MID-ATLANTIC | FISHERY MANAGEMENT COUNCIL

Mid-Atlantic Fishery Management Council
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Richard B. Robins, Jr., Chairman | Lee G. Anderson, Vice Chairman
Christopher M. Moore, Ph.D., Executive Director

MEMORANDUM

DATE: November 28, 2012

TO: Council

FROM: Jessica Coakley and Kiley Dancy, Staff

SUBJECT: Summer Flounder Recreational Management Measures for 2013

The following materials are enclosed for Council consideration of the above subject:

1) Summer Flounder Advisory Panel Meeting Summary

2) Summary of Monitoring Committee Recommendations

3) Staff Recommendation Memo

4) Email comments received on summer flounder

5) Report on Summer Flounder Recreational MSE (Wiedenmann et al. 2012)

Meeting Summary

Joint MAFMC/ASMFC SFSCBSB Advisory Panel (AP) Meeting

November 27, 2012

MAFMC Summer Flounder-Scup-Black Sea Bass AP: Robert Allen (VA), Adam Nowalsky (NJ), Joe O'Hara (MD), Ross Pearsall (RI), Thomas Siciliano (NJ), Steven Witthuhn (NY), Monty Hawkins (MD), James Cicchitti (NJ)

ASMFC Summer Flounder AP: Bob Busby (NY), Mike Plaia (RI); Public: Mark Hoffman, Bill Shillingford (CT) sent in comments

Staff and Council/Board Members: Jessica Coakley, Kiley Dancy, Toni Kerns, Chris Batsavage, Pat Augustine, Mike Luisi

Summer Flounder 2013 Measures

The AP is not satisfied with the process to estimate recreational fishing effort (i.e., phone based effort based on registered anglers in coastal counties) as a part of the recreational estimates. Estimates should consider the number of licensed, fishing anglers and use that number as the multiplier. The AP is not confident in the MRFSS or MRIP estimates themselves.

There is general consensus in the AP that the Council and Board should use conservation equivalency for the upcoming 2013 fishing year, with the exception of a New York advisor which would prefer a coastwide measure or voluntary regional approach. The group debated the pros and cons of using a voluntary regional approach and the difficulty in finding states that want to join region; the advisors were mixed on this issue. A coastwide measure of 18 inch minimum size, 4 fish possession limit, and open season from May 1 - September 30 may work for some states such as New York, but would not work for states such as Maryland and Virginia. It would result in very low landings. The precautionary default measures proposed by staff and the Monitoring Committee would be severely restrictive for all states and would put the party/charter fleets out of business. Continuing to use the vessel trip reports as part of the for-hire estimation process is useful and the for-hire VTRs should be more fully incorporated into the MRIP estimation process.

Given the recent impacts of Superstorm Sandy there will be significantly less fishing effort in the recreational fishery in the coming year. This will not be reflected in the recreational estimates (MRFSS) estimates, because the intercept surveys are only conducted on people who went fishing.

Meeting Summary

Summer Flounder Monitoring Committee (MC) Meeting

Baltimore, MD, November 16, 2012

Attendees: Allison Watts, Moira Kelly, John Maniscalco, Toni Kerns, Marin Hawk, Jessica Coakley, Kiley Dancy, Carli Bari, Mark Terceiro, Jason McNamee, Steve Doctor, Alexi Sharov, Rich Wong, Matt Gates, Peter Clarke, Lee Anderson, John Ward, Mike Luisi, Tom Wadsworth

Summer Flounder 2013 Measures

The group does not recommend a coastwide measure at 16 inch TL minimum fish size, because the lower size classes (discard lengths) may have been underrepresented in the analyses used by staff to develop that recommendation. The group is not comfortable with identifying the specific size, season, and possession limits that would be associated with a coastwide measure at this point. The new modeling analyses presented by John Ward and Mike Wilberg have resulted in progress towards development of a coastwide measure; however, additional work is needed before the group is comfortable with recommending a coastwide measure. Some in the group would prefer the implementation of a coastwide measure, because of the benefits of regulatory simplicity as well as the creation of a new baseline year. The group recommends conservation equivalency for the recreational summer flounder fishery in 2013. The group discussed the difficulty in finding common ground for developing coastwide measures. The baseline year (1998) was based on MRFSS and the new system of MRIP has now been implemented and recalibration of that past data may result in different recreational landings values for the states in 1998. Under conservation equivalency, the plan requires a non-preferred coastwide measure and precautionary default measures. The group recommends a 2013 non-preferred coastwide measure of 18 inch TL minimum fish size, 4 fish possession limit, and May 1 to September 30, which is a 2 fish increase from the status quo coastwide recommended the past two years. The group agrees with the staff recommended precautionary default of 20 inch TL minimum fish size, 2 fish possession limit, and open season from May 1 to September 30.

