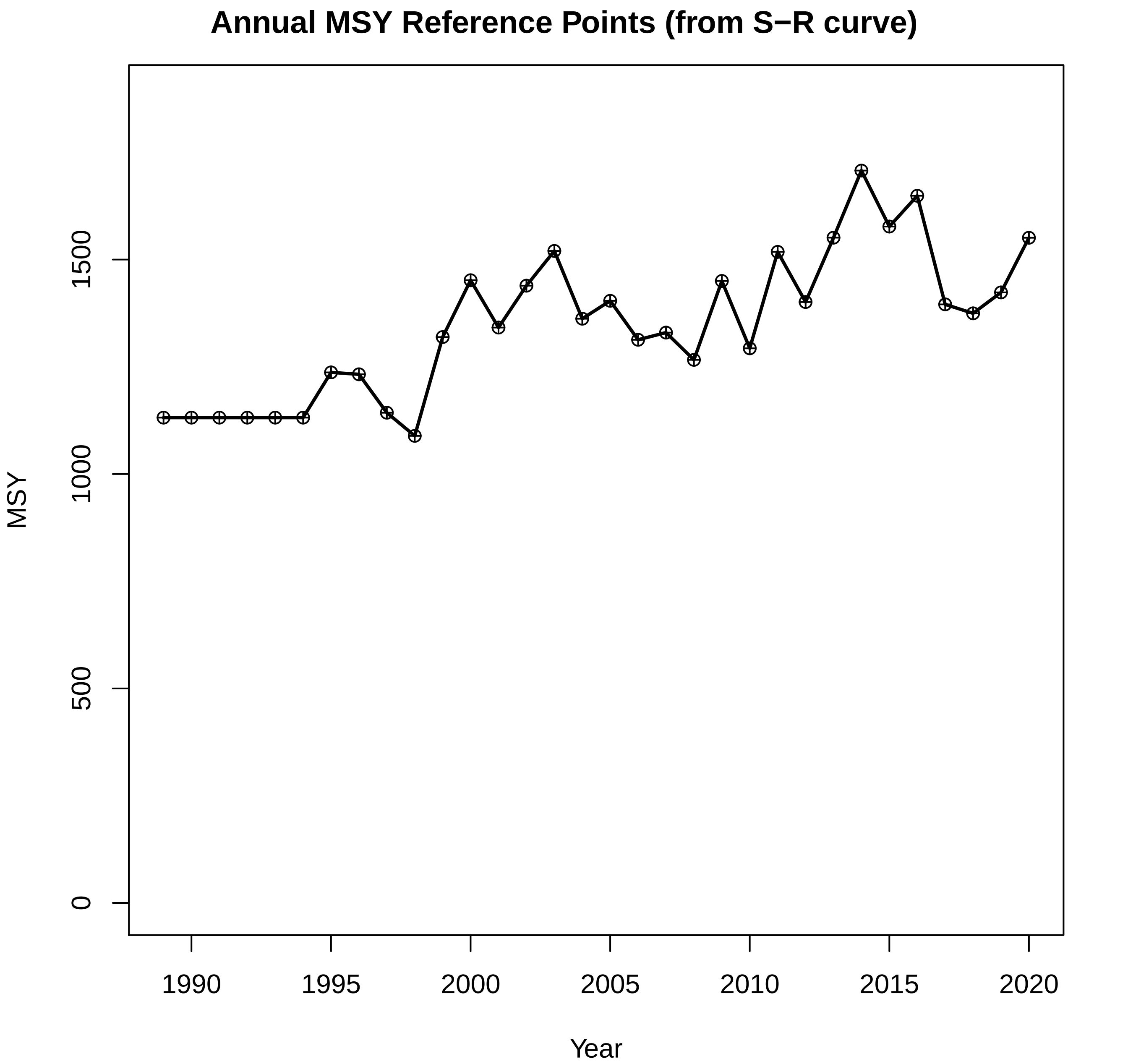



Annual MSY Reference Points (from S−R curve)
Frequency
Full F
0.11
0.12
0.13
0.14
0.15
SSB.MSY
11500
12000
12500
13000
MSY
1100
1300
1500
1700
R.MSY
6400
6800
7200

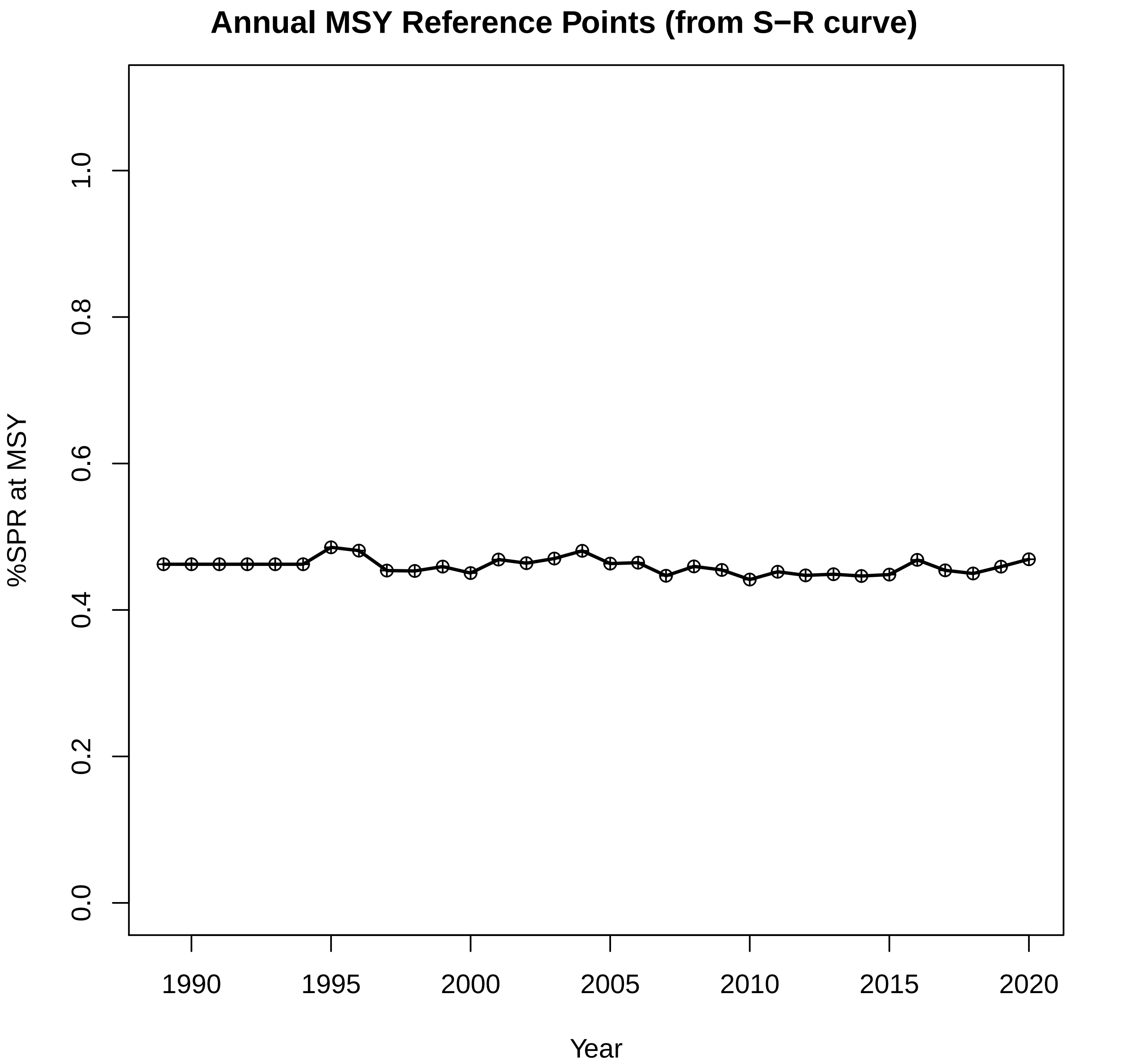

Annual MSY Reference Points (from S−R curve)
Frequency
0
5
10
15
20
25
30
0.5
0.6
0.7
0.8
0.9
1.0
steepness
Frequency
0
5
10
15
20
25
30
25000
35000
45000
SSB0
Frequency
0
2
4
6
8
10
12
0.45
0.46
0.47
0.48
SPR.MSY
Frequency
0
5
10
15
20
25
30
2500
3500
4500
5500
R0

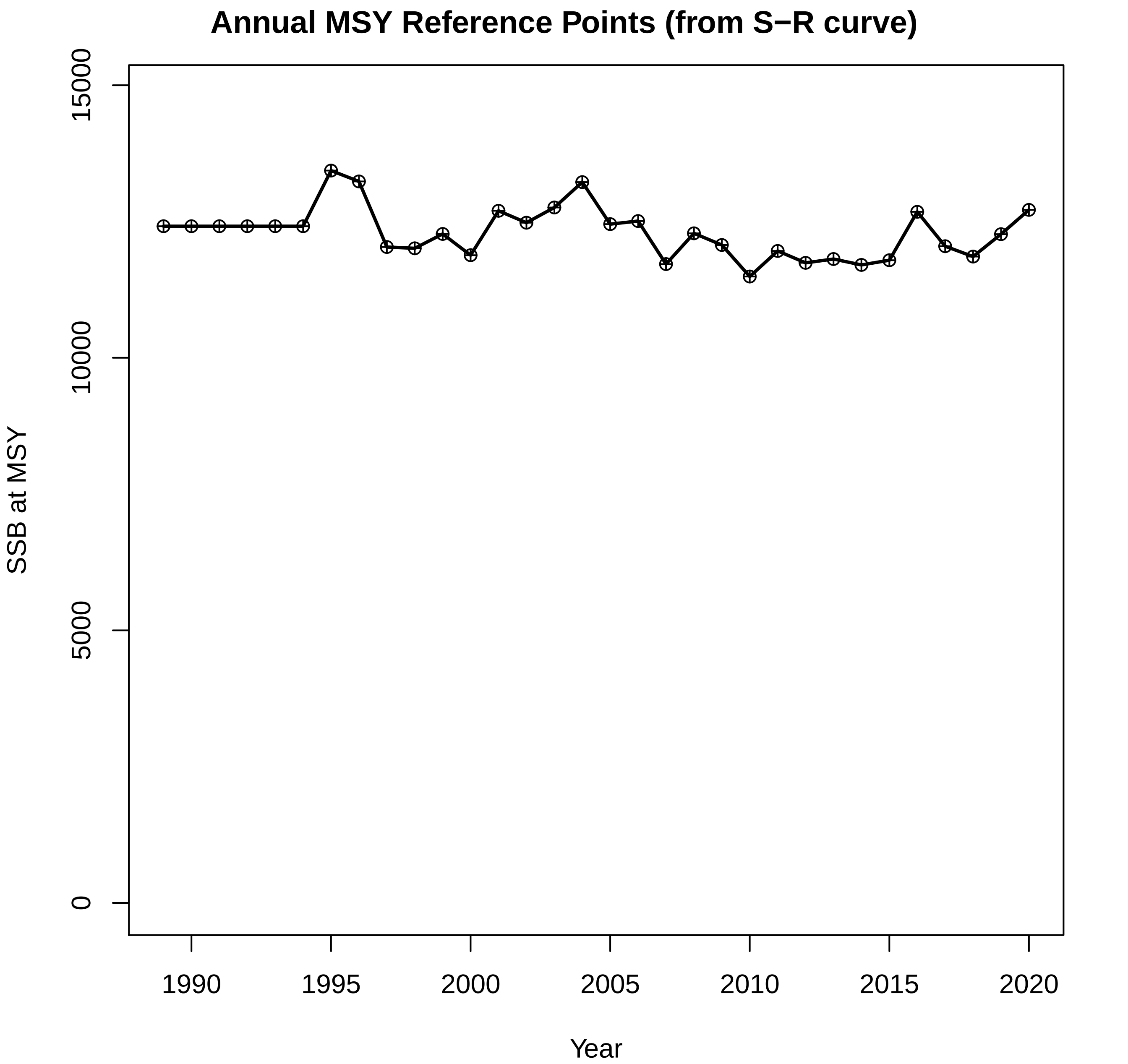

Annual Steepness and SPR.MSY (from S−R curve)
First Year
Last Year
1.0
0.8
0.6
0.4
0.2
0.0
SPR.MSY
0.2
0.4
0.6
0.8
1.0
Steepness

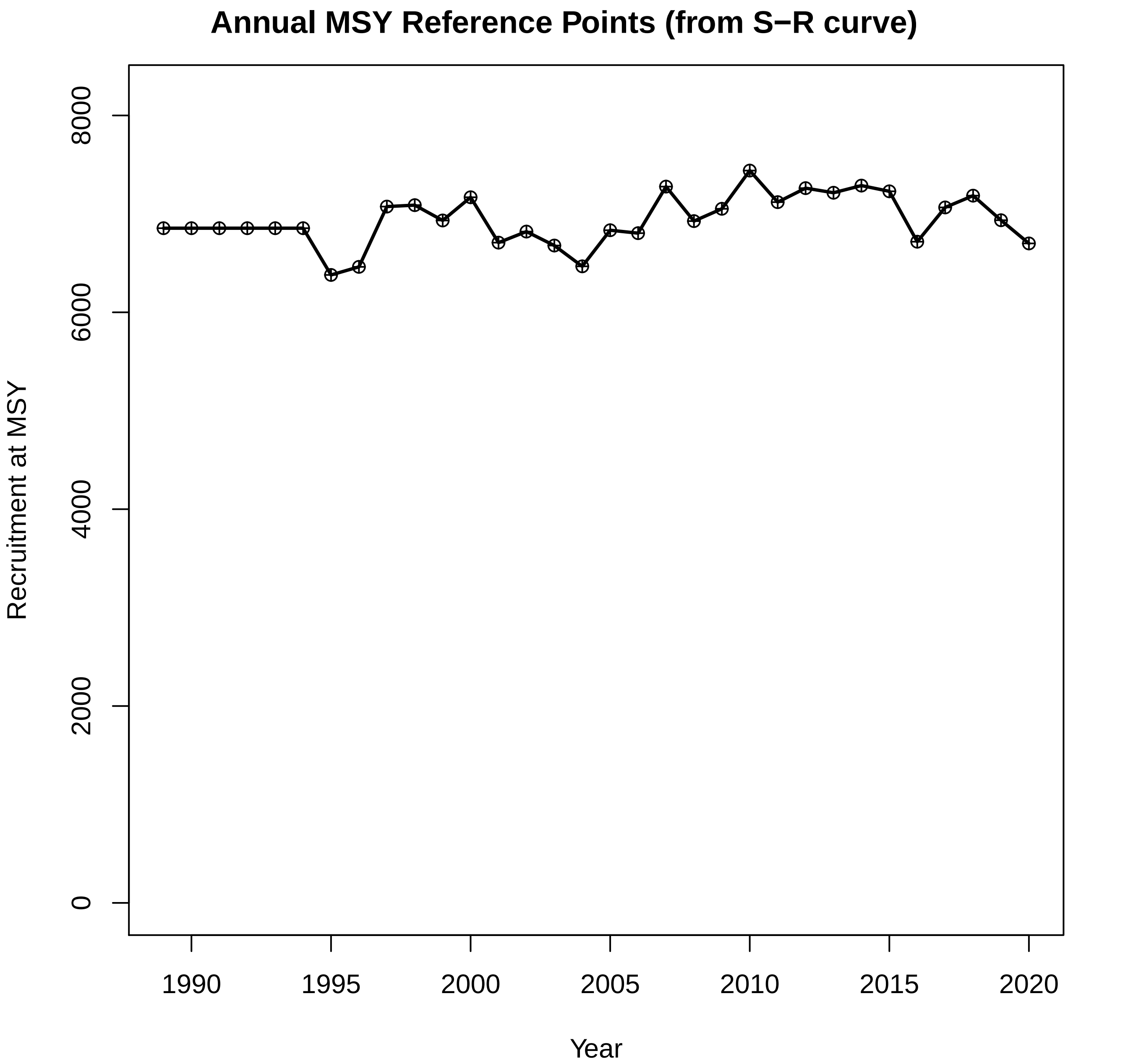

Annual MSY Reference Points (from S−R curve)
Full F at MSY
0.00
0.05
0.10
0.15
Year
1990
1995
2000
2005
2010
2015
2020

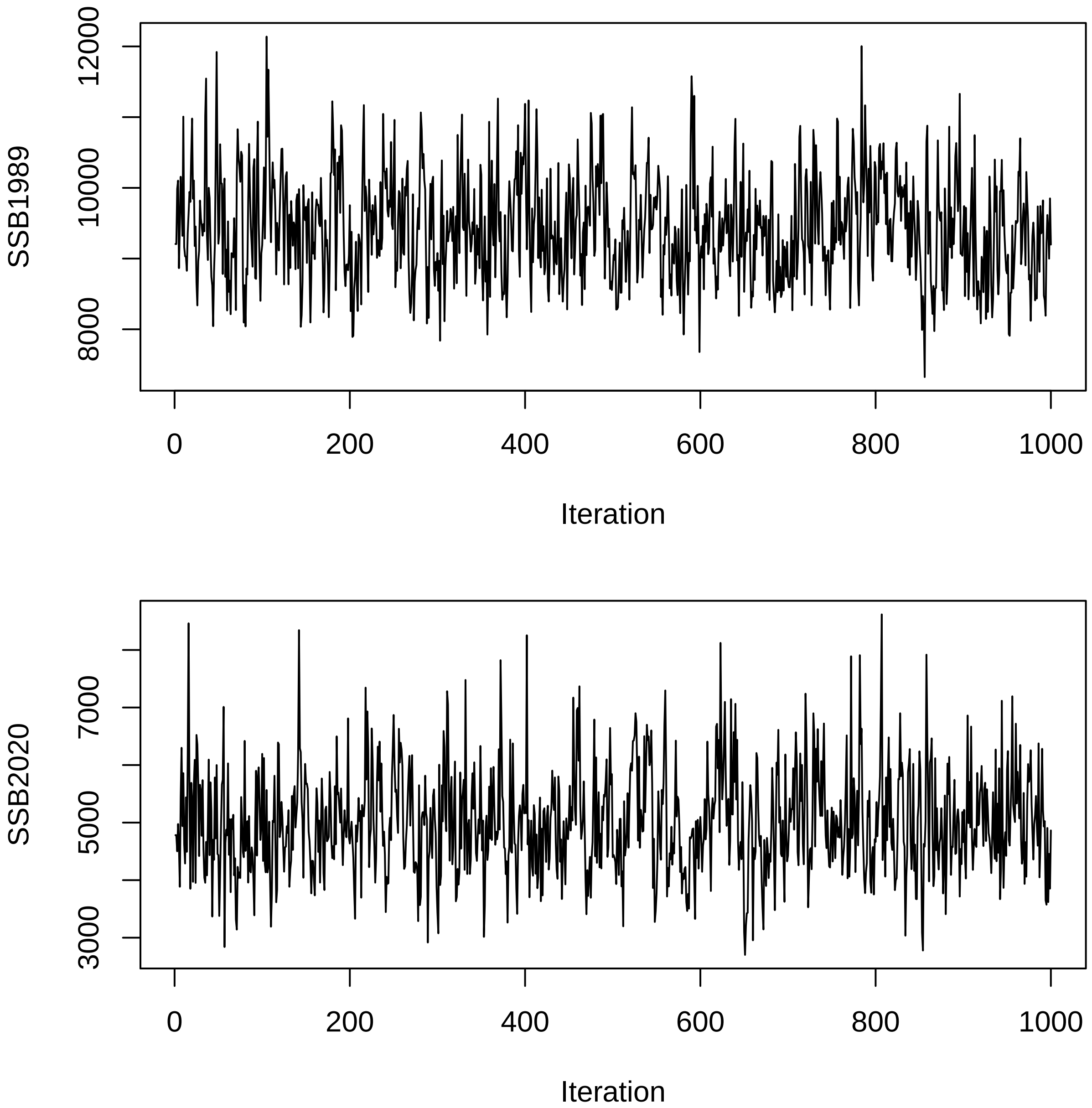


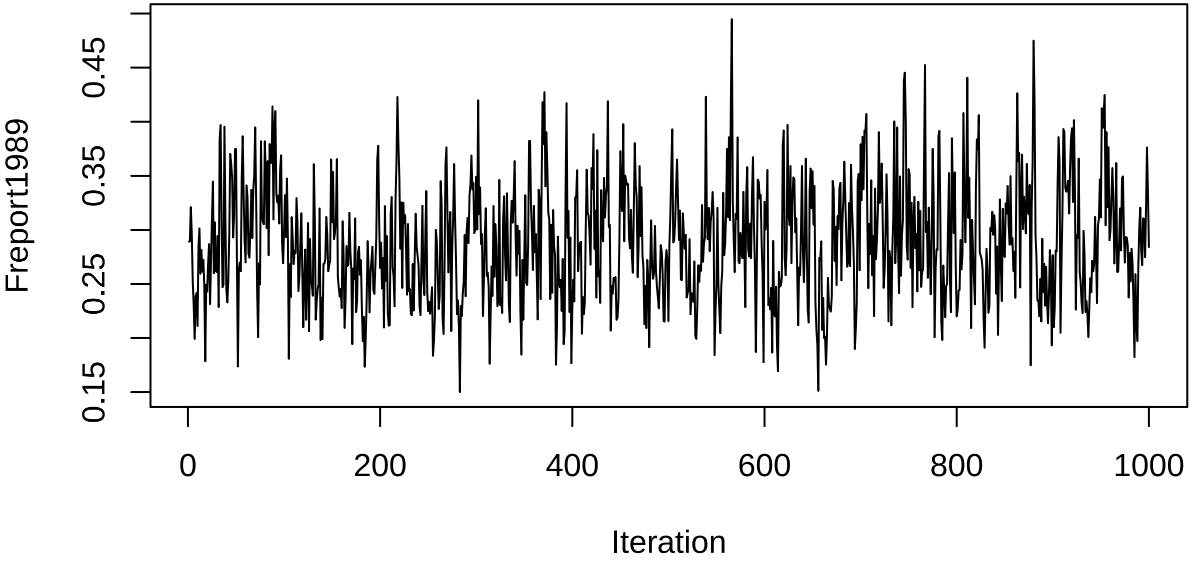
Annual MSY Reference Points (from S−R curve)
MSY
0
500
1000
1500
1990
1995
2000
2005
2010
2015
2020
Year

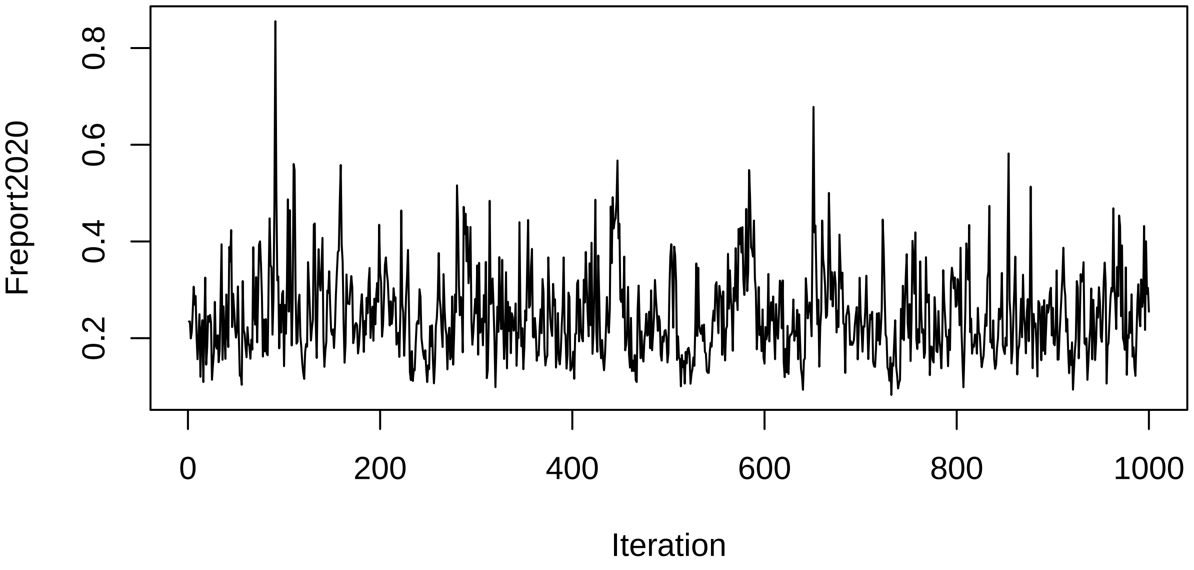

Annual MSY Reference Points (from S−R curve)
%SPR at MSY
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
2015
2020
Year

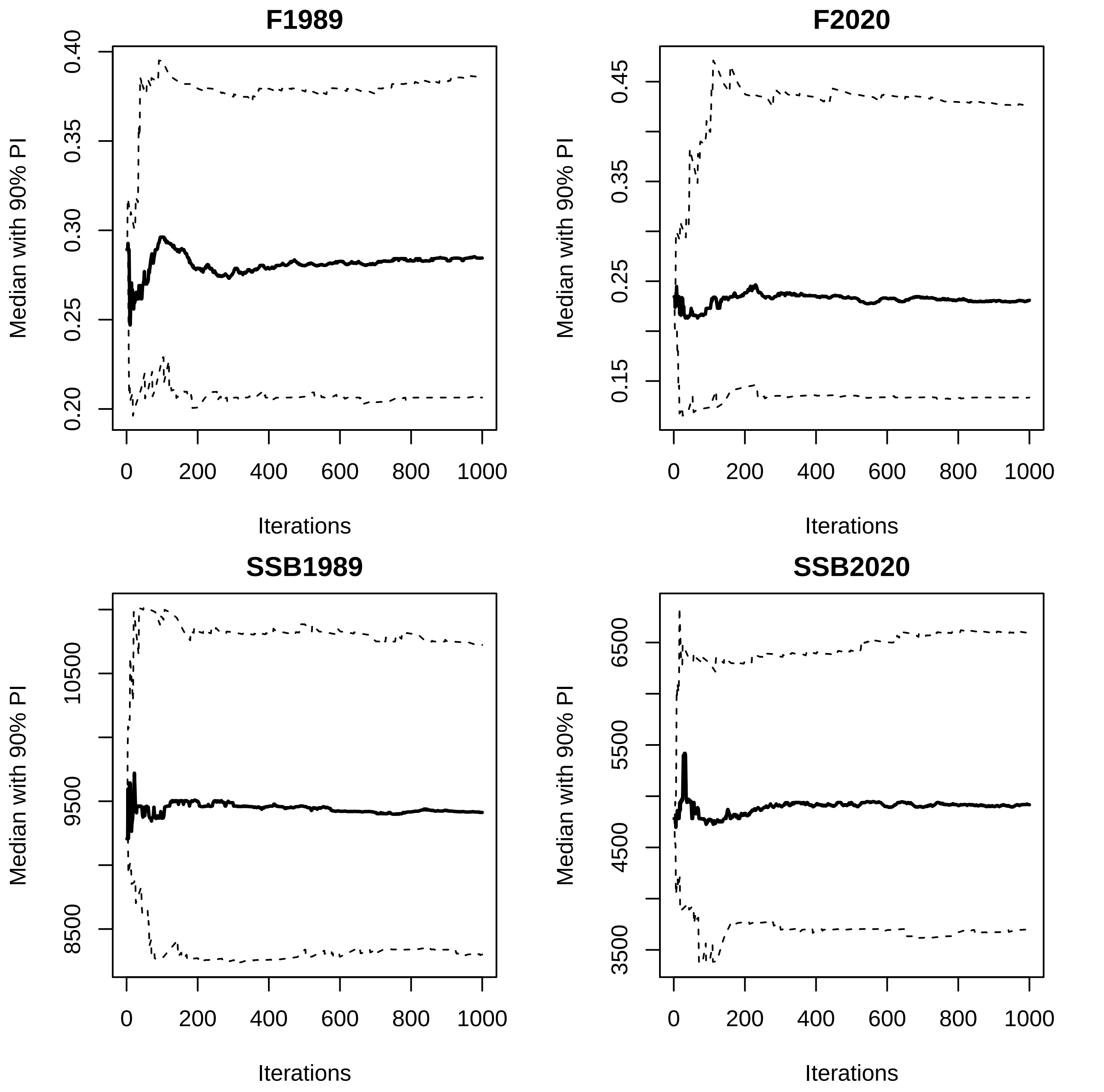

Annual MSY Reference Points (from S−R curve)
SSB at MSY
Year
0
5000
10000
15000
1990
1995
2000
2005
2010
2015
2020

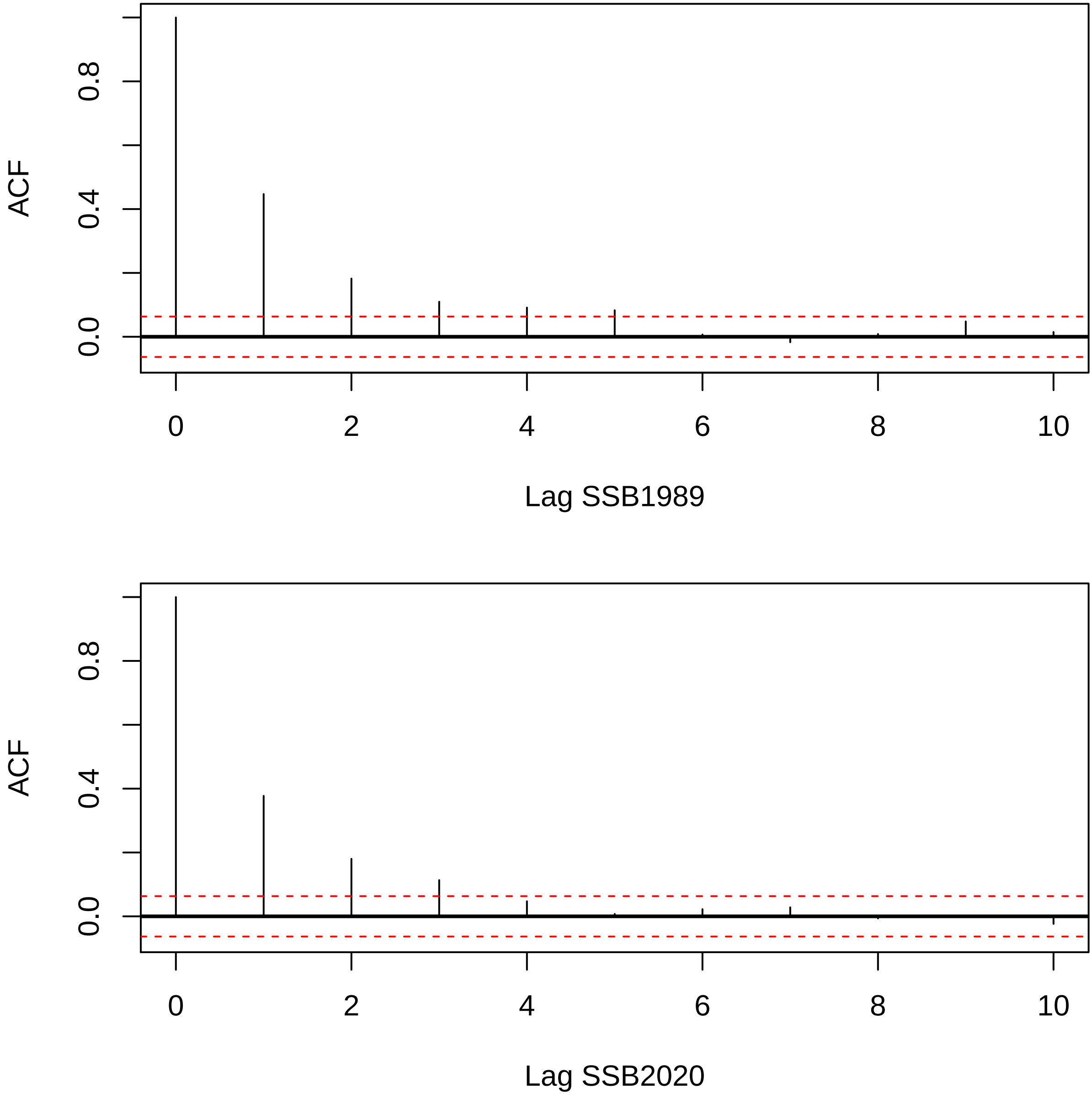

Annual MSY Reference Points (from S−R curve)
Recruitment at MSY
0
2000
4000
6000
8000
1990
1995
2000
2005
2010
2015
2020
Year

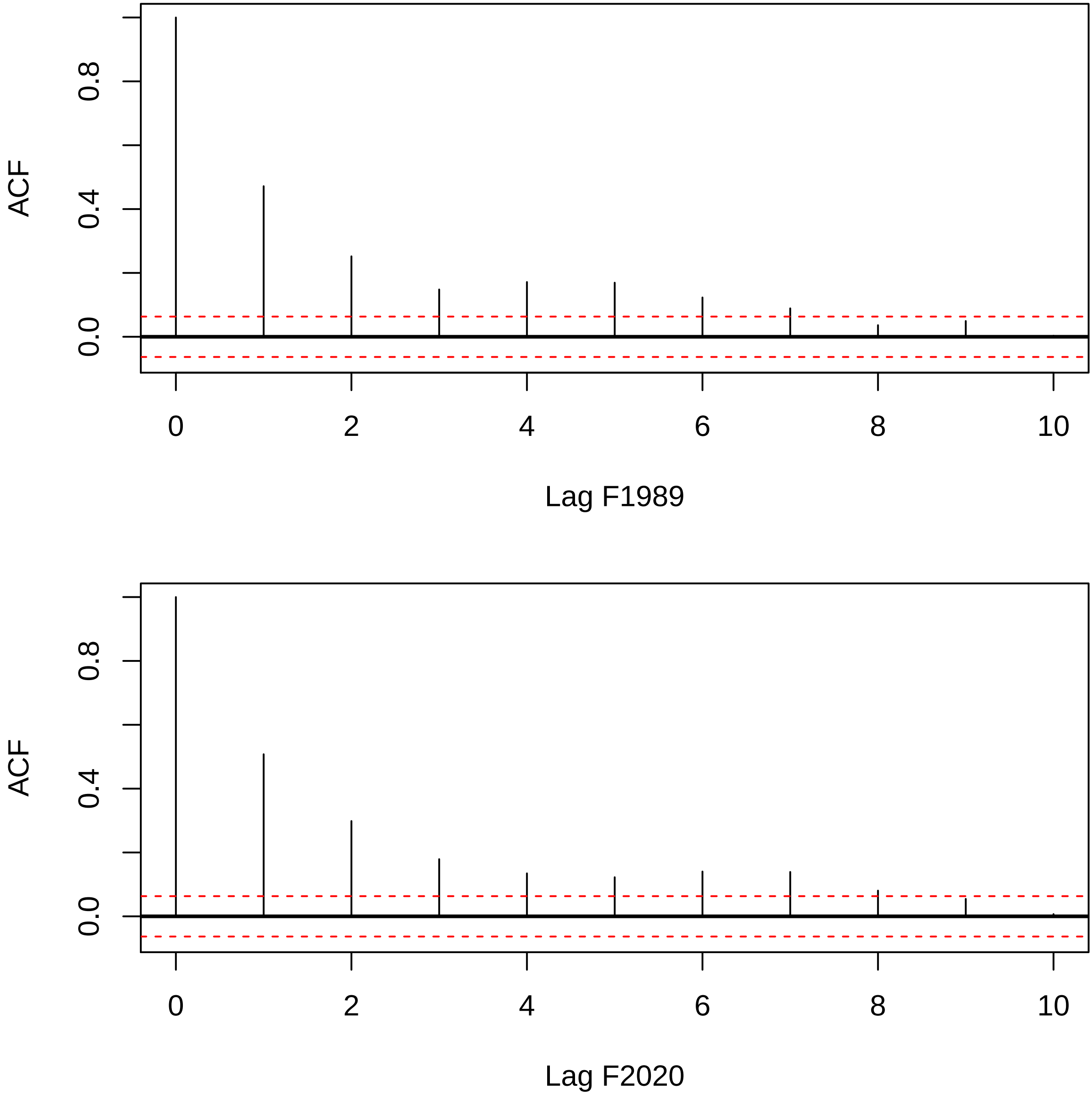

SSB1989
8000
10000
12000
0
200
400
600
800
1000
Iteration
SSB2020
3000
5000
7000
0
200
400
600
800
1000
Iteration

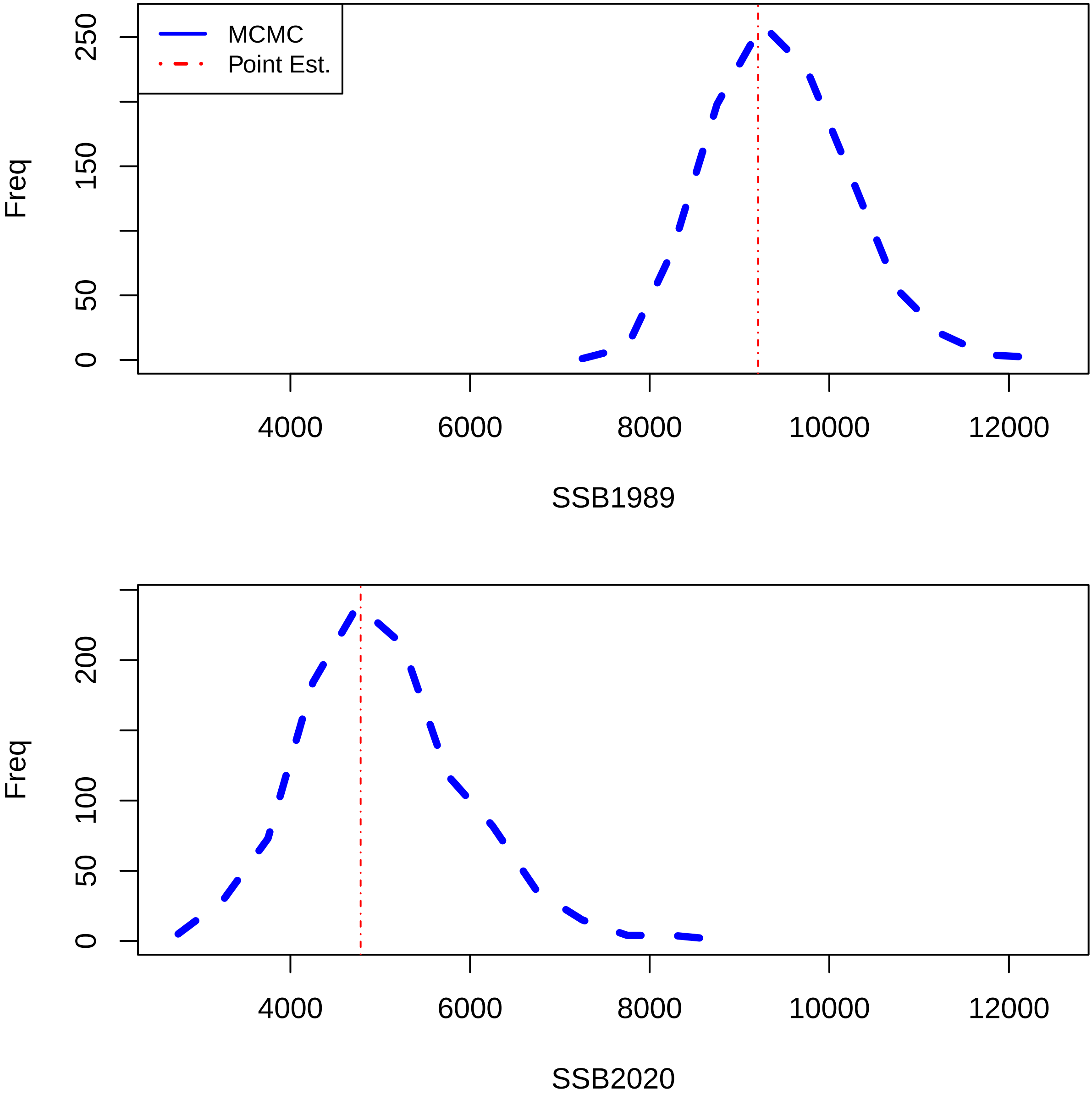

Freport1989
0.15
0.25
0.35
0.45
0
200
400
600
800
1000
Iteration

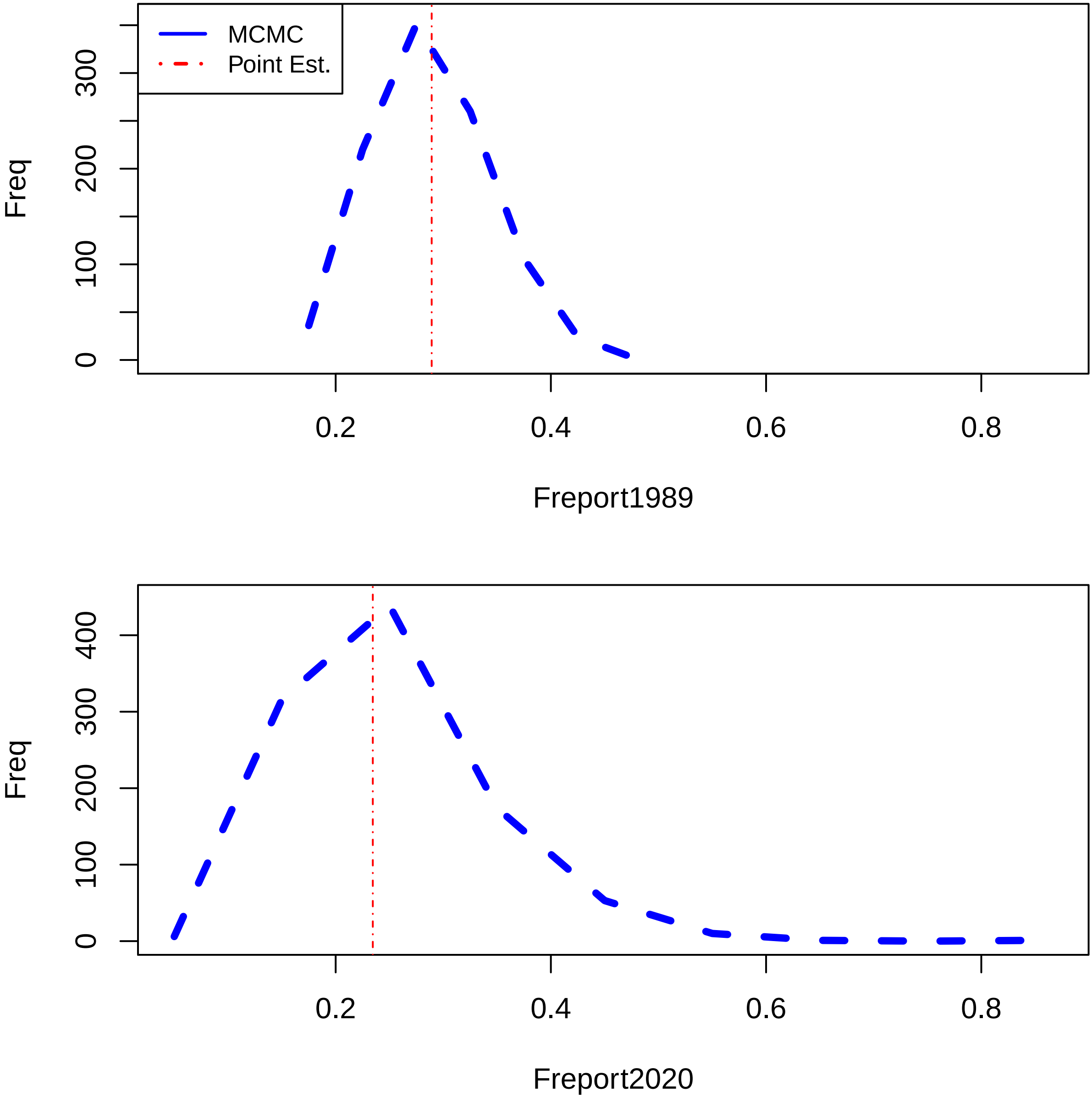

Freport2020
0.2
0.4
0.6
0.8
0
200
400
600
800
1000
Iteration

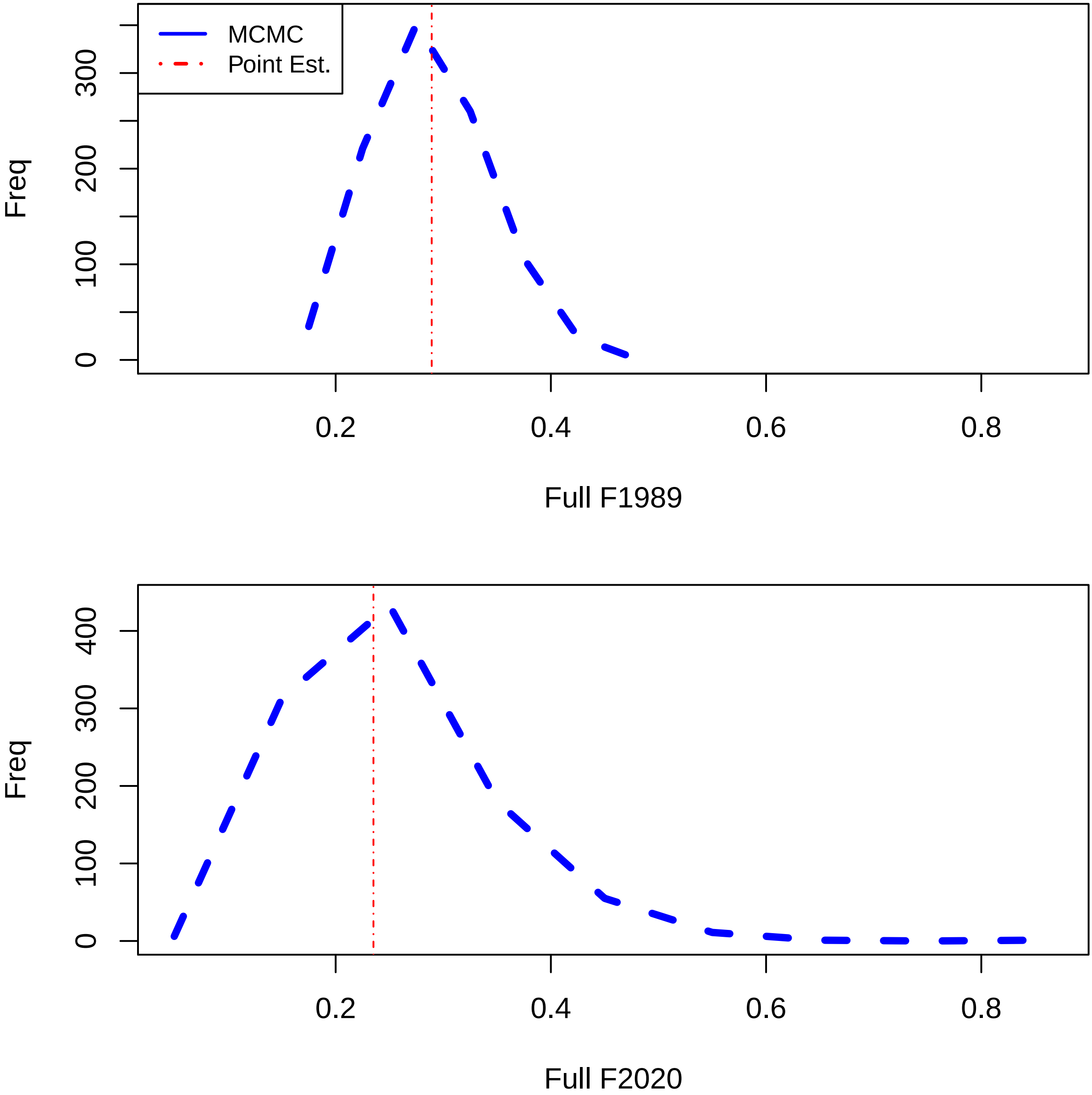

F1989
F2020
SSB1989
SSB2020
Median with 90% PI
Iterations
0
200
400
600
800
1000
0.20
0.25
0.30
0.35
0.40
0.15
0.25
0.35
0.45
8500
9500
10500
3500
4500
5500
6500

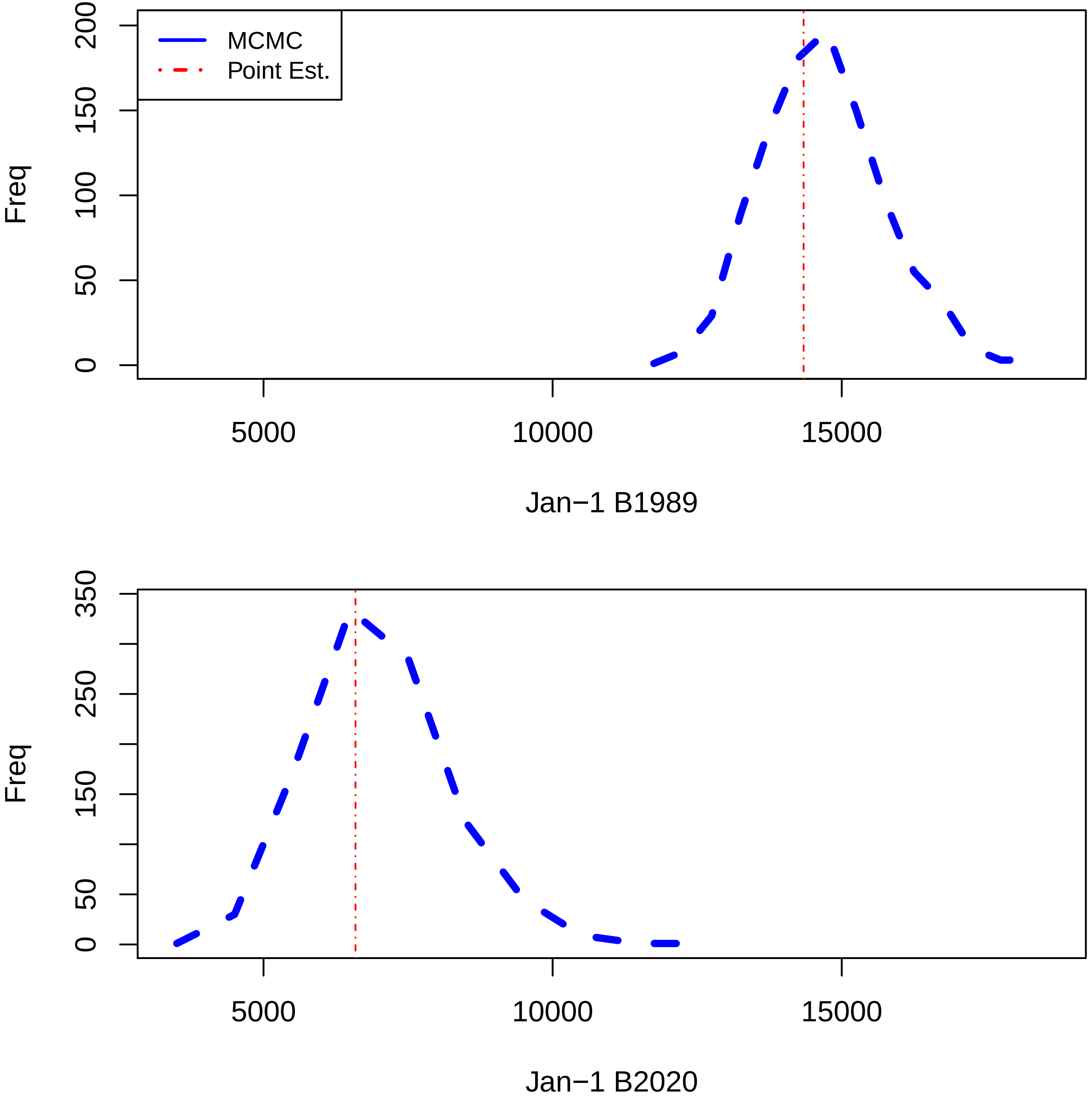

ACF
0.0
0.4
0.8
0
2
4
6
8
10
Lag SSB1989
ACF
0.0
0.4
0.8
0
2
4
6
8
10
Lag SSB2020

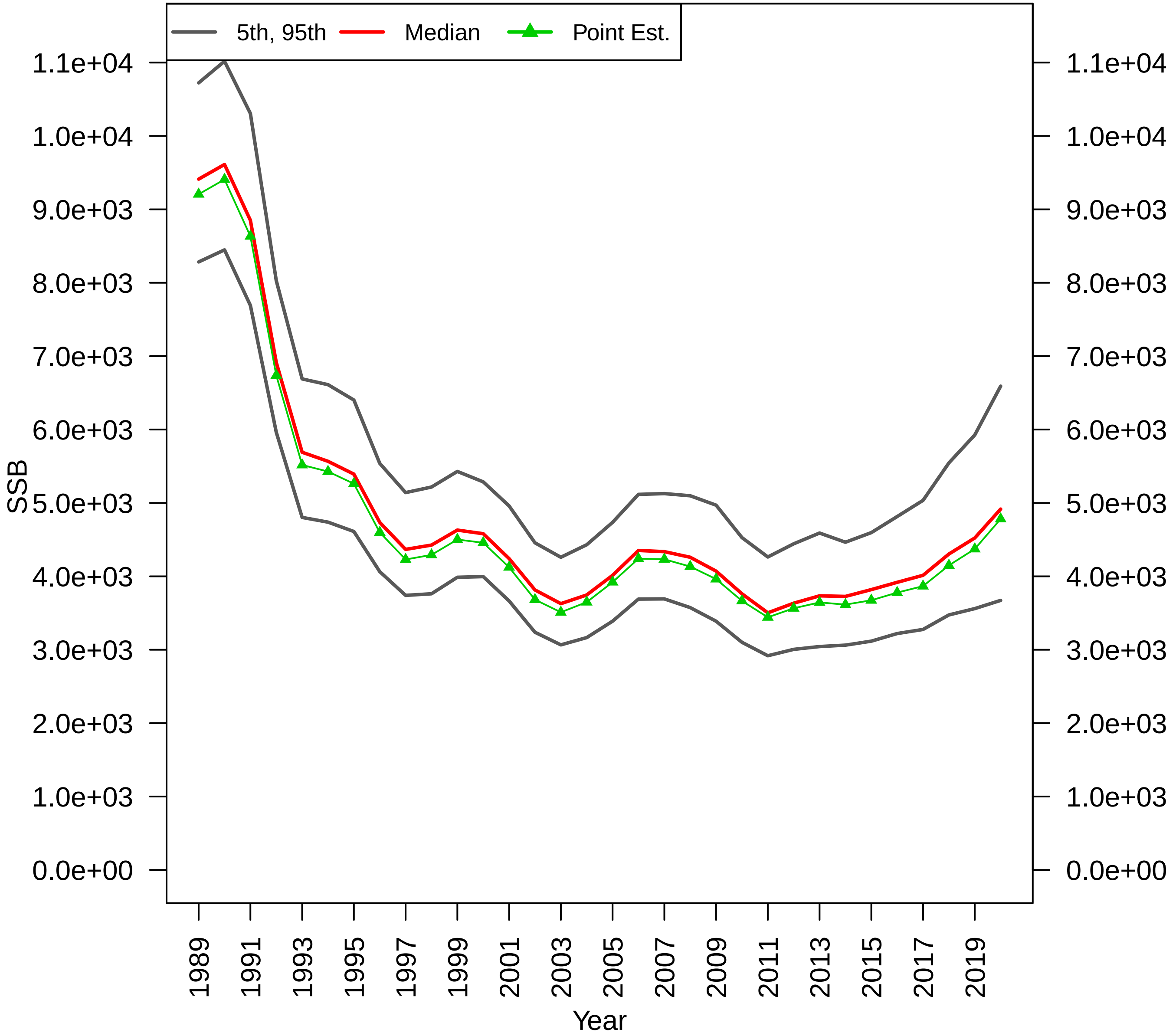

ACF
0.0
0.4
0.8
0
2
4
6
8
10
Lag F1989
ACF
0.0
0.4
0.8
0
2
4
6
8
10
Lag F2020


MCMC
Point Est.
250
150
50
0
Freq
4000
6000
8000
10000
12000
SSB1989
200
100
50
0
Freq
4000
6000
8000
10000
12000
SSB2020

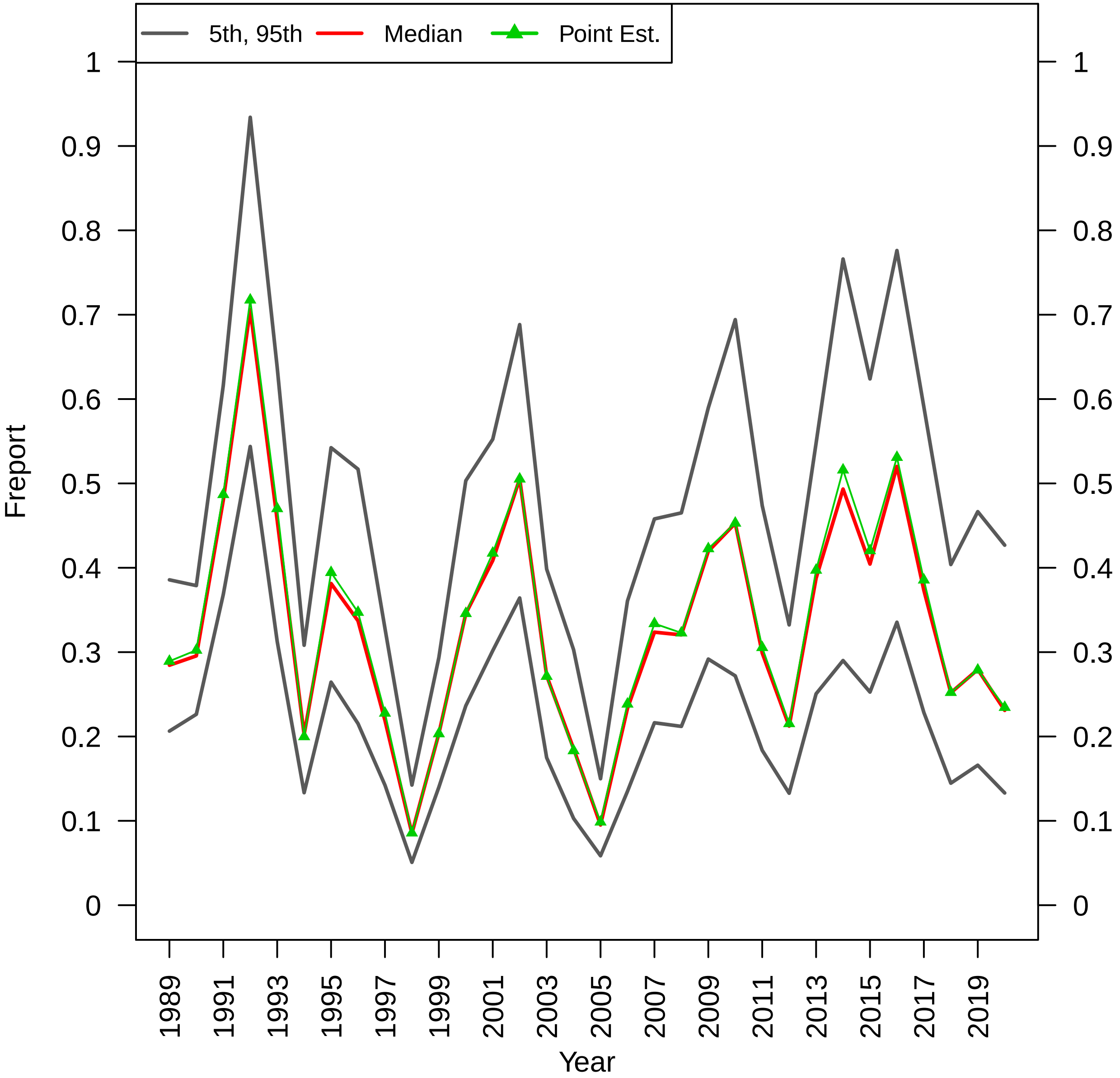

MCMC
Point Est.
Freq
0
100
200
300
0.2
0.4
0.6
0.8
Freport1989
Freq
0
100
200
300
400
0.2
0.4
0.6
0.8
Freport2020

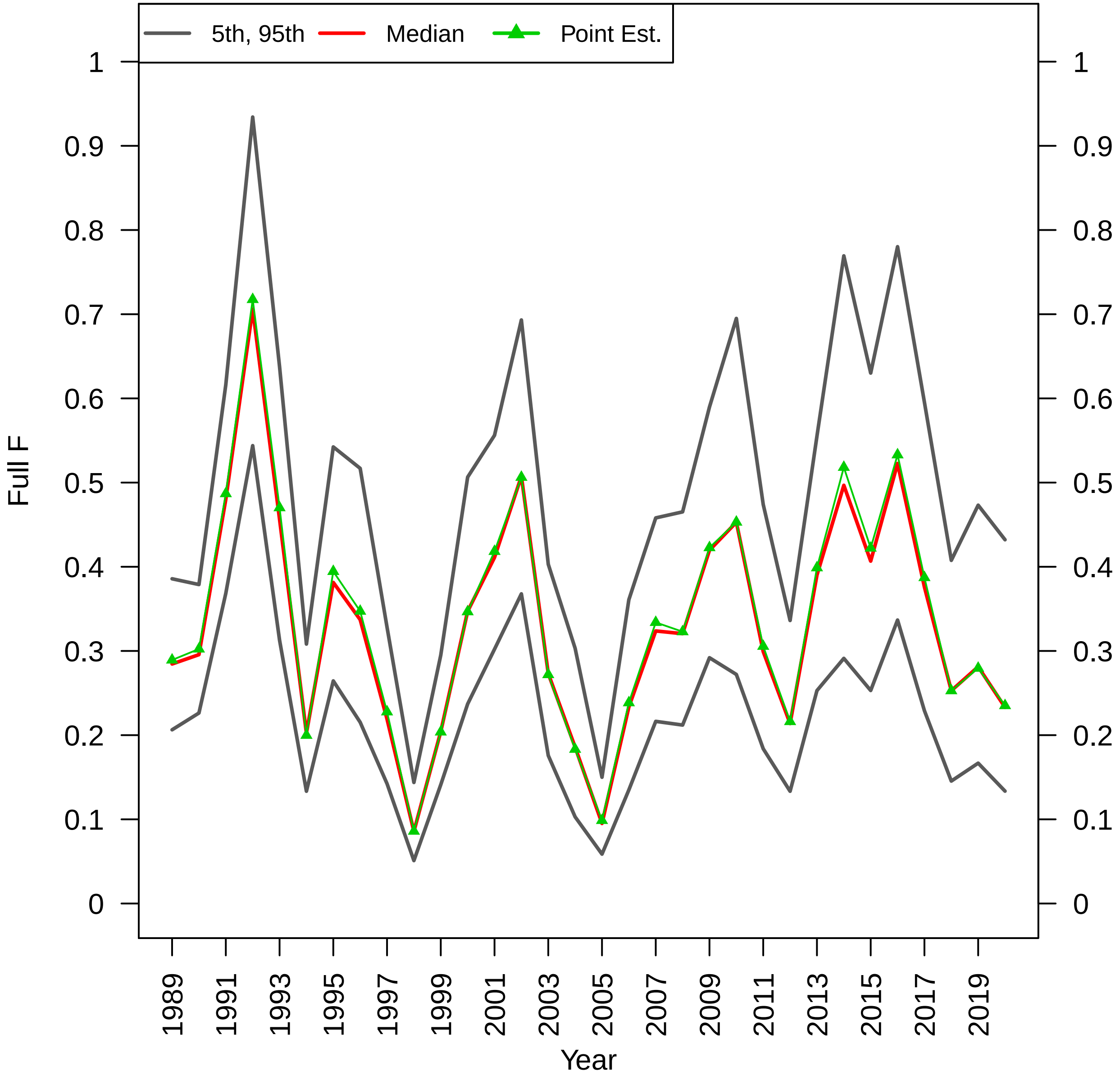

MCMC
Point Est.
Freq
0
100
200
300
0.2
0.4
0.6
0.8
Full F1989
Freq
0
100
200
300
400
0.2
0.4
0.6
0.8
Full F2020

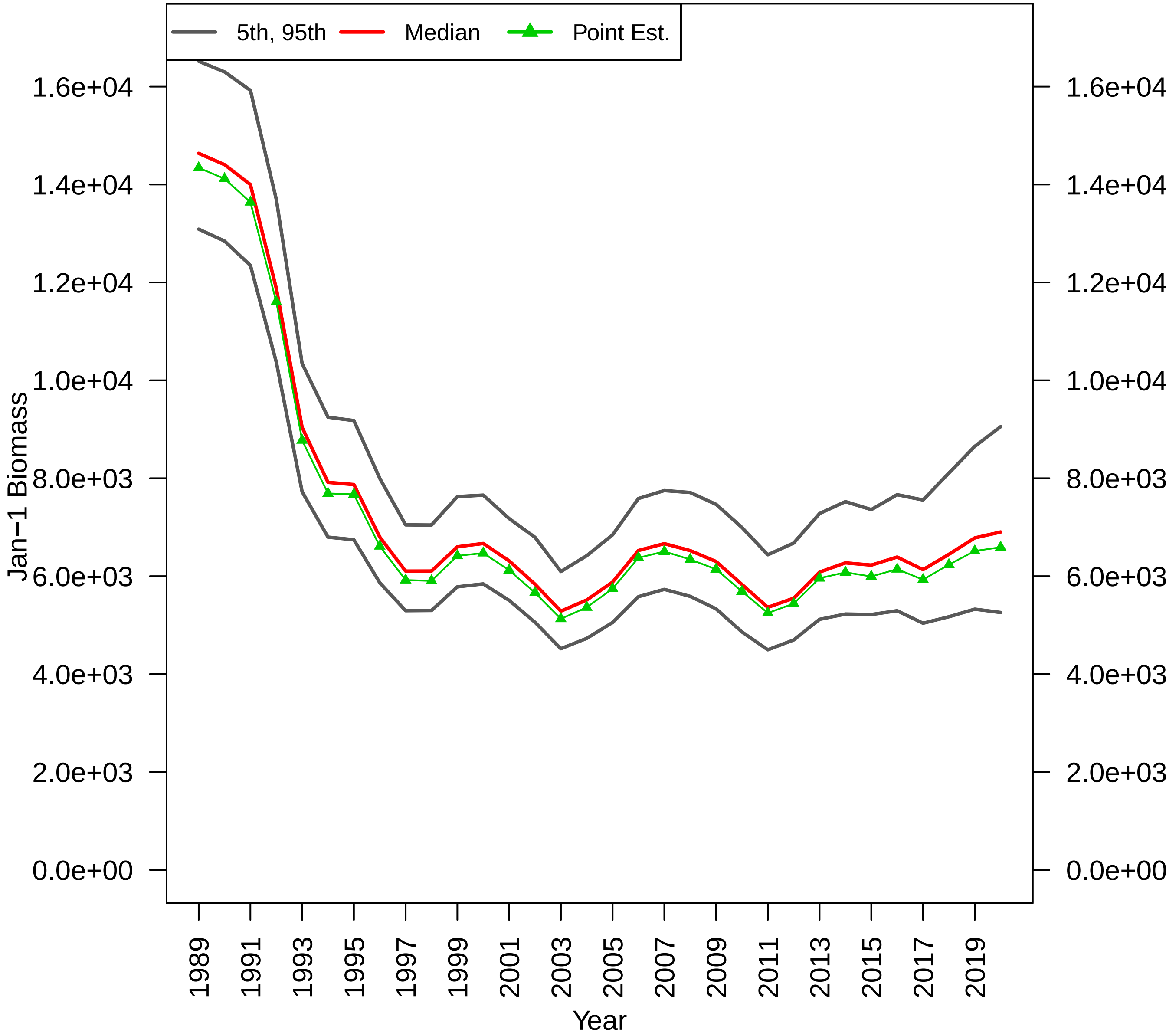

MCMC
Point Est.
Freq
0
50
100
150
200
5000
10000
15000
Jan−1 B1989
Freq
0
50
150
250
350
5000
10000
15000
Jan−1 B2020



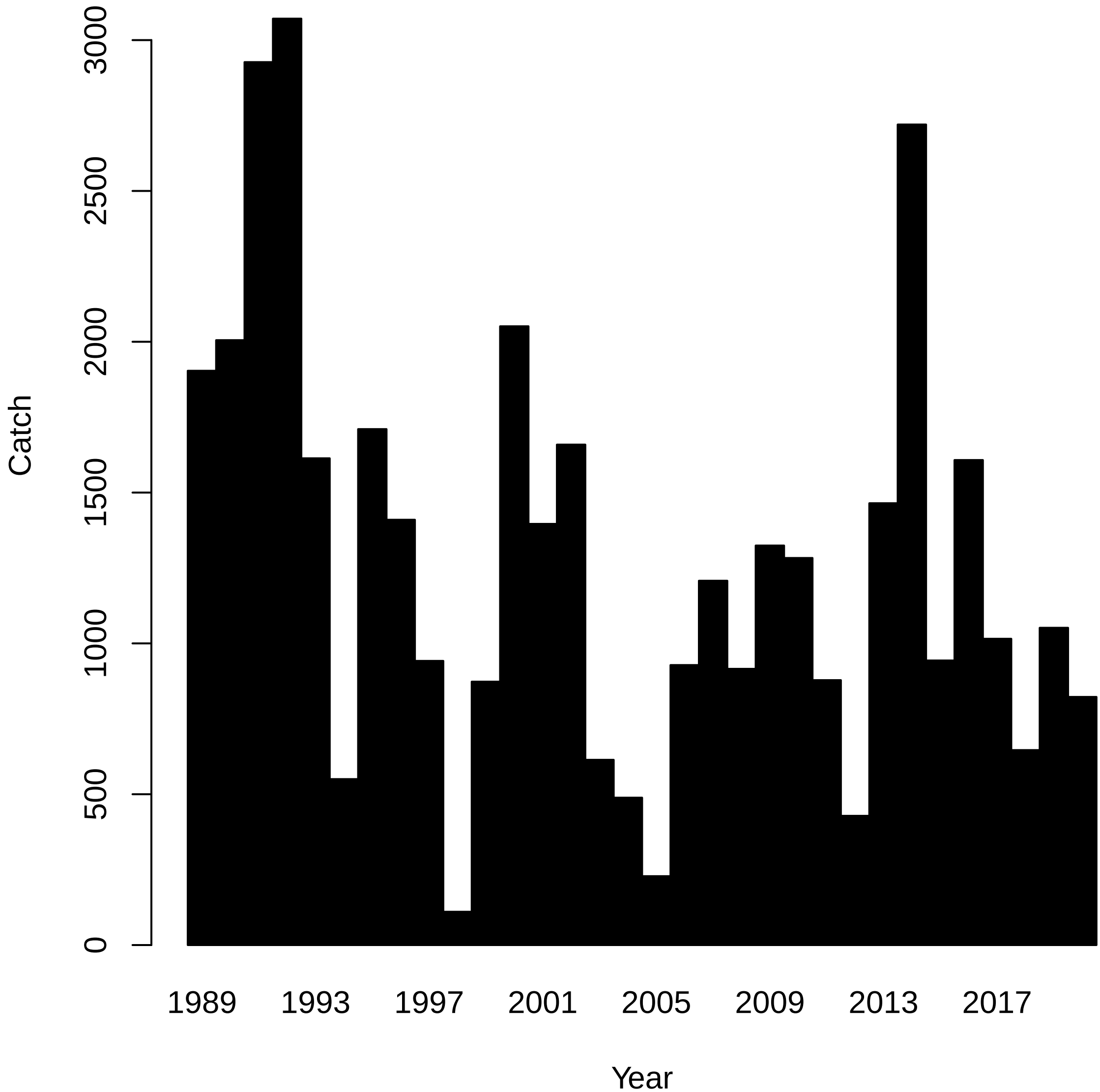
5th, 95th
Median
Point Est.
SSB
Year
1.1e+04
1.0e+04
9.0e+03
8.0e+03
7.0e+03
6.0e+03
5.0e+03
4.0e+03
3.0e+03
2.0e+03
1.0e+03
0.0e+00
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019


5th, 95th
Median
Point Est.
Freport
Year
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019

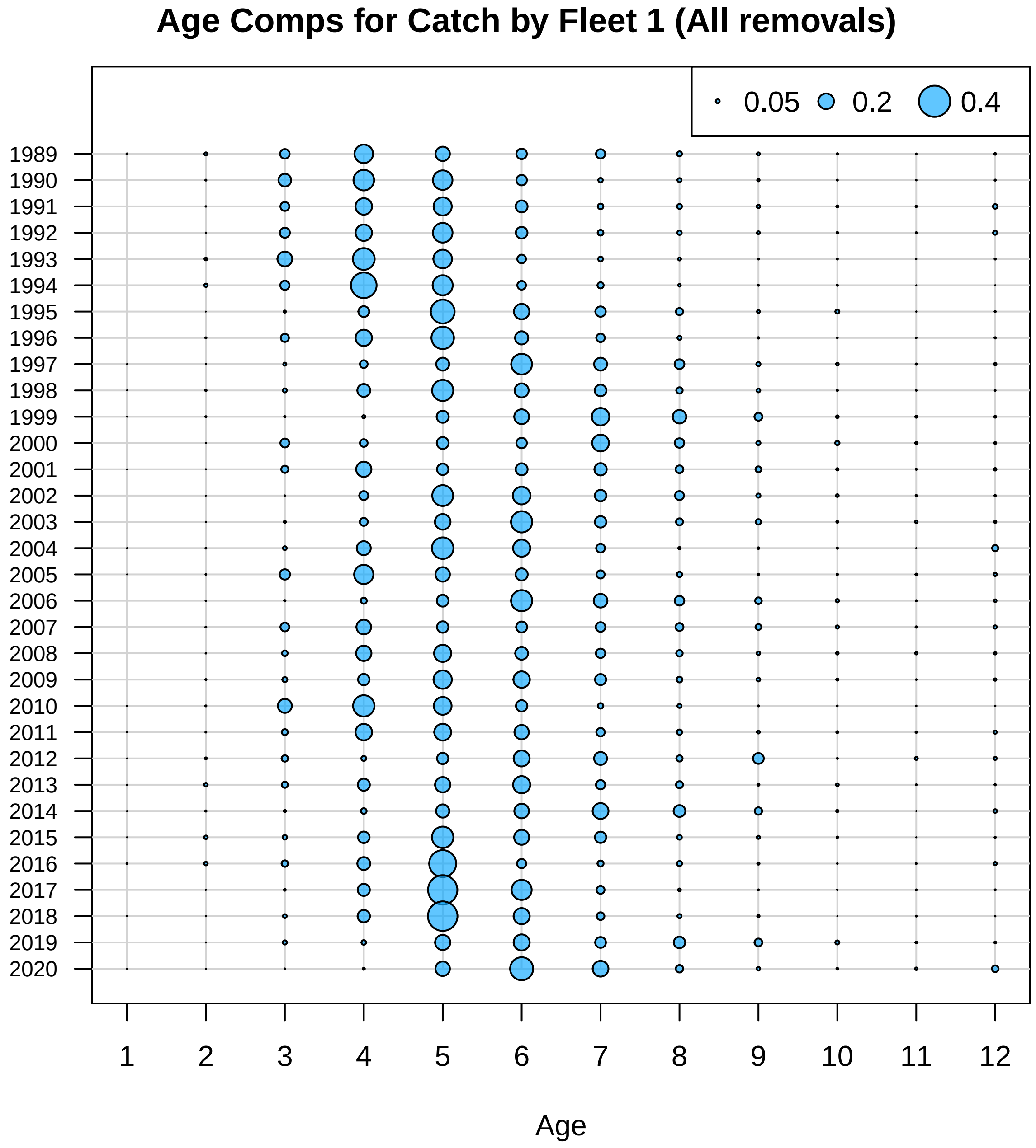

5th, 95th
Median
Point Est.
Full F
Year
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019

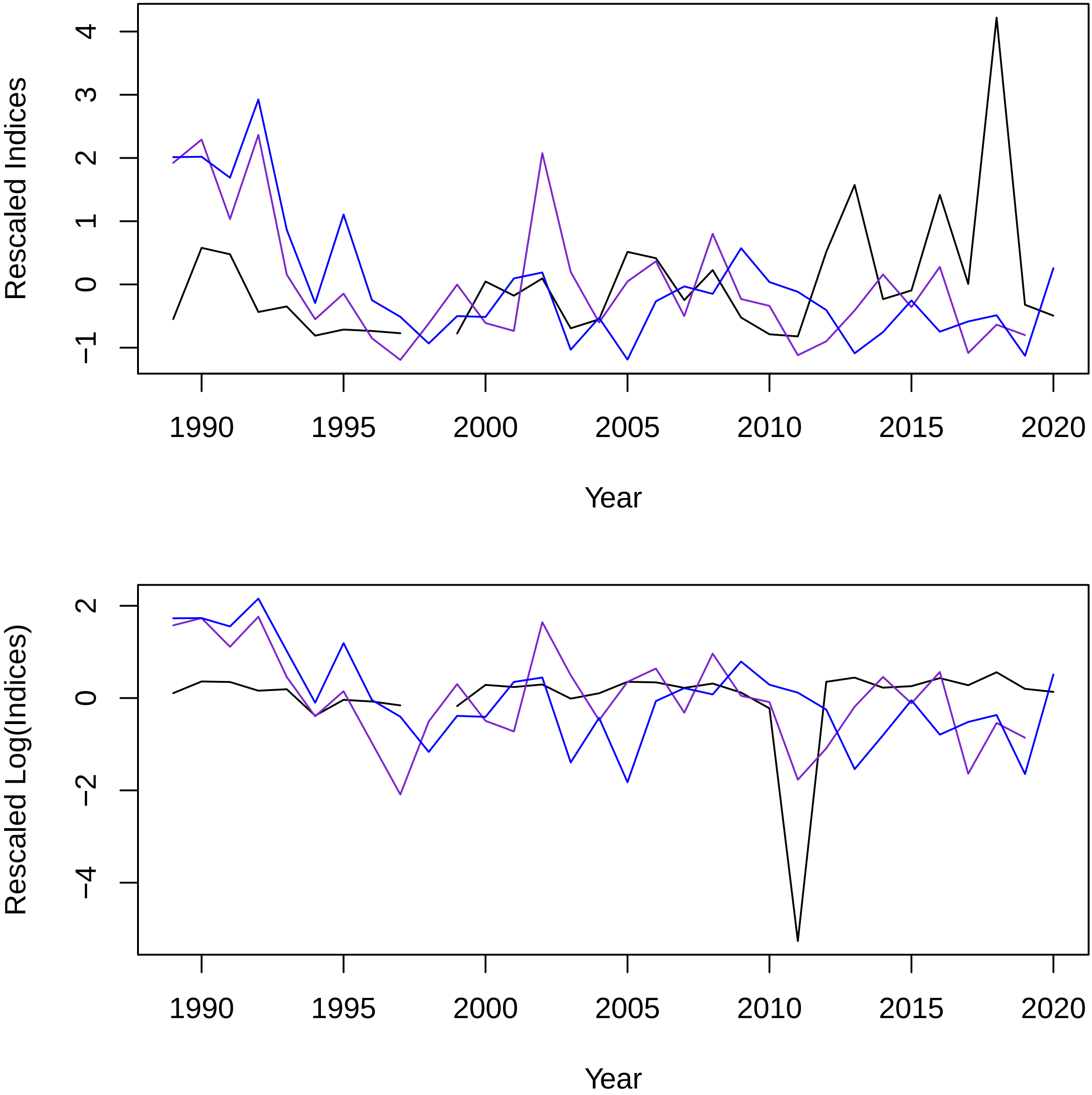


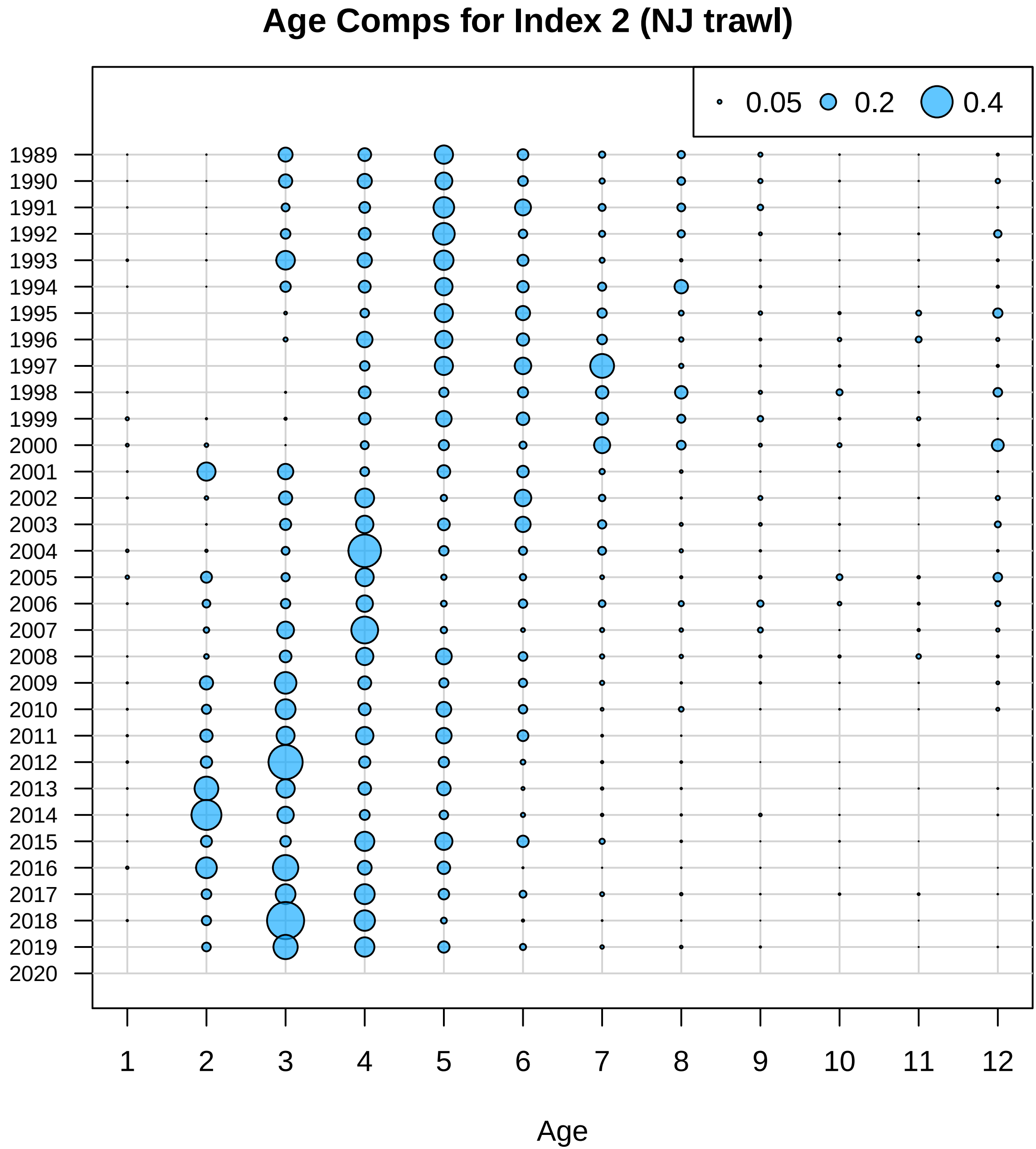
5th, 95th
Median
Point Est.
Jan−1 Biomass
1.6e+04
1.4e+04
1.2e+04
1.0e+04
8.0e+03
6.0e+03
4.0e+03
2.0e+03
0.0e+00
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year

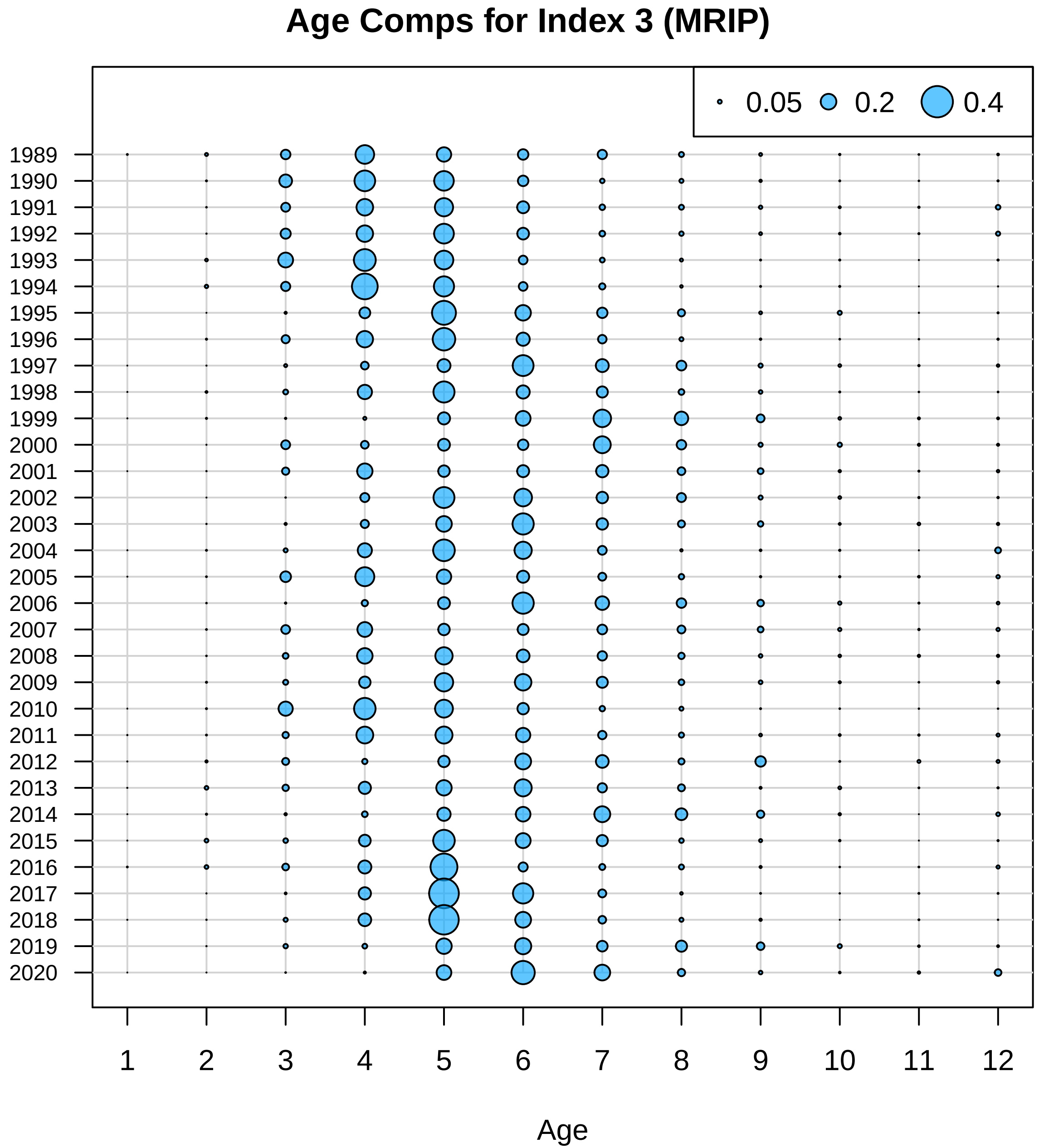


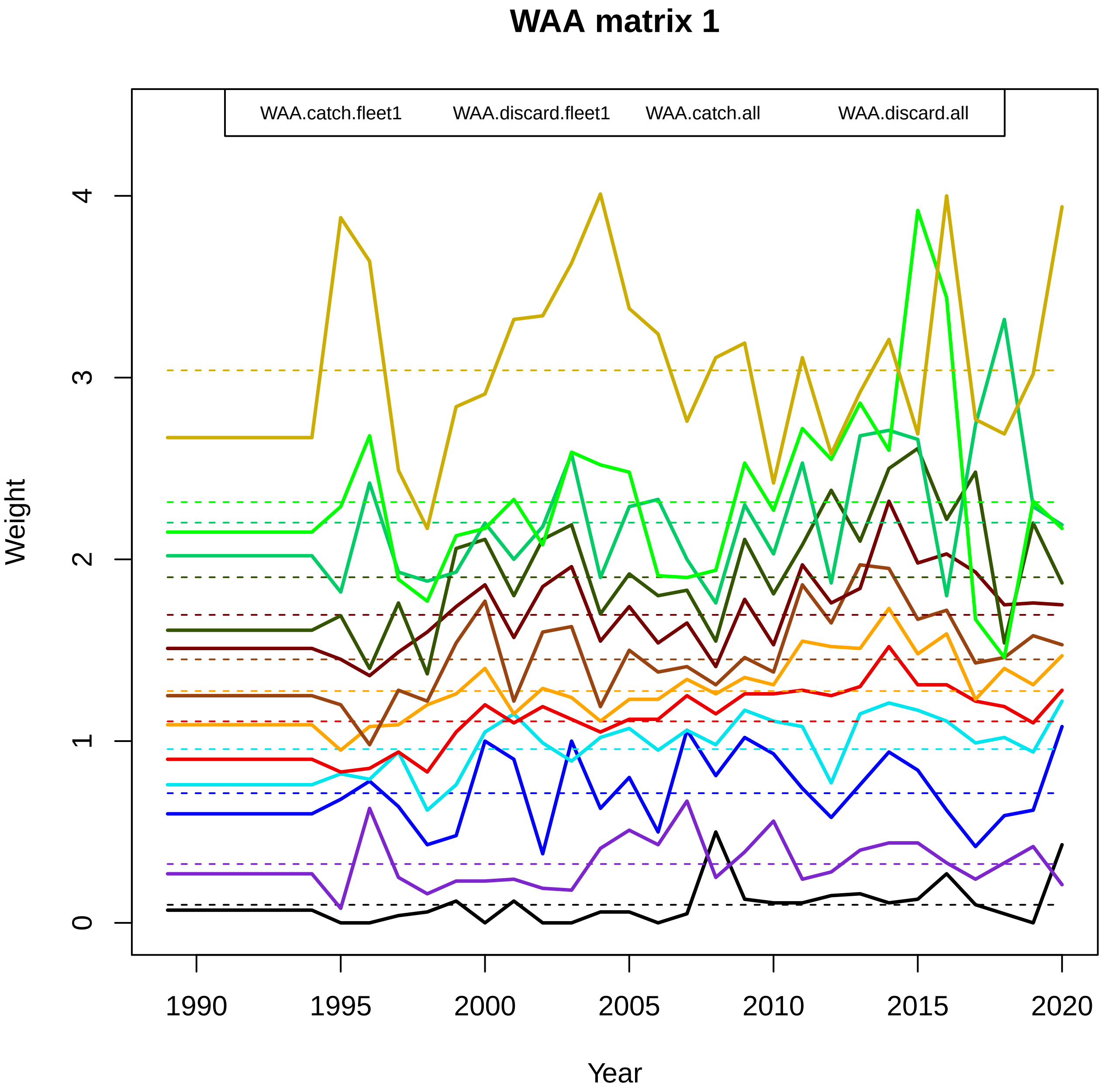
Catch
0
500
1000
1500
2000
2500
3000
1989
1993
1997
2001
2005
2009
2013
2017
Year


Age Comps for Catch by Fleet 1 (All removals)
0.05
0.2
0.4
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
1
2
3
4
5
6
7
8
9
10
11
12
Age

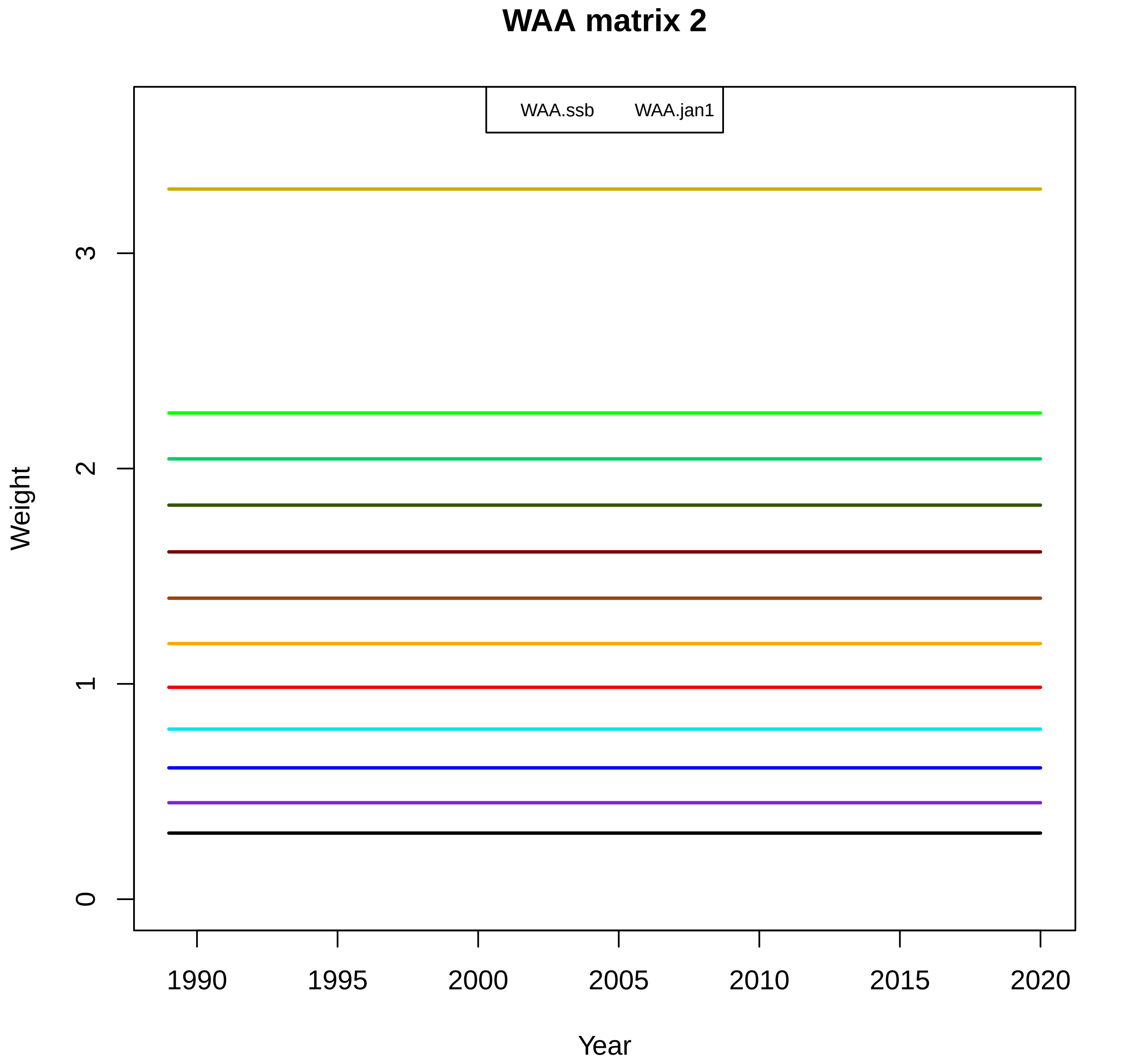

Rescaled Indices
4
3
2
1
0
−1
1990
1995
2000
2005
2010
2015
2020
Year
Rescaled Log(Indices)
2
0
−2
−4
1990
1995
2000
2005
2010
2015
2020
Year


Age Comps for Index 2 (NJ trawl)
0.05
0.2
0.4
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
1
2
3
4
5
6
7
8
9
10
11
12
Age

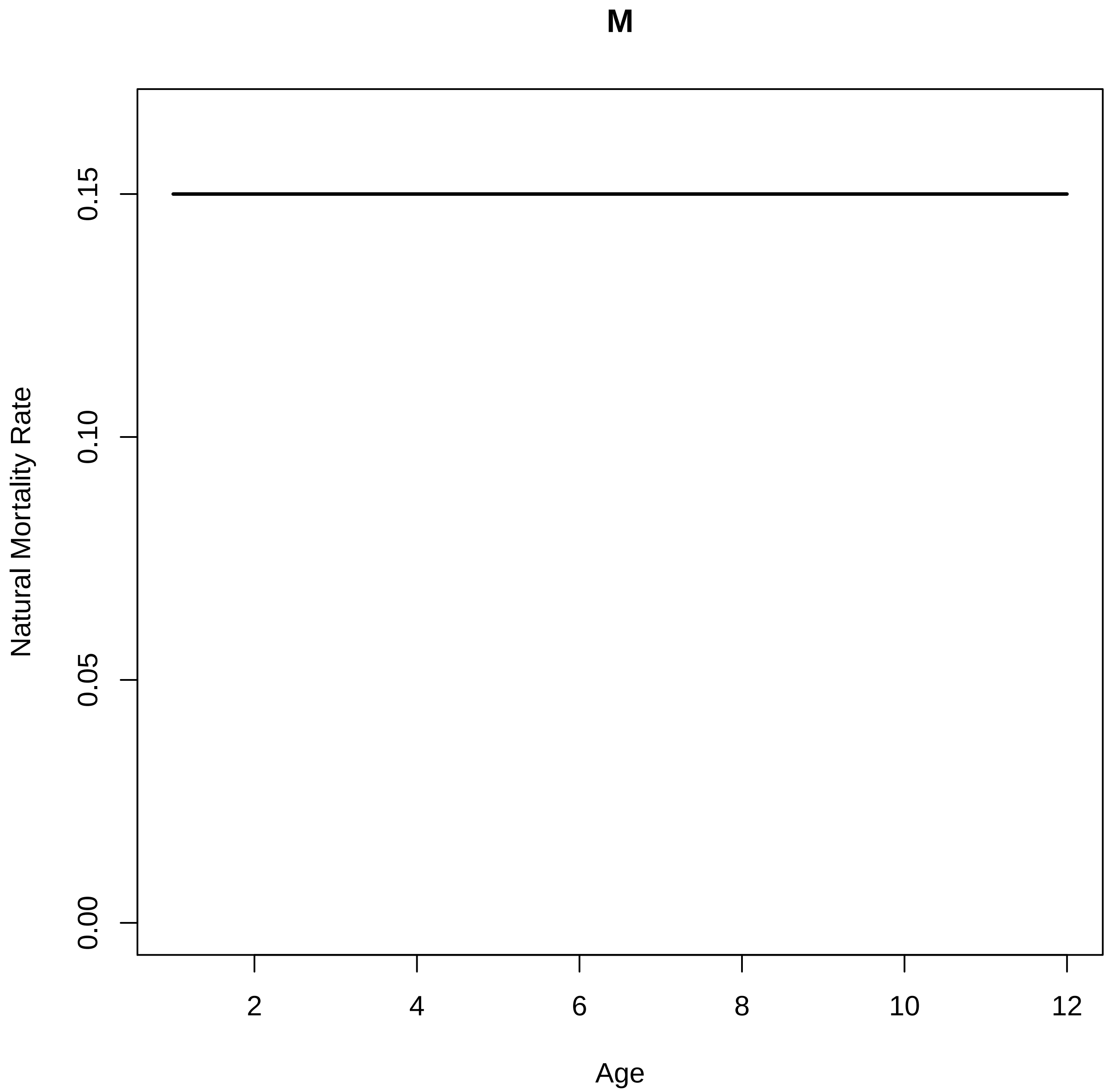

Age Comps for Index 3 (MRIP)
0.05
0.2
0.4
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age

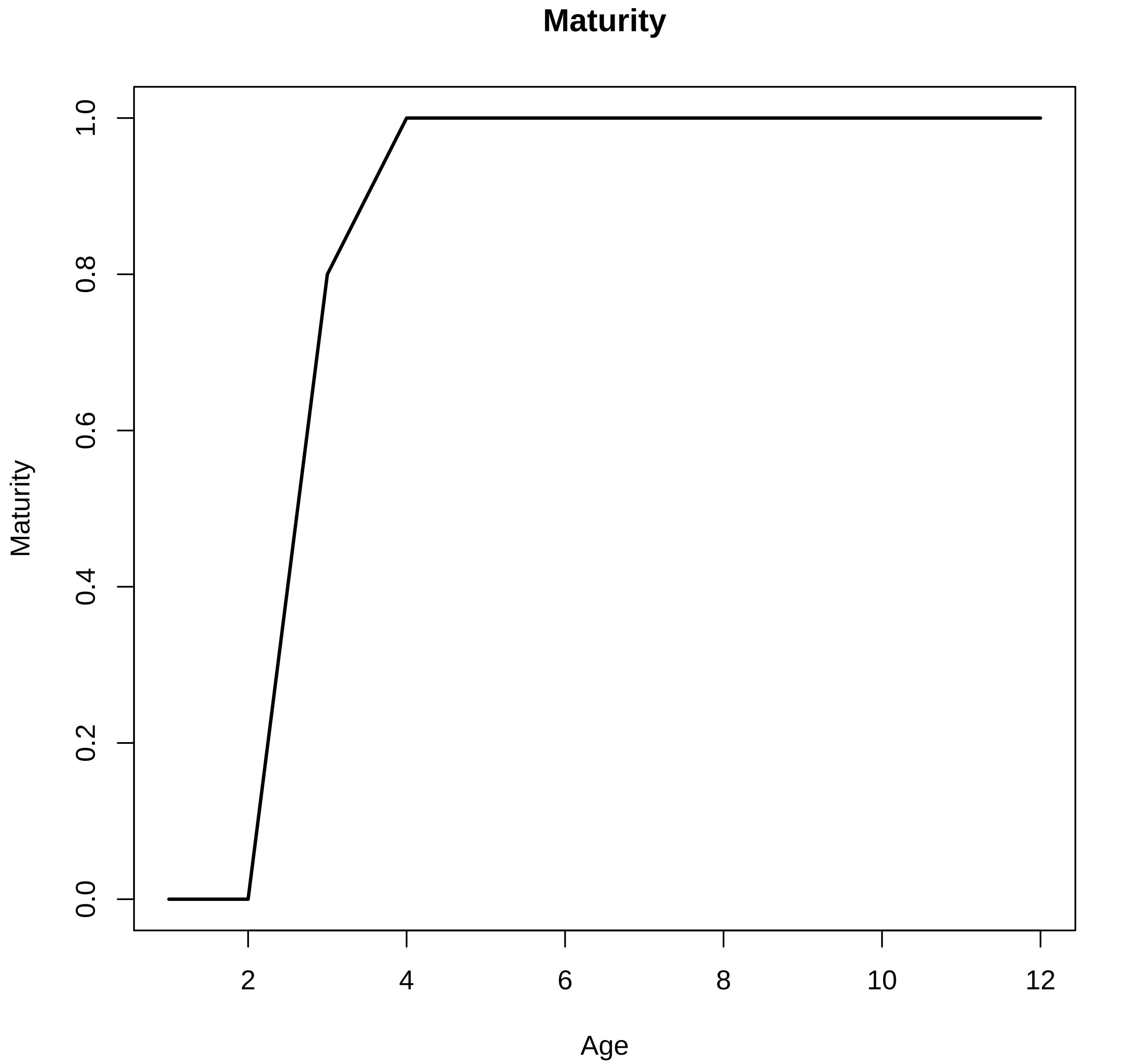


WAA matrix 1
WAA.catch.fleet1
WAA.discard.fleet1
WAA.catch.all
WAA.discard.all
Weight
0
1
2
3
4
1990
1995
2000
2005
2010
2015
2020
Year



WAA matrix 2
WAA.ssb
WAA.jan1
Weight
0
1
2
3
1990
1995
2000
2005
2010
2015
2020
Year


M
Natural Mortality Rate
0.00
0.05
0.10
0.15
2
4
6
8
10
12
Age


Maturity
Maturity
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
Age

Tautog Stock Assessment Update
NJ-NYB Region 2021

Appendix 2: Sensitivity Runs and Retrospective Adjustment

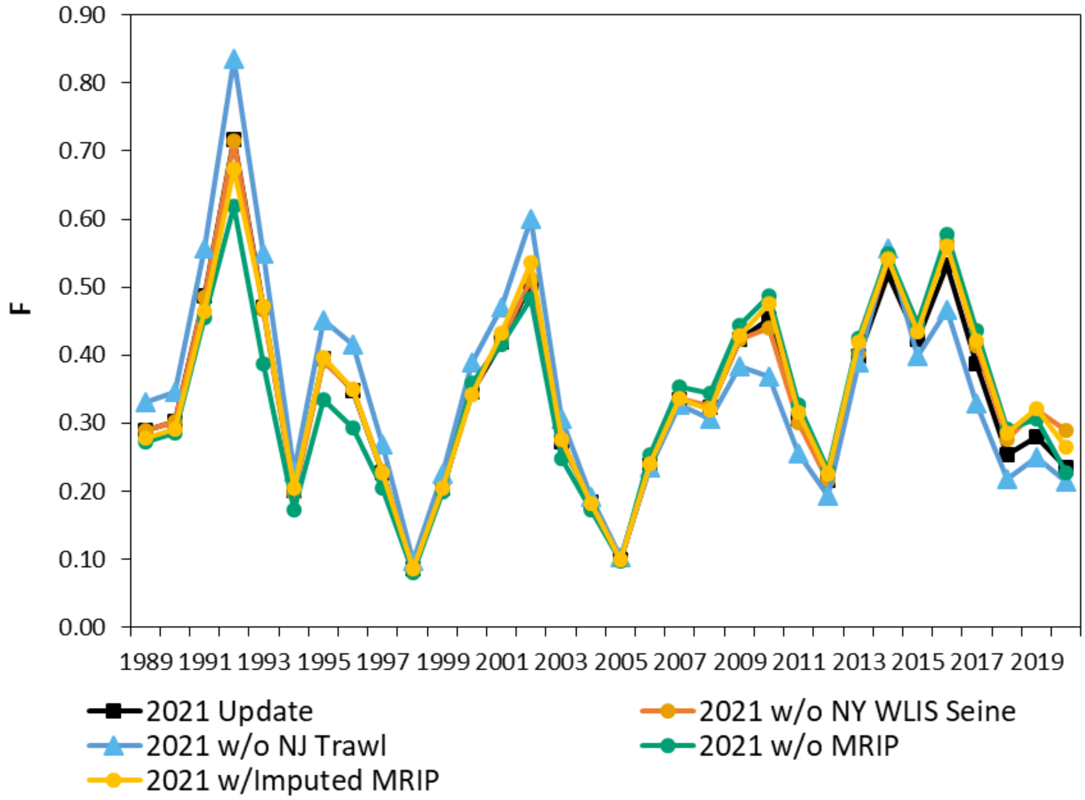


Figure A2.1. Annual *F* estimates from sensitivity runs without NY Seine index, without NJ Trawl index, without MRIP index, and with the MRIP index using imputed values.