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MEMORANDUM

Date: November 15, 2012

To: Chris Moore

From: Jessica Coakley and Kiley Dancy

Subject: Summer Flounder Recreational Management Measures in 2013

In August 2012, the Council and Atlantic States Marine Fisheries Commission's (Commission's) Summer Flounder, Scup, and Black Sea Bass Board (Board) recommended commercial quotas and recreational harvest limits for the 2013 and 2014 fishing years, after considering the recommendations of the Scientific and Statistical Committee (SSC) and Summer Flounder Monitoring Committee. The National Marine Fisheries Service proposed rule has filed, with a recreational harvest limit of 7.63 million lb for 2013 and 7.59 million lb for 2014. This is consistent with the recommendations of the Council and Board.

The Summer Flounder Monitoring Committee must recommend recreational management measures for 2013 that will constrain landings to the recreational harvest limit. The following is a review of recreational catch and landings data for the black sea bass fishery.

Recreational Catch and Landings

Recreational catch of summer flounder has fluctuated since 1981, from a peak in 1983 of 32.06 million fish to a time series low of 2.68 million fish in 1989 (Table 1). Landings were estimated to be 5.95 million lb in 2011. The 2012 MRIP data are incomplete and preliminary. To date, only the first four waves of catch and landings data are available (Table 2). The Monitoring Committee does an early review of the data because the Council and Board agreed that recommendations should be made late in the current year (i.e., 2012) to give the states enough time to enact changes in their regulations for the upcoming year (i.e., 2013).

Catch estimates for 2012 waves 1-4 (January through August) are 14.65 million fish, which is slightly lower than the 2011 catch estimates (Table 2). The number of landed fish in these four waves increased from 1.71 to 2.00 million fish between 2011 and 2012. Landings by weight increased from 5.51 million lb to 6.09 million lb between 2011 and 2012 for these four waves. The mean weight of a landed fish in 2012 was 3.05 lb per fish. In the first four waves of 2012, recreational landings by number decreased in

Rhode Island, Delaware, Virginia, and North Carolina, when compared to the 2011 landings estimates for the same period (Table 3).

Preliminary wave data for 2012 can be used to project catch and landings for the entire year. By assuming the same proportion of catch and landings by state and wave in 2012 as in 2011, projected catch estimates for 2012 would be 16.39 million fish and projected landings would be 6.70 million lb (Table 1). Because prior year proportions are used in the projections, for states with more restrictive seasons in 2012, landings will likely be overestimated, and for those with less restrictive measures landings will likely be underestimated.

Past Harvest Limits and Management Measures

Recreational harvest limits and management measures have varied since the FMP was first implemented from a high of 11.98 million lb in 2005 to a low of 6.22 million lb in 2008 (Table 4). Over the time period from 1993-2001, coastwide possession limits ranged from 3-10 fish with size limits ranging from 14.0-15.5 inches. In 2002, conservation equivalency was implemented and has been used as the preferred management system since then. In 2011, the state-specific possession limits ranged from 1-8 fish with size limits ranging from 15.0-20.5 inches, with assorted seasons (Table 5). In 2012, the state-specific possession limits ranged from 3-8 fish with size limits ranging from 15.0-19.5 inches, with assorted seasons (Table 6). The non-preferred and precautionary default measures that were adopted in 2012 (as required for implementation of conservation equivalency) included 2 fish with a minimum size of 18.0 inch TL and an open season from May 1 to September 30, and 2 fish with a 20.0 inch TL minimum fish size and an open season from May 1 to September 30, respectively. Based on projected landings for 2012, only New York is projected to exceed their state-specific 2012 targets (Table 7).

Accountability Measures

The NMFS Regional Administrator (RA) has inseason closure authority for the summer flounder recreational fishery. Specifically, the RA will monitor recreational landings for summer flounder and if the recreational annual catch limit and the recreational harvest limit has been met or exceeded based on observed landings (i.e., not projections of future landings). In addition, there are overage deductions for the recreational fishery that are linked to the recreational ACL being exceeded. If data indicate that the recreational sector ACL has been exceeded and the landings have exceeded the recreational harvest limit, the exact poundage of the landings overage will be deducted as soon as possible from a subsequent single fishing year recreational sector ACT. The recreational harvest limit is derived from the ACT, after discards and RSA have been removed. The recreational sector ACL will be evaluated based on a 3-year moving average comparison of total catch (landings and dead discards). The 3-year moving average is being phased in over the first 3 years, beginning with 2012.

Methodology

The Monitoring Committee must consider and recommend whether coastwide measures or conservation equivalency (state-by-state or regional) are appropriate for 2013 (Table 8). Specifically, this group must recommend measures that will ensure the recreational harvest limit of 7.63 million lb is not exceeded in 2013. Based on projected 2012 landings of 6.70 million lb, a coastwide reduction in landings would not be required. The projected 2012 landings are about 12 percent lower than the proposed 2013 recreational harvest limits. As previously mentioned, these projections are sensitive to prior year landings proportions.

The methodology detailed in Framework 2 (Addendum III) to the Summer Flounder, Scup and Black Sea Bass FMP and Framework 6 to the FMP (Addendum XVII) could be used to develop state-specific or regional regulations to meet the state-specific or region-specific targets (Table 8). Based on projected 2012 landings developed from 2012 preliminary MRIP wave 1-4 data and 2011 prior year proportions, additional constraints would only be required by New York if conservation equivalency were implemented under the potential 2013 recreational harvest limit of 7.63 million lb. If state-by-state or regional conservation equivalency is adopted, Commission's staff will update the 2013 projections in Table 9 using preliminary 2012 wave 1-5 data prior to the development of management measure proposals. The Monitoring Committee must also make recommendations for a non-preferred coastwide alternative and a precautionary default under conservation equivalency.