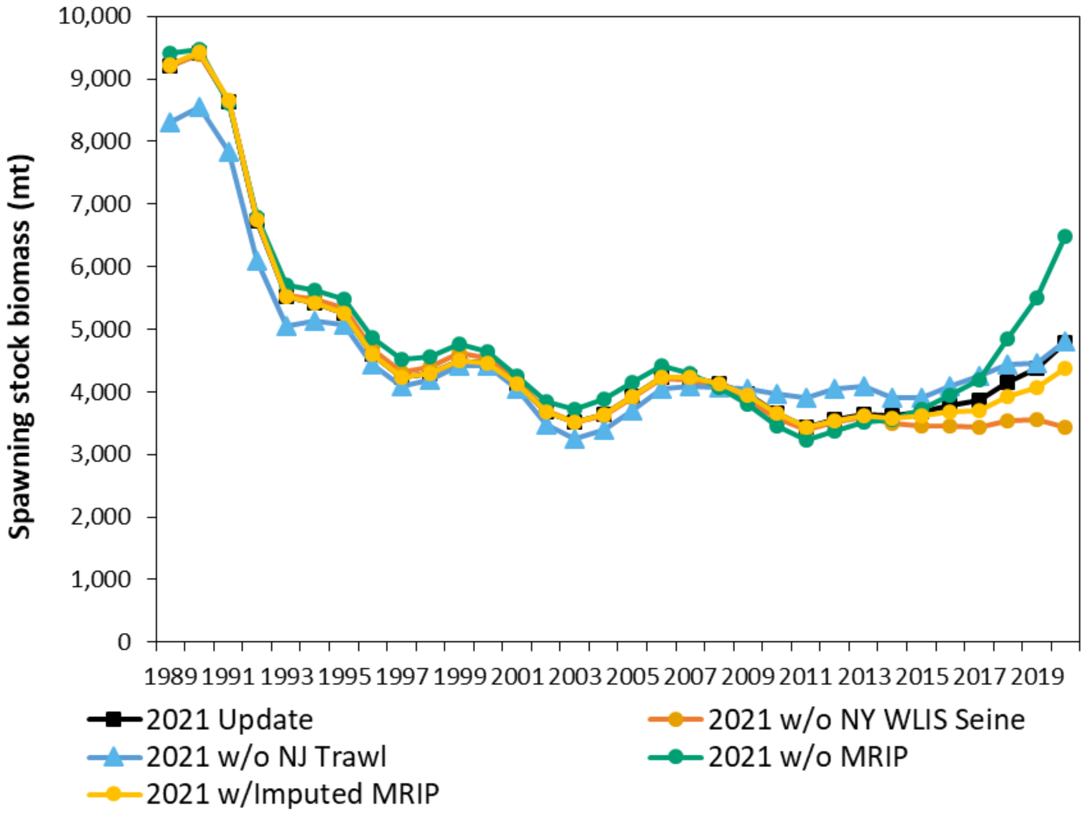


Figure A2.2. Estimates of SSB from sensitivity runs without NY Seine index, without NJ Trawl index, without MRIP index, and with the MRIP index using imputed values.

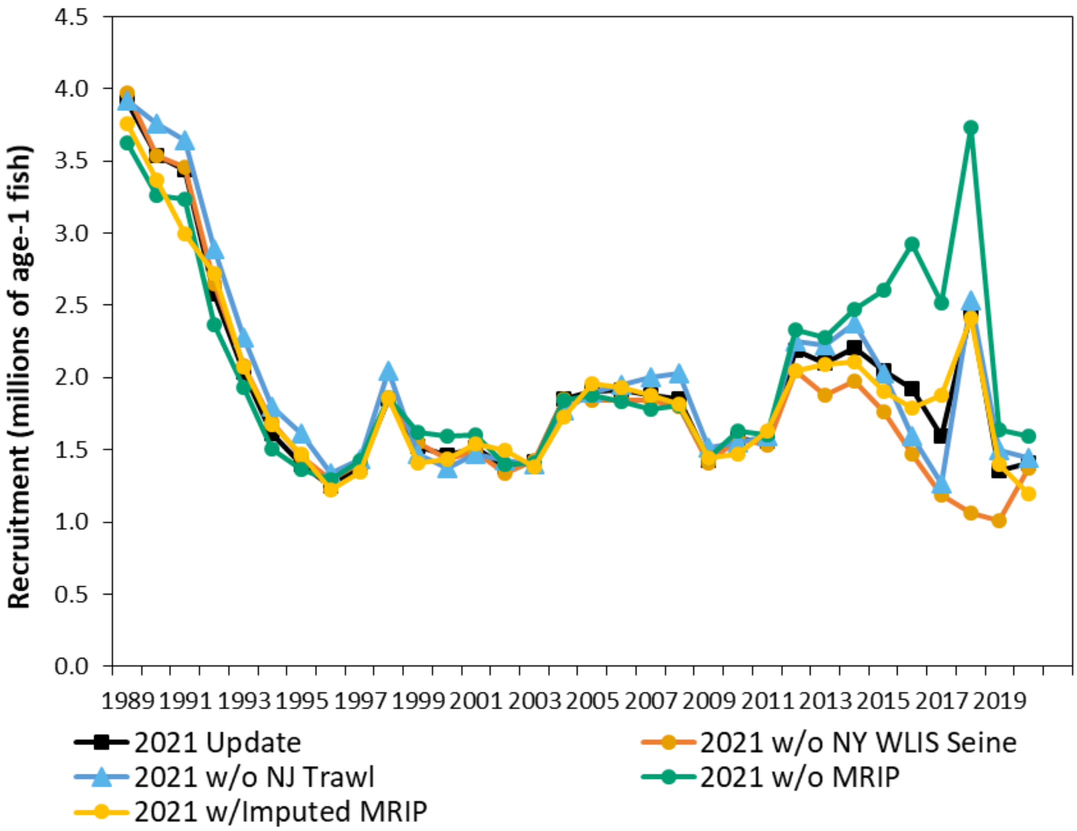


Figure A2.3. Estimates of recruitment from sensitivity runs without NY Seine index, without NJ Trawl index, without MRIP index, and with the MRIP index using imputed values (bottom)

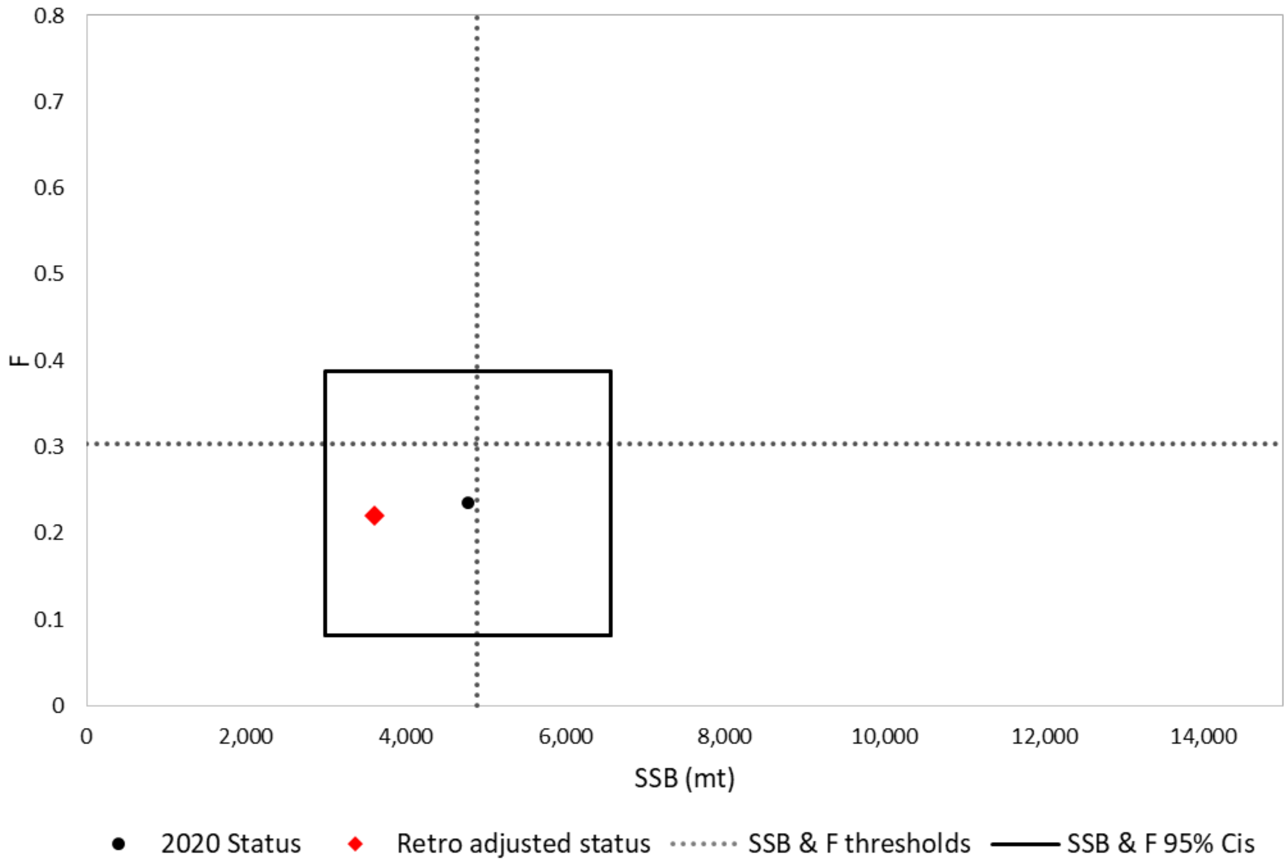


Figure A2.4. Comparison of retrospective adjusted status in 2020 with the base model status. Solid black lines indicate the 95% confidence intervals of the estimates of SSB and *F*.

Tautog Stock Assessment Update
DMV Region 2021

Appendix 1: ASAP Input, Diagnostic, and Results Plots for the Base Run

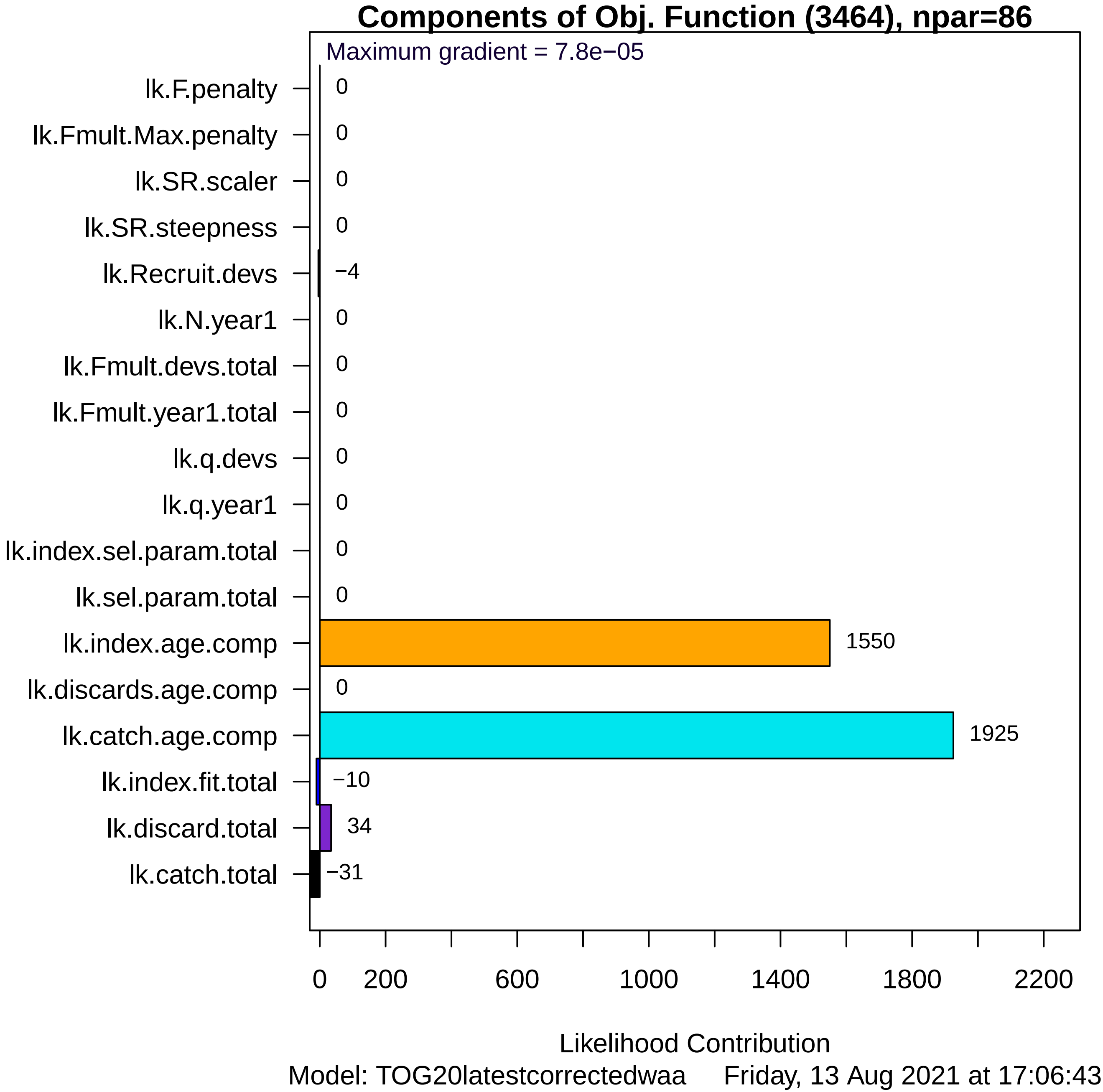
File = TOG20latestcorrectedwaa.dat

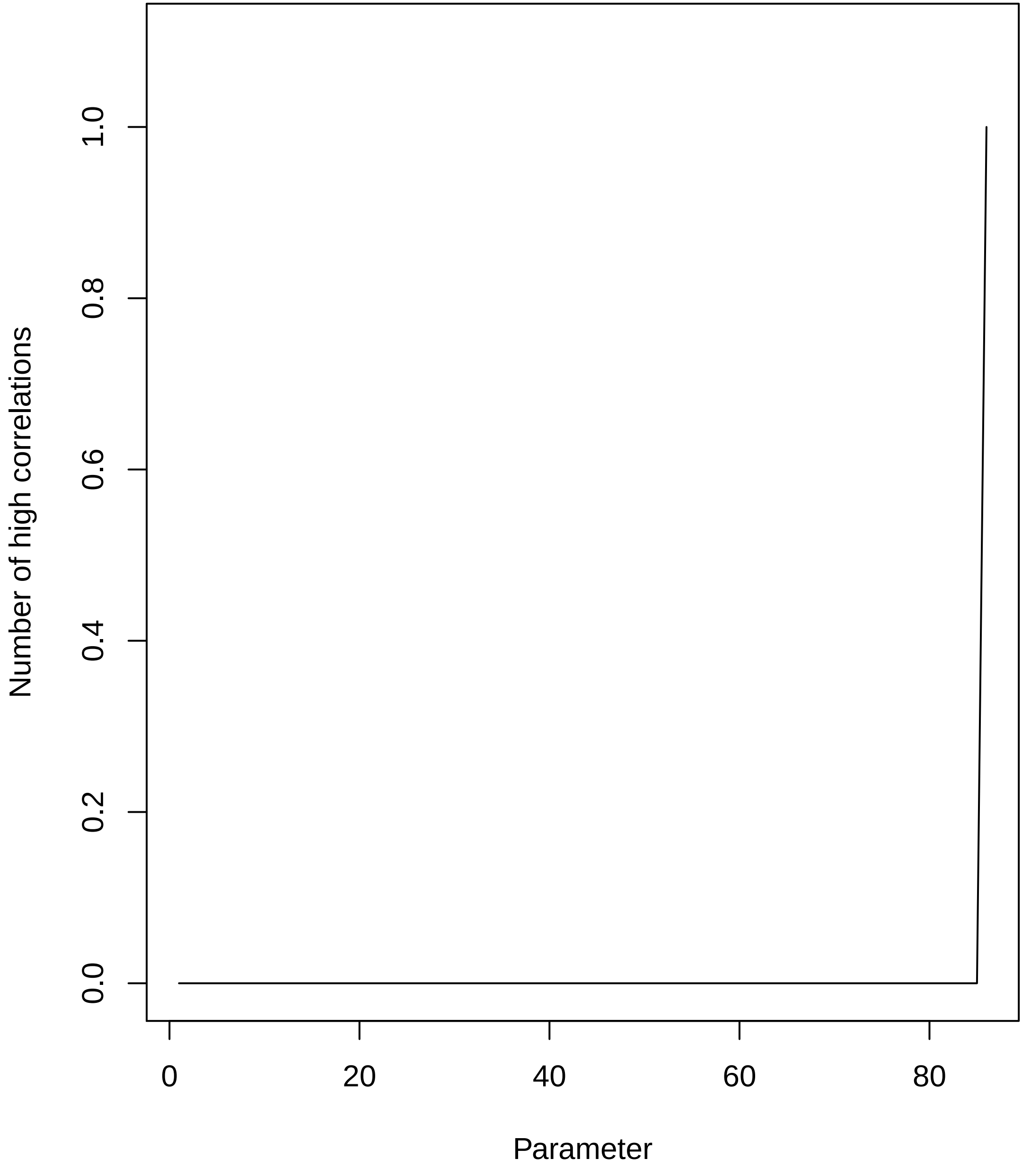
ASAP3 run on Friday, 13 Aug 2021 at 17:06:43

dir = C:\aatogtest

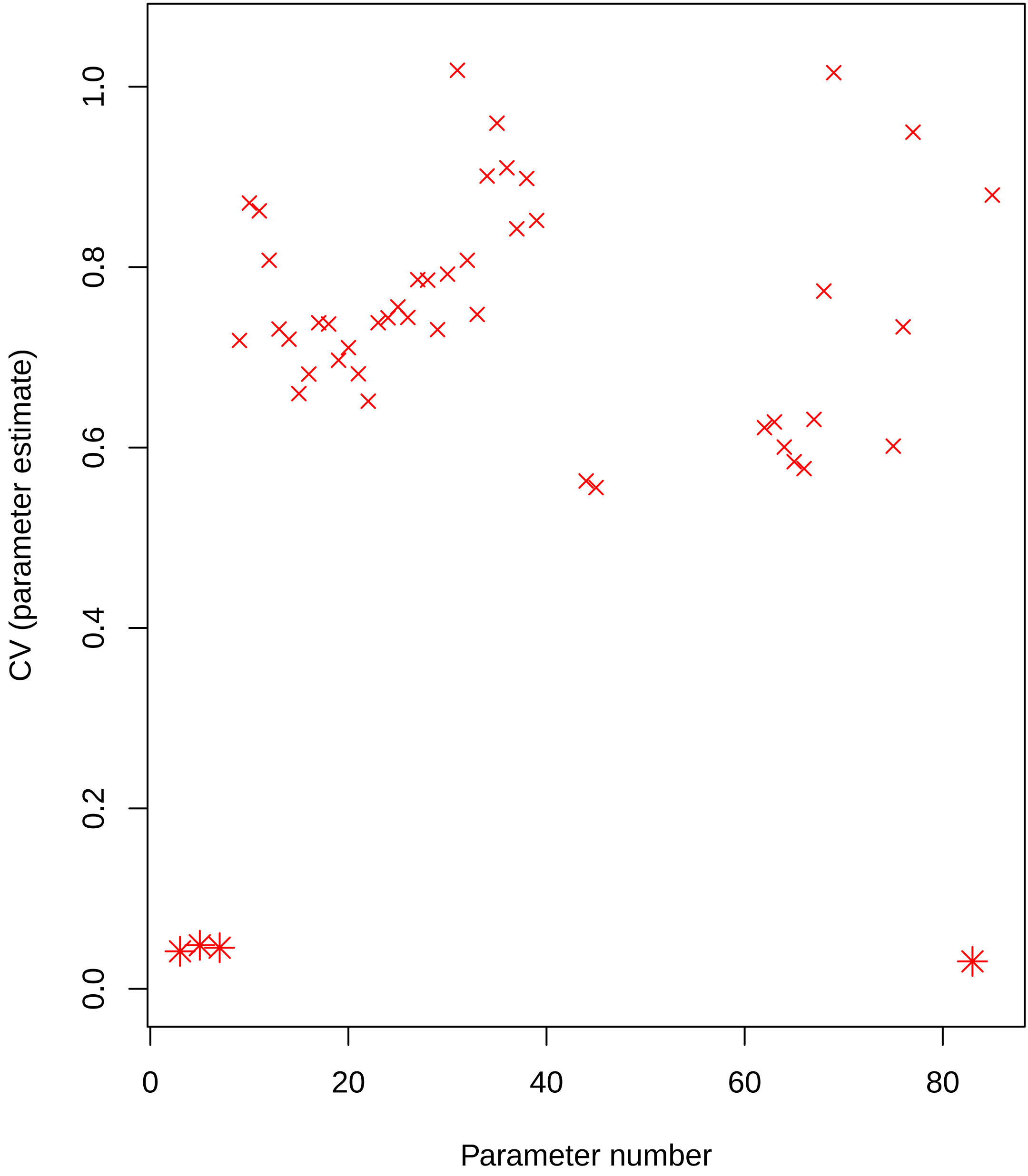
ASAPplots version = 0.2.17

npar = 86, maximum gradient = 7.79610e−005


Components of Obj. Function (3464), npar=86
Maximum gradient = 7.8e−05
lk.F.penalty
lk.Fmult.Max.penalty
lk.SR.scaler
lk.SR.steepness
lk.Recruit.devs
lk.N.year1
lk.Fmult.devs.total
lk.Fmult.year1.total
lk.q.devs
lk.q.year1
lk.index.sel.param.total
lk.sel.param.total
lk.index.age.comp
lk.discards.age.comp
lk.catch.age.comp
lk.index.fit.total
lk.discard.total
lk.catch.total
0
0
0
0
−4
0
0
0
0
0
0
0
1550
0
1925
−10
34
−31
0
200
600
1000
1400
1800
2200
Likelihood Contribution
Model: TOG20latestcorrectedwaa
Friday, 13 Aug 2021 at 17:06:43

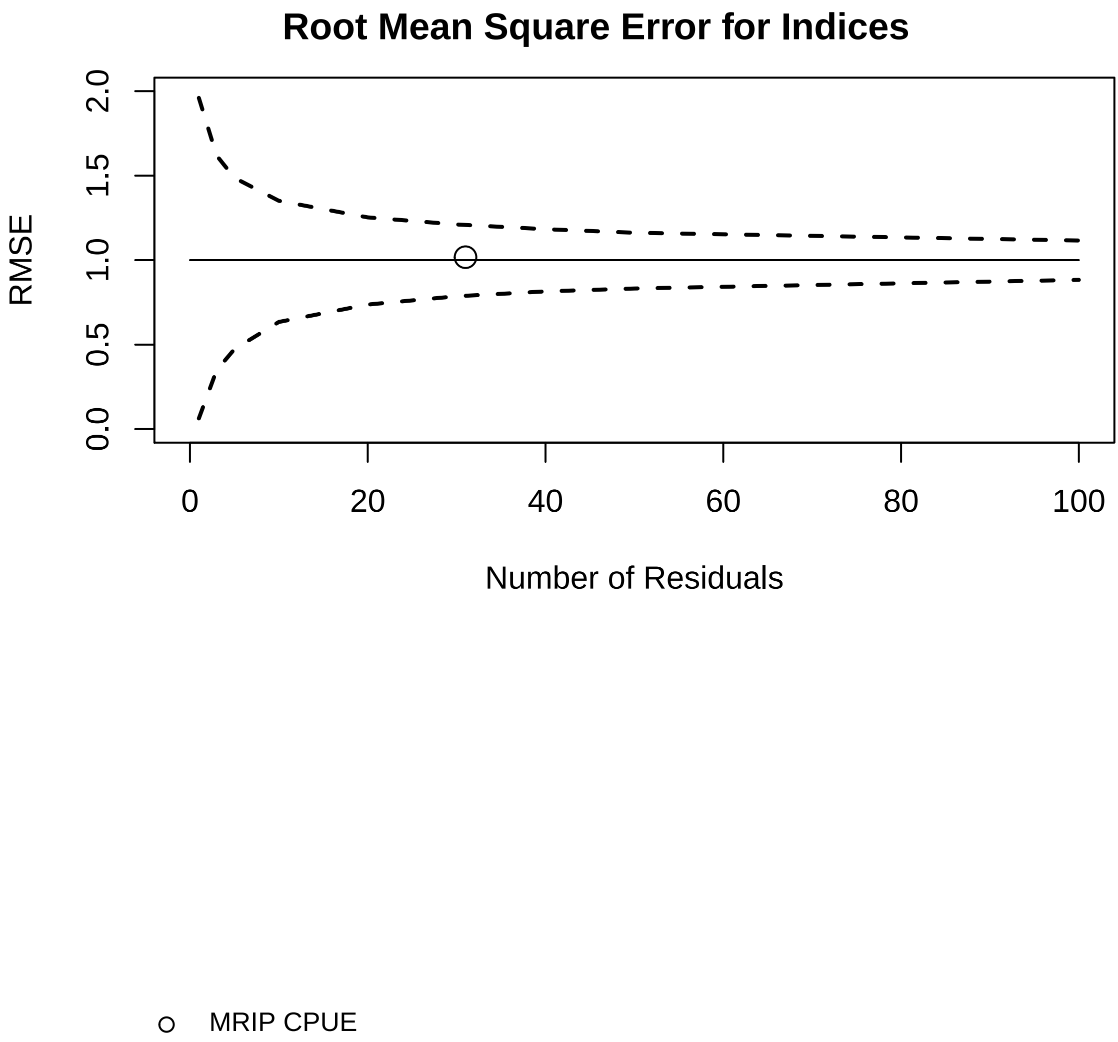


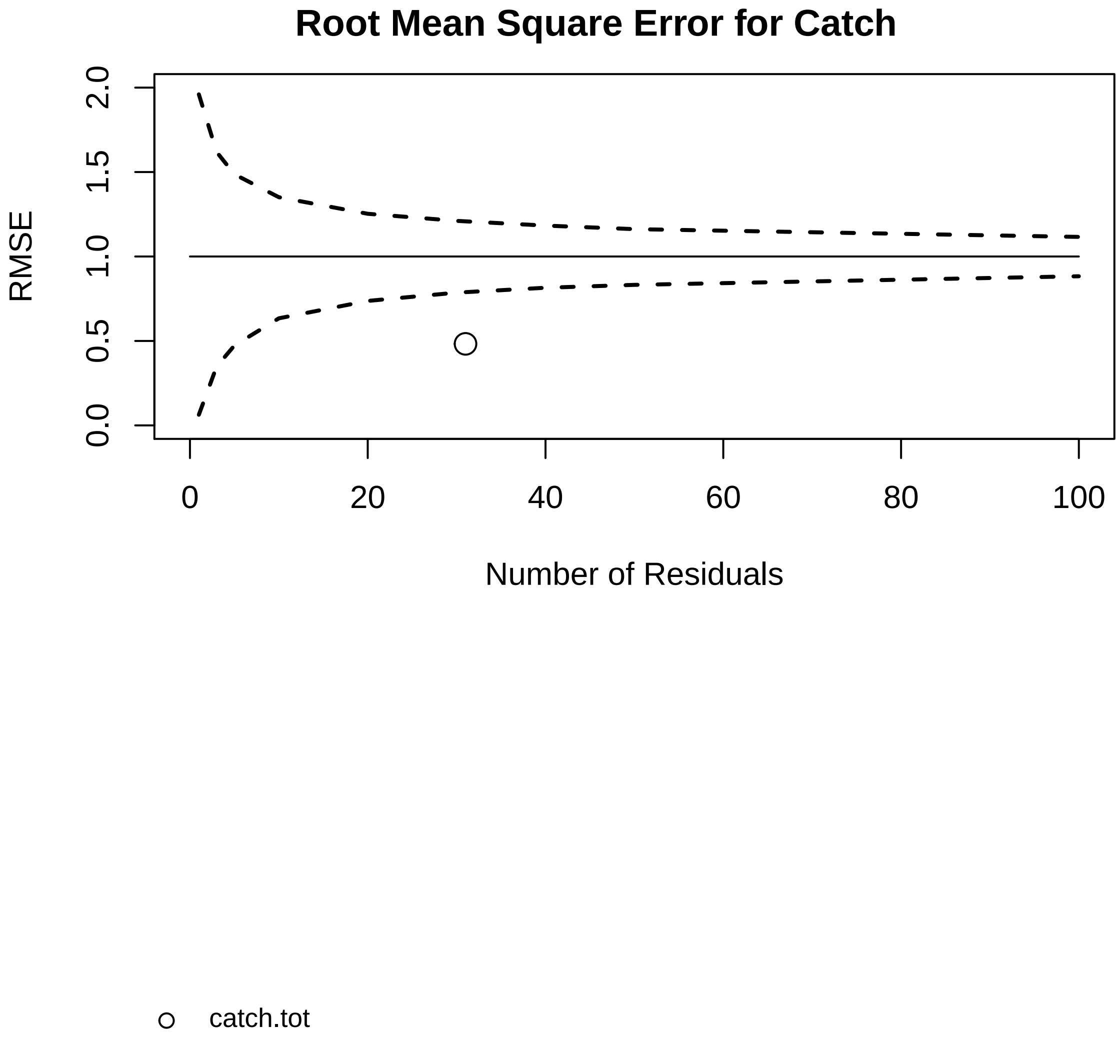
Number of high correlations
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Parameter


CV (parameter estimate)
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Parameter number

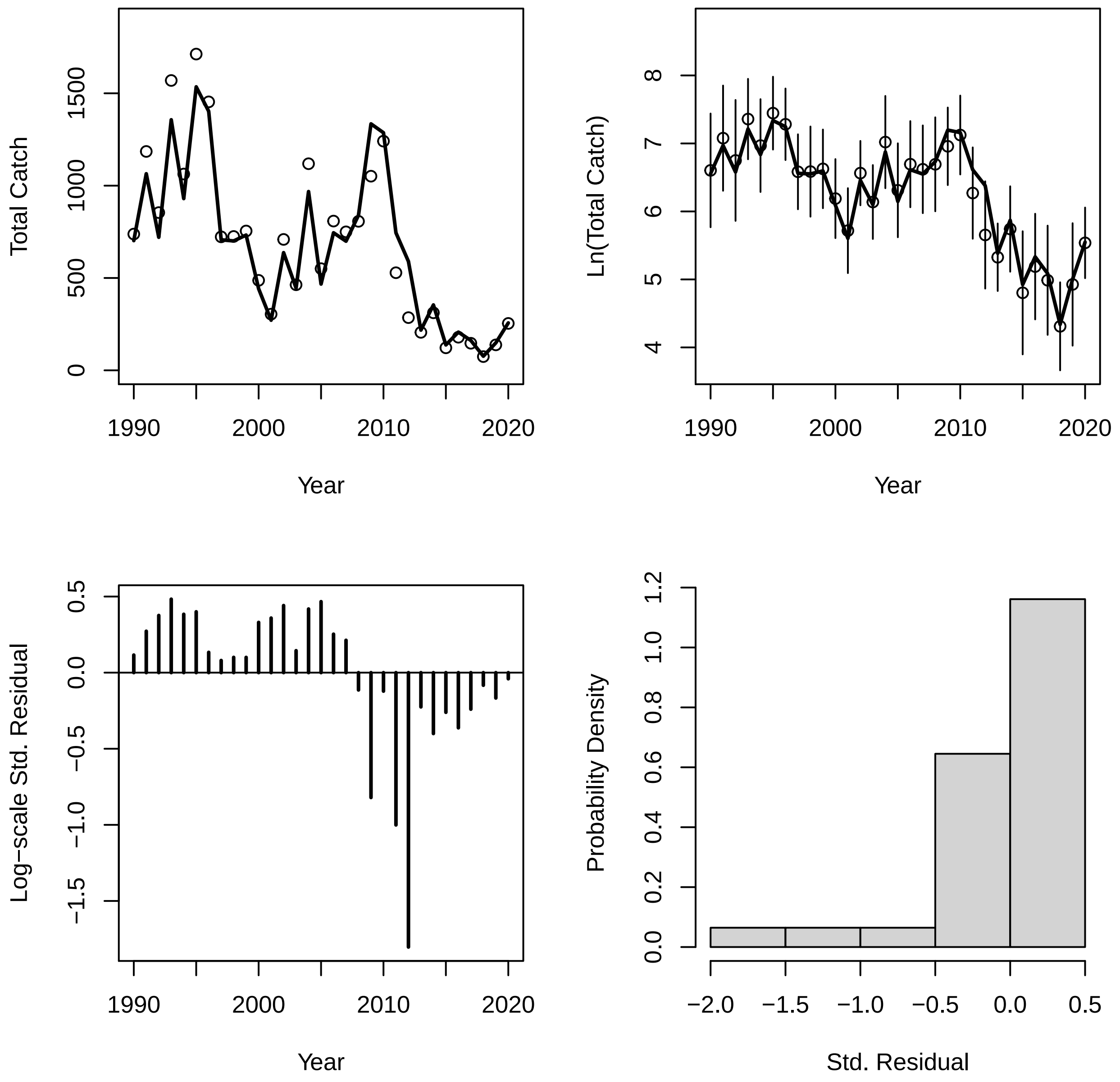
Root Mean Square Error computed from Standardized Residuals

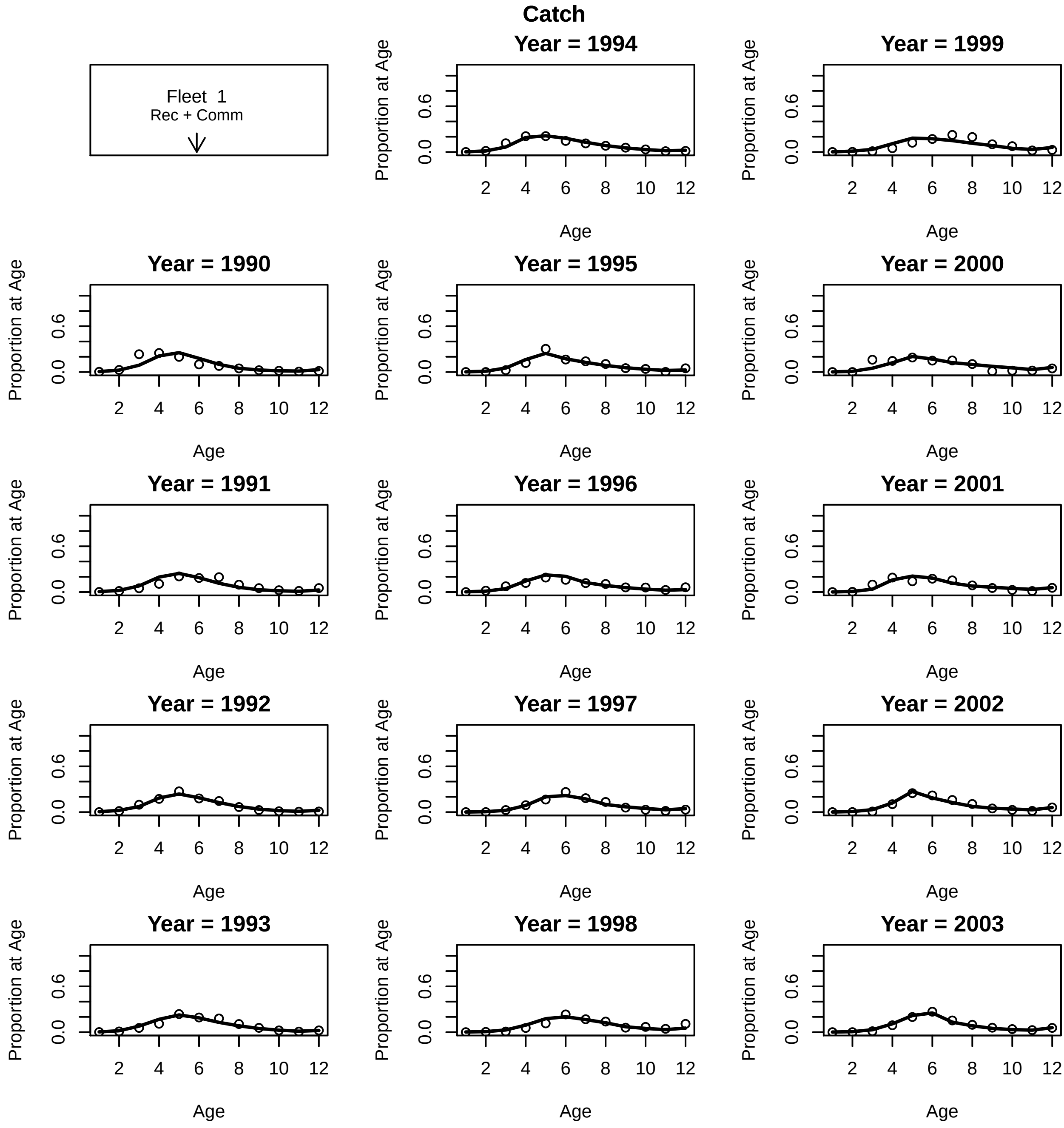
Component	# resids	RMSE
catch.tot	31	0.483
discard.tot	0	0
ind.total	31	1.02
N.year1	0	0
Fmult.year1	0	0
Fmult.devs.total	0	0
recruit.devs	31	0.299
fleet.sel.params	0	0
index.sel.params	0	0
q.year1	0	0
q.devs	0	0
SR.steepness	0	0
SR.scaler	0	0

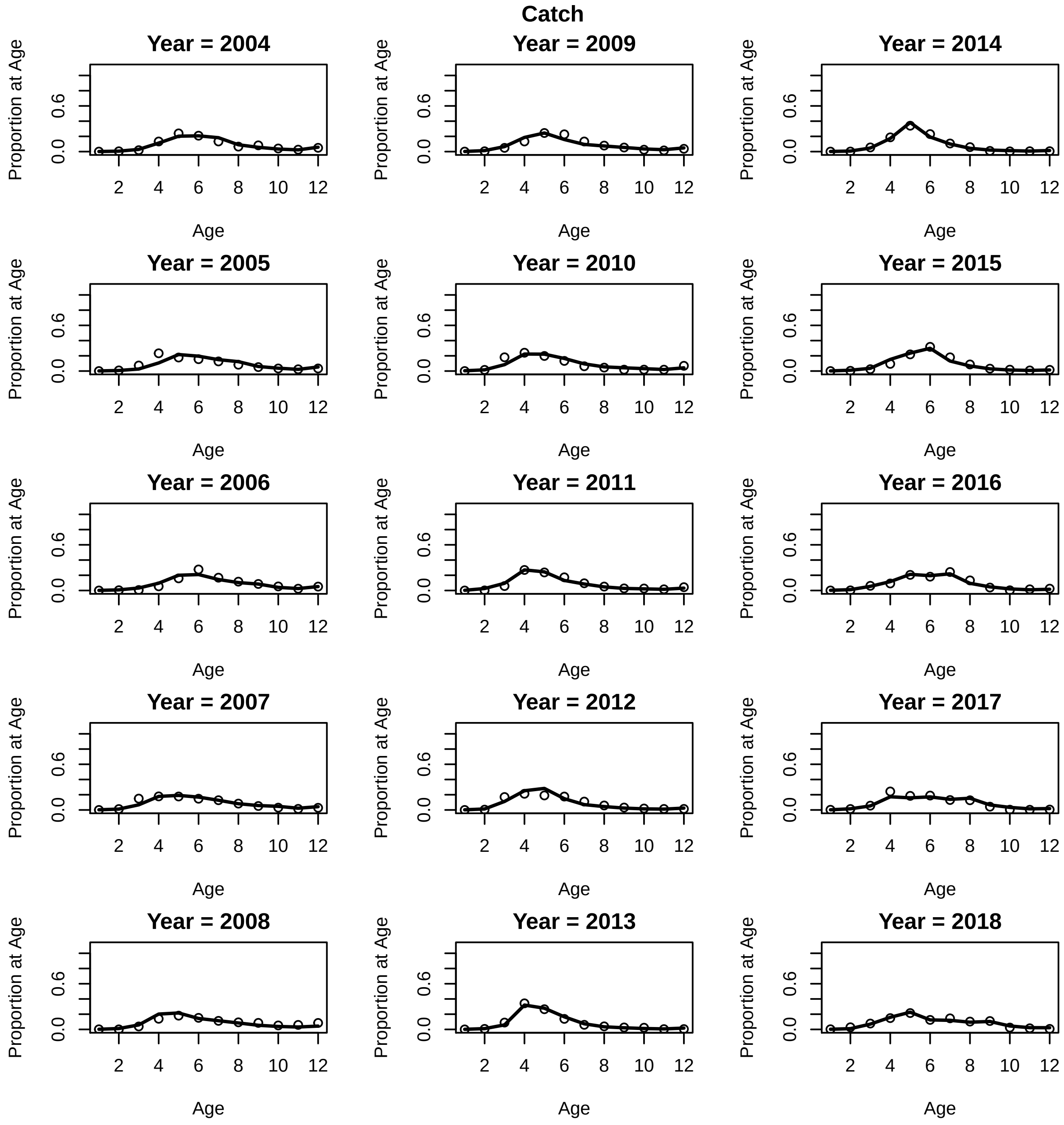

Root Mean Square Error for Indices
RMSE
0.0
0.5
1.0
1.5
2.0
0
20
40
60
80
100
Number of Residuals
MRIP CPUE


Root Mean Square Error for Catch
RMSE
2.0
1.5
1.0
0.5
0.0
0
20
40
60
80
100
Number of Residuals
catch.tot

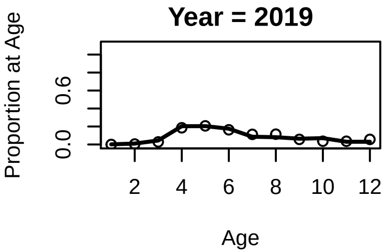
Fleet 1 Catch (Rec + Comm)

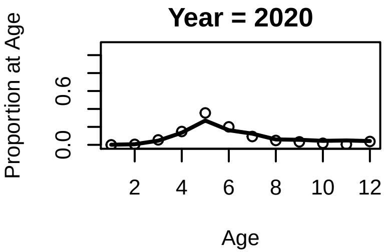


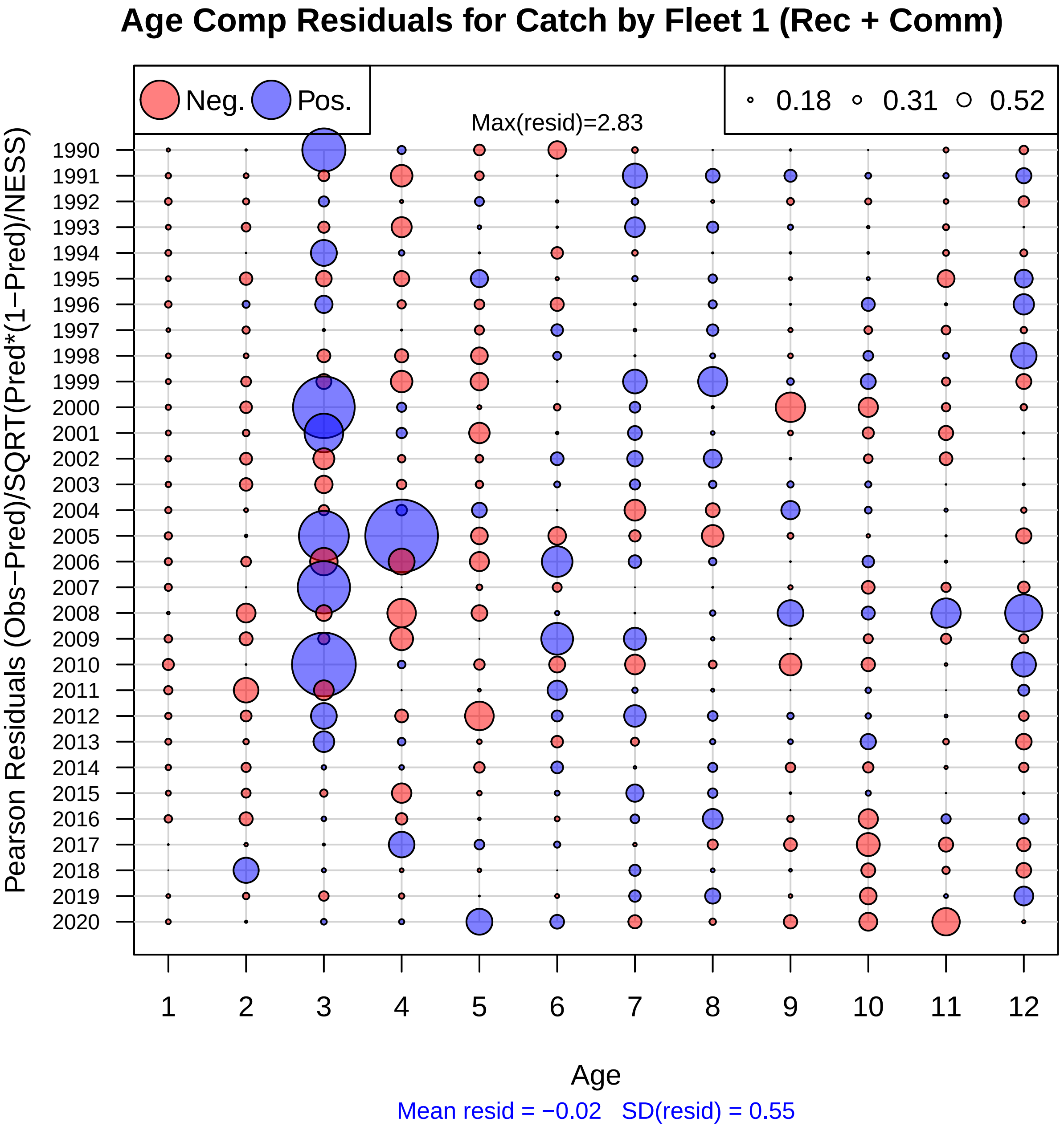

Catch
Fleet 1
Rec + Comm
Year = 1990
Year = 1991
Year = 1992
Year = 1993
Year = 1994
Year = 1995
Year = 1996
Year = 1997
Year = 1998
Year = 1999
Year = 2000
Year = 2001
Year = 2002
Year = 2003
Proportion at Age
Age

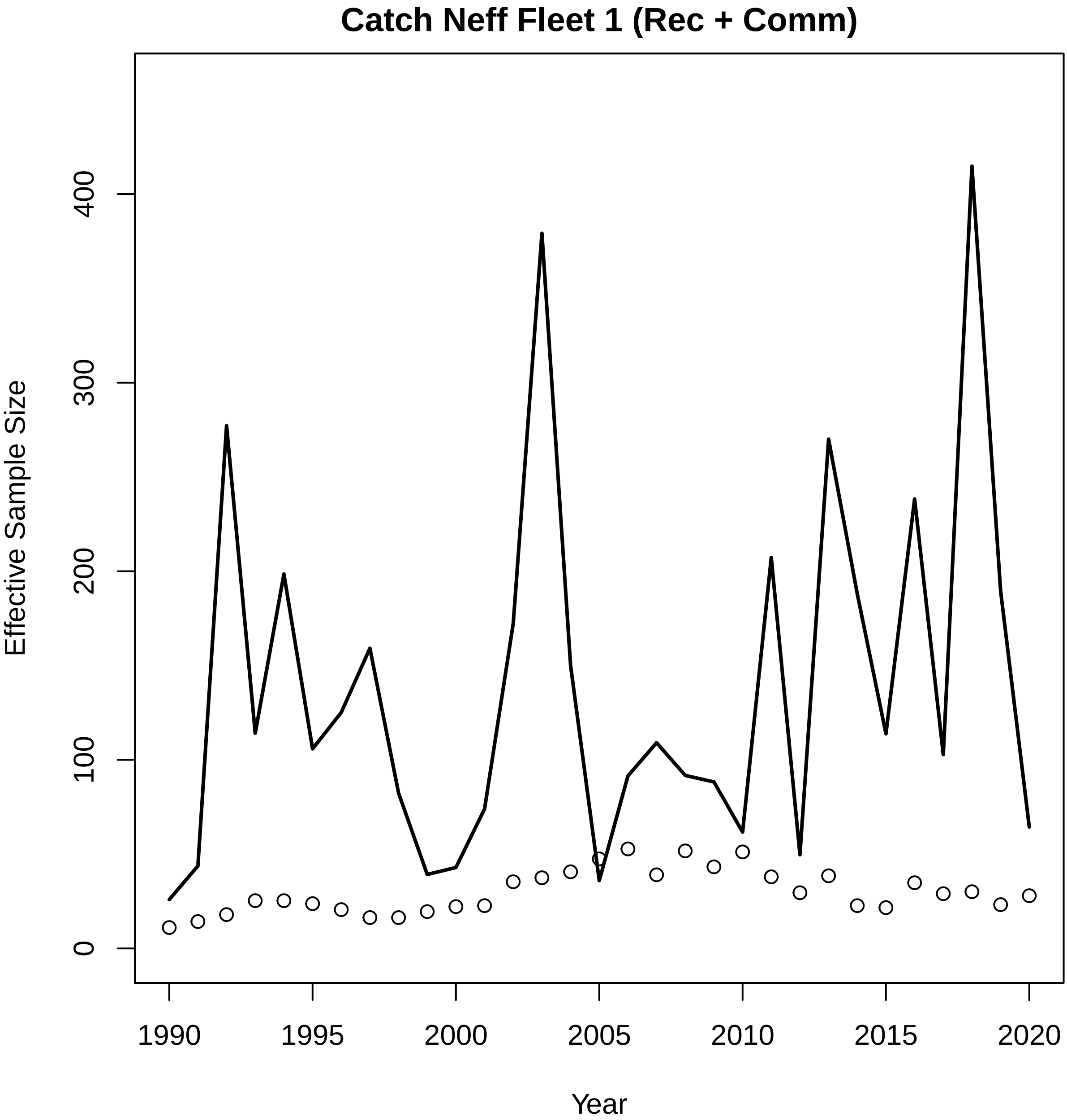

Catch
Year = 2004
Year = 2009
Year = 2014
Year = 2005
Year = 2010
Year = 2015
Year = 2006
Year = 2011
Year = 2016
Year = 2007
Year = 2012
Year = 2017
Year = 2008
Year = 2013
Year = 2018
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age

Catch

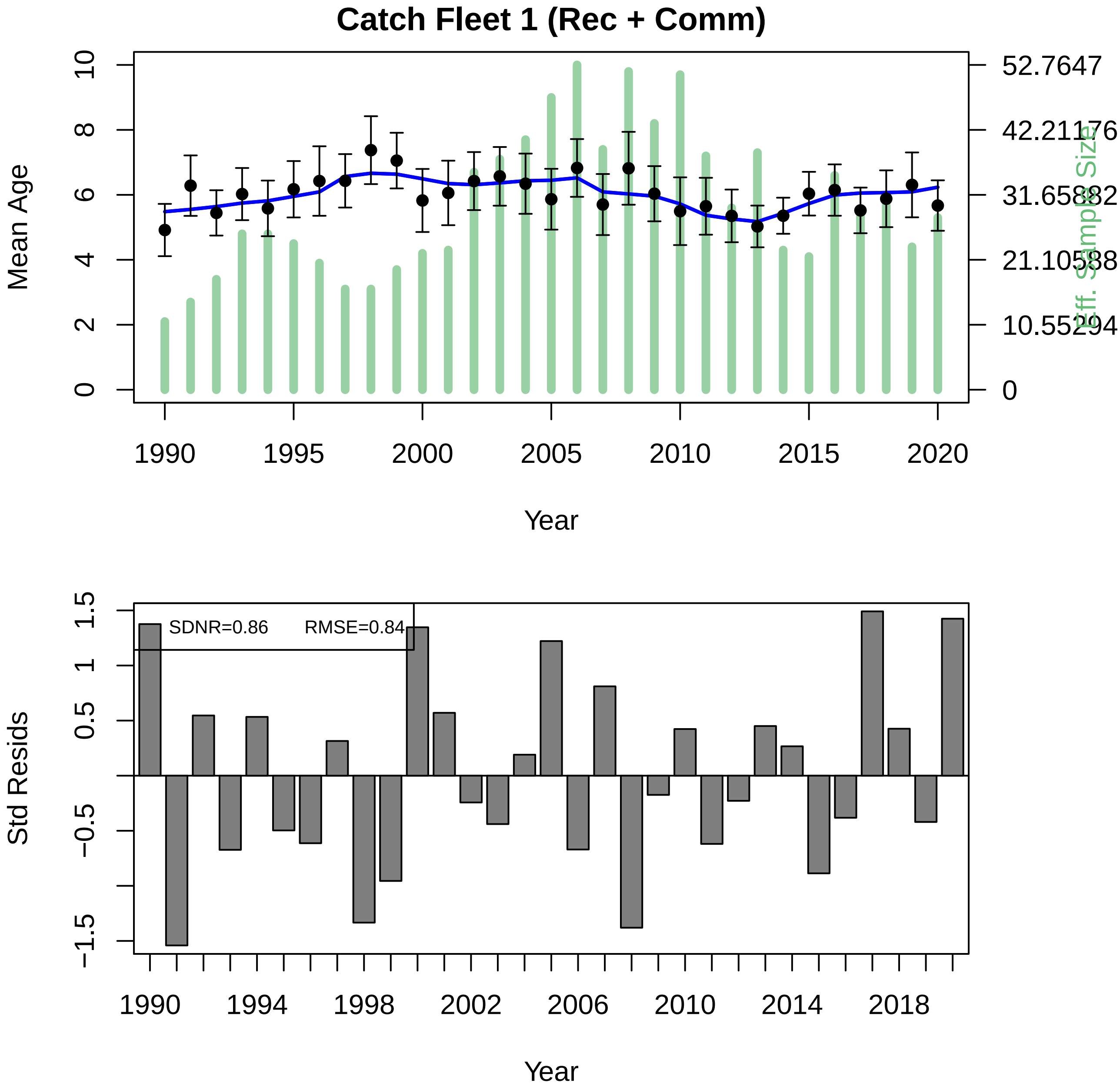

Year = 2019
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age


Year = 2020
Proportion at Age
0.0
0.6
2
4
6
8
10
12
Age

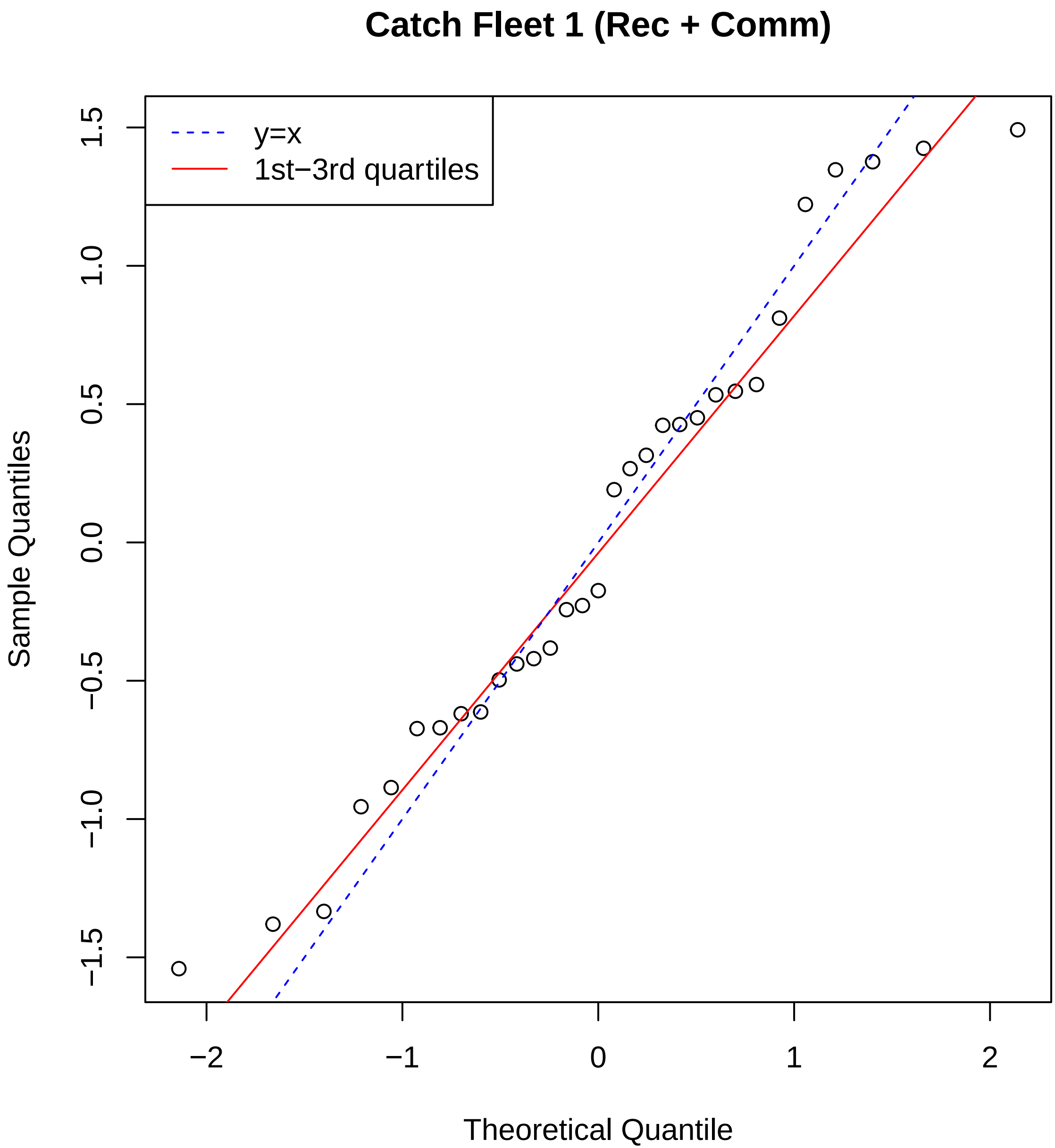

Age Comp Residuals for Catch by Fleet 1 (Rec + Comm)
Neg.
Pos.
0.18
0.31
0.52
Max(resid)=2.83
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
1 2 3 4 5 6 7 8 9 10 11 12
Age
Mean resid = −0.02   SD(resid) = 0.55



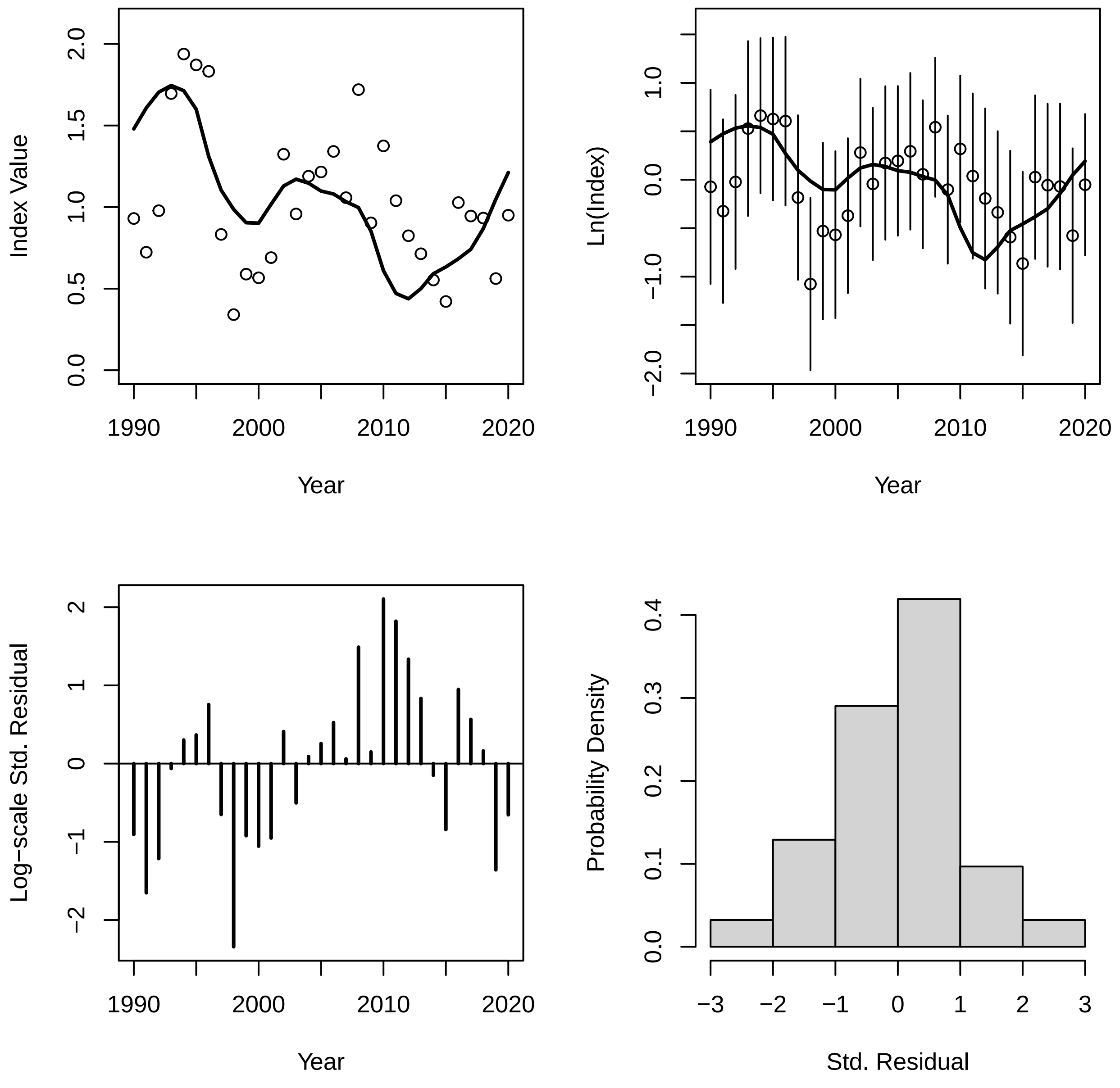
Catch Neff Fleet 1 (Rec + Comm)
Effective Sample Size
0
100
200
300
400
1990
1995
2000
2005
2010
2015
2020
Year

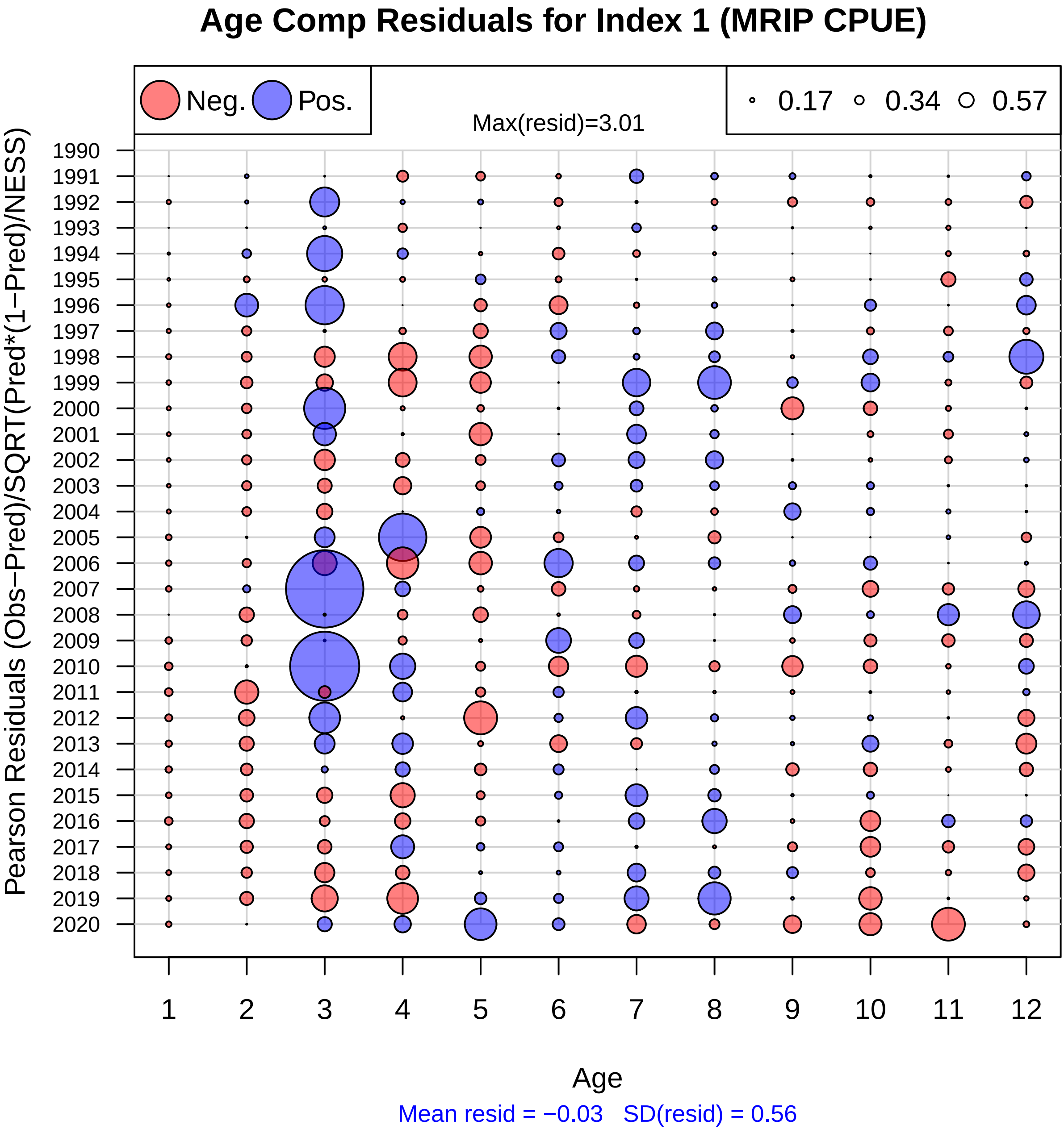


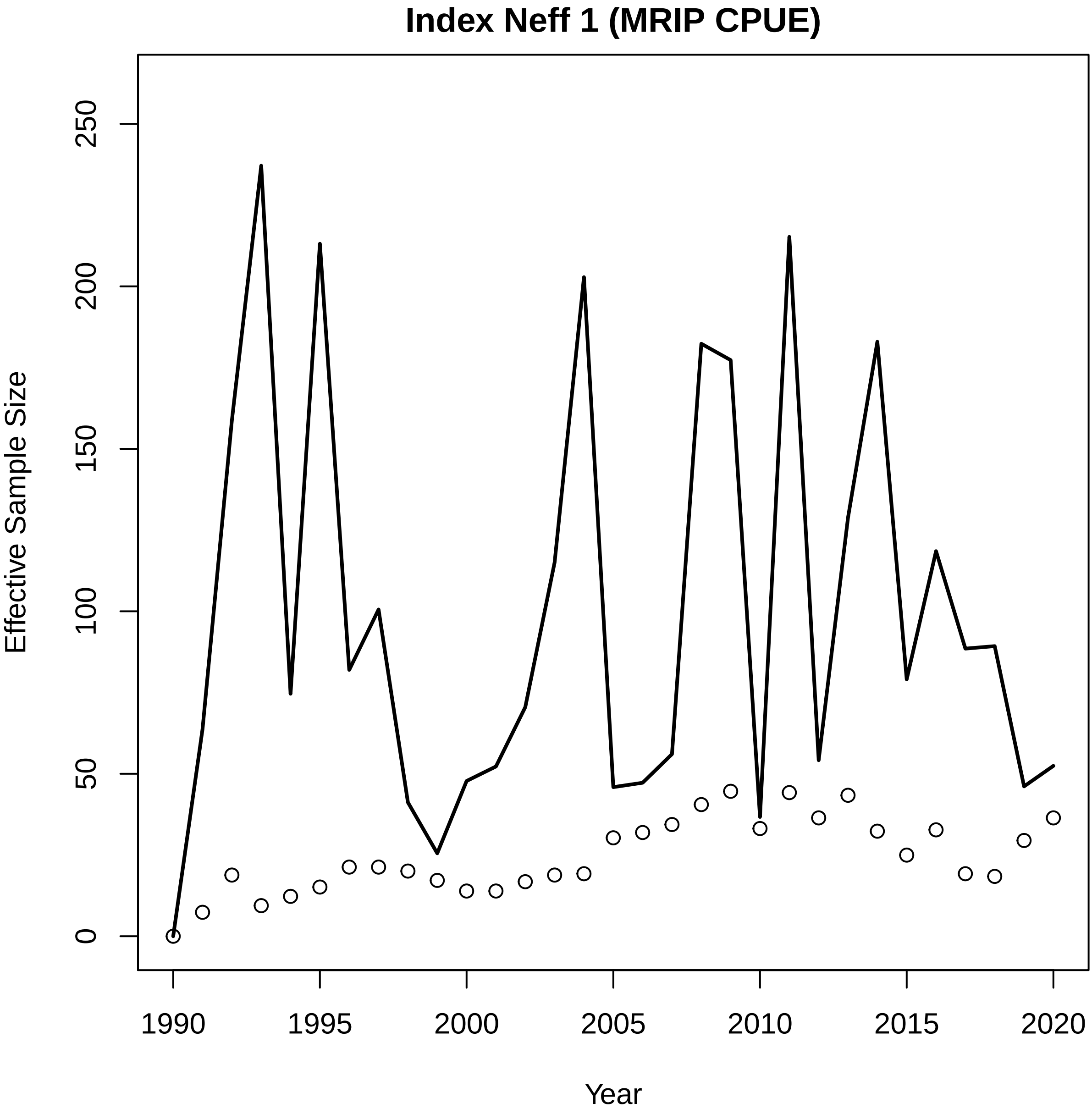
Catch Fleet 1 (Rec + Comm)
Mean Age
Eff. Sample Size
0
2
4
6
8
10
0
10.55294
21.10588
31.65882
42.21176
52.7647
1990
1995
2000
2005
2010
2015
2020
Year
Std Resids
SDNR=0.86
RMSE=0.84
−1.5
−0.5
0.5
1
1.5
1990
1994
1998
2002
2006
2010
2014
2018
Year


Catch Fleet 1 (Rec + Comm)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
−2
−1
0
1
2

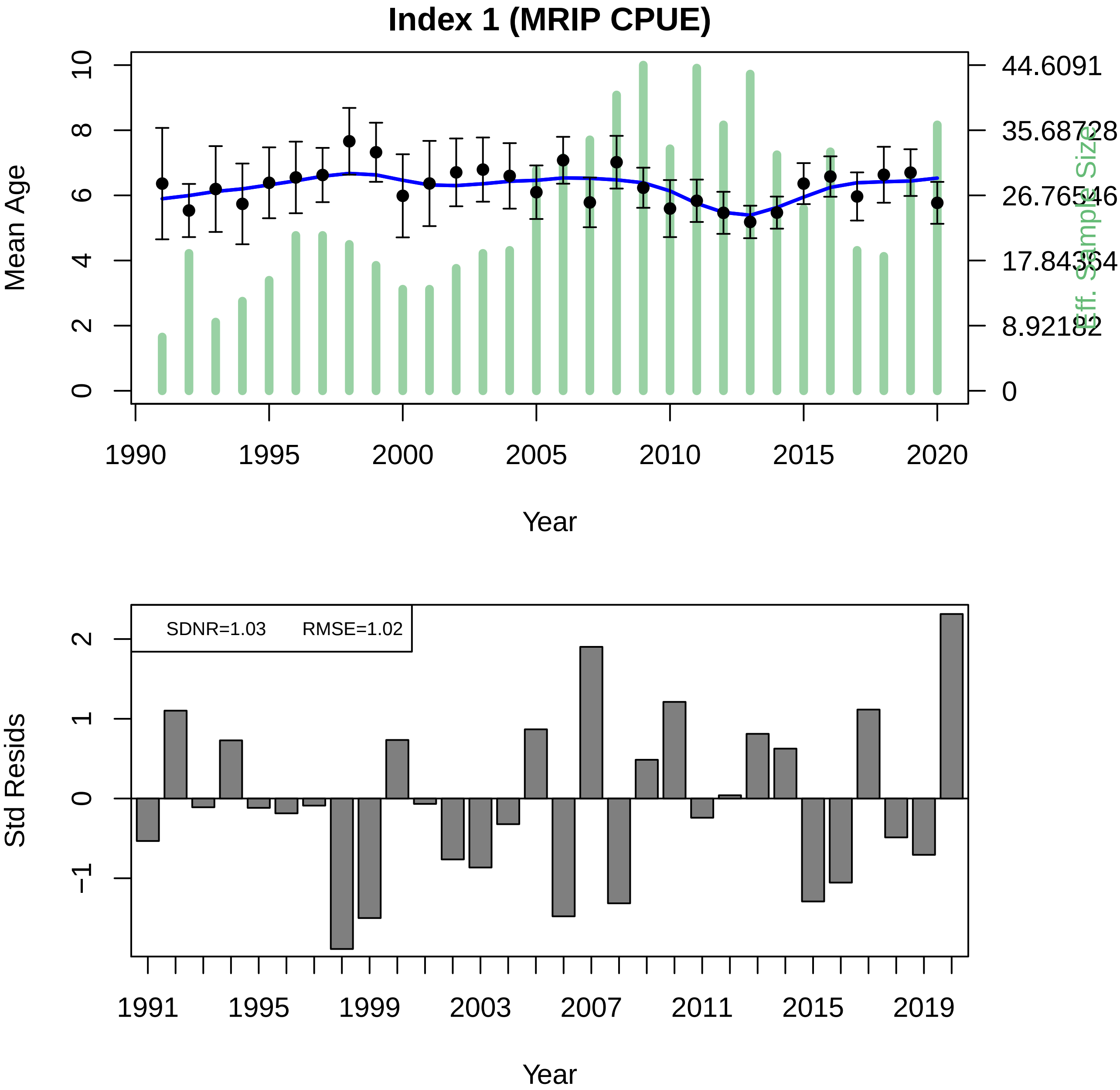
Index 1 (MRIP CPUE)

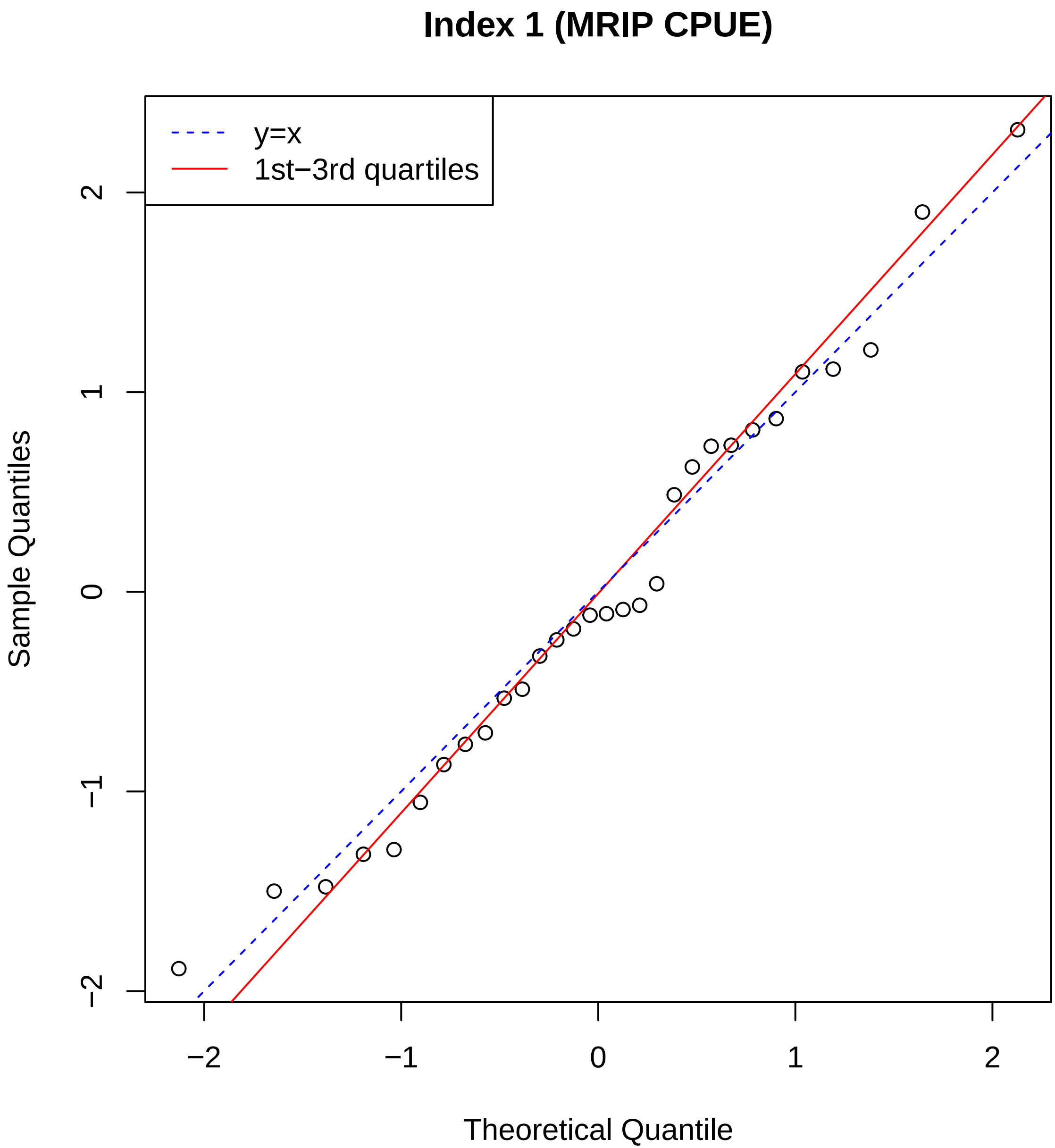



Age Comp Residuals for Index 1 (MRIP CPUE)
Neg.
Pos.
0.17
0.34
0.57
Max(resid)=3.01
Pearson Residuals (Obs−Pred)/SQRT(Pred*(1−Pred)/NESS)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age
Mean resid = −0.03 SD(resid) = 0.56

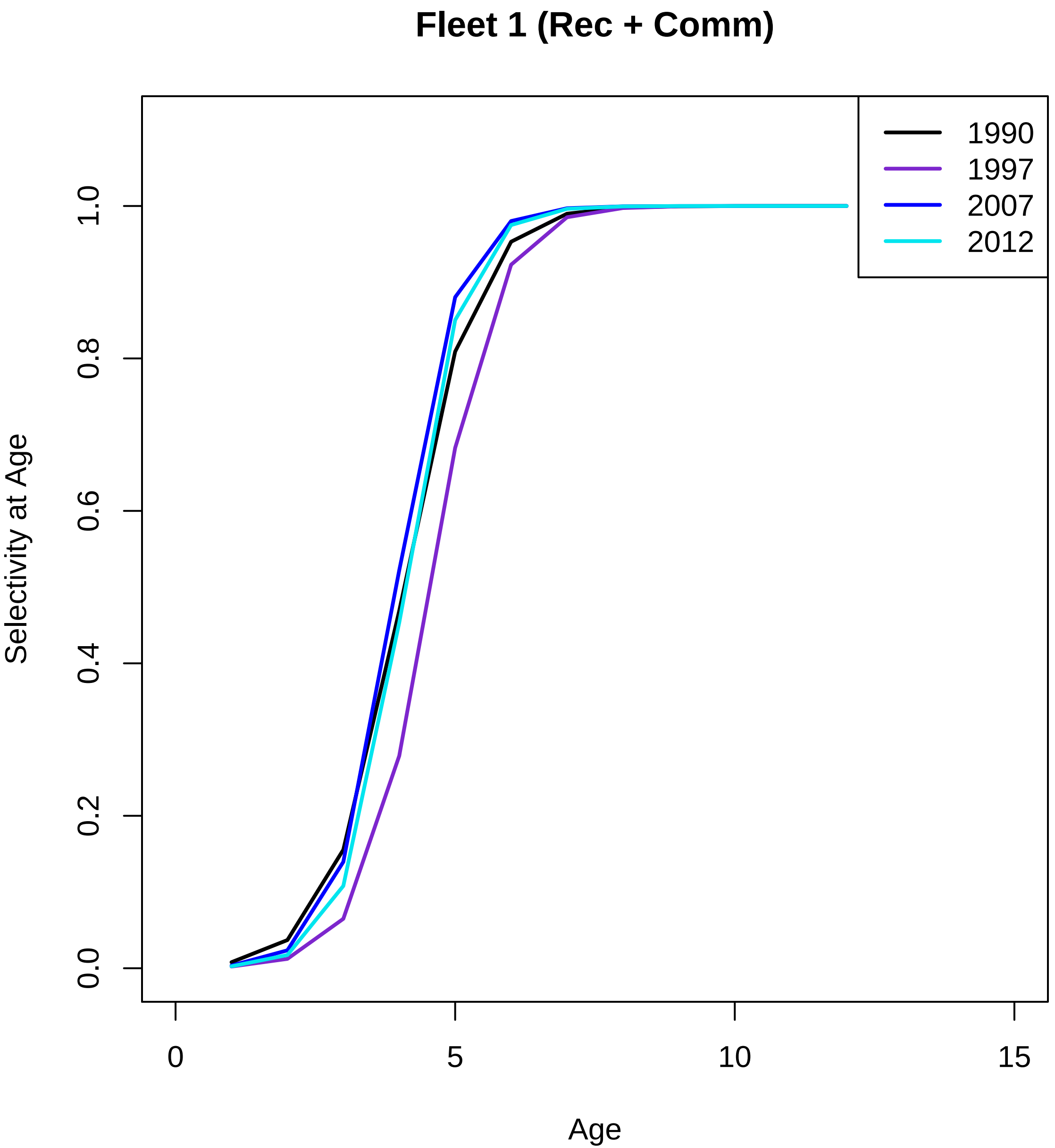


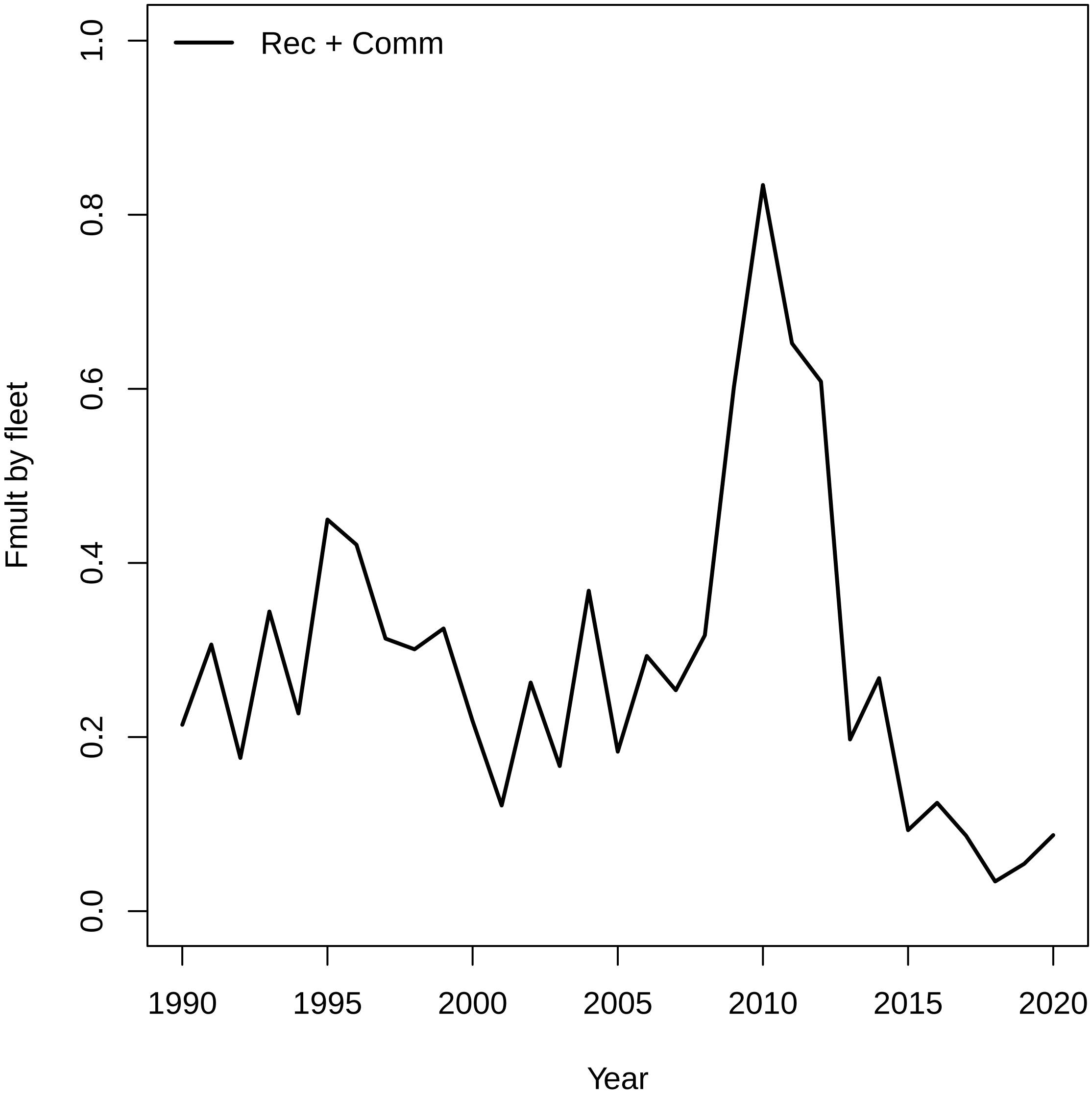
Index Neff 1 (MRIP CPUE)
Effective Sample Size
0
50
100
150
200
250
1990
1995
2000
2005
2010
2015
2020
Year


Index 1 (MRIP CPUE)
Mean Age
0
2
4
6
8
10
0
8.92182
17.84364
26.76546
35.68728
44.6091
Eff. Sample Size
1990
1995
2000
2005
2010
2015
2020
Year
SDNR=1.03
RMSE=1.02
Std Resids
−1
0
1
2
1991
1995
1999
2003
2007
2011
2015
2019
Year

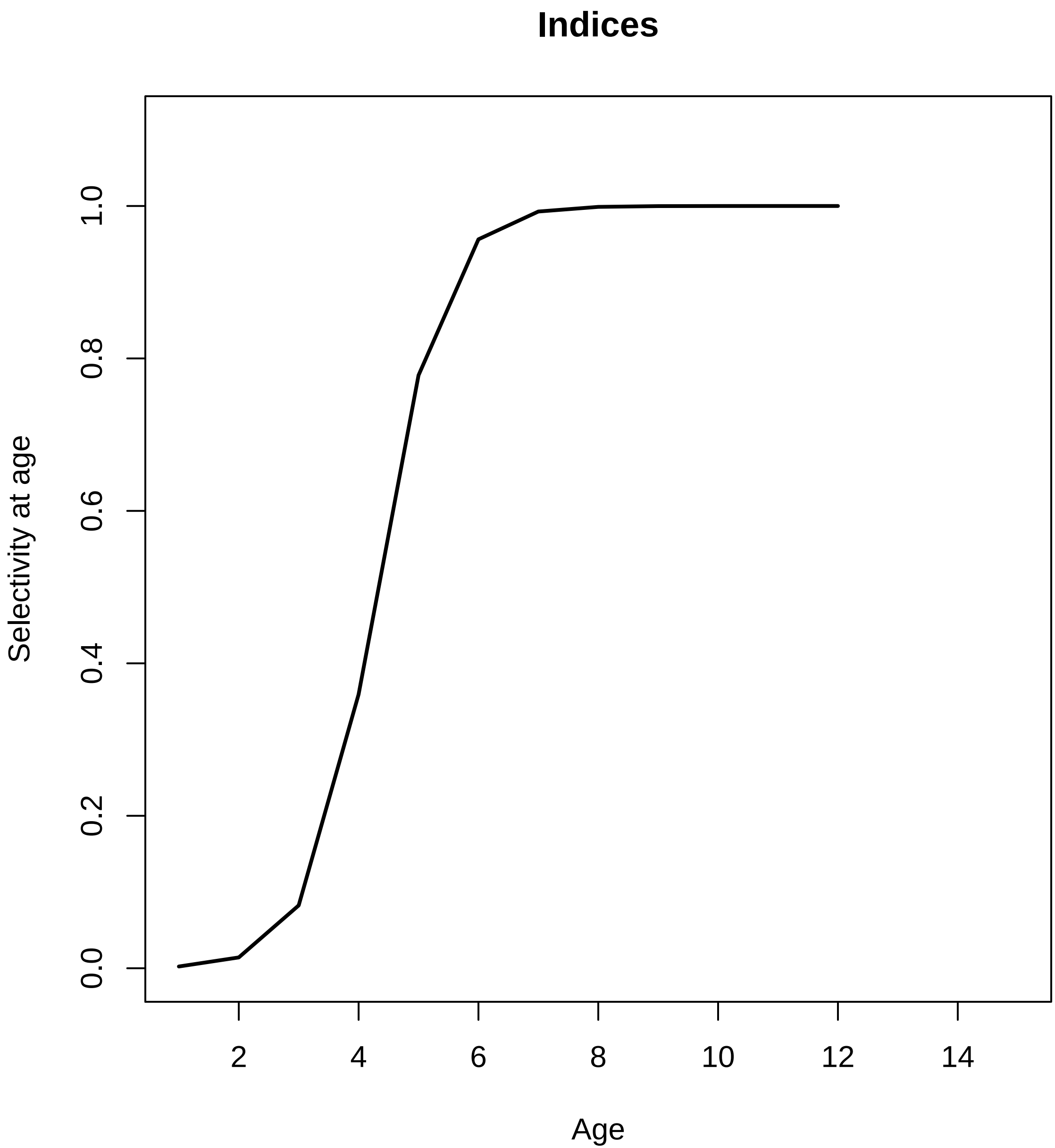


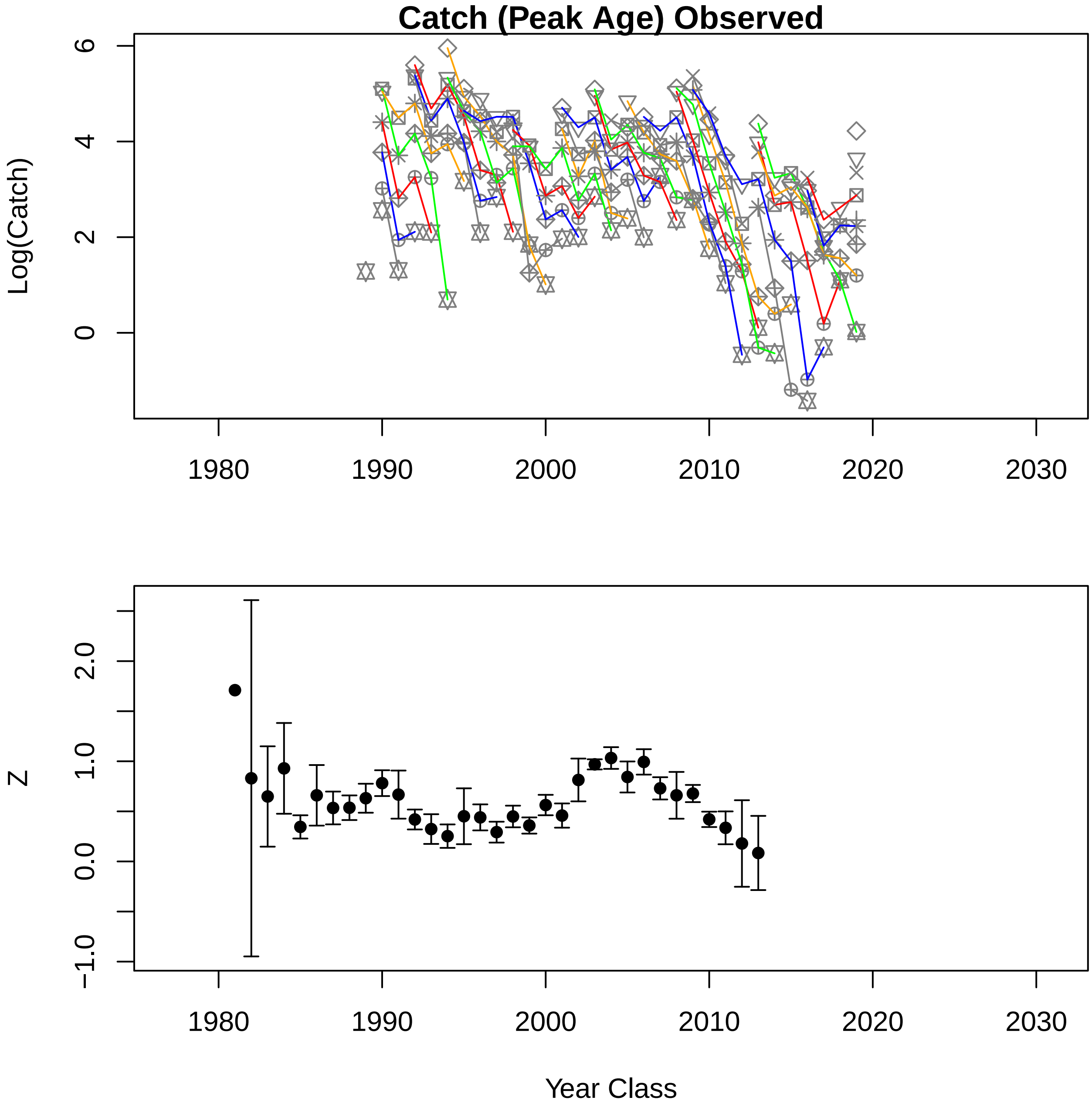
Index 1 (MRIP CPUE)
y=x
1st−3rd quartiles
Sample Quantiles
Theoretical Quantile
−2
−1
0
1
2


Fleet 1 (Rec + Comm)
1990
1997
2007
2012
Selectivity at Age
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
Age

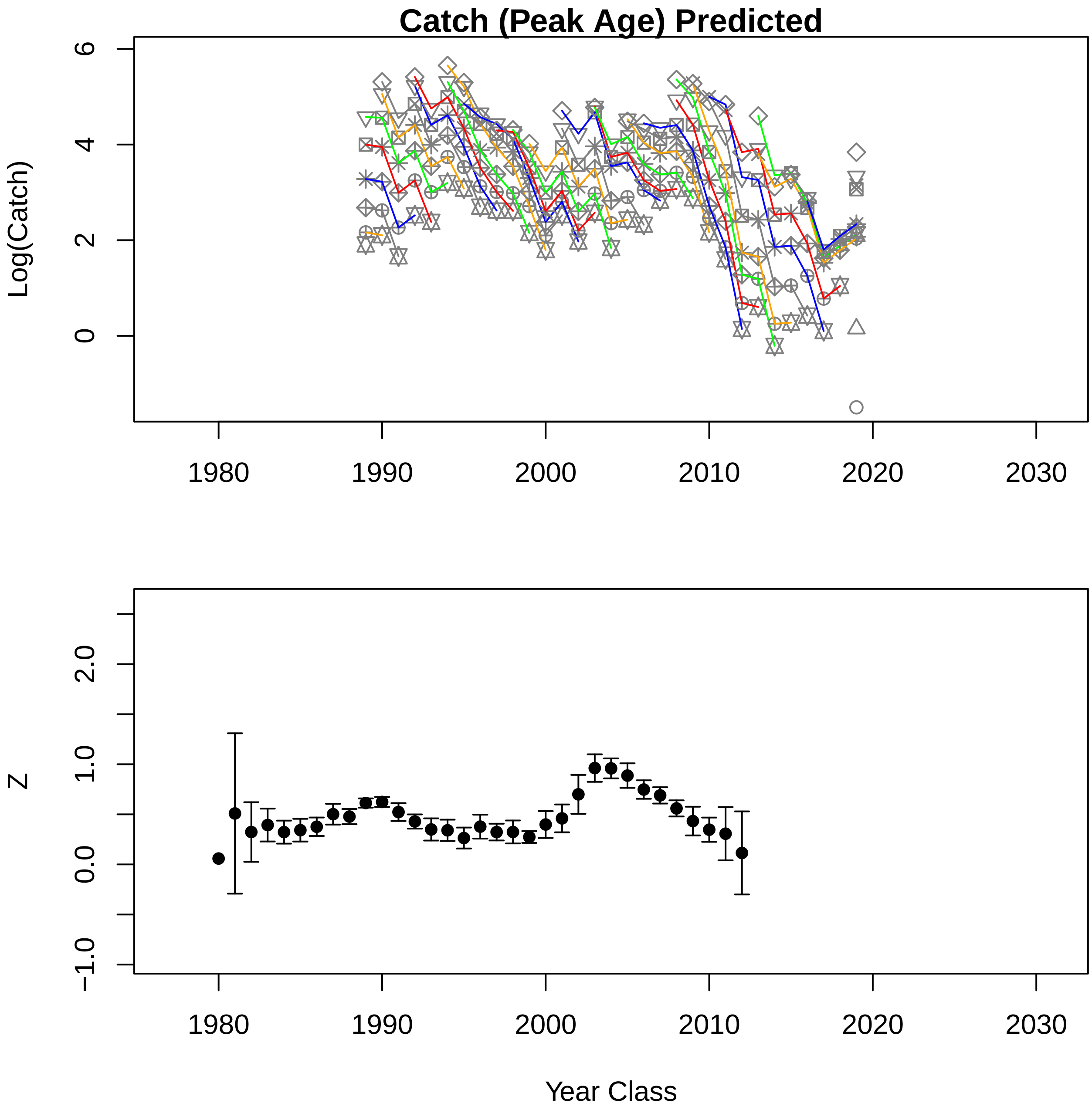


Rec + Comm
Fmult by fleet
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
2015
2020
Year

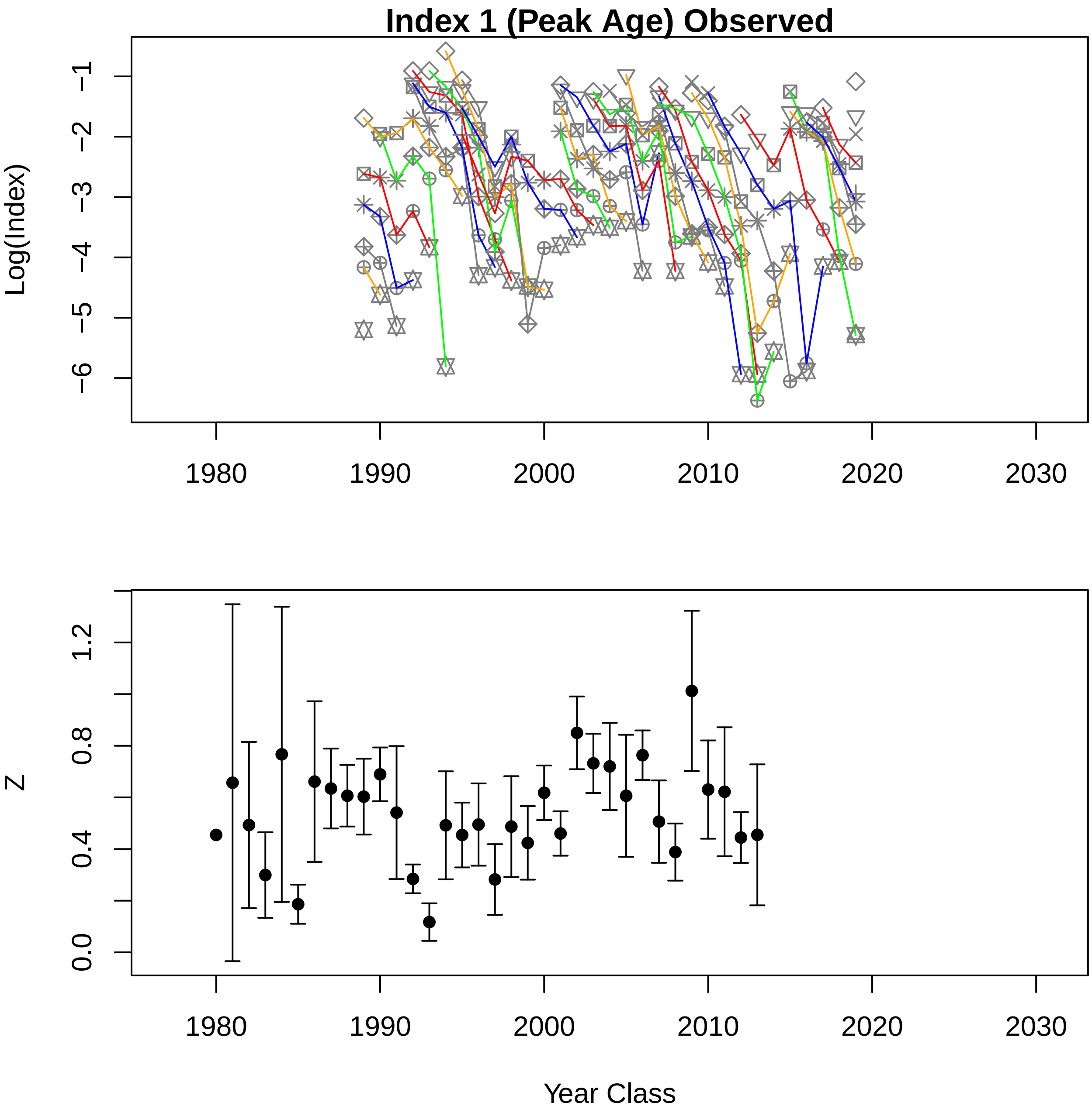

Indices
Selectivity at age
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
14
Age

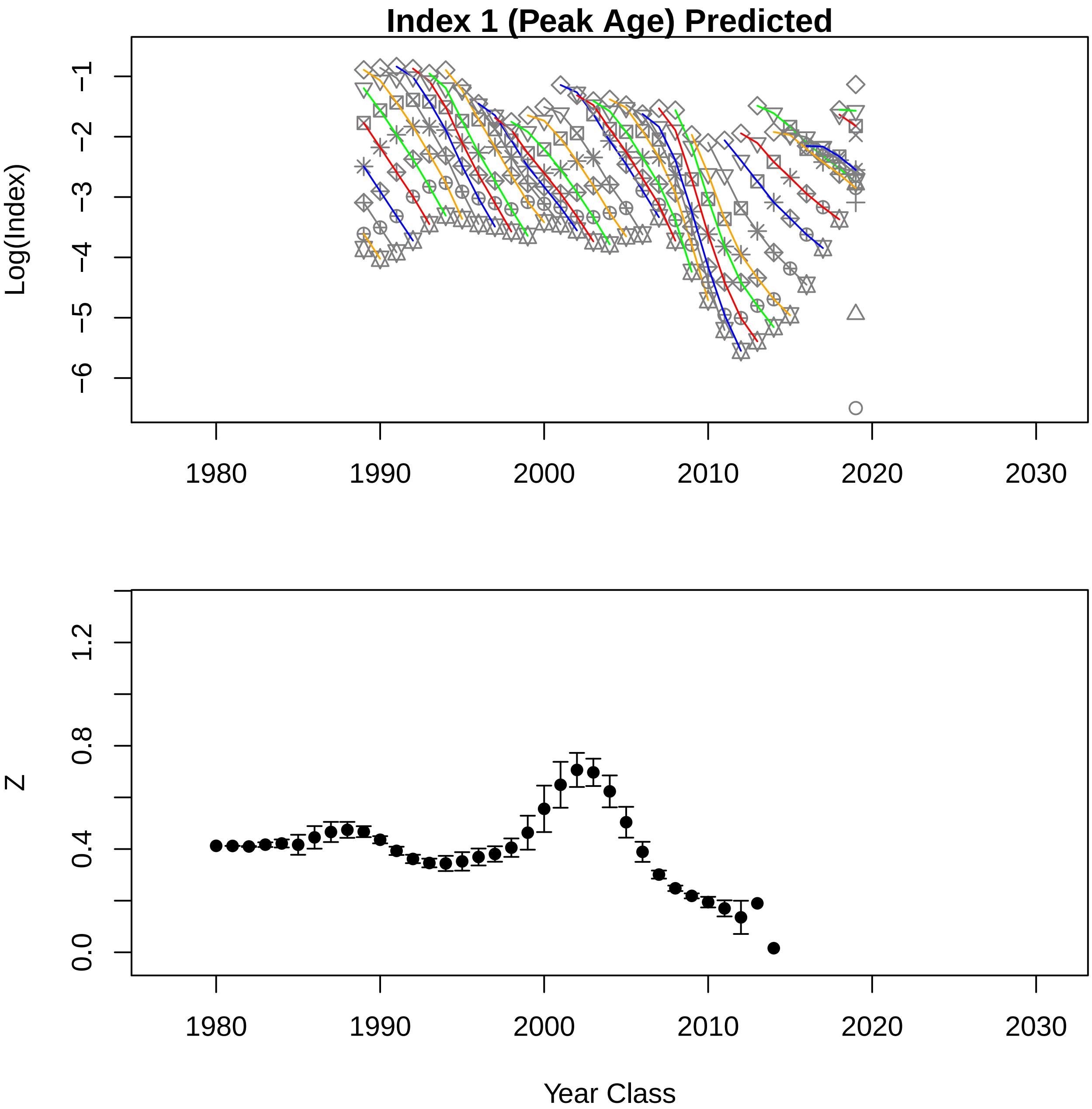


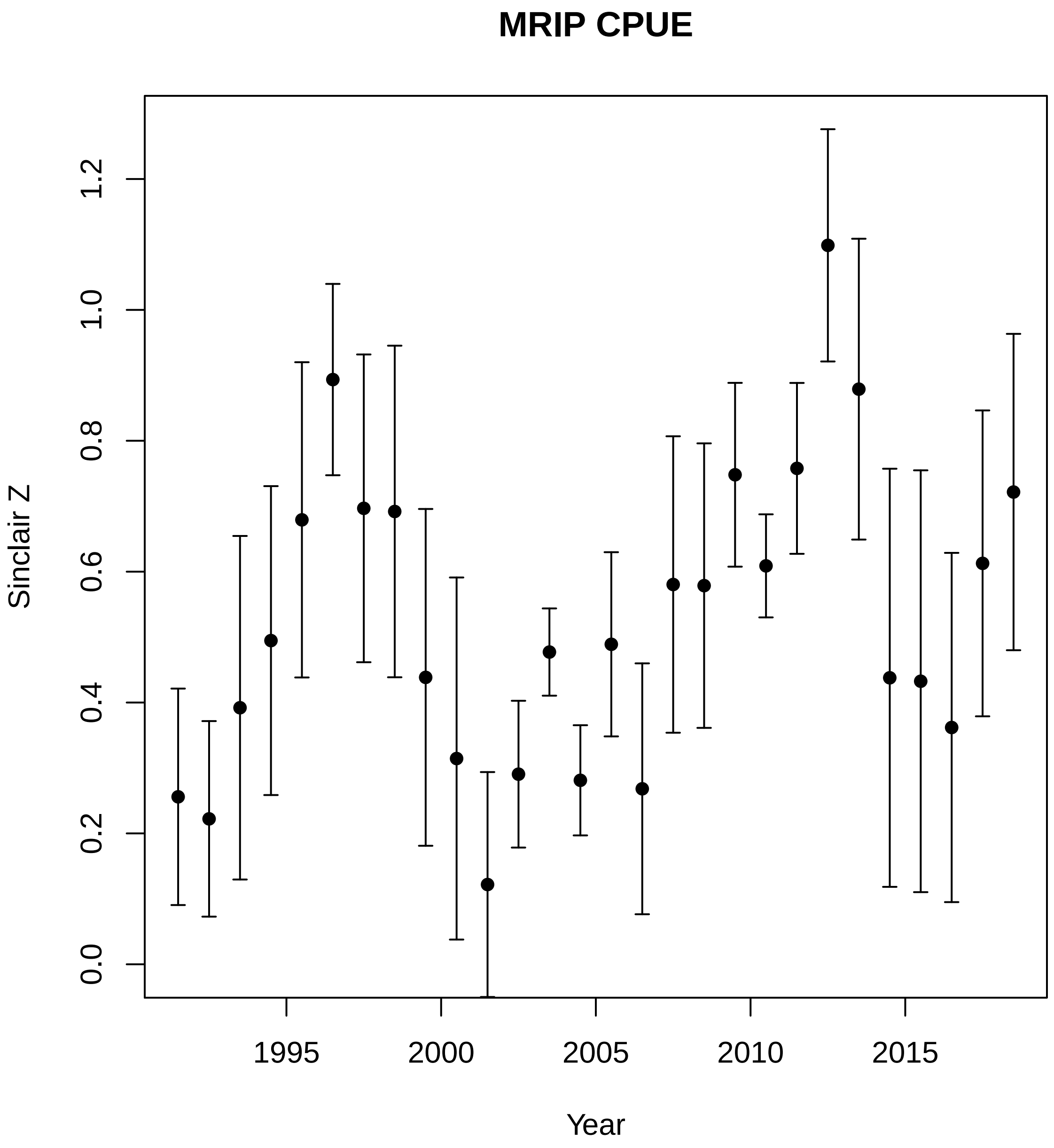
Catch (Peak Age) Observed
Log(Catch)
6
4
2
0
1980
1990
2000
2010
2020
2030
Z
2.0
1.0
0.0
−1.0
1980
1990
2000
2010
2020
2030
Year Class

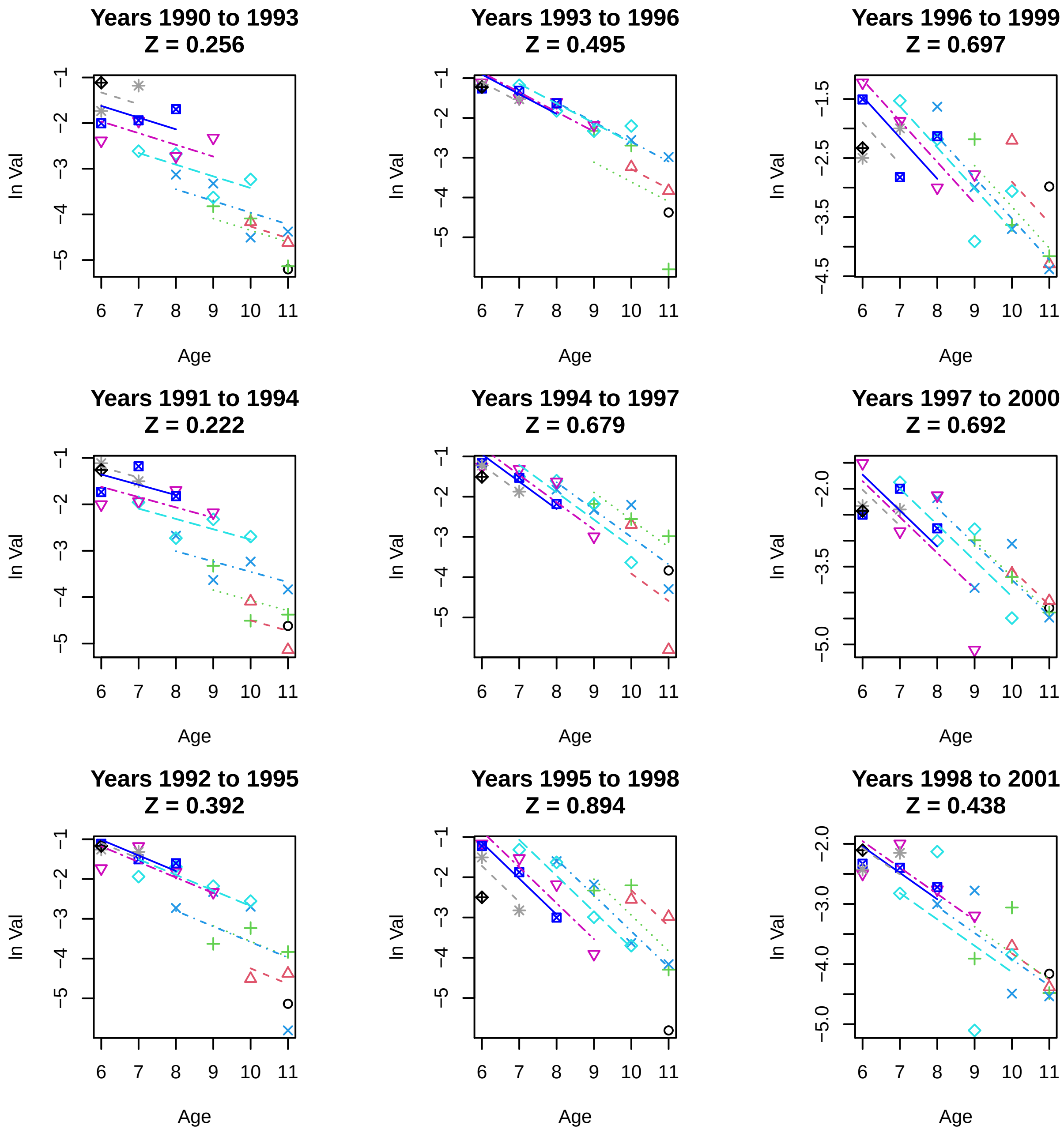


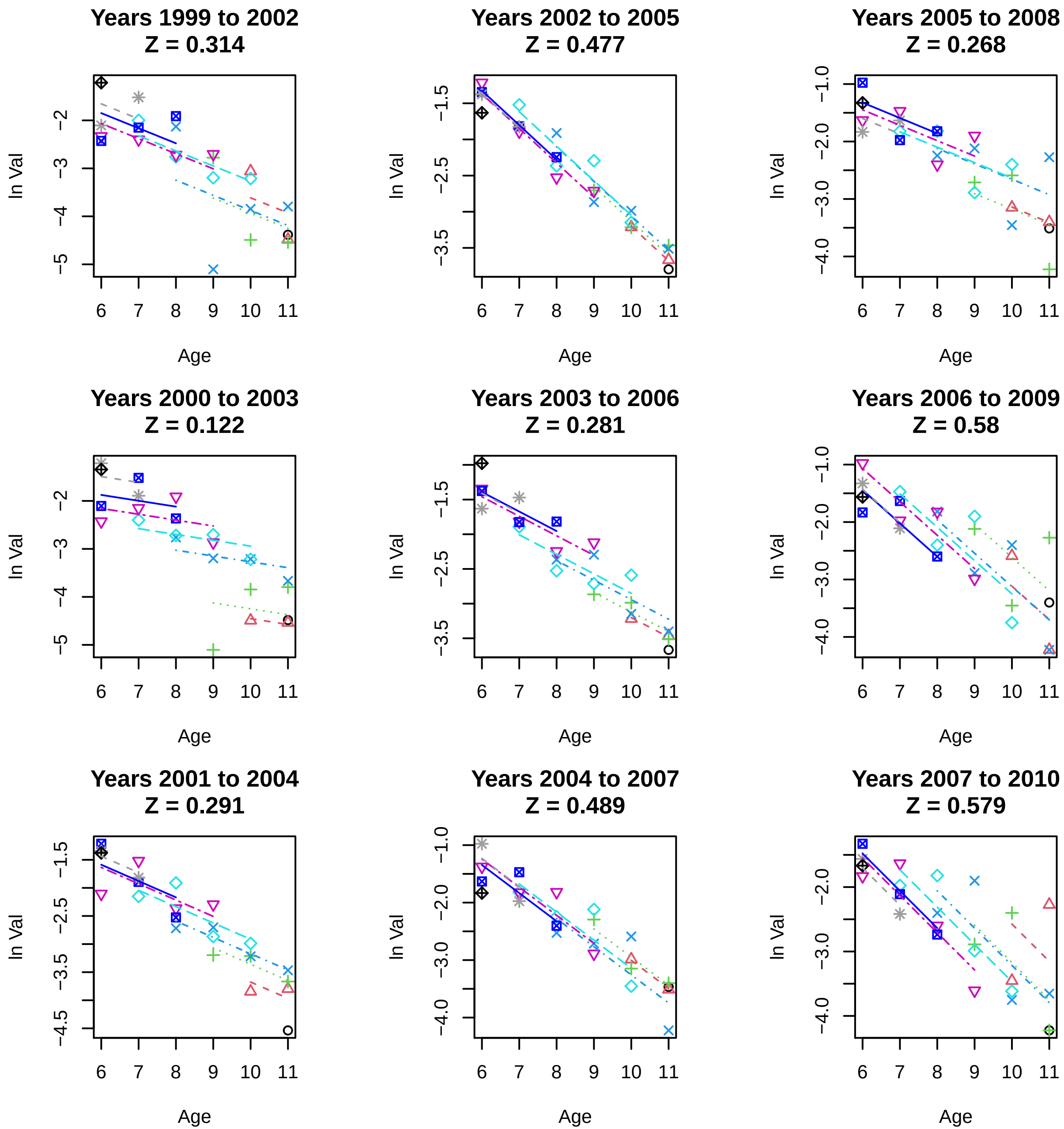
Catch (Peak Age) Predicted
Log(Catch)
0
2
4
6
1980
1990
2000
2010
2020
2030
Z
−1.0
0.0
1.0
2.0
1980
1990
2000
2010
2020
2030
Year Class


Index 1 (Peak Age) Observed
Log(Index)
−1
−2
−3
−4
−5
−6
1980
1990
2000
2010
2020
2030
Z
0.0
0.4
0.8
1.2
1980
1990
2000
2010
2020
2030
Year Class

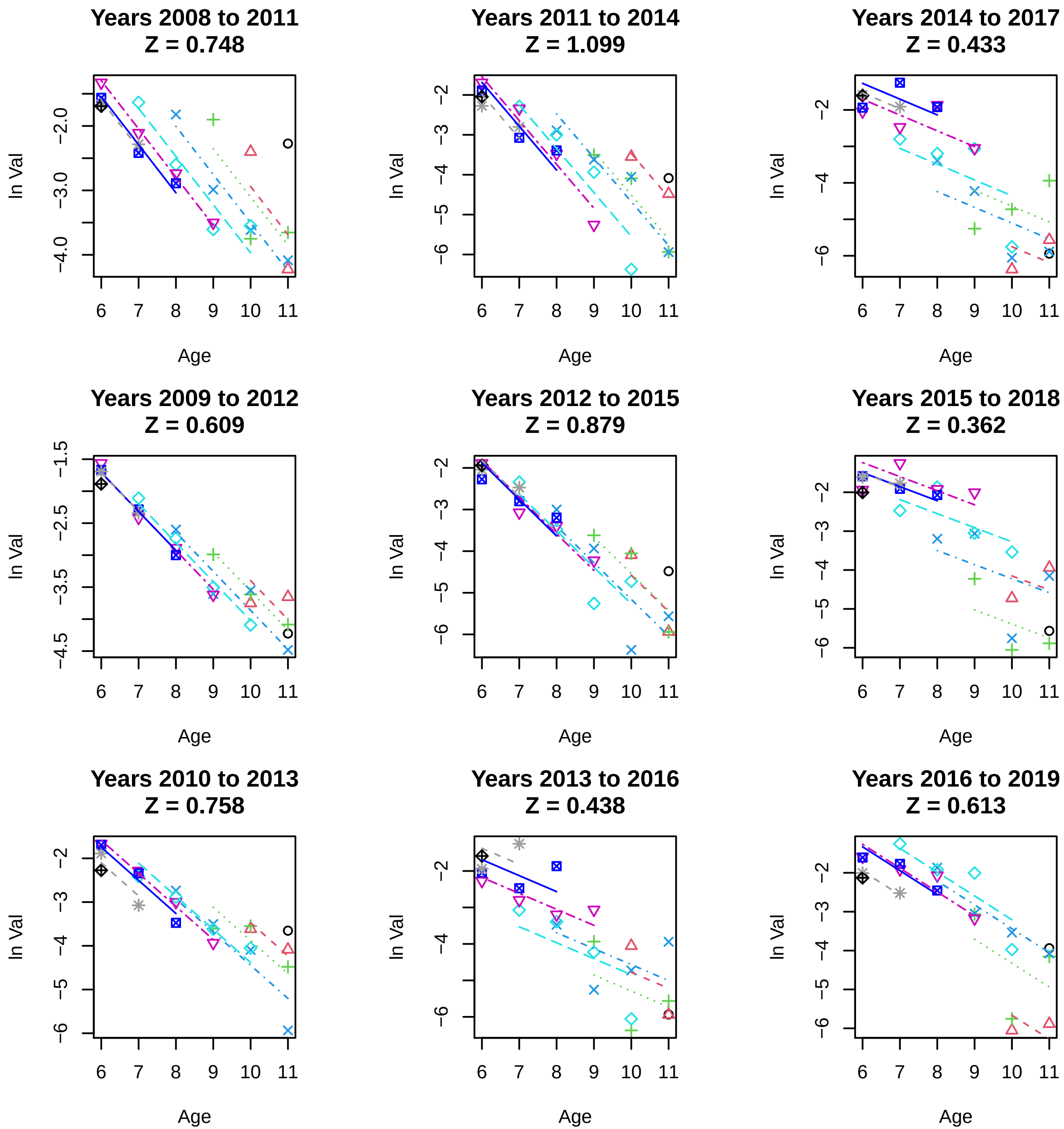

Index 1 (Peak Age) Predicted
Log(Index)
−1
−2
−3
−4
−5
−6
1980
1990
2000
2010
2020
2030
Z
0.0
0.4
0.8
1.2
Year Class

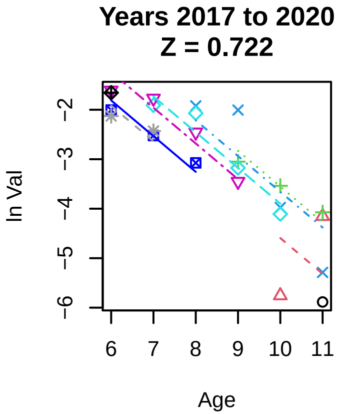

MRIP CPUE
Sinclair Z
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1995
2000
2005
2010
2015
Year


Years 1990 to 1993
Z = 0.256
Years 1993 to 1996
Z = 0.495
Years 1996 to 1999
Z = 0.697
Years 1991 to 1994
Z = 0.222
Years 1994 to 1997
Z = 0.679
Years 1997 to 2000
Z = 0.692
Years 1992 to 1995
Z = 0.392
Years 1995 to 1998
Z = 0.894
Years 1998 to 2001
Z = 0.438
ln Val
Age

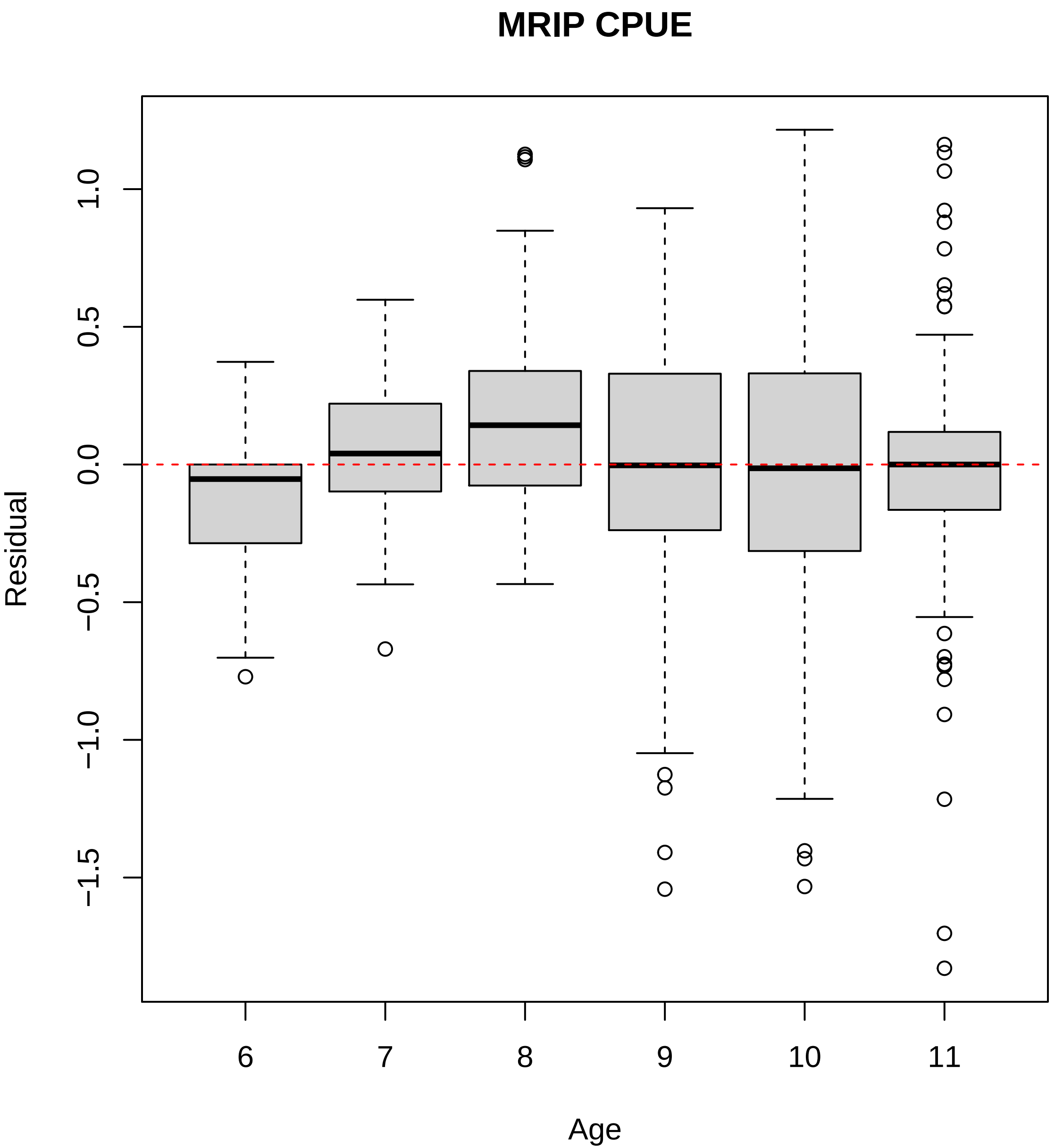


Years 1999 to 2002
Z = 0.314
Years 2002 to 2005
Z = 0.477
Years 2005 to 2008
Z = 0.268
Years 2000 to 2003
Z = 0.122
Years 2003 to 2006
Z = 0.281
Years 2006 to 2009
Z = 0.58
Years 2001 to 2004
Z = 0.291
Years 2004 to 2007
Z = 0.489
Years 2007 to 2010
Z = 0.579
ln Val
Age
6 7 8 9 10 11

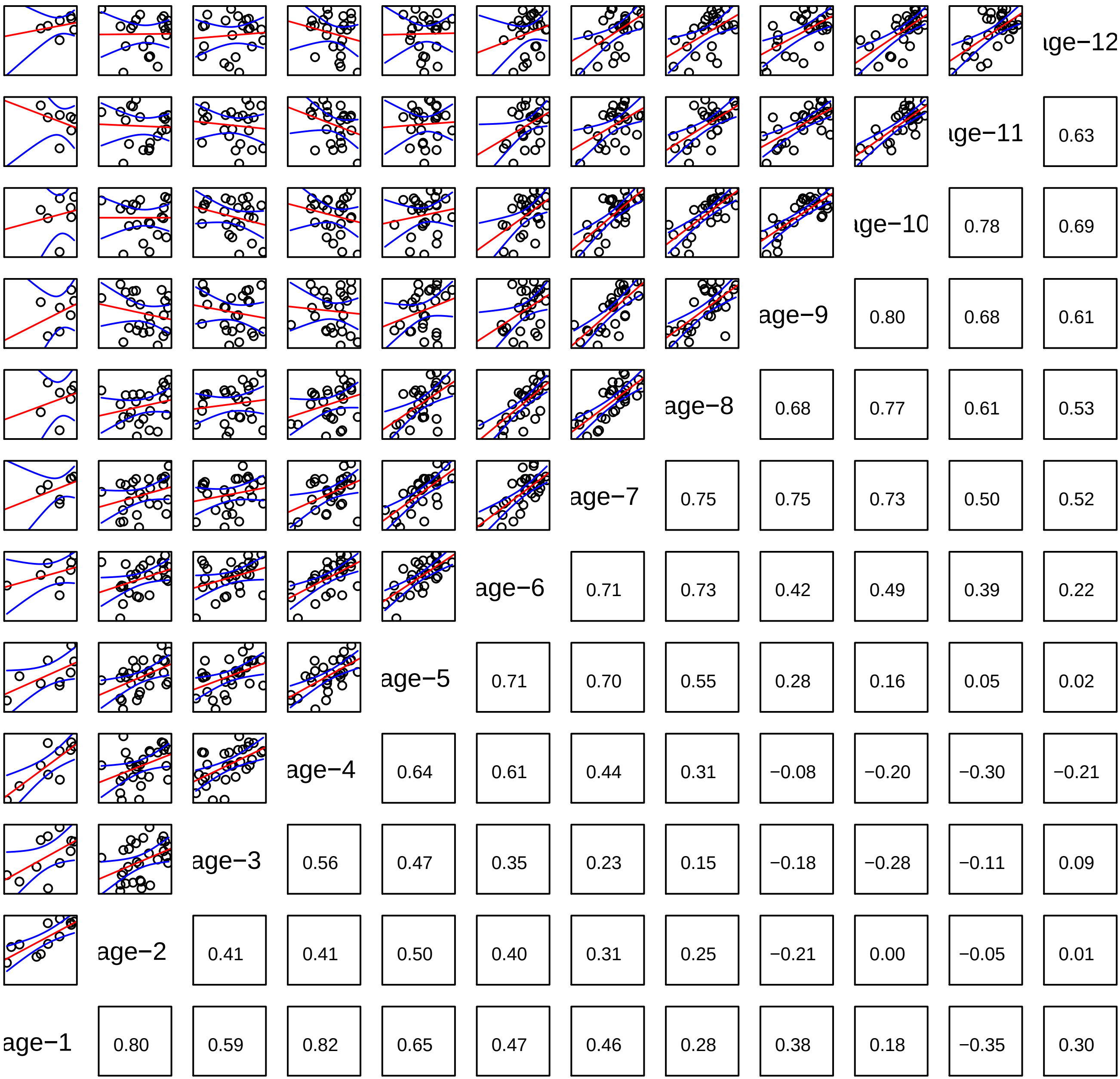

Years 2008 to 2011
Z = 0.748
Years 2011 to 2014
Z = 1.099
Years 2014 to 2017
Z = 0.433
Years 2009 to 2012
Z = 0.609
Years 2012 to 2015
Z = 0.879
Years 2015 to 2018
Z = 0.362
Years 2010 to 2013
Z = 0.758
Years 2013 to 2016
Z = 0.438
Years 2016 to 2019
Z = 0.613
ln Val
Age



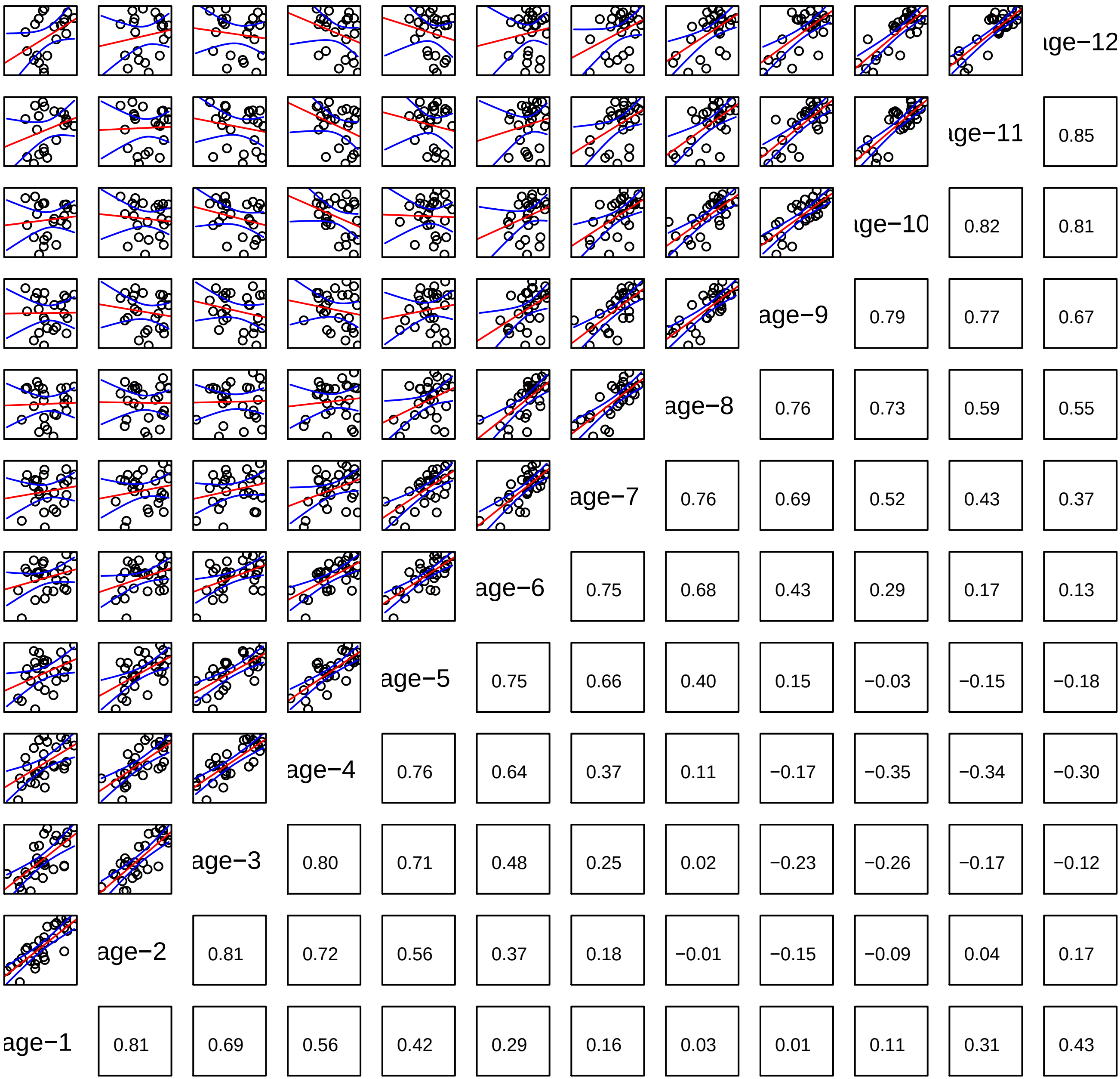
Years 2017 to 2020
Z = 0.722
ln Val
−2
−3
−4
−5
−6
6
7
8
9
10
11
Age


MRIP CPUE
Residual
1.0
0.5
0.0
−0.5
−1.0
−1.5
6
7
8
9
10
11
Age

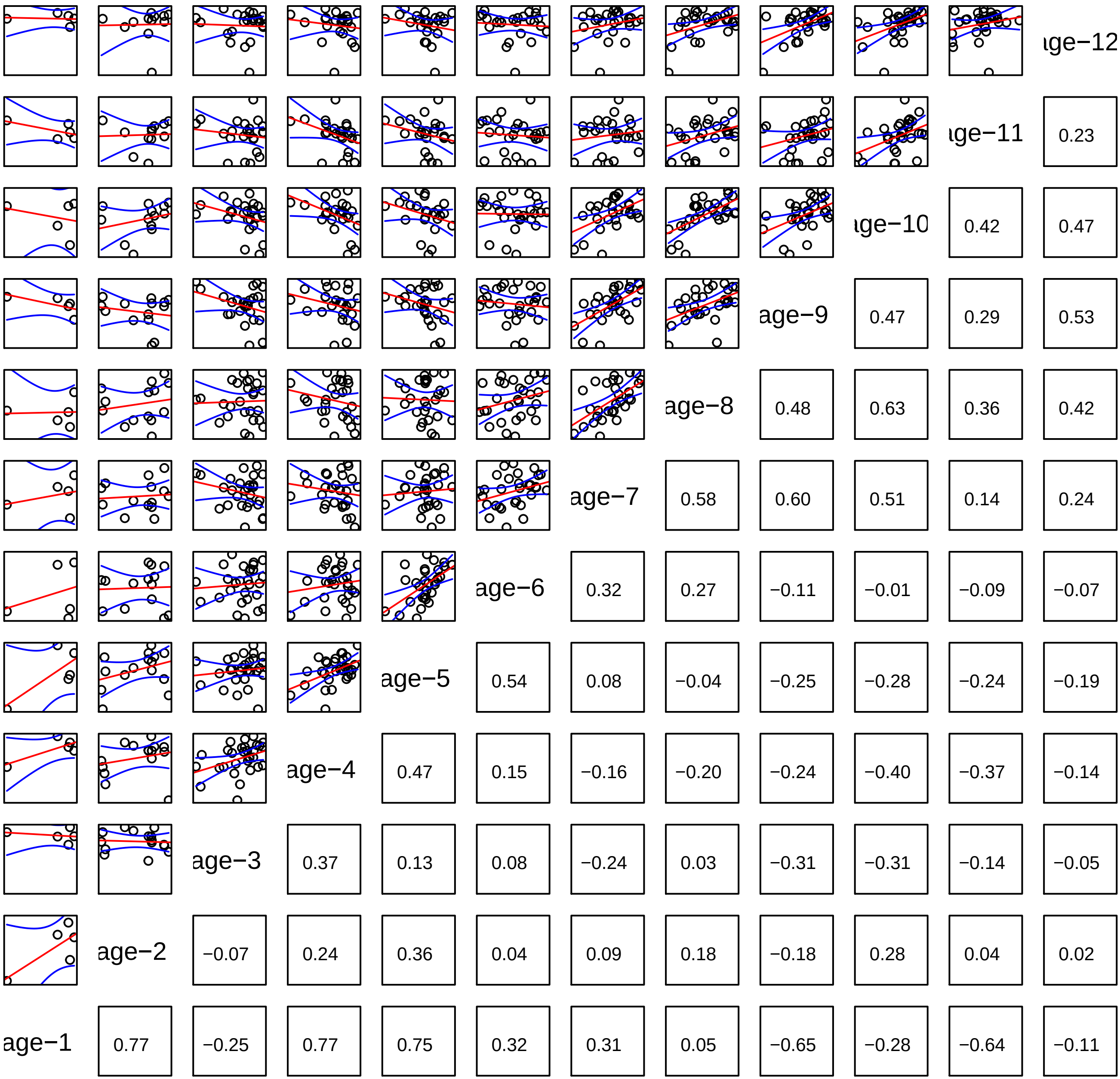
Catch Observed



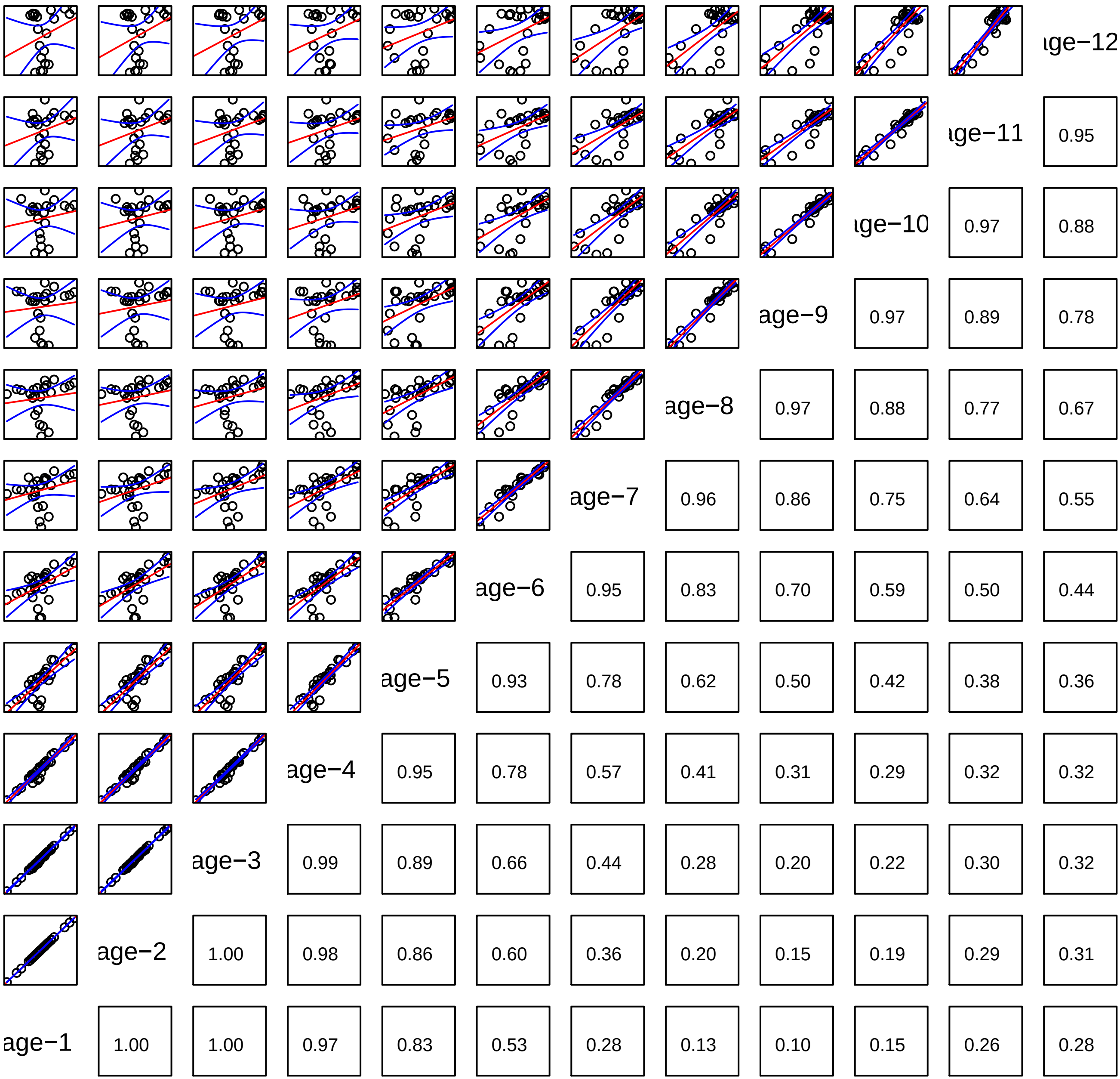
Catch Predicted

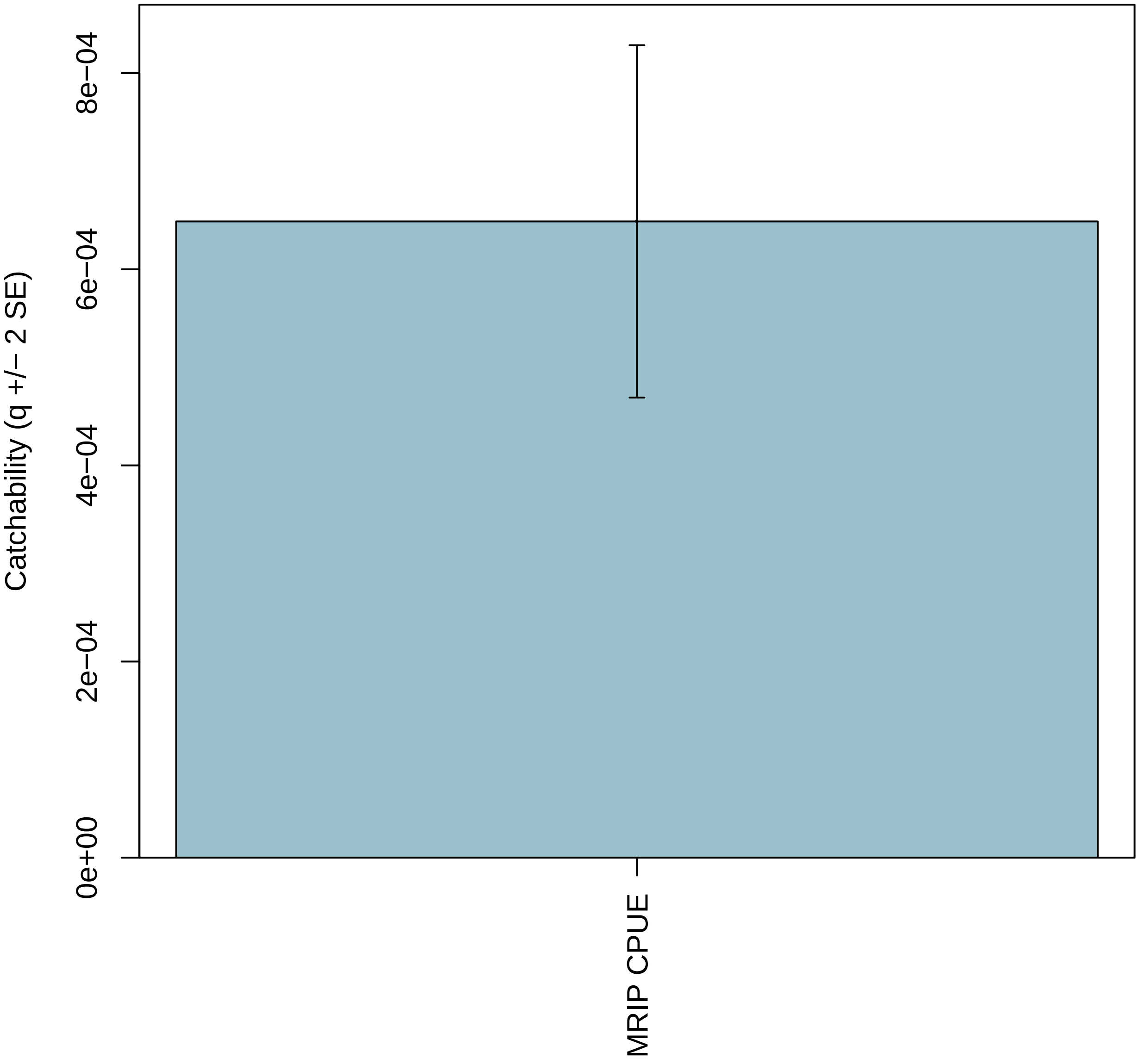


Index 1 (MRIP CPUE) Observed

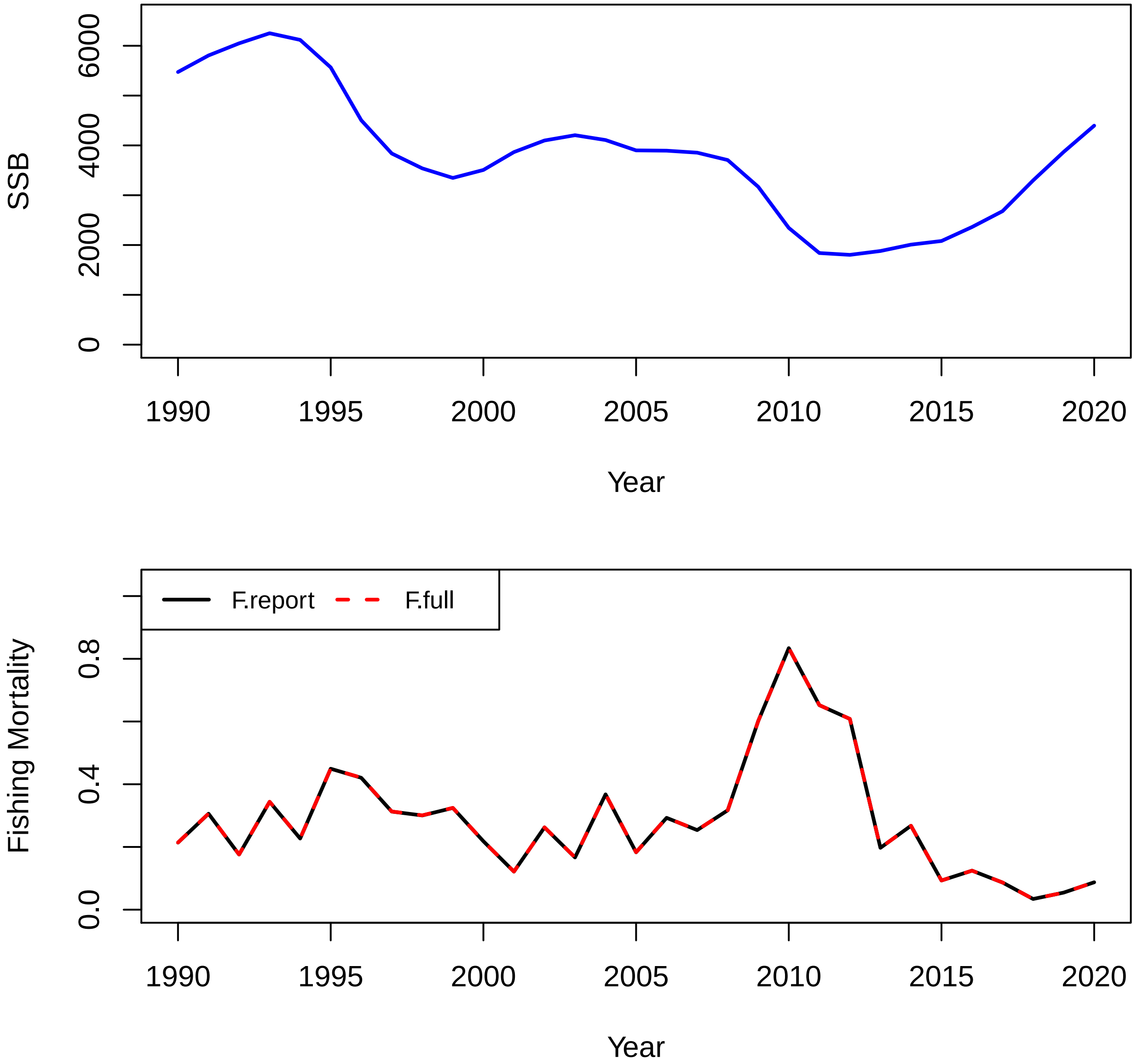


Index 1 (MRIP CPUE) Predicted

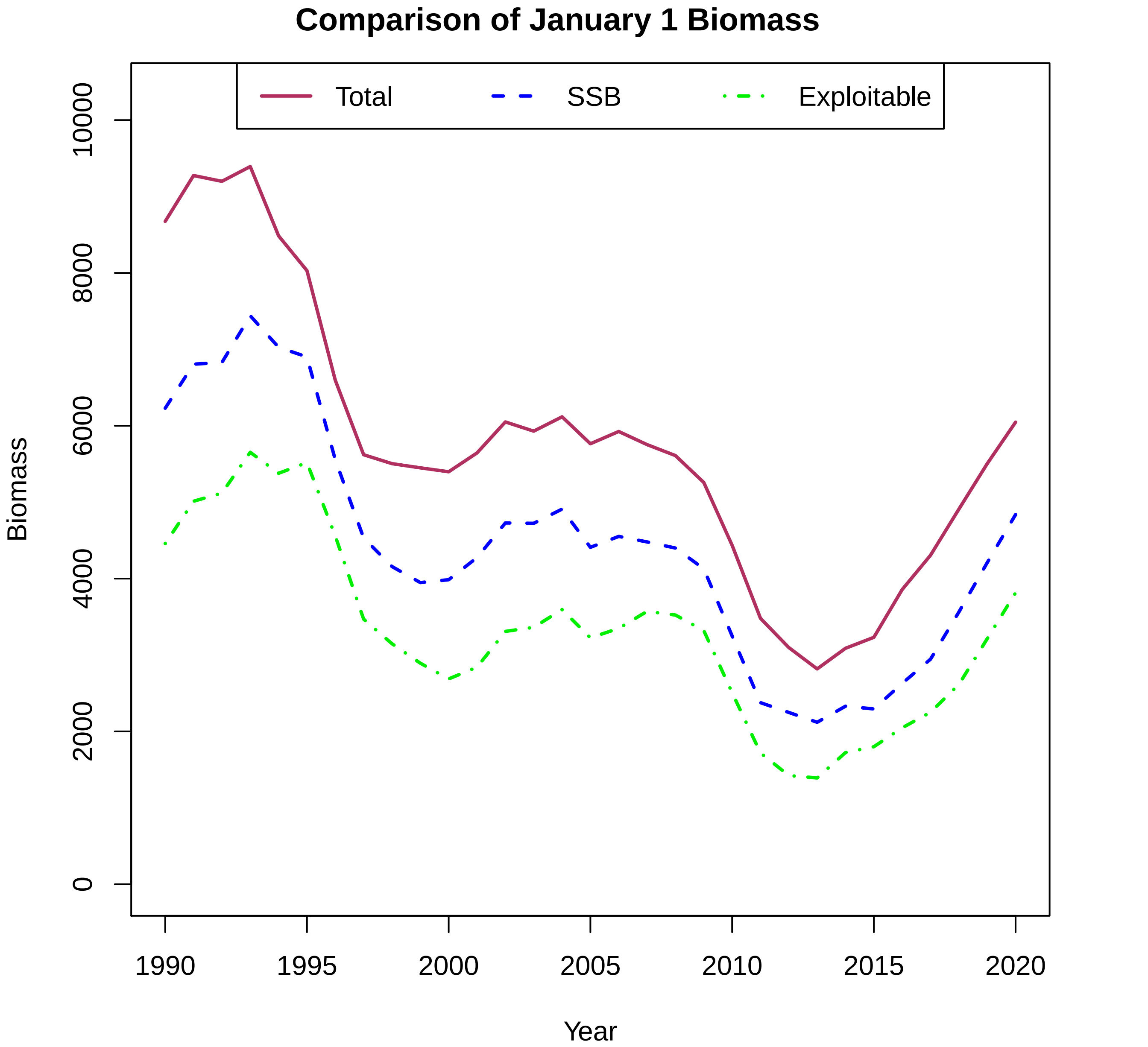


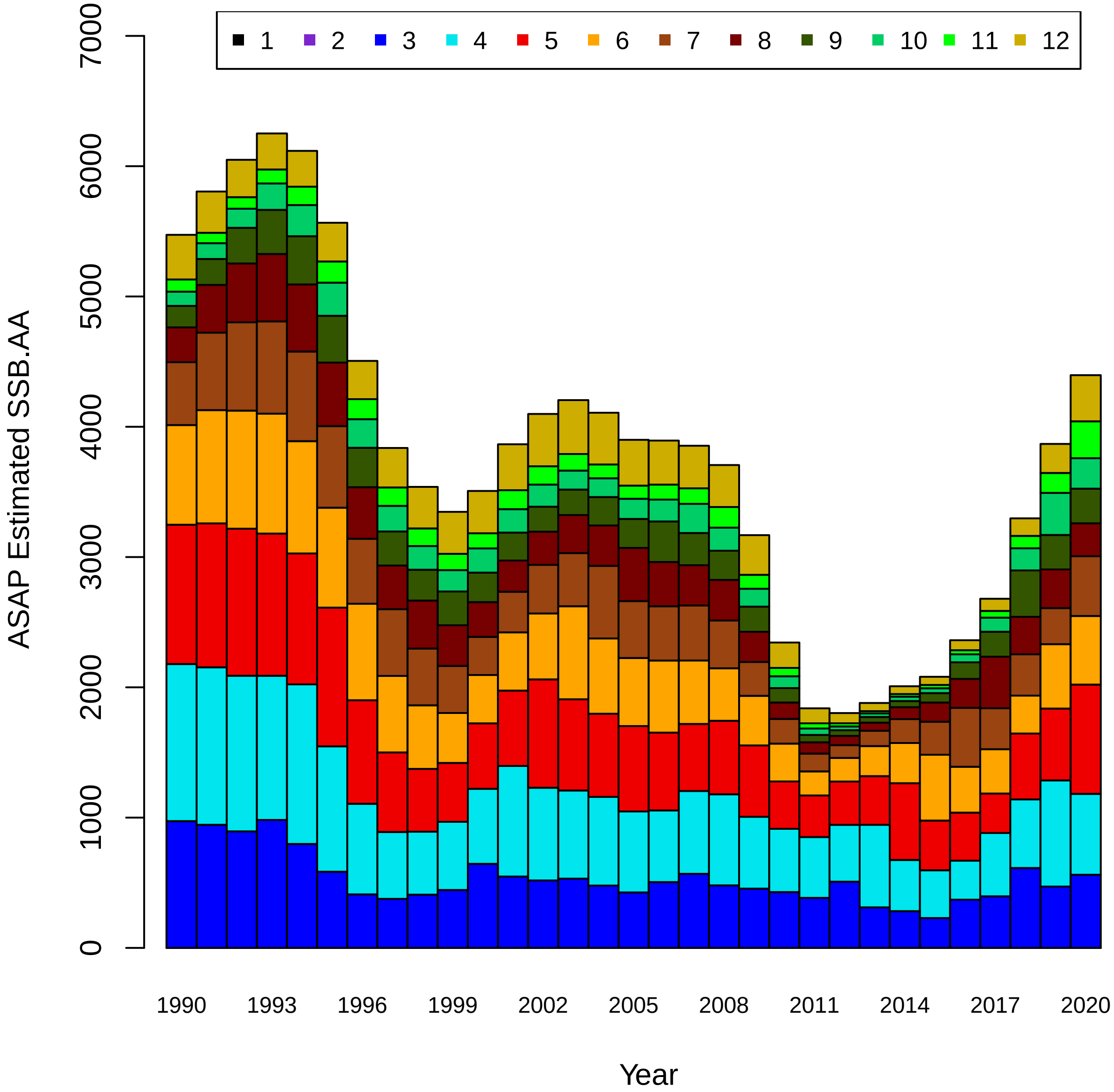


Catchability (q +/− 2 SE)
0e+00
2e−04
4e−04
6e−04
8e−04
MRIP CPUE

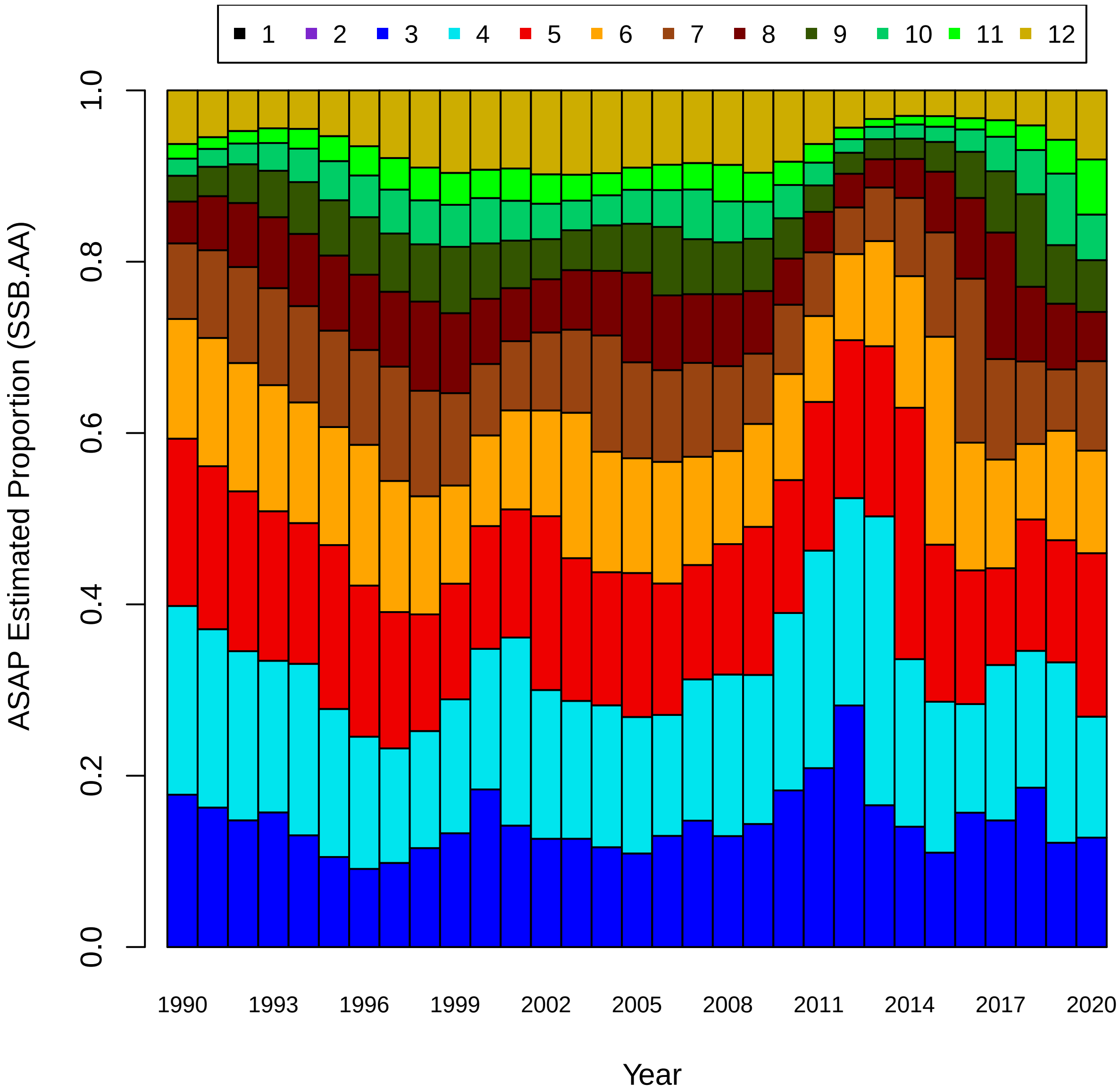


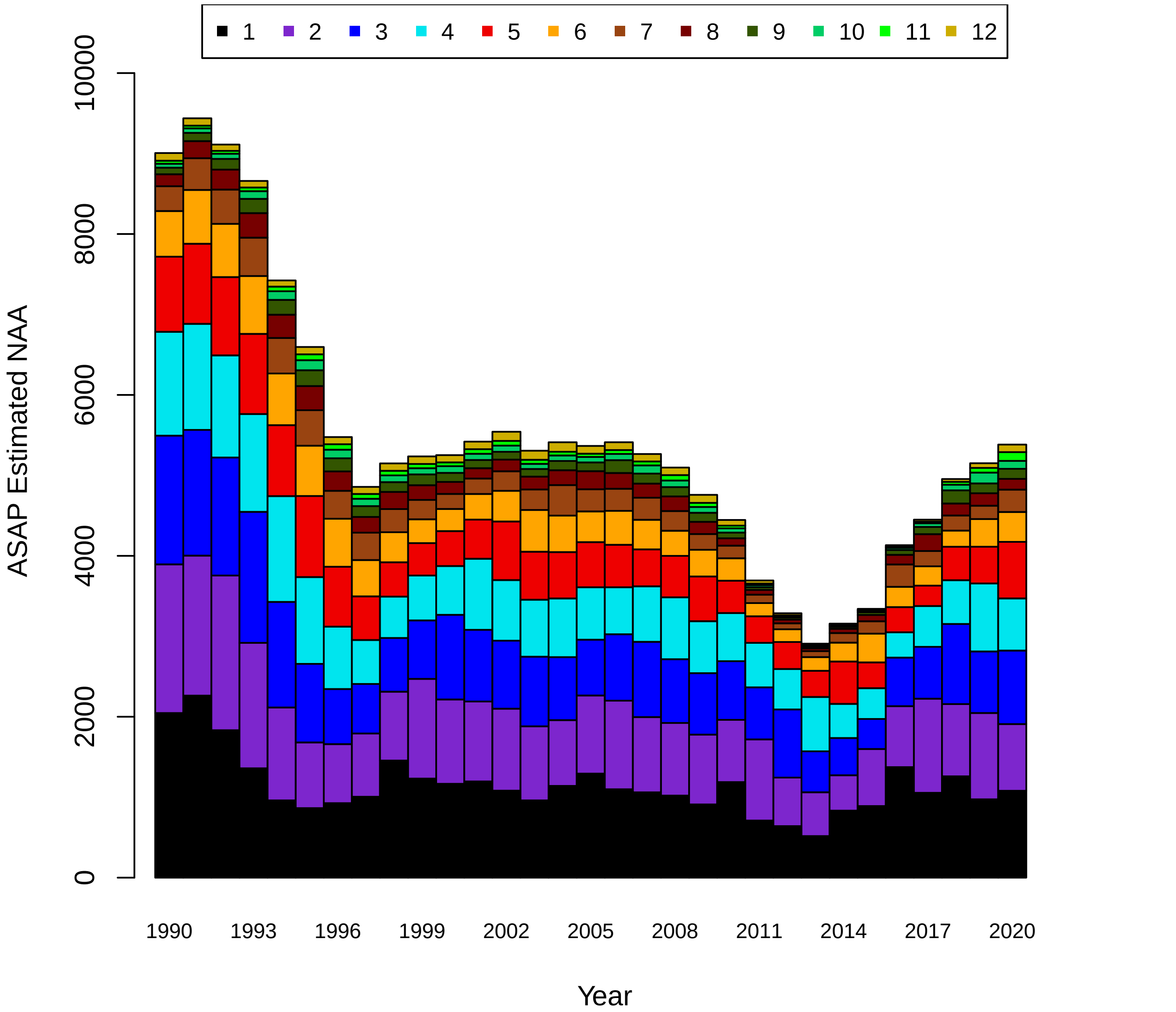
SSB
6000
4000
2000
0
1990
1995
2000
2005
2010
2015
2020
Year
Fishing Mortality
F.report
F.full
0.8
0.4
0.0
1990
1995
2000
2005
2010
2015
2020
Year


Comparison of January 1 Biomass
Total
SSB
Exploitable
Biomass
0
2000
4000
6000
8000
10000
Year
1990
1995
2000
2005
2010
2015
2020

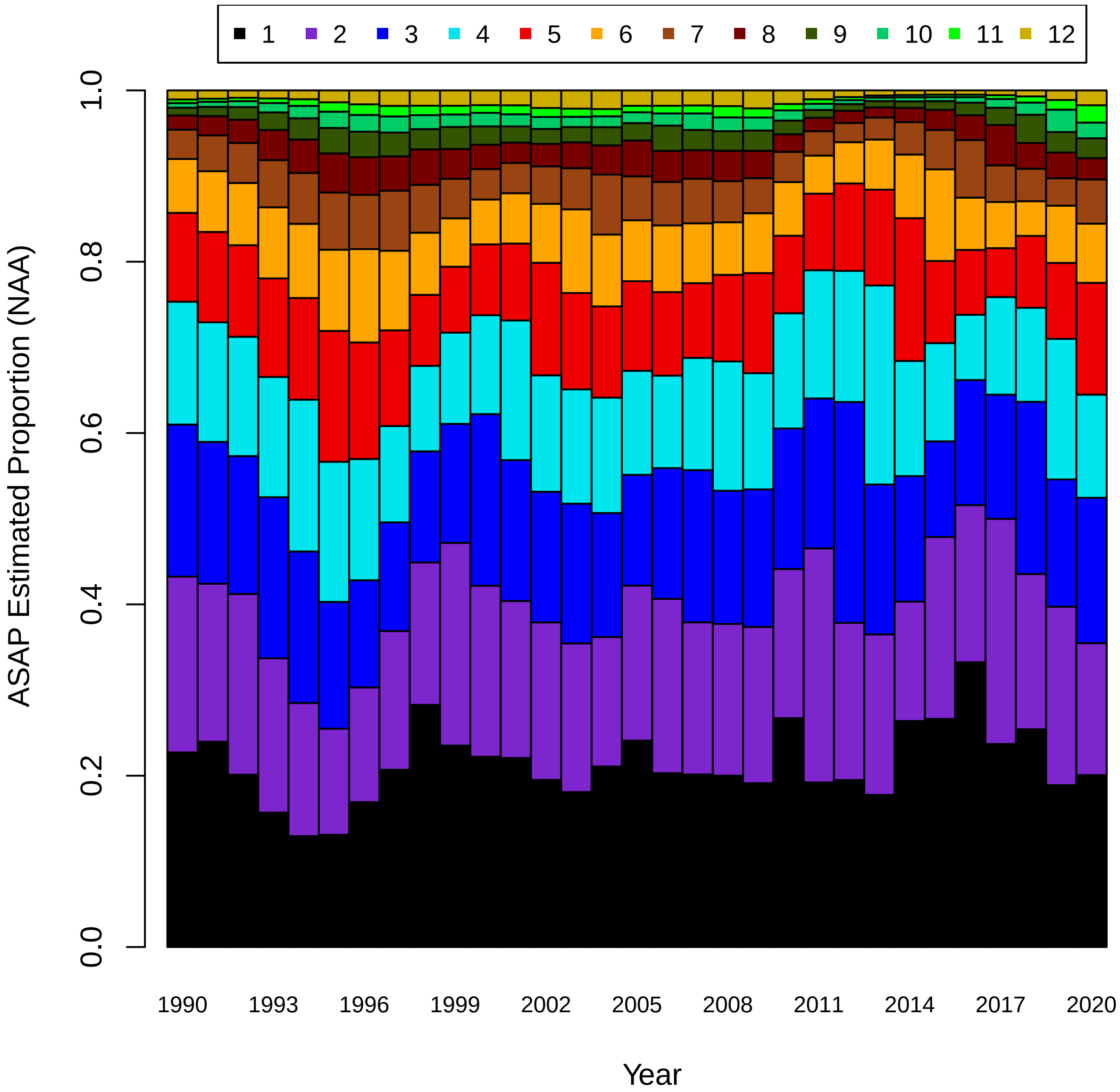


1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated SSB.AA
0
1000
2000
3000
4000
5000
6000
7000
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year

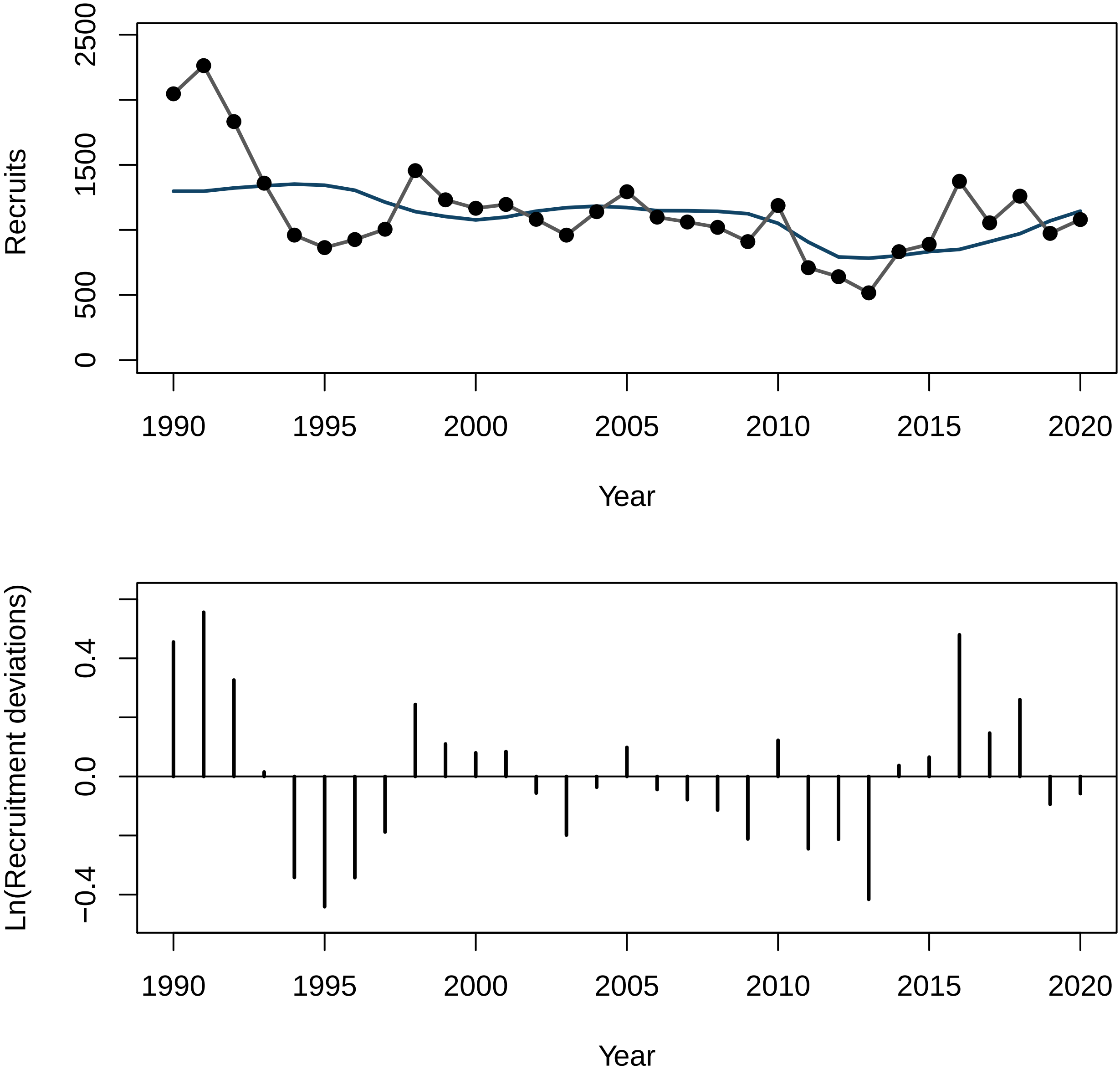

1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (SSB.AA)
0.0
0.2
0.4
0.6
0.8
1.0
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year



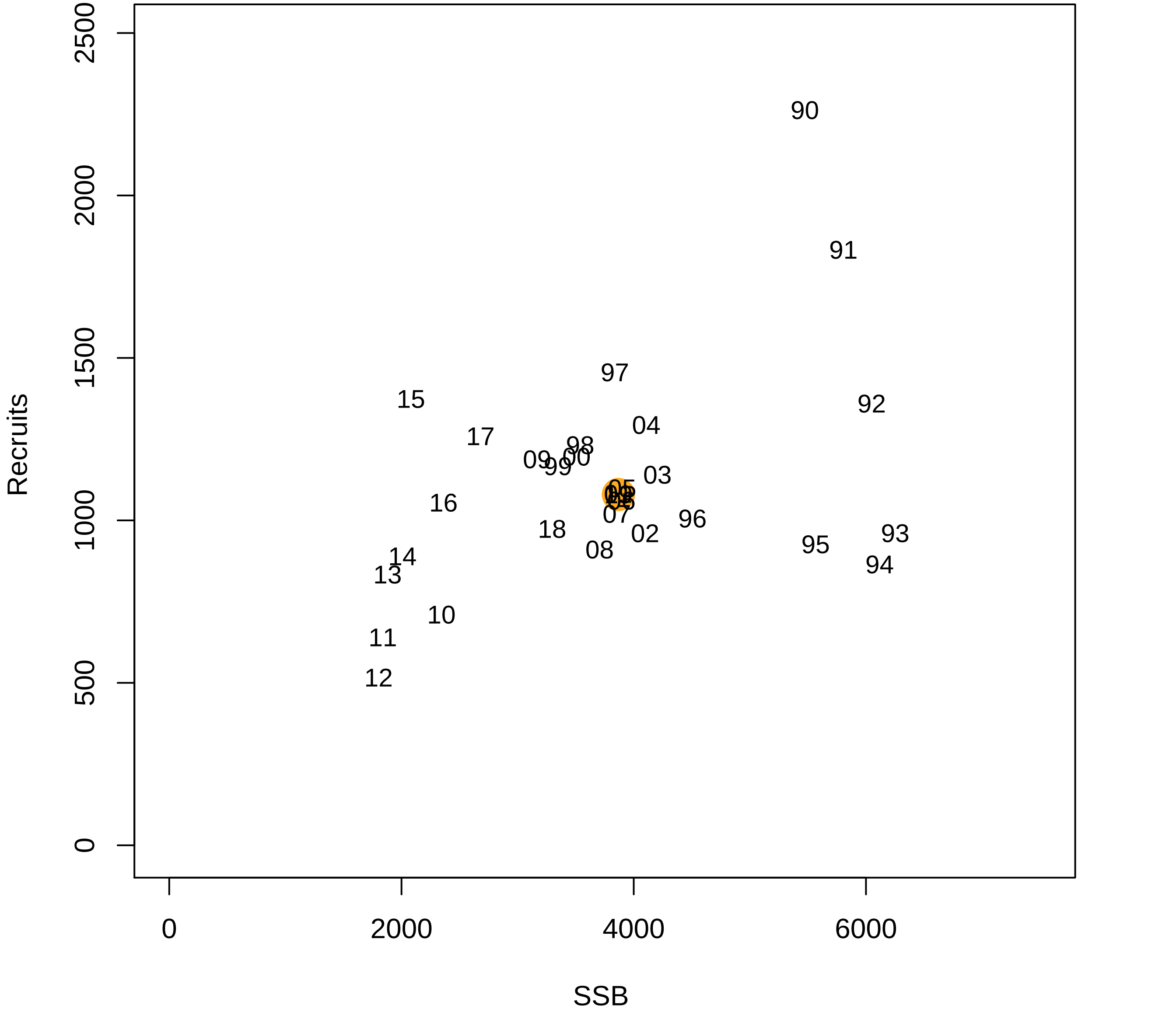
1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated NAA
0
2000
4000
6000
8000
10000
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year



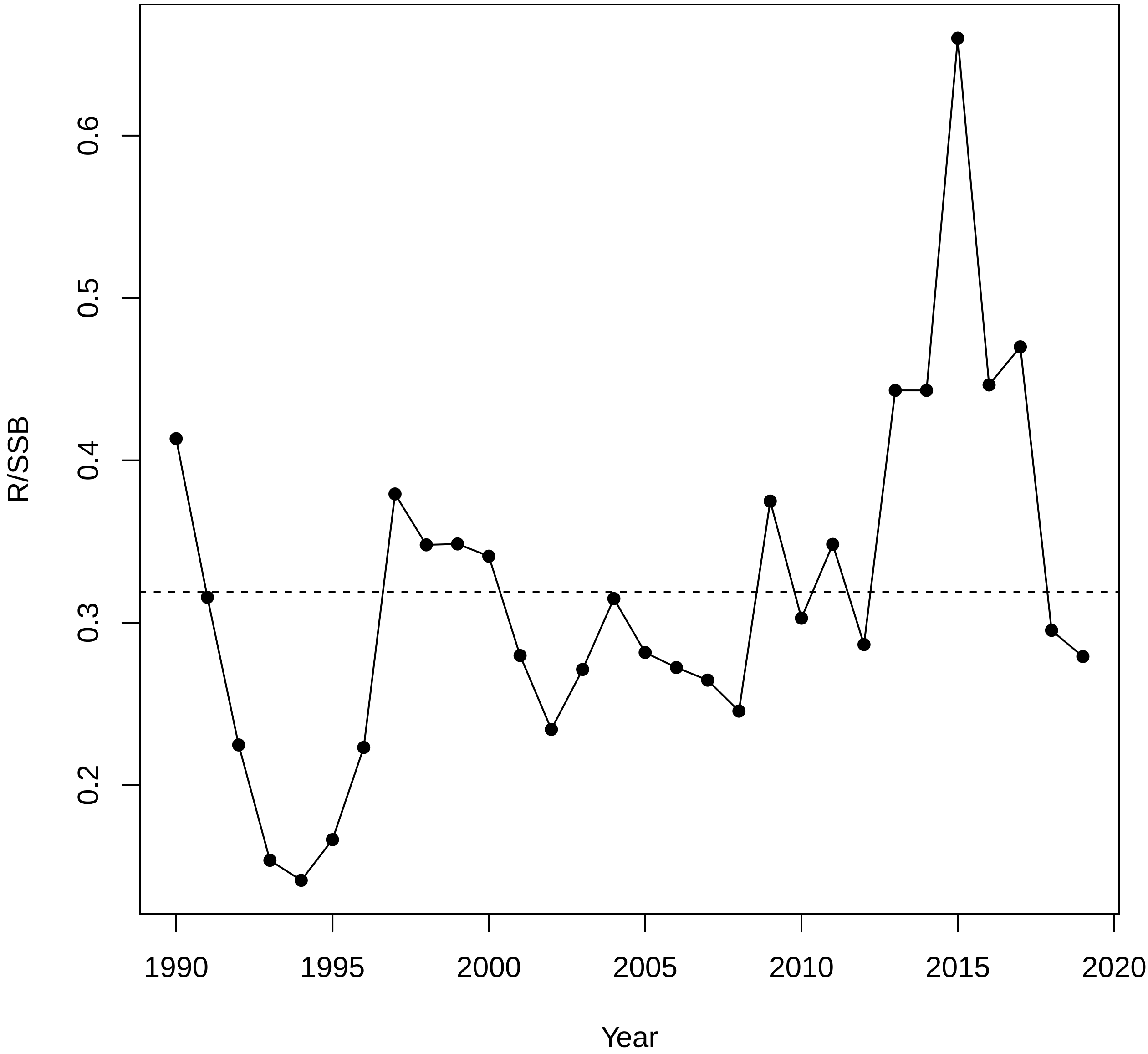
1
2
3
4
5
6
7
8
9
10
11
12
ASAP Estimated Proportion (NAA)
0.0
0.2
0.4
0.6
0.8
1.0
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year

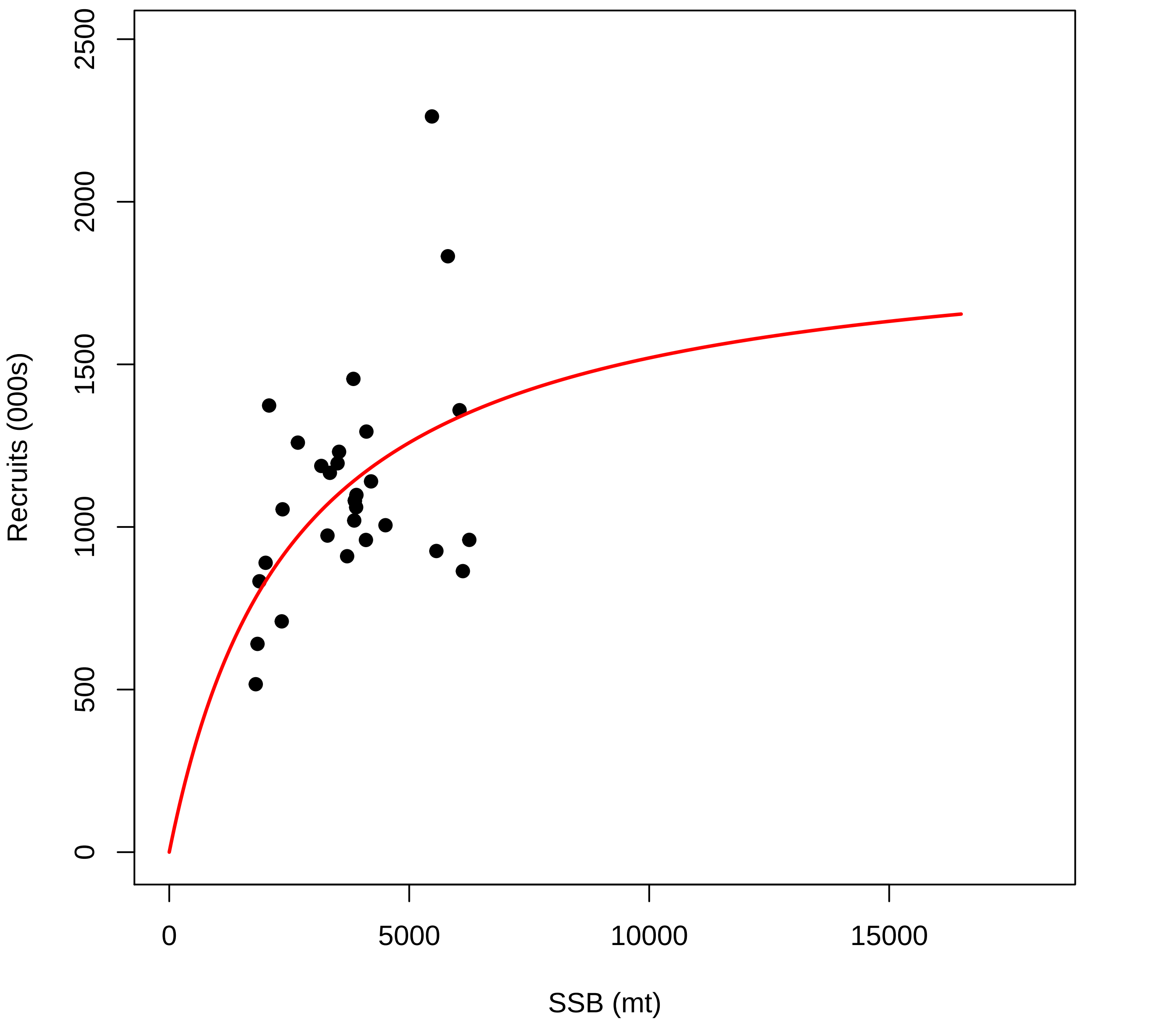


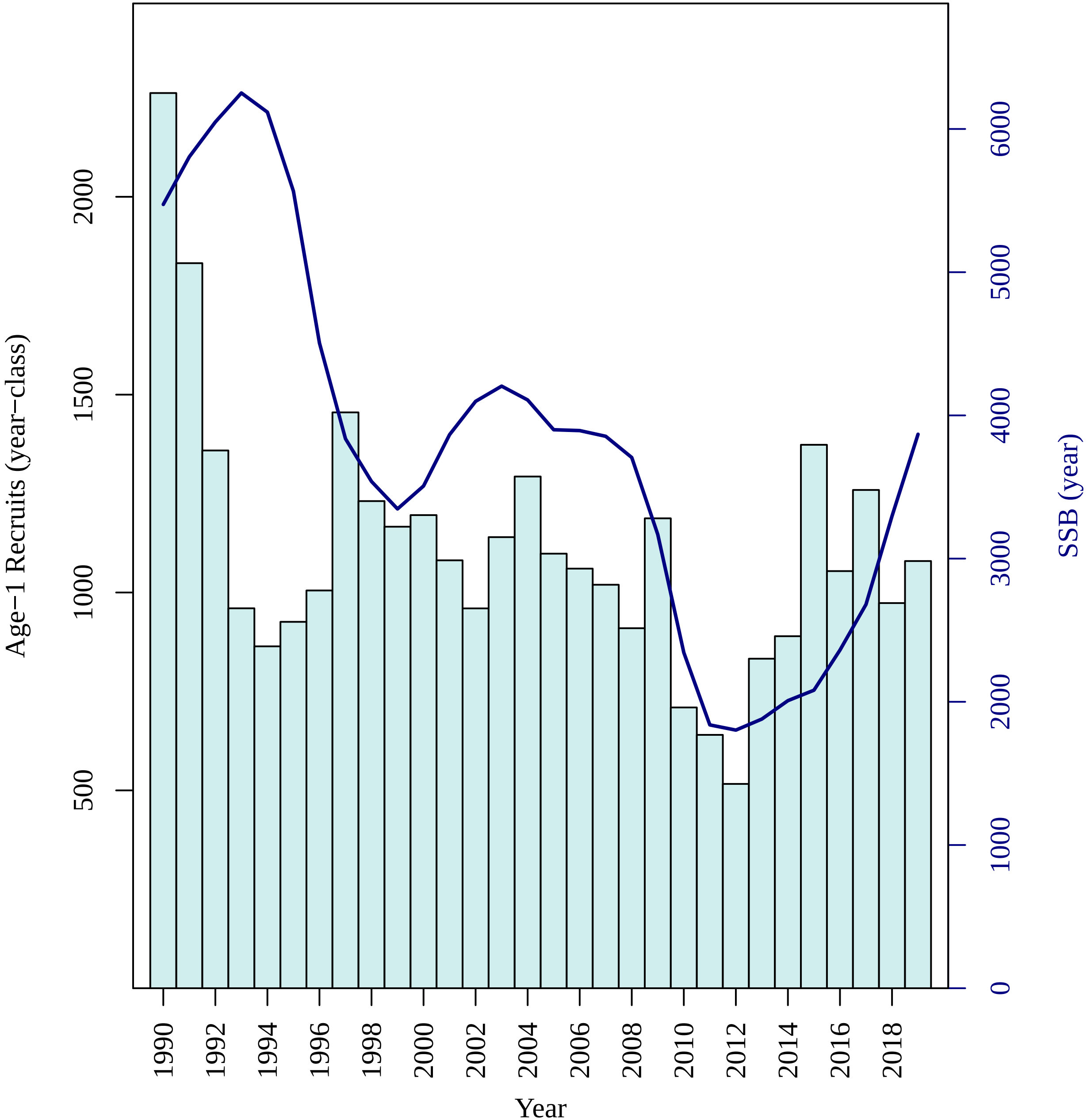
Recruits
0
500
1500
2500
1990
1995
2000
2005
2010
2015
2020
Year
Ln(Recruitment deviations)
−0.4
0.0
0.4
1990
1995
2000
2005
2010
2015
2020
Year



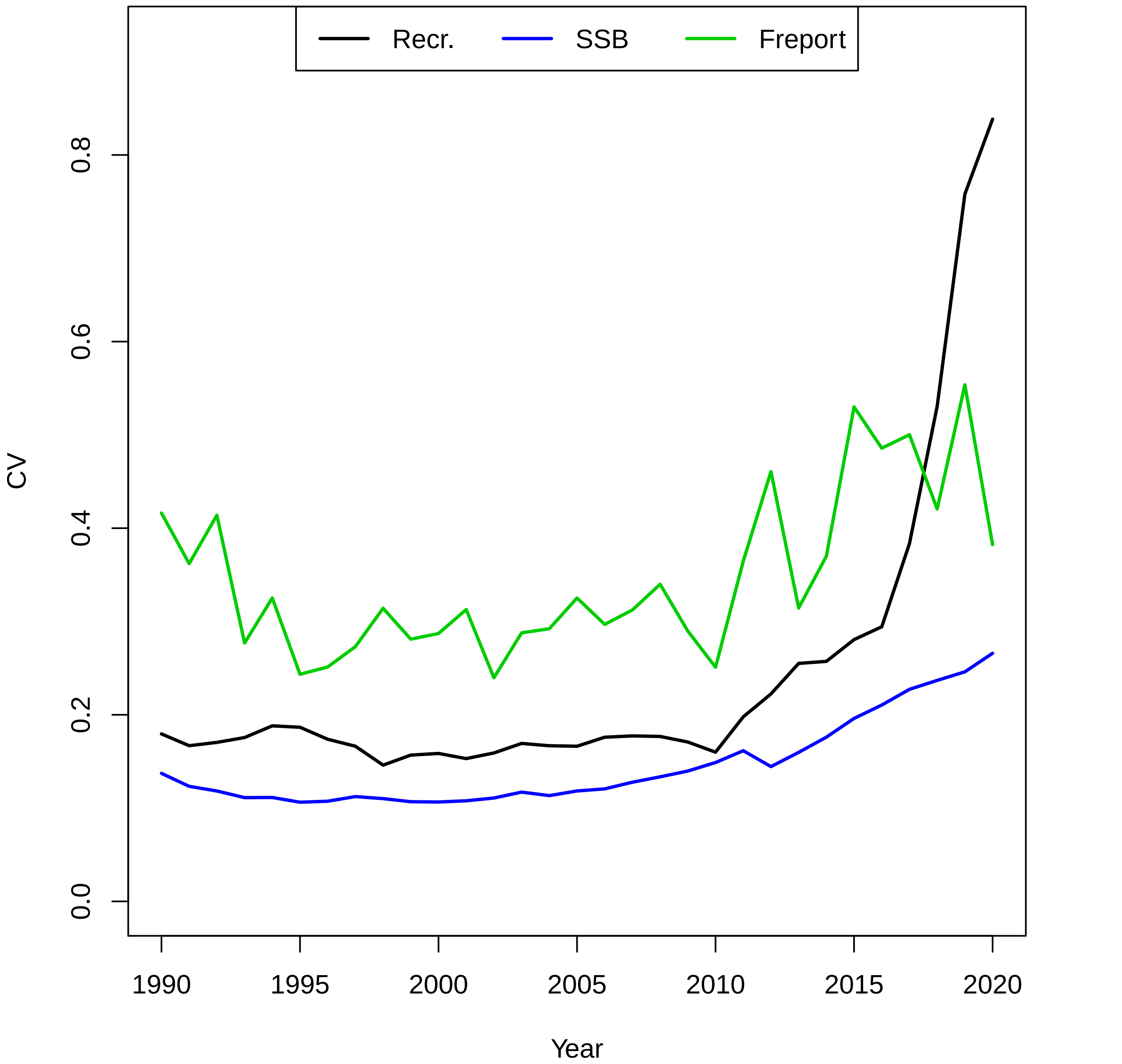
Recruits
SSB
0
500
1000
1500
2000
2500
0
2000
4000
6000
90
91
92
93
94
95
96
97
98
99
00
02
03
04
07
08
09
10
11
12
13
14
15
16
17
18

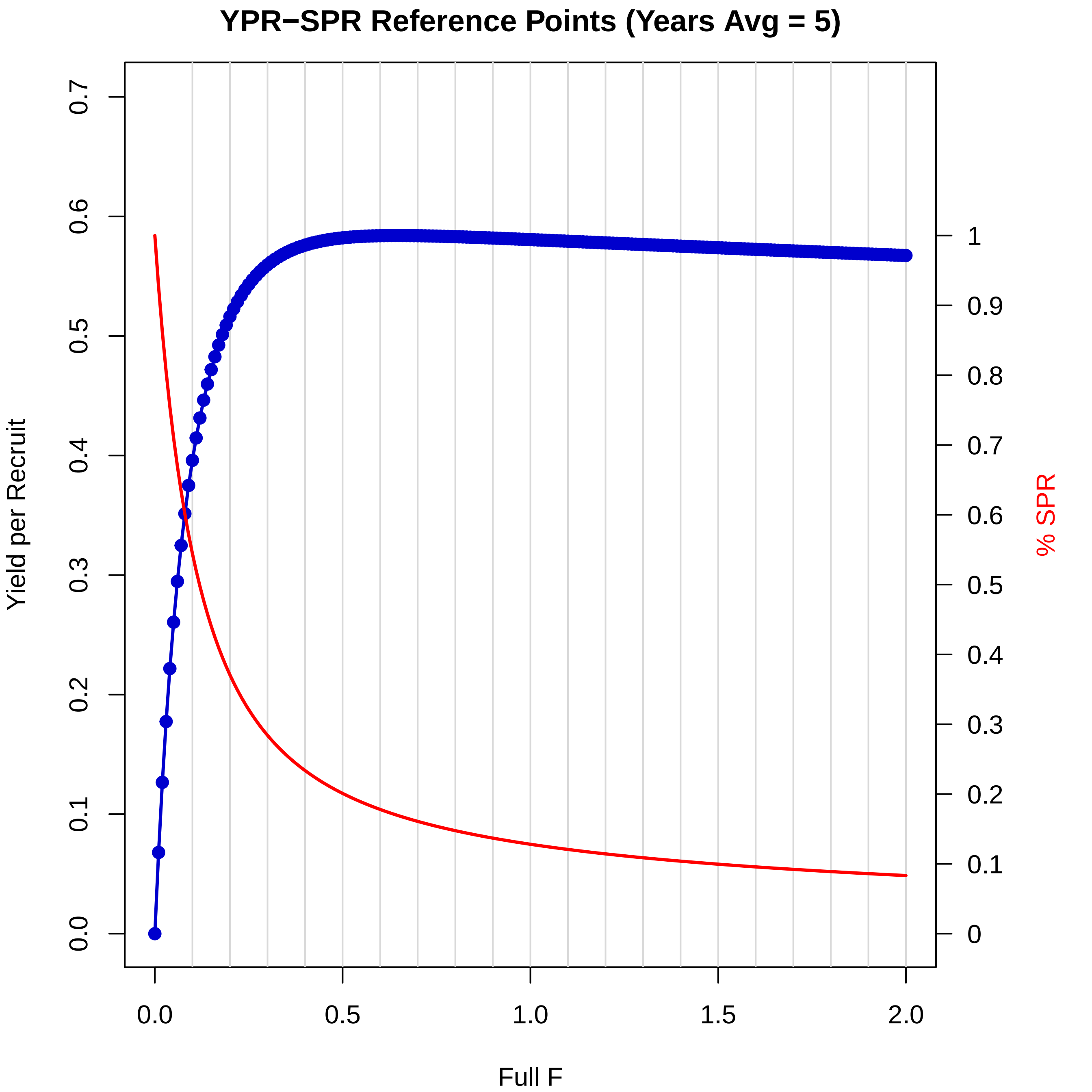

0.6
0.5
0.4
0.3
0.2
R/SSB
1990
1995
2000
2005
2010
2015
2020
Year


Recruits (000s)
0
500
1000
1500
2000
2500
0
5000
10000
15000
SSB (mt)



Age−1 Recruits (year−class)
500
1000
1500
2000
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
0
1000
2000
3000
4000
5000
6000
SSB (year)

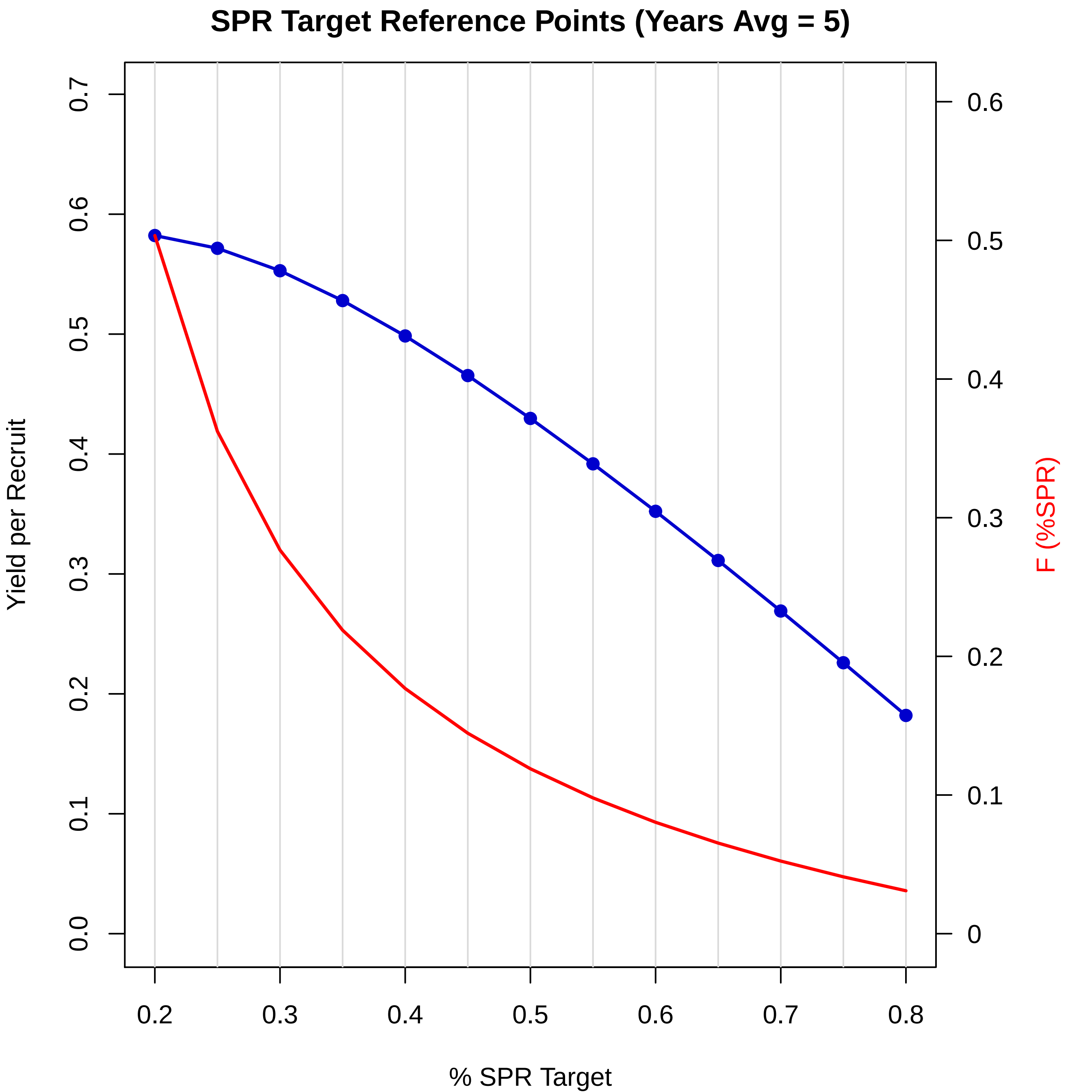

Recr.
SSB
Freport
CV
0.0
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
2020
Year



YPR−SPR Reference Points (Years Avg = 5)
Yield per Recruit
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
% SPR
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Full F
0.0
0.5
1.0
1.5
2.0

YPR−SPR Reference Points (Years Avg = 5)

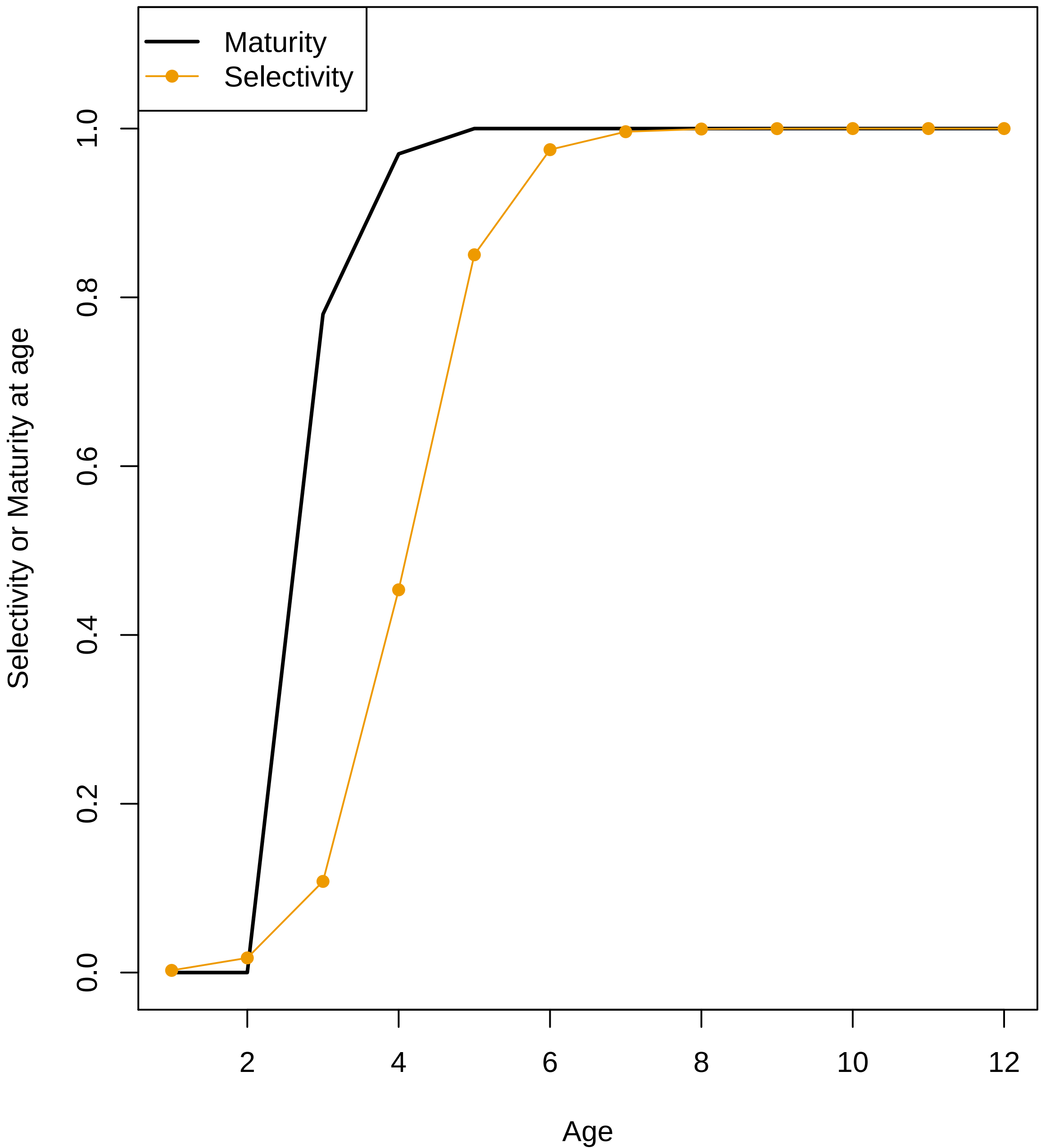
F	YPR	SPR	F	YPR	SPR	F	YPR	SPR
0	0	1	0.35	0.5697	0.2559	0.7	0.5839	0.1609
0.01	0.068	0.9264	0.36	0.5712	0.251	0.71	0.5838	0.1594
0.02	0.1266	0.8619	0.37	0.5726	0.2464	0.72	0.5837	0.1579
0.03	0.1775	0.8051	0.38	0.5739	0.242	0.73	0.5837	0.1565
0.04	0.2218	0.7548	0.39	0.575	0.2377	0.74	0.5836	0.1552
0.05	0.2606	0.7099	0.4	0.576	0.2337	0.75	0.5835	0.1538
0.06	0.2947	0.6698	0.41	0.5769	0.2298	0.76	0.5834	0.1525
0.07	0.3248	0.6336	0.42	0.5778	0.2261	0.77	0.5834	0.1512
0.08	0.3514	0.601	0.43	0.5785	0.2225	0.78	0.5833	0.15
0.09	0.375	0.5715	0.44	0.5792	0.219	0.79	0.5832	0.1488
0.1	0.396	0.5446	0.45	0.5798	0.2157	0.8	0.5831	0.1476
0.11	0.4147	0.5201	0.46	0.5804	0.2125	0.81	0.583	0.1464
0.12	0.4314	0.4977	0.47	0.5809	0.2095	0.82	0.5829	0.1453
0.13	0.4464	0.4771	0.48	0.5813	0.2065	0.83	0.5827	0.1441
0.14	0.4598	0.4582	0.49	0.5817	0.2037	0.84	0.5826	0.143
0.15	0.4718	0.4407	0.5	0.5821	0.2009	0.85	0.5825	0.142
0.16	0.4826	0.4245	0.51	0.5824	0.1983	0.86	0.5824	0.1409
0.17	0.4924	0.4096	0.52	0.5827	0.1957	0.87	0.5823	0.1399
0.18	0.5012	0.3957	0.53	0.5829	0.1932	0.88	0.5822	0.1389
0.19	0.5091	0.3827	0.54	0.5831	0.1908	0.89	0.582	0.1379
0.2	0.5163	0.3707	0.55	0.5833	0.1885	0.9	0.5819	0.1369
0.21	0.5227	0.3594	0.56	0.5835	0.1863	0.91	0.5818	0.1359
0.22	0.5286	0.3488	0.57	0.5836	0.1841	0.92	0.5817	0.135
0.23	0.5339	0.3389	0.58	0.5837	0.182	0.93	0.5815	0.1341
0.24	0.5387	0.3297	0.59	0.5838	0.1799	0.94	0.5814	0.1332
0.25	0.5431	0.3209	0.6	0.5839	0.1779	0.95	0.5813	0.1323
0.26	0.547	0.3127	0.61	0.5839	0.176	0.96	0.5811	0.1314
0.27	0.5506	0.3049	0.62	0.584	0.1741	0.97	0.581	0.1306
0.28	0.5539	0.2976	0.63	0.584	0.1723	0.98	0.5809	0.1297
0.29	0.5569	0.2907	0.64	0.584	0.1705	0.99	0.5807	0.1289
0.3	0.5596	0.2841	0.65	0.584	0.1688	1	0.5806	0.1281
0.31	0.562	0.2779	0.66	0.584	0.1671	1.01	0.5805	0.1273
0.32	0.5642	0.272	0.67	0.584	0.1655	1.02	0.5803	0.1265
0.33	0.5662	0.2663	0.68	0.584	0.1639	1.03	0.5802	0.1257
0.34	0.5681	0.261	0.69	0.5839	0.1624	1.04	0.5801	0.125



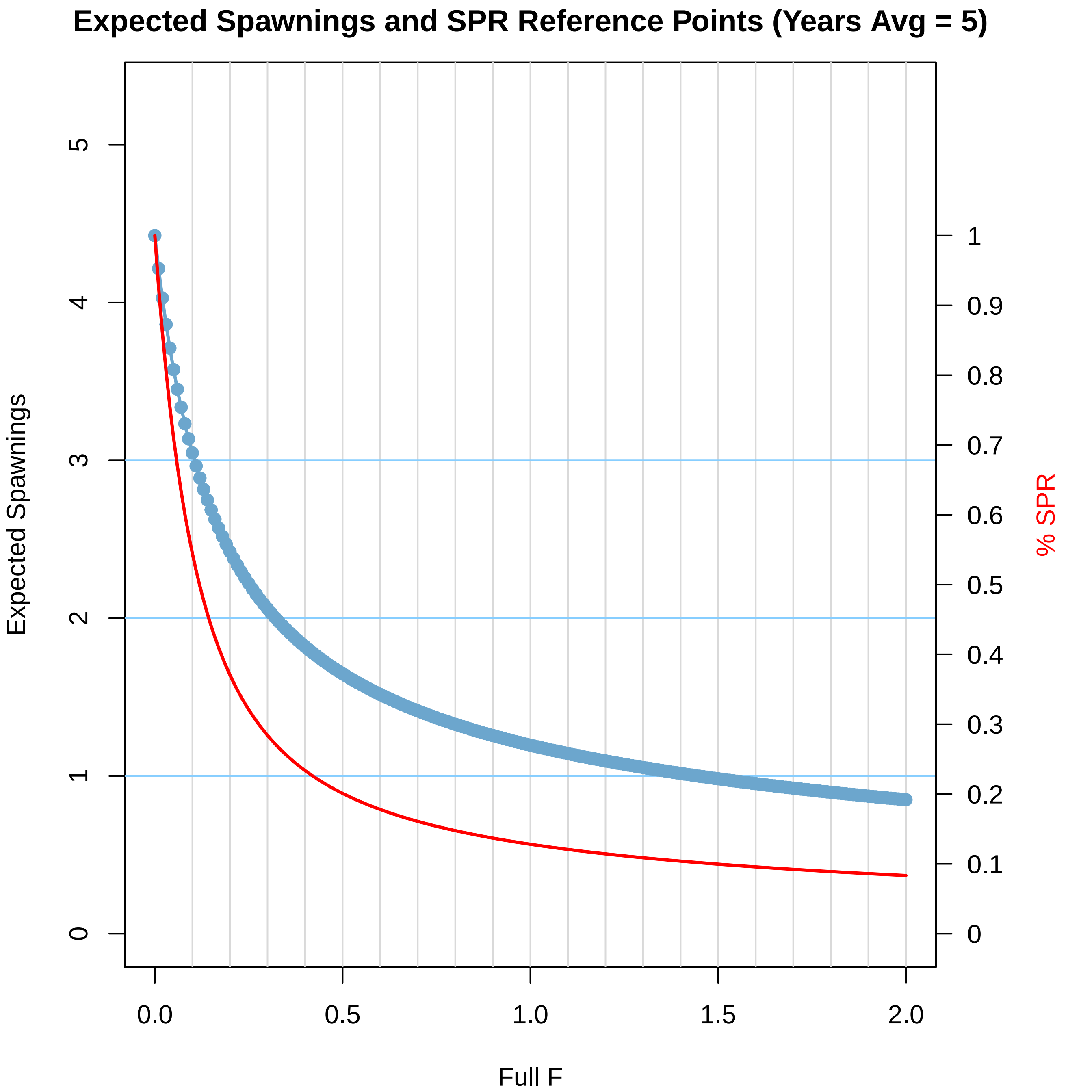
SPR Target Reference Points (Years Avg = 5)
Yield per Recruit
F (%SPR)
% SPR Target
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.1
0.2
0.3
0.4
0.5
0.6
0.2
0.3
0.4
0.5
0.6
0.7
0.8

SPR Target Reference Points (Years Avg = 5)

% SPR	F(%SPR)	YPR
0.2	0.5035	0.5822
0.25	0.3622	0.5716
0.3	0.2767	0.5528
0.35	0.2189	0.528
0.4	0.1768	0.4985
0.45	0.1446	0.4654
0.5	0.1189	0.4297
0.55	0.0979	0.3918
0.6	0.0803	0.3522
0.65	0.0653	0.3112
0.7	0.0524	0.2691
0.75	0.041	0.2259
0.8	0.031	0.182



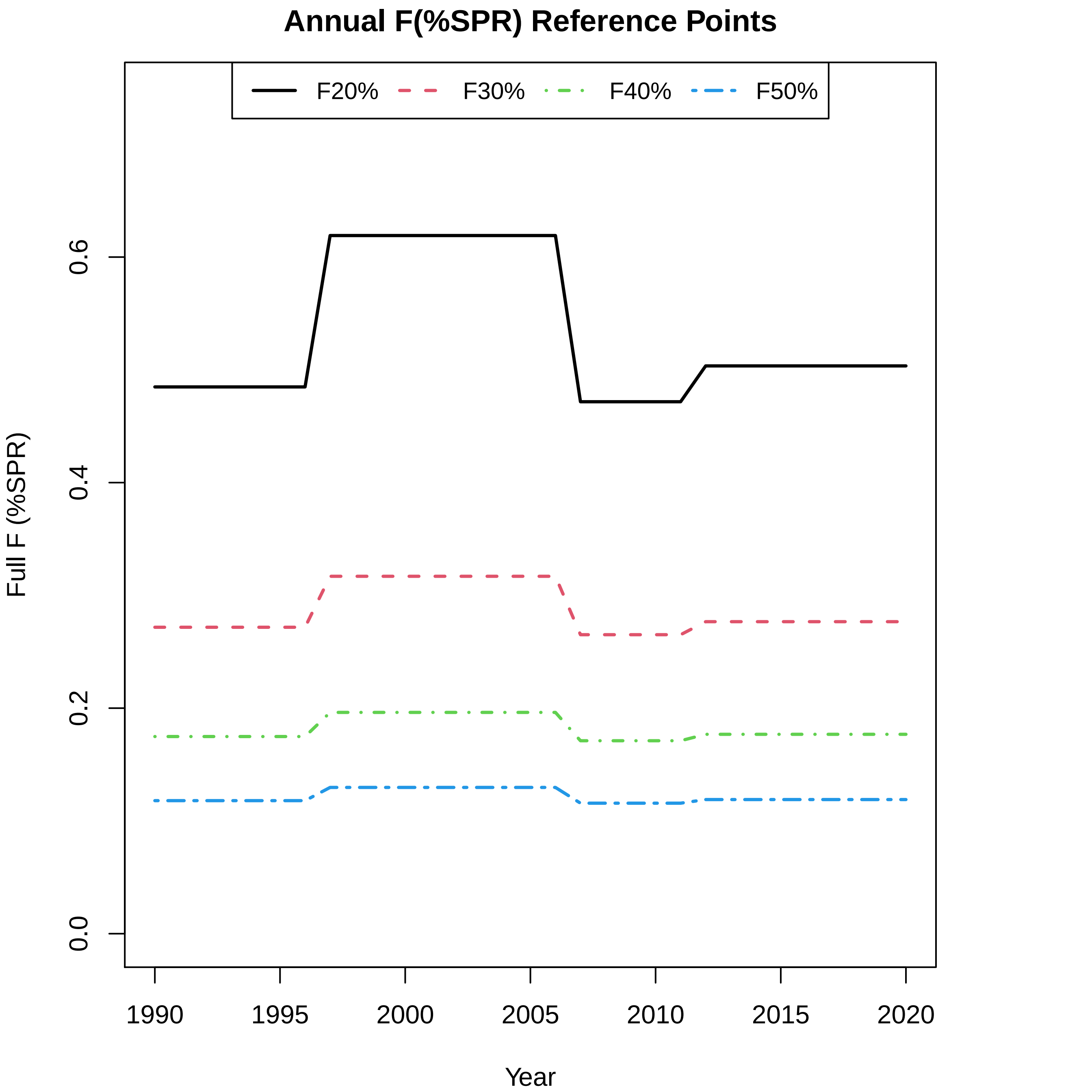
Maturity
Selectivity
Selectivity or Maturity at age
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
12
Age

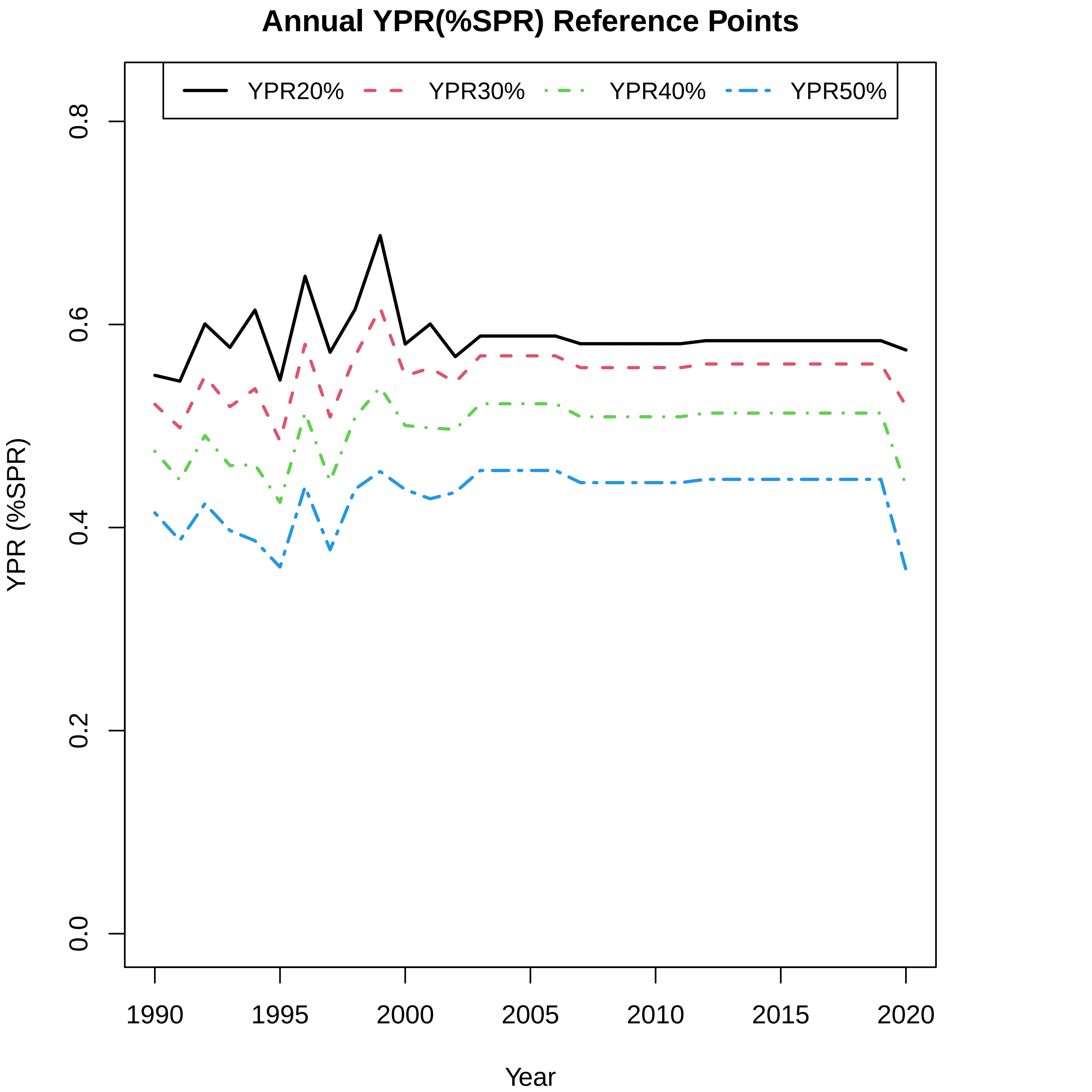


Expected Spawnings and SPR Reference Points (Years Avg = 5)
Expected Spawnings
0
1
2
3
4
5
% SPR
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.0
0.5
1.0
1.5
2.0
Full F

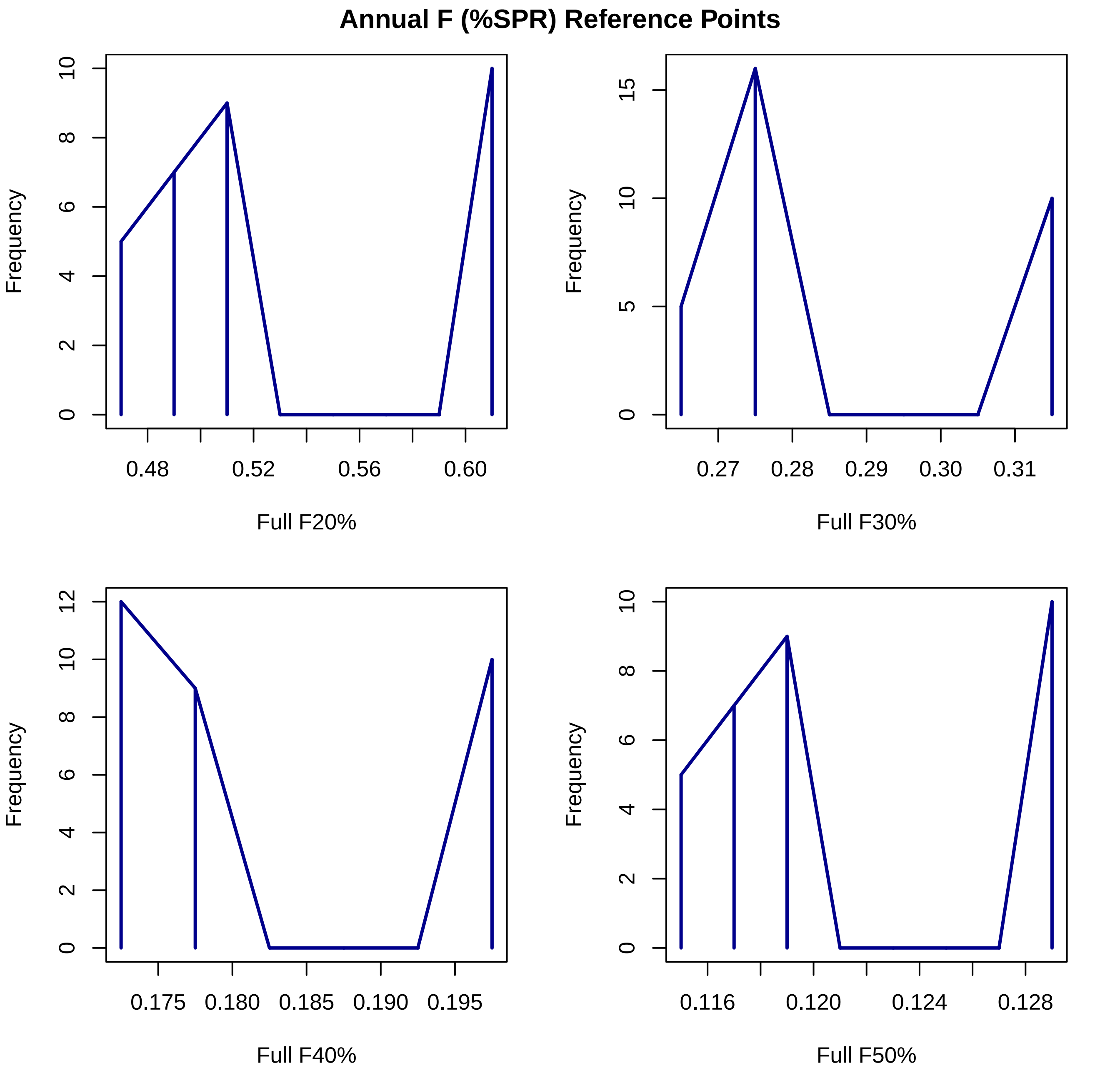
Expected Spawnings & SPR Reference Points (Years Avg = 5)

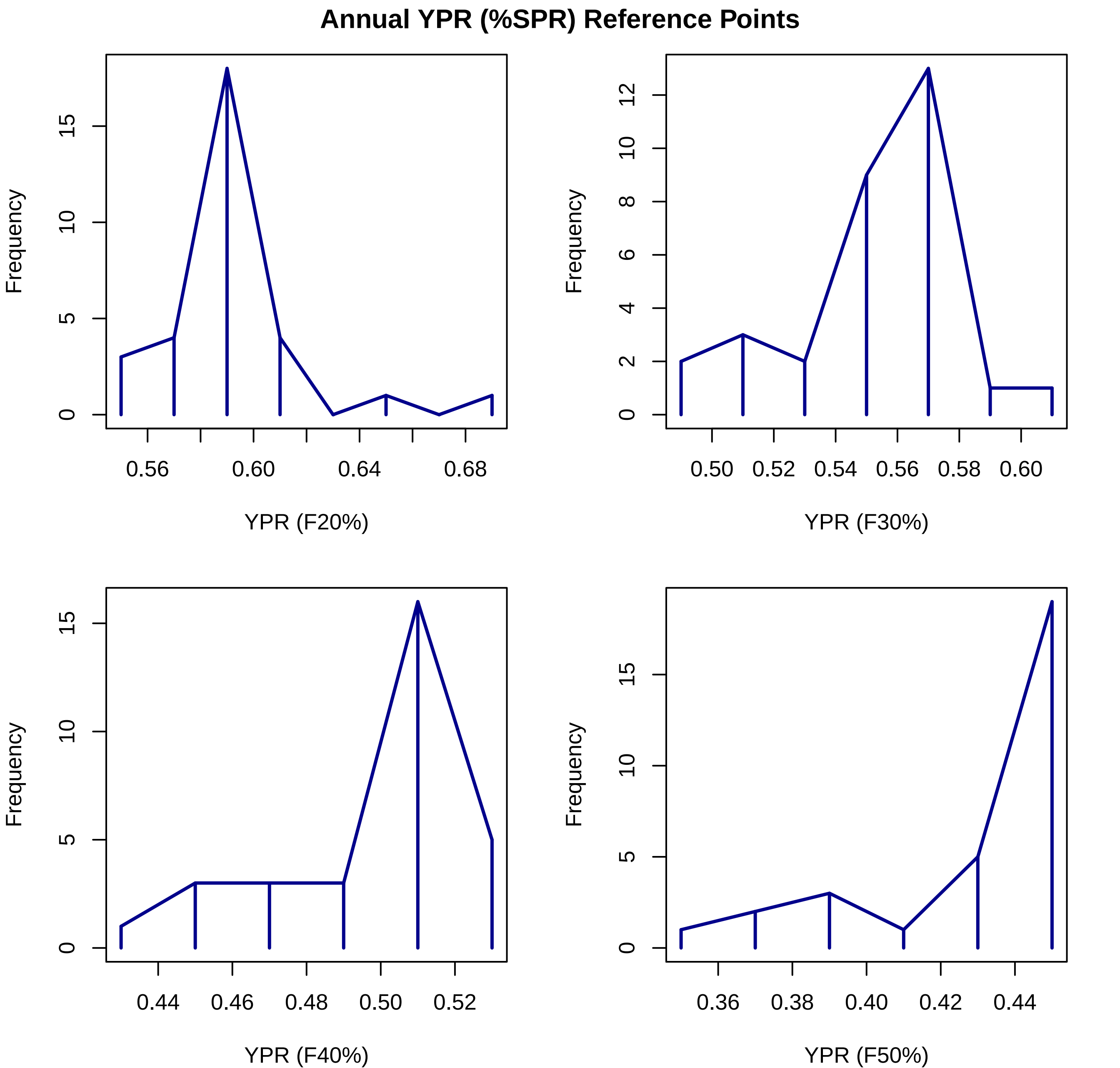
F	E[Sp]	SPR	F	E[Sp]	SPR	F	E[Sp]	SPR
0	4.4253	1	0.35	1.9287	0.2559	0.7	1.4123	0.1609
0.01	4.2158	0.9264	0.36	1.9054	0.251	0.71	1.4031	0.1594
0.02	4.0293	0.8619	0.37	1.8828	0.2464	0.72	1.394	0.1579
0.03	3.8622	0.8051	0.38	1.8611	0.242	0.73	1.3851	0.1565
0.04	3.7116	0.7548	0.39	1.8401	0.2377	0.74	1.3763	0.1552
0.05	3.575	0.7099	0.4	1.8197	0.2337	0.75	1.3678	0.1538
0.06	3.4507	0.6698	0.41	1.8	0.2298	0.76	1.3594	0.1525
0.07	3.337	0.6336	0.42	1.781	0.2261	0.77	1.3511	0.1512
0.08	3.2325	0.601	0.43	1.7625	0.2225	0.78	1.343	0.15
0.09	3.1362	0.5715	0.44	1.7446	0.219	0.79	1.335	0.1488
0.1	3.0472	0.5446	0.45	1.7272	0.2157	0.8	1.3272	0.1476
0.11	2.9645	0.5201	0.46	1.7103	0.2125	0.81	1.3195	0.1464
0.12	2.8876	0.4977	0.47	1.6939	0.2095	0.82	1.3119	0.1453
0.13	2.8159	0.4771	0.48	1.678	0.2065	0.83	1.3045	0.1441
0.14	2.7488	0.4582	0.49	1.6625	0.2037	0.84	1.2972	0.143
0.15	2.6859	0.4407	0.5	1.6474	0.2009	0.85	1.29	0.142
0.16	2.6267	0.4245	0.51	1.6327	0.1983	0.86	1.283	0.1409
0.17	2.5711	0.4096	0.52	1.6185	0.1957	0.87	1.276	0.1399
0.18	2.5185	0.3957	0.53	1.6046	0.1932	0.88	1.2692	0.1389
0.19	2.4689	0.3827	0.54	1.591	0.1908	0.89	1.2624	0.1379
0.2	2.4219	0.3707	0.55	1.5778	0.1885	0.9	1.2558	0.1369
0.21	2.3773	0.3594	0.56	1.5649	0.1863	0.91	1.2493	0.1359
0.22	2.335	0.3488	0.57	1.5523	0.1841	0.92	1.2428	0.135
0.23	2.2947	0.3389	0.58	1.54	0.182	0.93	1.2365	0.1341
0.24	2.2564	0.3297	0.59	1.528	0.1799	0.94	1.2303	0.1332
0.25	2.2198	0.3209	0.6	1.5163	0.1779	0.95	1.2241	0.1323
0.26	2.1848	0.3127	0.61	1.5049	0.176	0.96	1.2181	0.1314
0.27	2.1514	0.3049	0.62	1.4937	0.1741	0.97	1.2121	0.1306
0.28	2.1195	0.2976	0.63	1.4827	0.1723	0.98	1.2062	0.1297
0.29	2.0888	0.2907	0.64	1.472	0.1705	0.99	1.2004	0.1289
0.3	2.0594	0.2841	0.65	1.4615	0.1688	1	1.1947	0.1281
0.31	2.0312	0.2779	0.66	1.4513	0.1671	1.01	1.1891	0.1273
0.32	2.0041	0.272	0.67	1.4412	0.1655	1.02	1.1835	0.1265
0.33	1.978	0.2663	0.68	1.4314	0.1639	1.03	1.178	0.1257
0.34	1.9529	0.261	0.69	1.4218	0.1624	1.04	1.1726	0.125


Annual F(%SPR) Reference Points
F20%
F30%
F40%
F50%
Full F (%SPR)
0.0
0.2
0.4
0.6
1990
1995
2000
2005
2010
2015
2020
Year



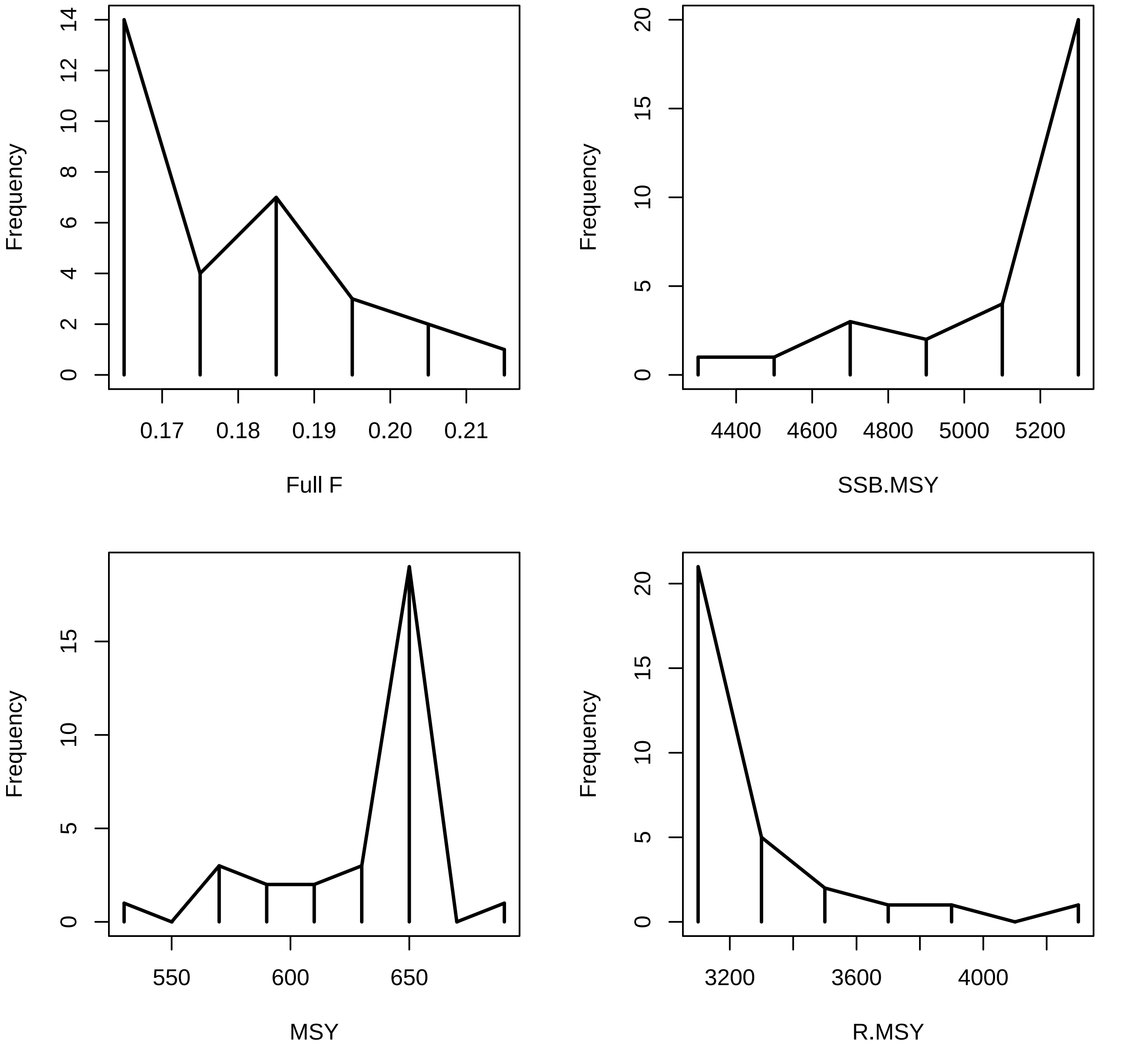
Annual YPR(%SPR) Reference Points
YPR20%
YPR30%
YPR40%
YPR50%
0.0
0.2
0.4
0.6
0.8
YPR (%SPR)
1990
1995
2000
2005
2010
2015
2020
Year

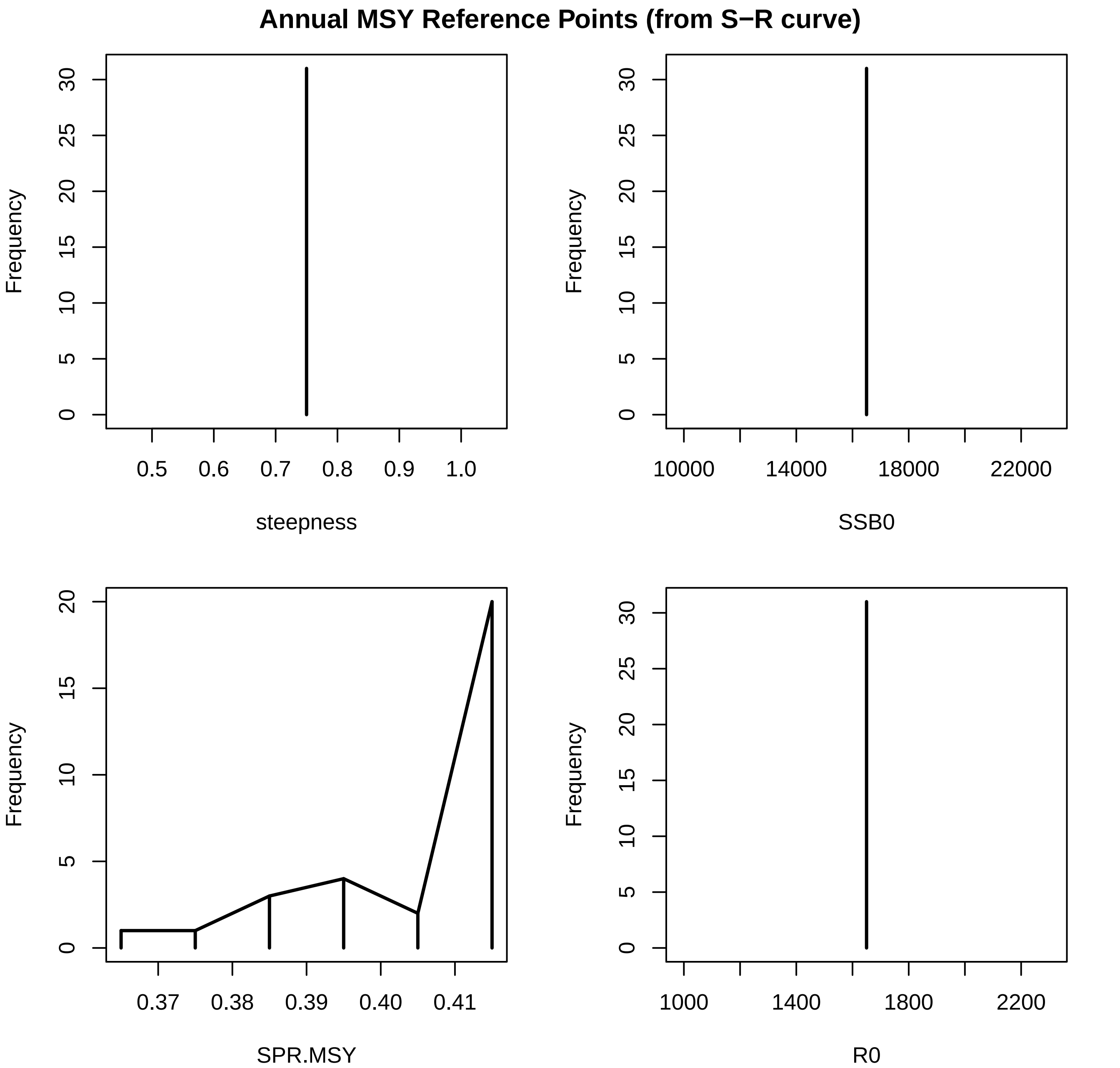

Annual F (%SPR) Reference Points
Frequency
0
2
4
6
8
10
0.48
0.52
0.56
0.60
Full F20%
Frequency
0
5
10
15
0.27
0.28
0.29
0.30
0.31
Full F30%
Frequency
0
2
4
6
8
10
12
0.175
0.180
0.185
0.190
0.195
Full F40%
Frequency
0
2
4
6
8
10
0.116
0.120
0.124
0.128
Full F50%

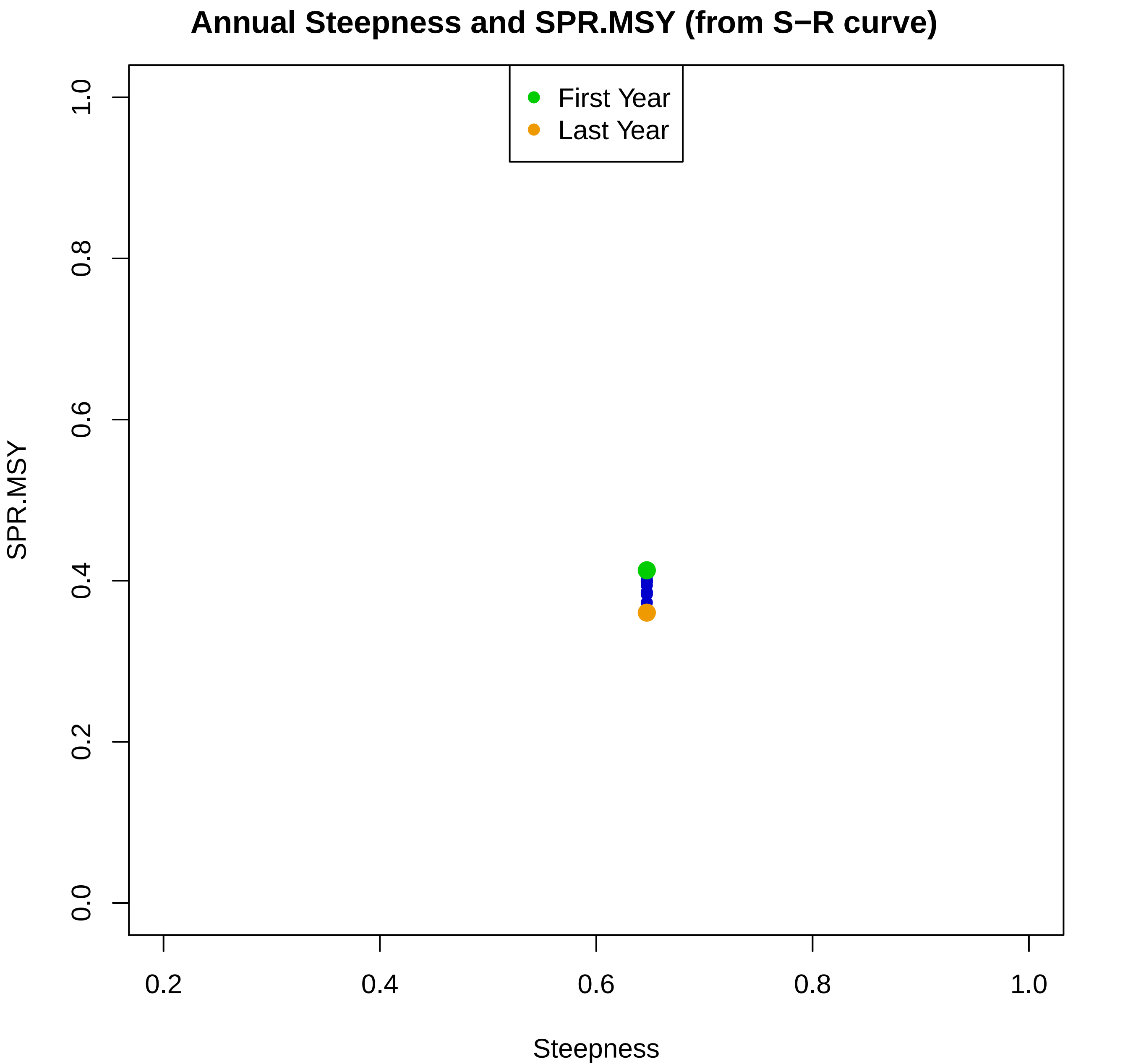


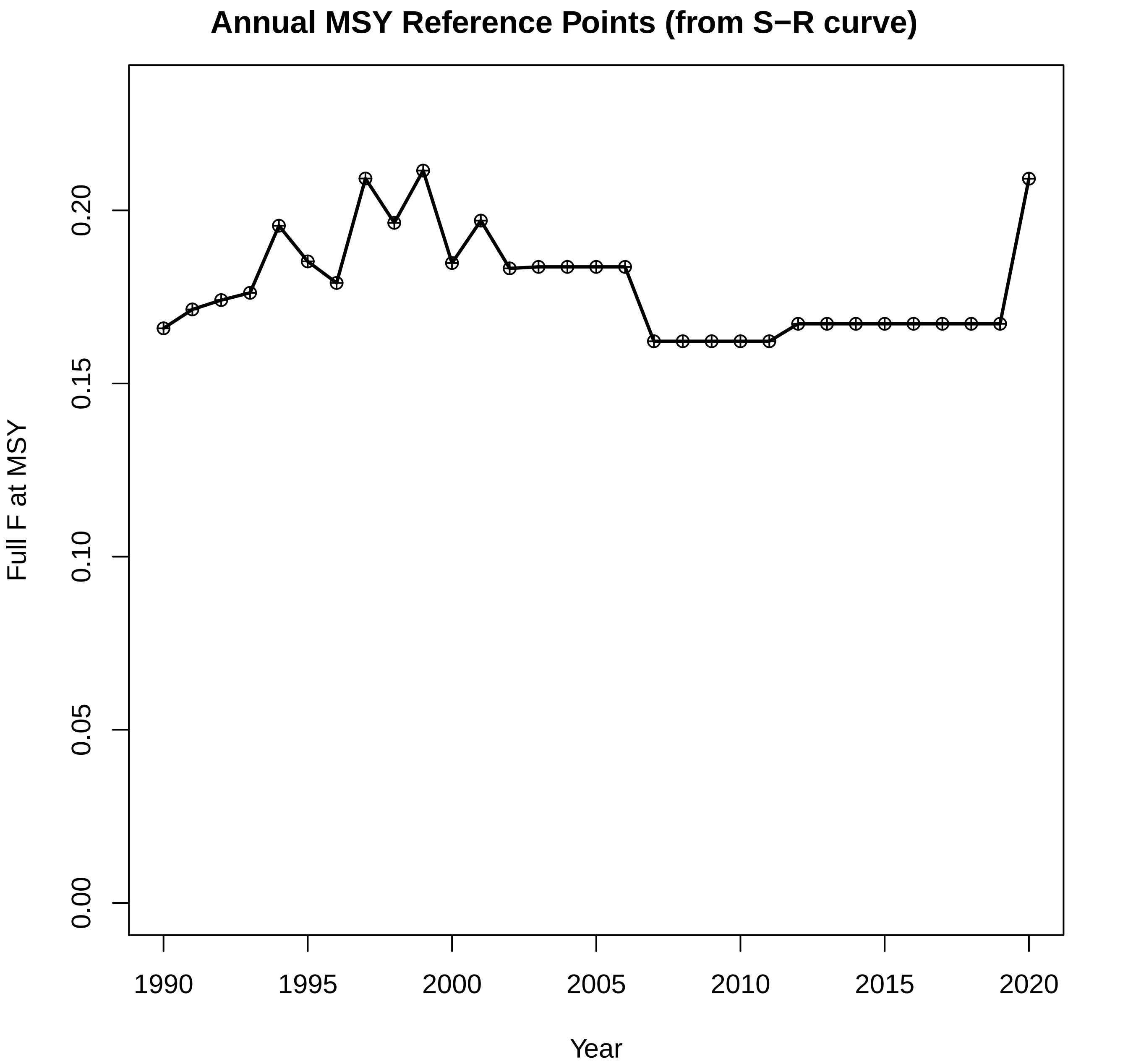
Annual YPR (%SPR) Reference Points
Frequency
YPR (F20%)
0.56
0.60
0.64
0.68
0
5
10
15
Frequency
YPR (F30%)
0.50
0.52
0.54
0.56
0.58
0.60
0
2
4
6
8
10
12
Frequency
YPR (F40%)
0.44
0.46
0.48
0.50
0.52
0
5
10
15
Frequency
YPR (F50%)
0.36
0.38
0.40
0.42
0.44
0
5
10
15

Annual MSY Reference Points (from S−R curve)

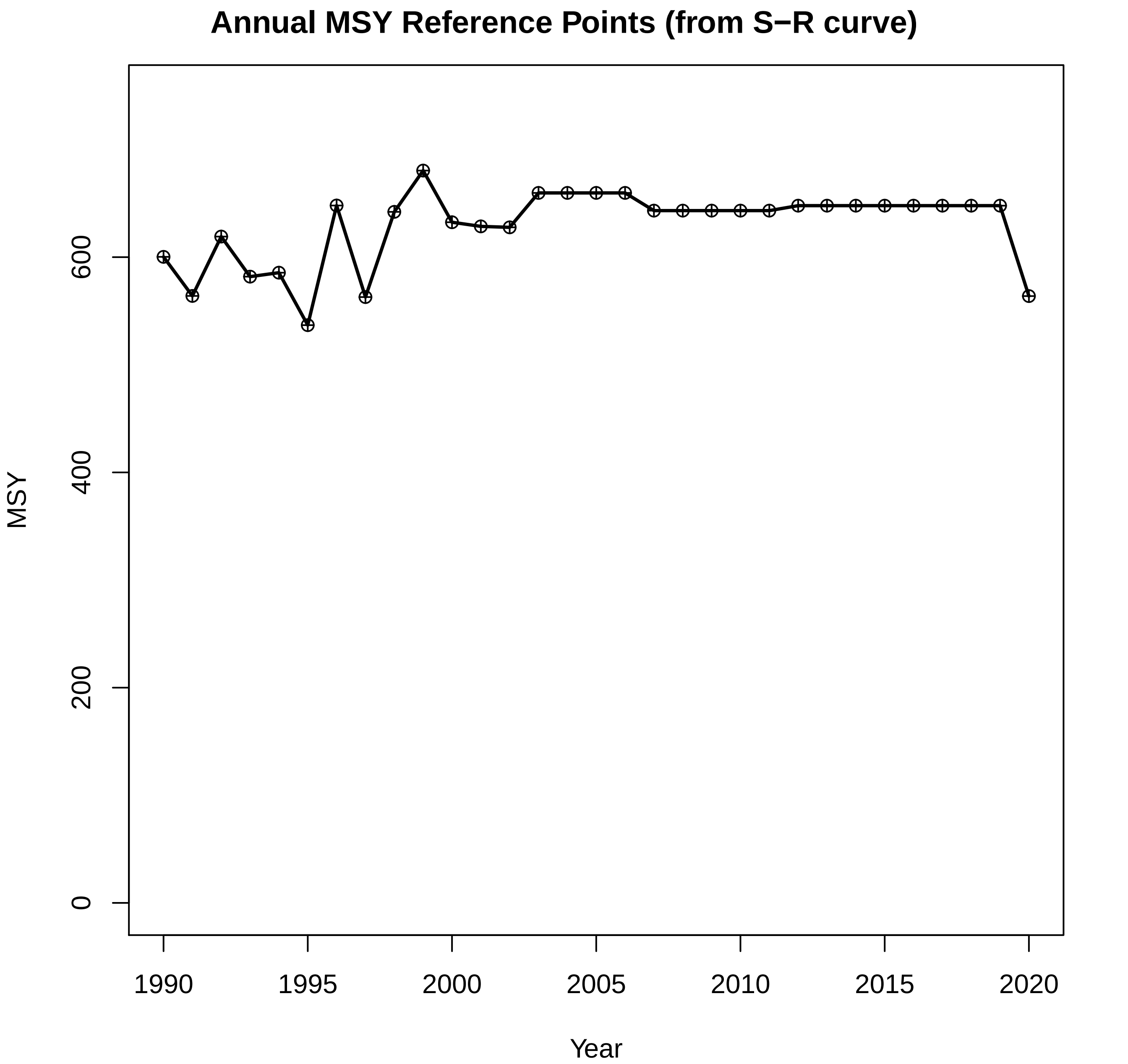


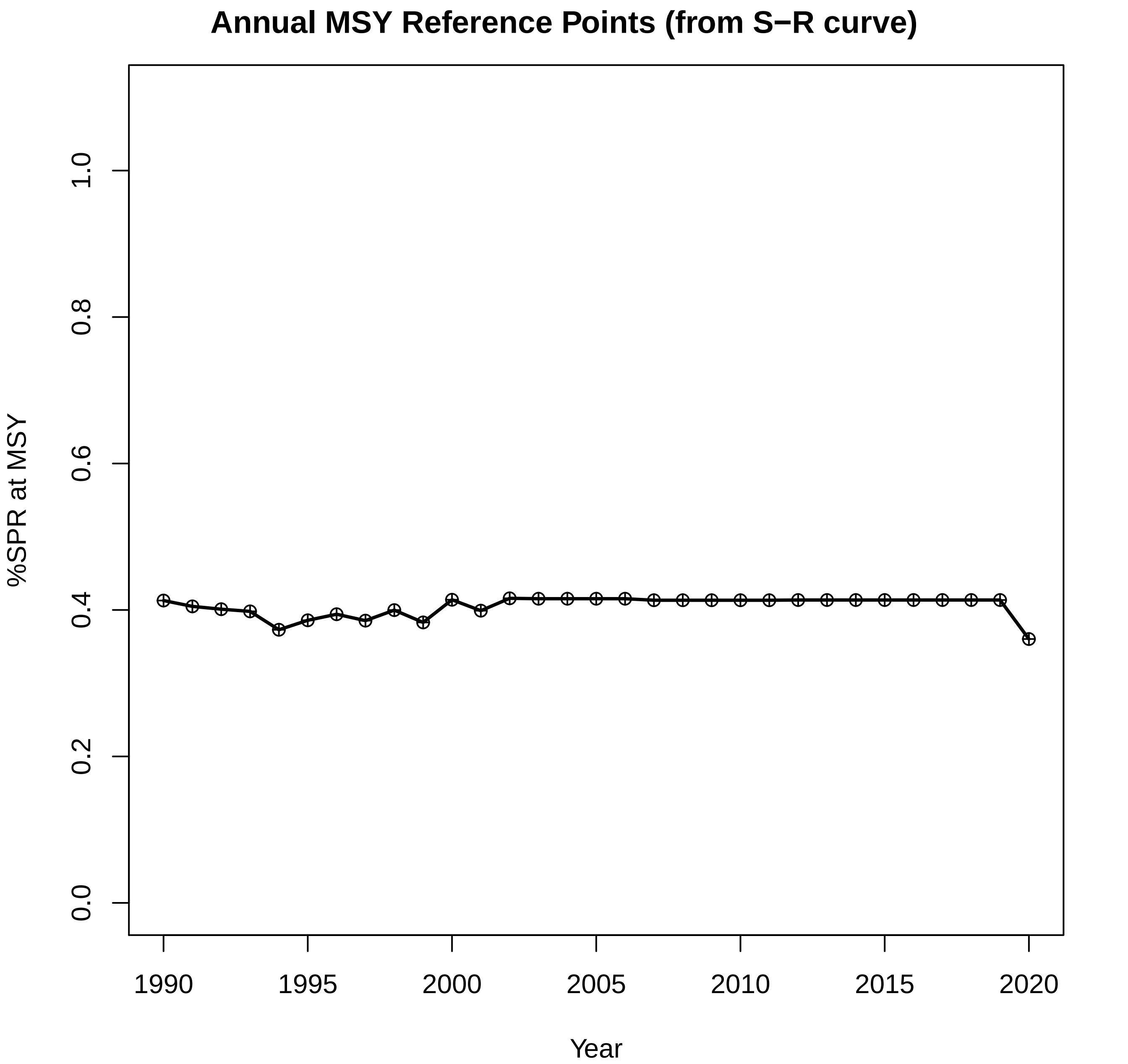

Annual MSY Reference Points (from S−R curve)
Frequency
steepness
0.5
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30
Frequency
SSB0
10000
14000
18000
22000
Frequency
SPR.MSY
0.37
0.38
0.39
0.40
0.41
Frequency
R0
1000
1400
1800
2200

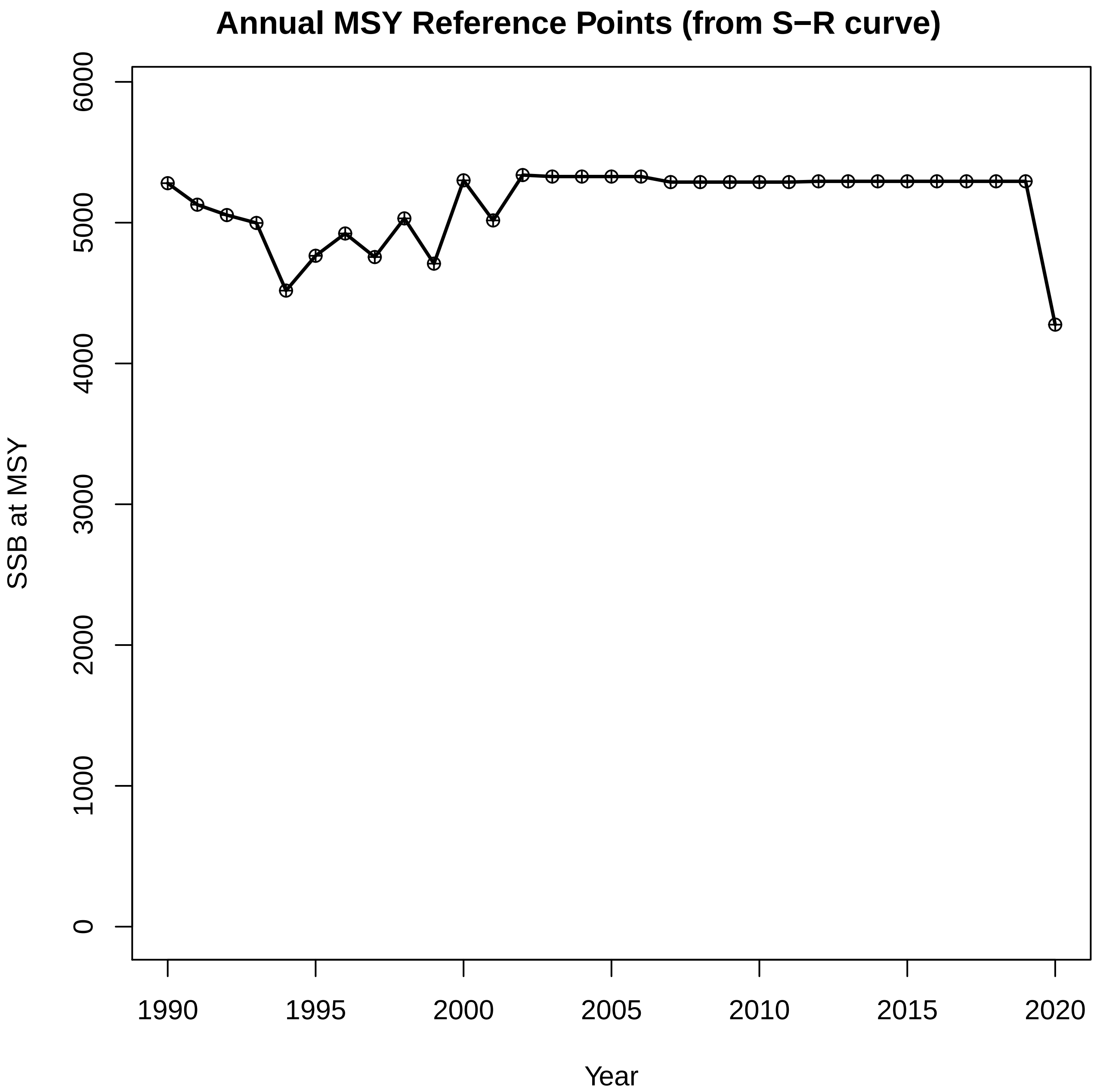

Annual Steepness and SPR.MSY (from S−R curve)
First Year
Last Year
SPR.MSY
Steepness
0.0
0.2
0.4
0.6
0.8
1.0
0.2
0.4
0.6
0.8
1.0

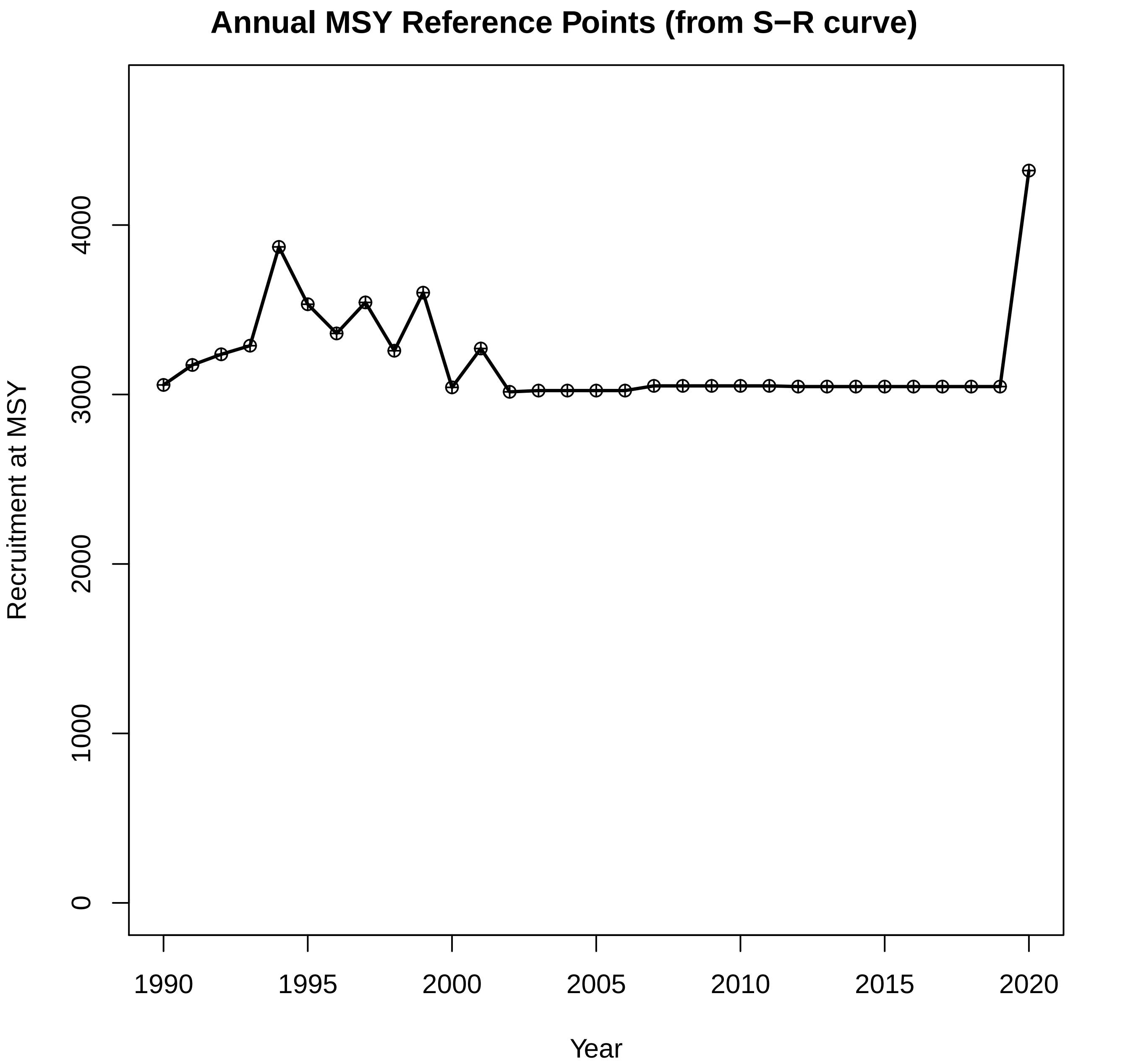


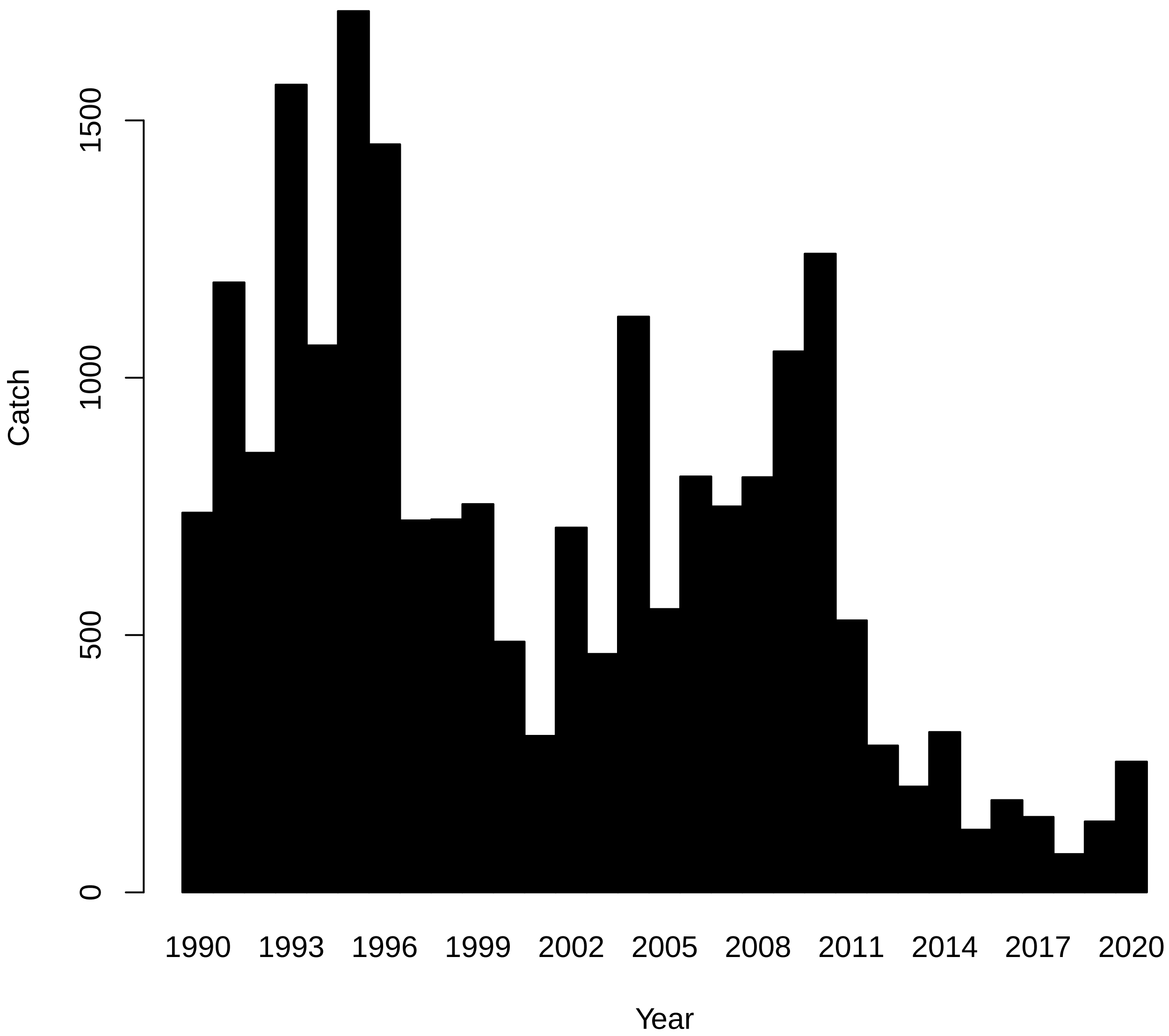
Annual MSY Reference Points (from S−R curve)
Full F at MSY
0.00
0.05
0.10
0.15
0.20
1990
1995
2000
2005
2010
2015
2020
Year


Annual MSY Reference Points (from S−R curve)
MSY
0
200
400
600
1990
1995
2000
2005
2010
2015
2020
Year

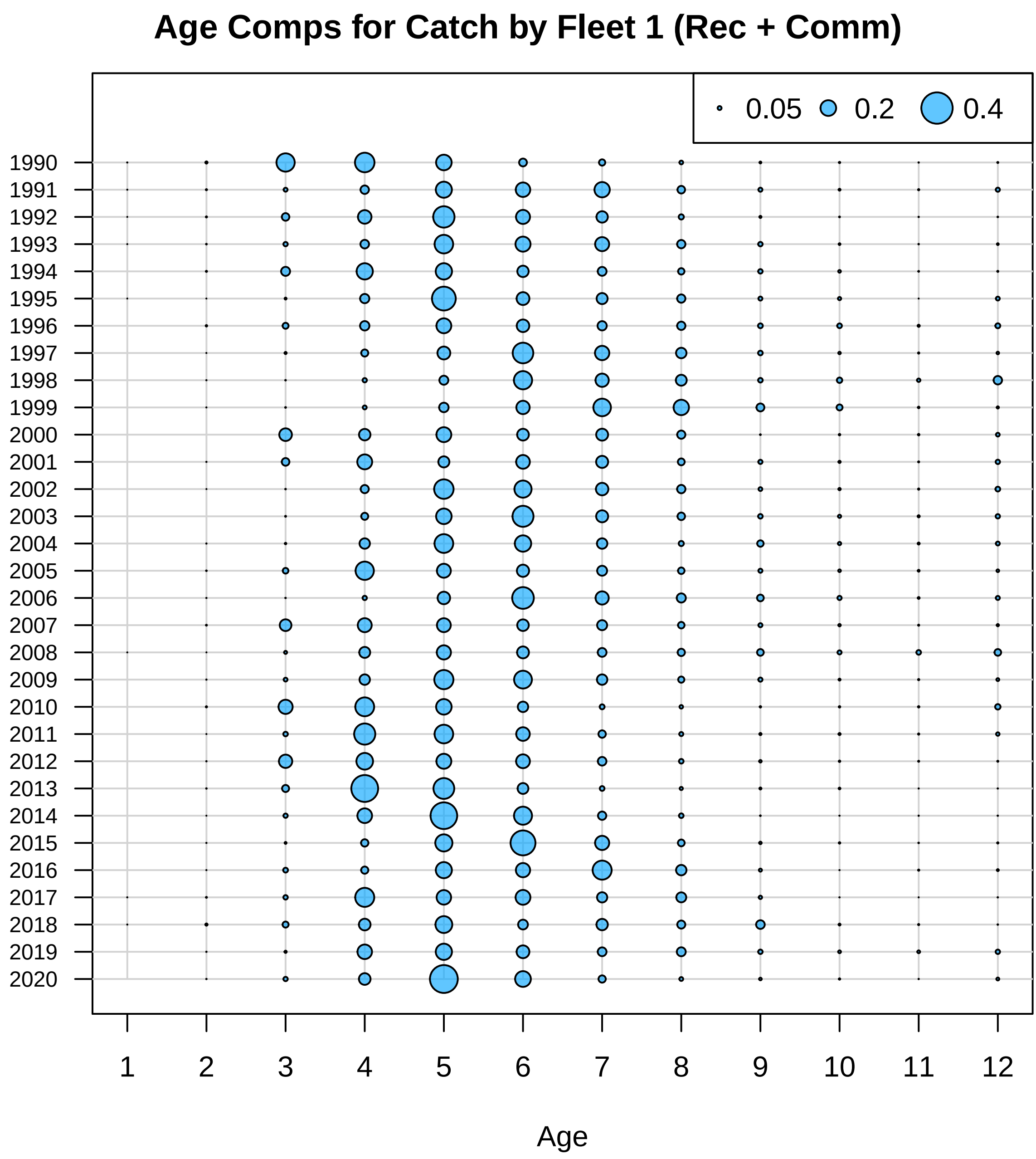

Annual MSY Reference Points (from S−R curve)
%SPR at MSY
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
2015
2020
Year

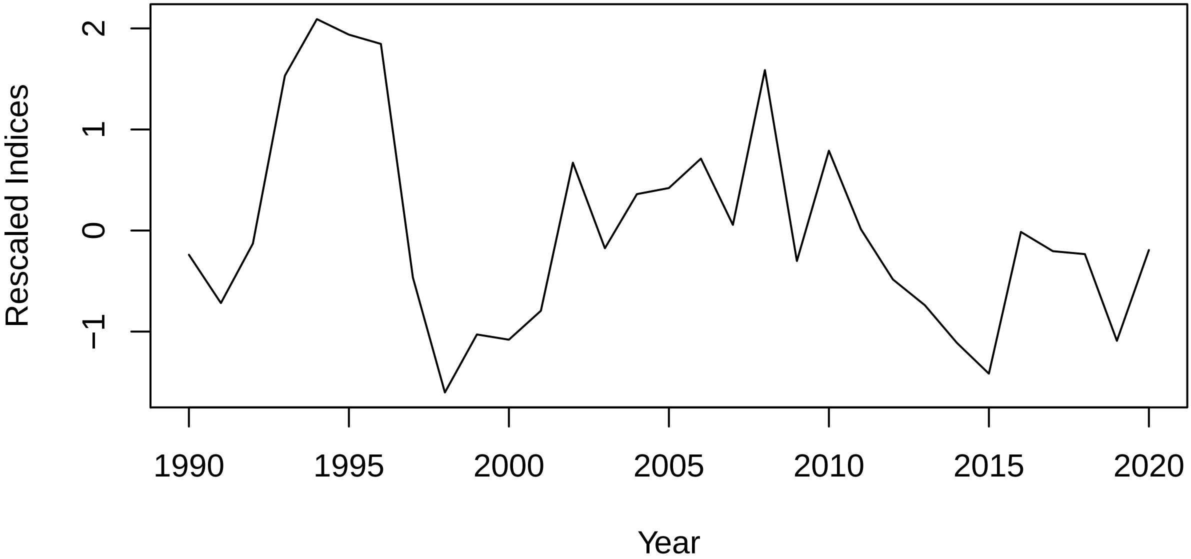

Annual MSY Reference Points (from S−R curve)
SSB at MSY
Year
0
1000
2000
3000
4000
5000
6000
1990
1995
2000
2005
2010
2015
2020

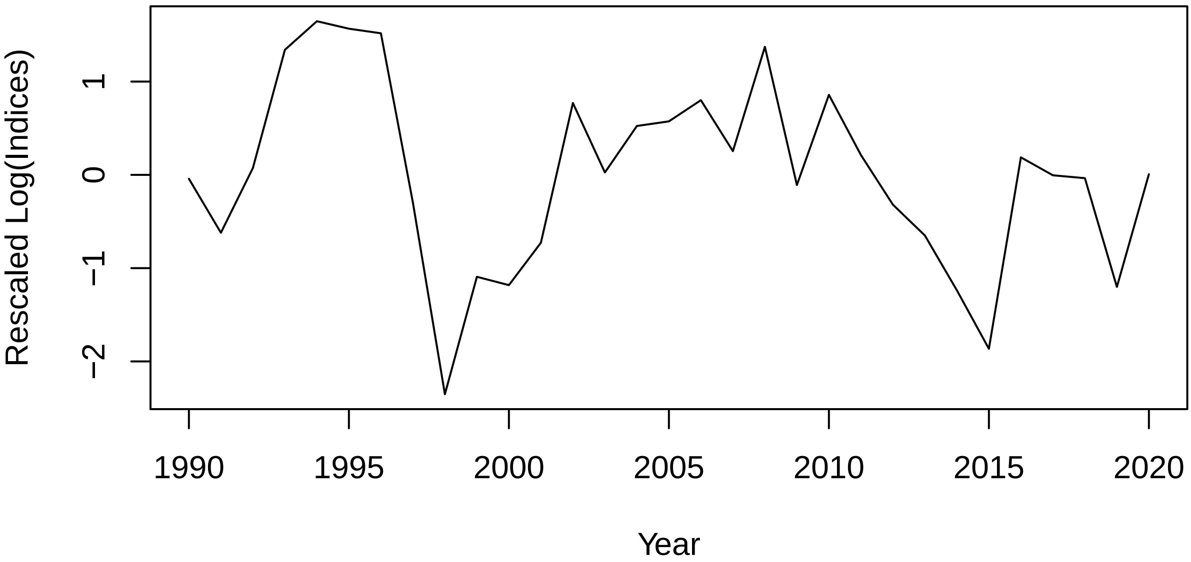

Annual MSY Reference Points (from S−R curve)
Recruitment at MSY
Year
0
1000
2000
3000
4000
1990
1995
2000
2005
2010
2015
2020

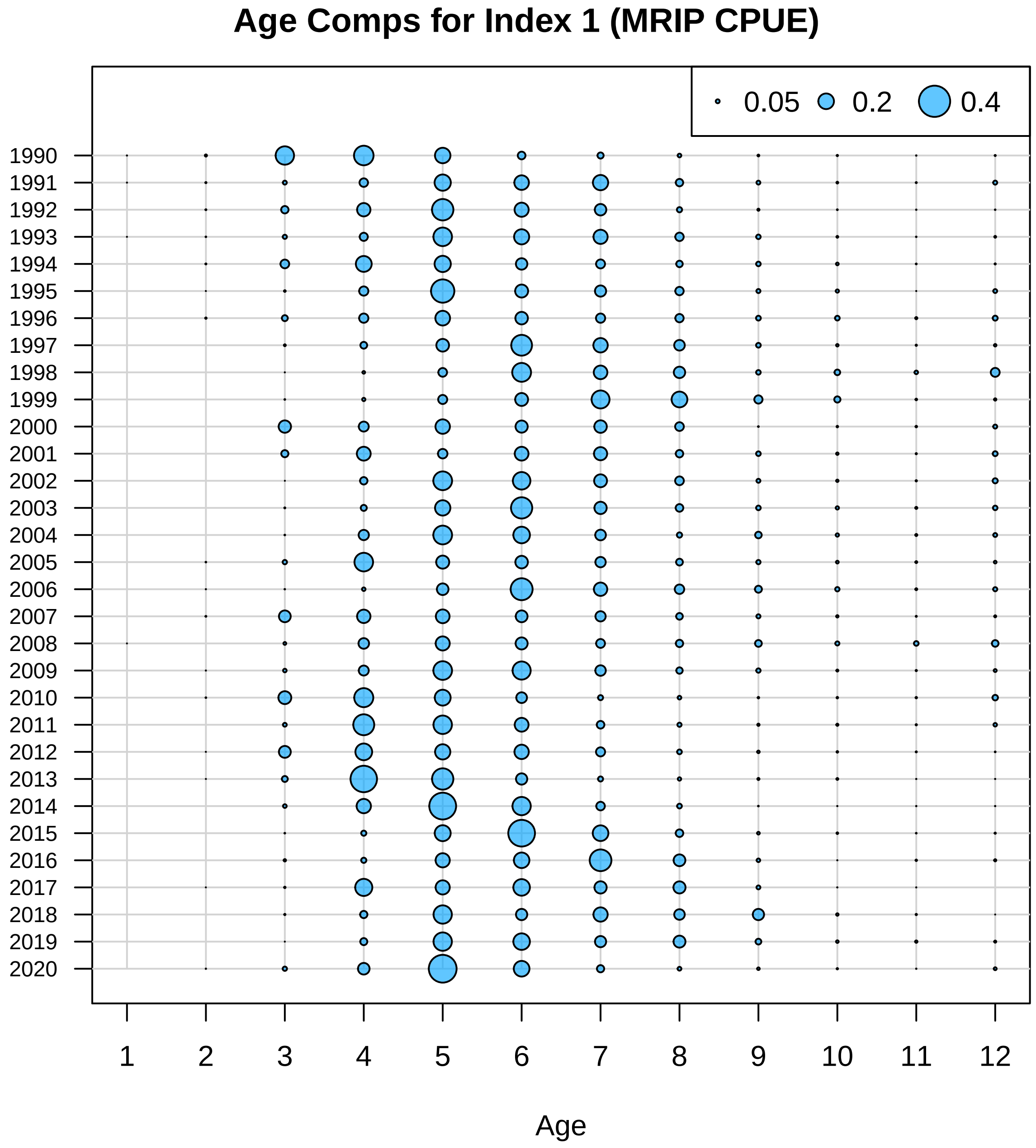


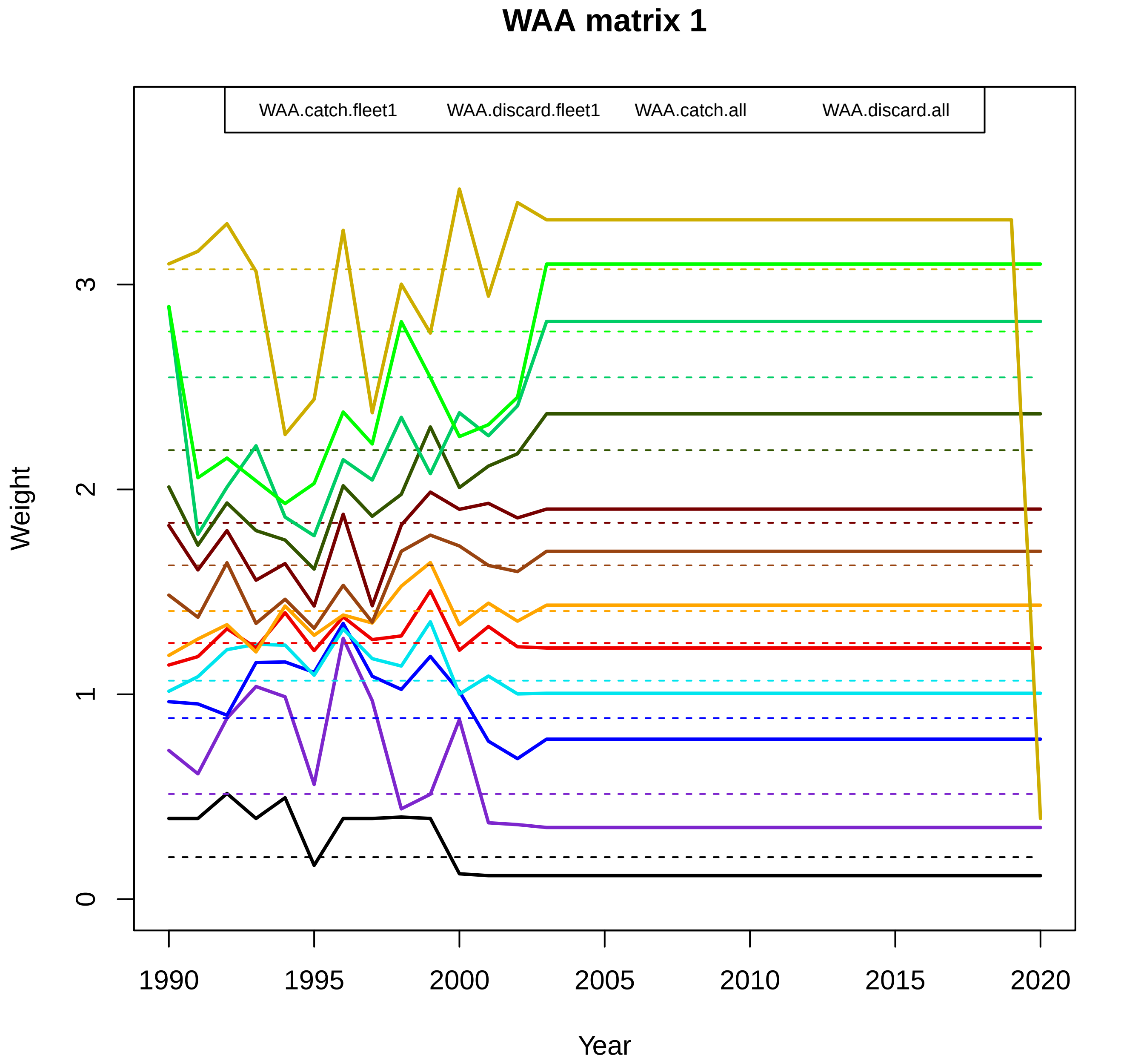
Catch
0
500
1000
1500
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Year

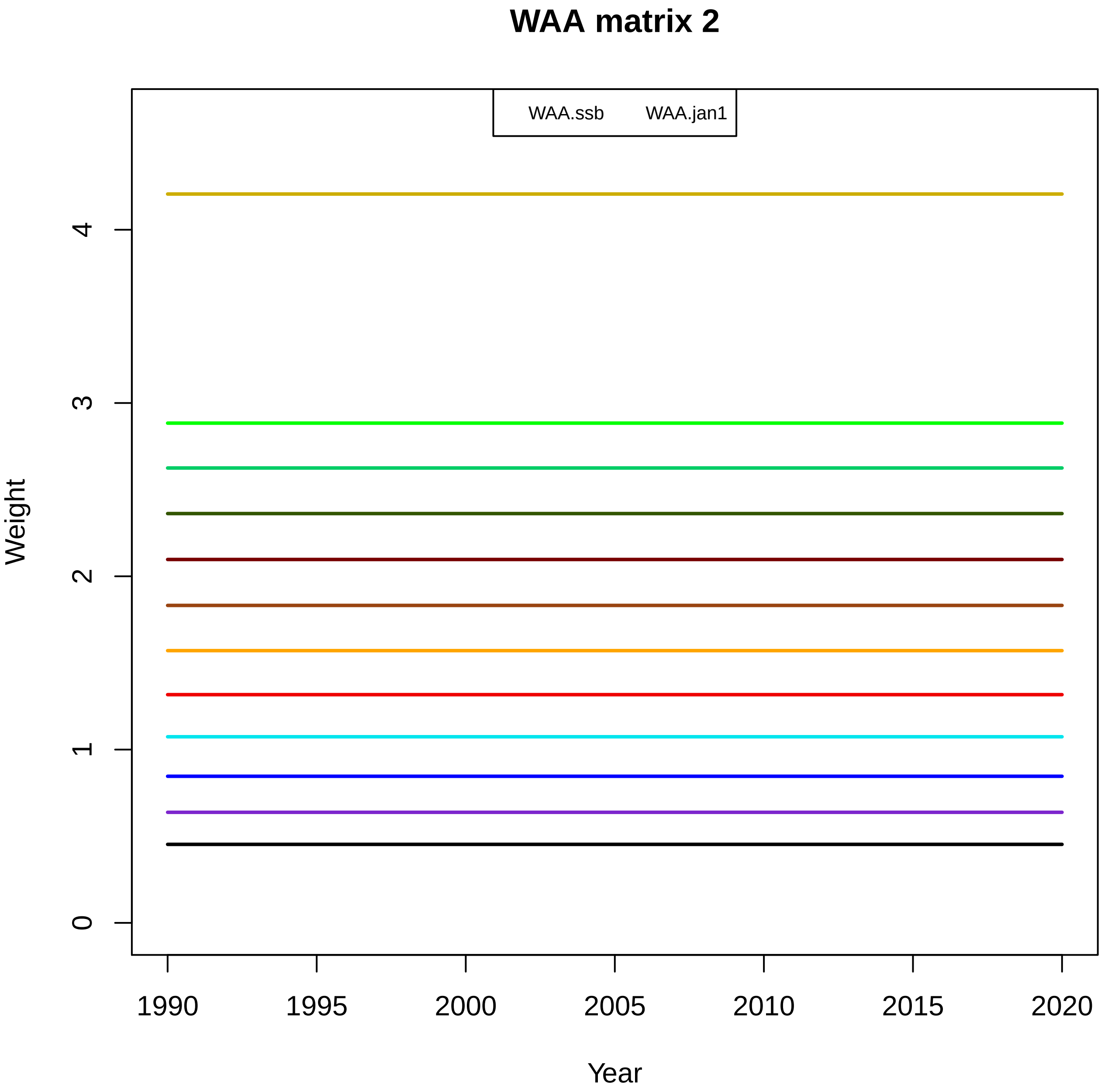

Age Comps for Catch by Fleet 1 (Rec + Comm)
0.05
0.2
0.4
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age


Rescaled Indices
2
1
0
−1
1990
1995
2000
2005
2010
2015
2020
Year

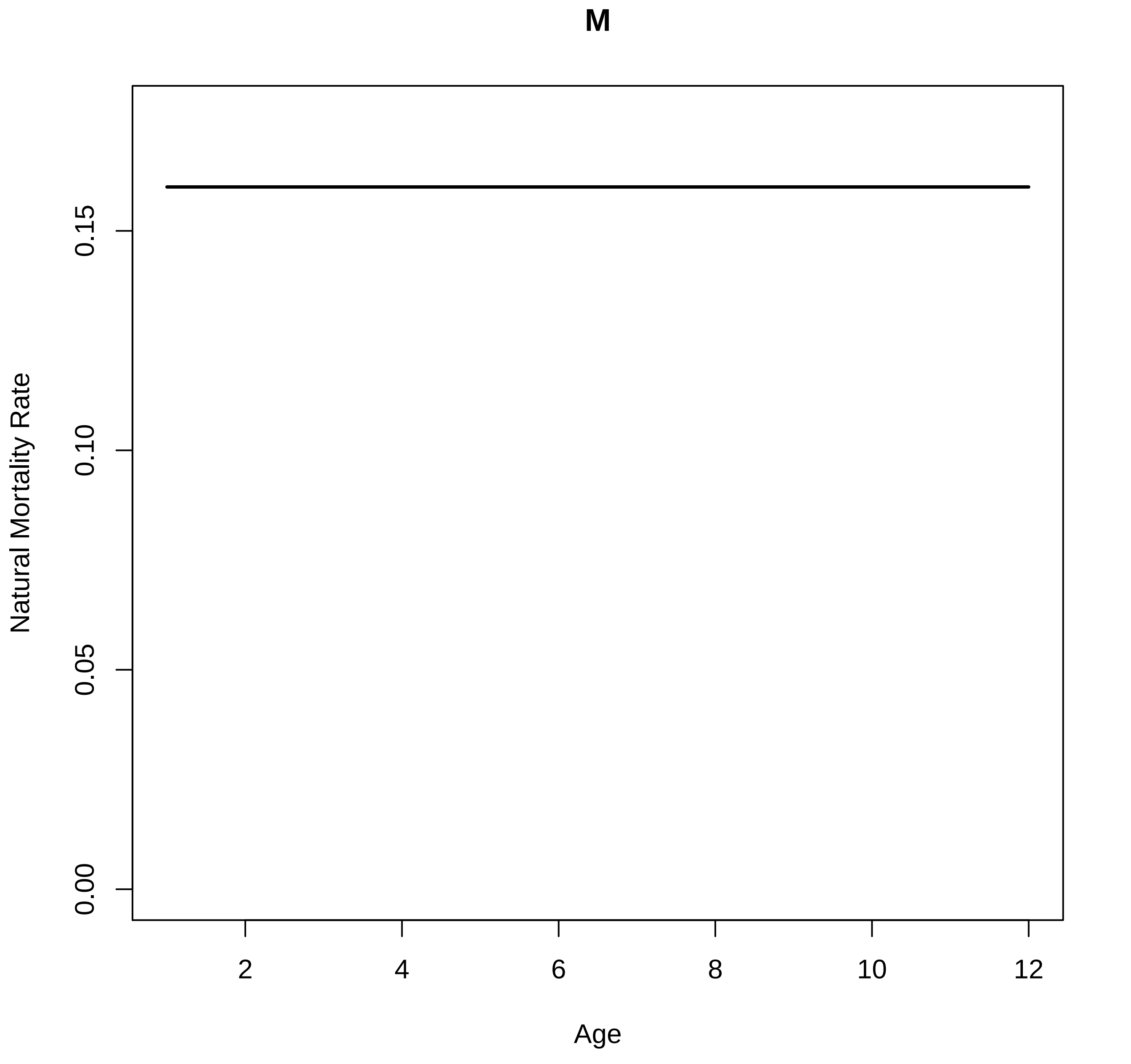

Rescaled Log(Indices)
1
0
−1
−2
1990
1995
2000
2005
2010
2015
2020
Year

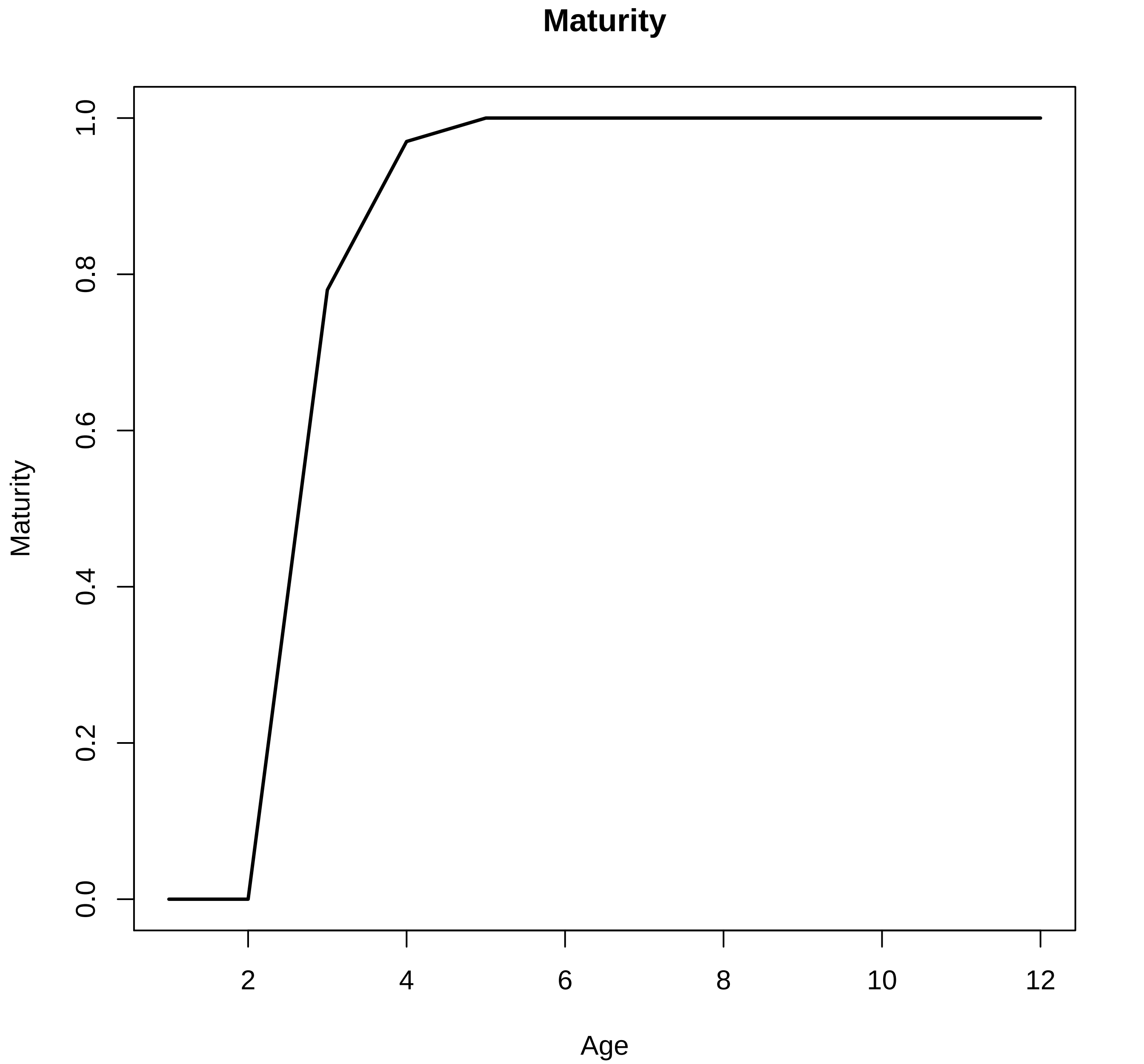

Age Comps for Index 1 (MRIP CPUE)
0.05
0.2
0.4
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
1
2
3
4
5
6
7
8
9
10
11
12
Age


WAA matrix 1
WAA.catch.fleet1
WAA.discard.fleet1
WAA.catch.all
WAA.discard.all
Weight
0
1
2
3
Year
1990
1995
2000
2005
2010
2015
2020



WAA matrix 2
WAA.ssb
WAA.jan1
Weight
0
1
2
3
4
1990
1995
2000
2005
2010
2015
2020
Year


M
Natural Mortality Rate
0.00
0.05
0.10
0.15
2
4
6
8
10
12
Age



Maturity
1.0
0.8
0.6
0.4
0.2
0.0
Maturity
2
4
6
8
10
12
Age

Tautog Stock Assessment Update
DMV Region 2021

Appendix 2: Sensitivity Runs and Retrospective Adjustment

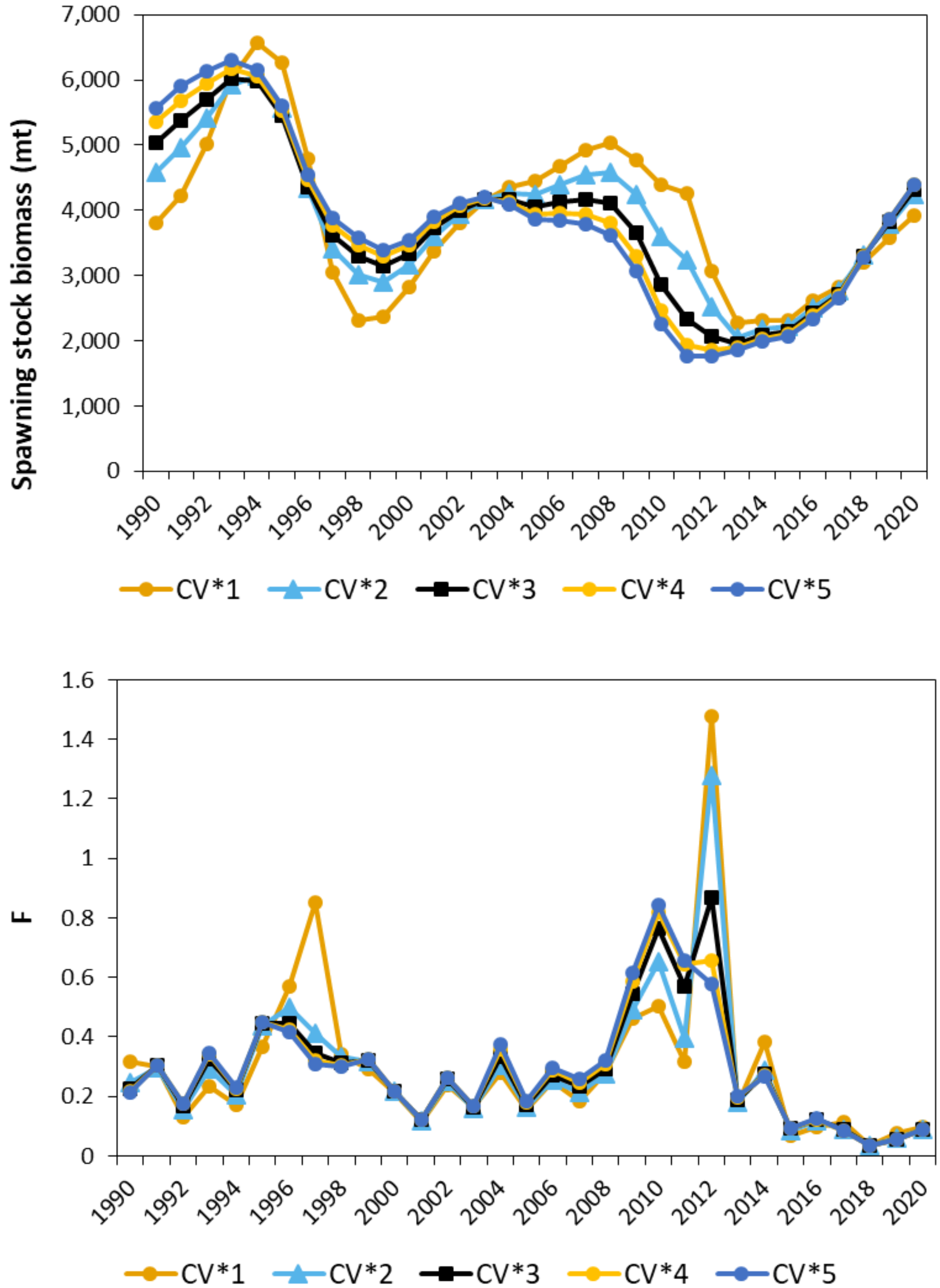
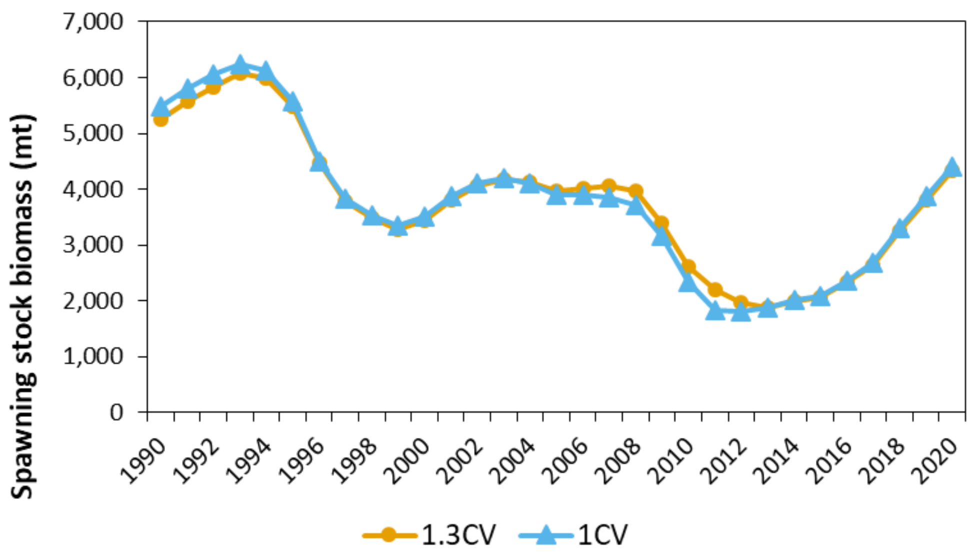


Figure A2.1. Spawning stock biomass (top) and annual *F* (bottom) estimates from ASAP runs with different multipliers on the base CVs for the MRIP index.



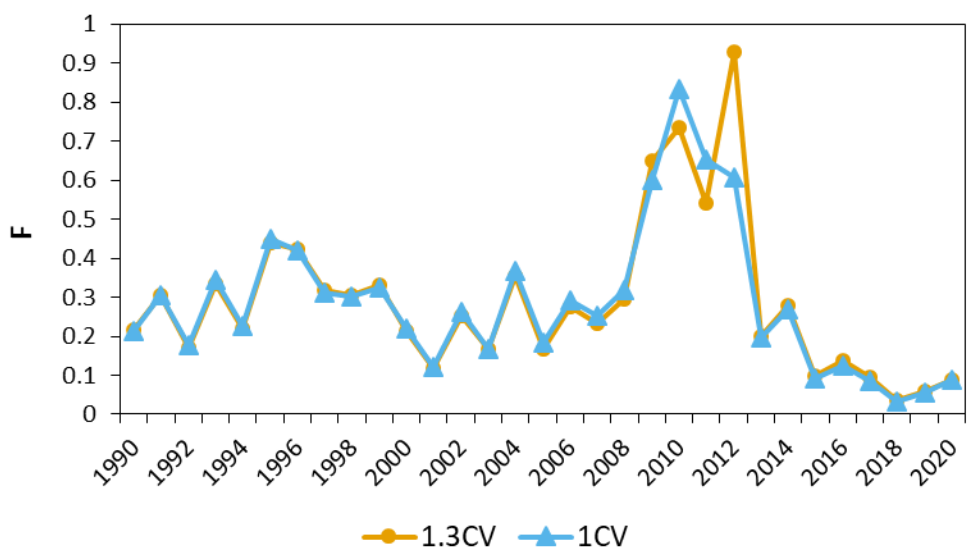


Figure A2.2. Estimates of SSB (top) and annual *F* (bottom) from ASAP runs using the base model CV for catch (1CV) and 1.3 times the base CV (1.3CV).

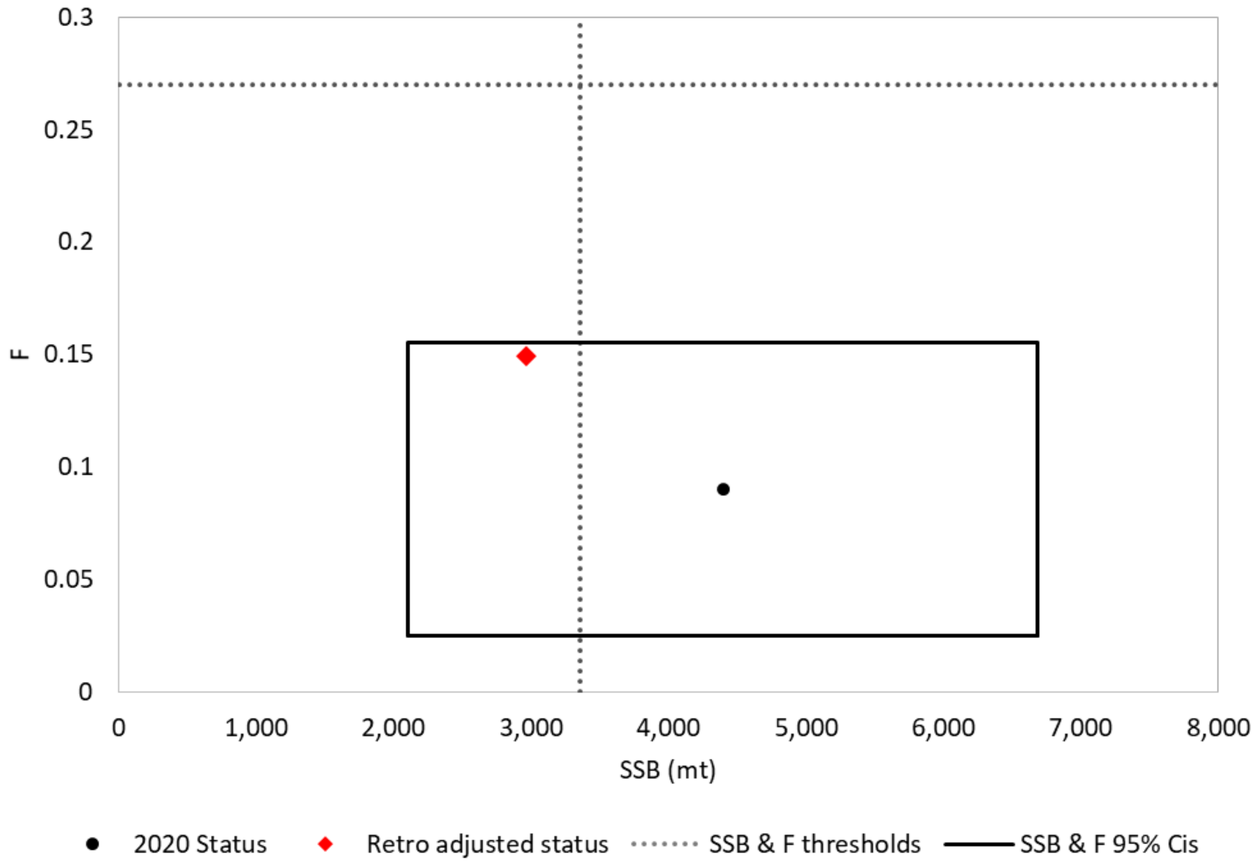


Figure A2.3. Comparison of retrospective adjusted status in 2020 with the base model status. Solid black lines indicate the 95% confidence intervals of the estimates of SSB and F.