It is noted that the level of precision of annual harvest estimates from MRIP data depend on the survey sample sizes, the frequency of sampled angler trips that caught the species, and the variability of numbers caught among those trips. Harvest estimates are always progressively less precise at lower levels of stratification; annual estimates are more precise than bimonthly estimates, coastal estimates are more precise than regional estimates, and regional estimates are more precise than state estimates. Coastwide measures could provide greater precision in the harvest estimates and provide the opportunity to create a new base year(s) to characterize landings distributions at present [as opposed to relying on the 1998 base year].

In the past, this Committee used a regression to predict increases in the mean weight of summer flounder being landed, given the steadily increasing trend. However, in the last two years, because the observed mean weights do not appear to be increasing, this Committee recommended using the observed mean fish weight from the most recent year, to derive harvest targets for the upcoming fishing year. Consistent with this approach, the 2012 mean weight (Table 2) was used to derive targets for 2013 (Table 7).

Because of the long-term implementation of state-specific regulations since 2011, the use of a coastwide reduction table (minimum size/possession limit table) to analyze coastwide regulations is no longer feasible. As such, the Council hired an analyst, Dr. John Ward, to develop a model to evaluate coastwide management measures. The model, a constructed dynamic equation (to be presented at the Monitoring Committee meeting), utilized a variety of factors, including prior landings, regulations, and summer flounder abundance to determine likely management measures. Preliminary analyses based on the model suggest that in 2012, under a 16 inch minimum fish size, 3 fish possession limit, and open season from

May 1 to September 30, 2.17 million fish would have been landed. The 7.63 million lb harvest limit in 2013 converts to 2.50 million fish based on an average mean weight of 3.05 lb per fish (Table 2). As such, these measures could constrain landings to the 2013 harvest limit. In addition, a summer flounder recreational management strategy evaluation (also to be presented at the meeting) was developed by John Wiedmemann, and several other investigators, which examines the performance of several recreational management strategies.

Fishing Trips and Year Class Effects

Table 13 provides an overview of coastwide recreational fishery performance and provides estimates of the number of summer flounder trips where summer flounder was reported as the primary target. An examination of summer flounder directed trips to total trips suggests that summer flounder continues to be a substantial component of the total number of angler trips, ranging from about 14-21 percent of total trips taken from 1993-2011 (Table 10). Predicting the number of summer flounder trips that might be taken in 2012 is complicated because many factors affect the demand for angler fishing trips. Changes in angler behavior are also difficult to predict and complex. Changes in angler behavior may result in a breakdown in the assumptions associated with specific sets of regulations and their anticipated results. Summer flounder SSB reached the target level in 2010, and at the proposed catch the SSB is expected to remain near the target through 2013. Year-class effects in terms of fish availability can influence the expected impacts of management measures and should be considered.

2013 Staff Recommendation

Staff recommend a coastwide measure of 16.0 inch TL minimum size, 3 fish possession limit, and coastwide season from May 1 to September 30, 2013 based on analyses from the constructed dynamics equations developed by Dr. John Ward. A coastwide measure for both state and Federal waters would reduce the complexity of the regulations (particularly in shared waters/bays). In addition, MRIP harvest estimates are always progressively less precise at lower levels of stratification; therefore, the data would be more precise when used at the coastwide level.

If conservation equivalency is instead selected (although not staff recommended), then a non-preferred coastwide measure and a precautionary default measure must be identified. The non-preferred coastwide measures would be comprised of an identical minimum fish size, possession limit, and season, for 2013, to be implemented by all states and in federal waters. The precautionary default measures are defined as the set of measures that would achieve at least the highest percent reduction for any state on a coastwide basis. It is intended to be an unappealing measure for any state to implement. The Commission would require adoption of the precautionary default measures by any state that either does not submit a summer flounder management proposal to the Commission's Summer Flounder Technical Committee, or that submits measures that are determined not to achieve the required level of reduction for that state. Staff recommends a non-preferred coastwide measure of 16.0 inch TL minimum size, 3 fish possession limit, and coastwide season from May 1 to September 30, 2013. In addition, if conservation equivalency is chosen, staff recommends default measures that include a 20.0 inch TL minimum size, 2 fish possession limit, and coastwide season from May 1 to September 30, 2013. This default is likely to be more restrictive than any measure an individual state will implement in 2013.

2012 Recommendations in Summary

A coastwide measure of 16 inch TL minimum size, 3 fish possession limit, and open season from May 1 to September 30, for 2013 for both state and Federal waters.

Table 1. Summer flounder recreational catch and landings by year, Maine through North Carolina, 1981-2012. The number of fish released is presented as a proportion of the total catch (% Rel).

Year	Catch[a] ('000 fish)	Landings[a] ('000 fish)	Landings[a] ('000 lb)	% Released
1981	13,579	9,567	10,081	30%
1982	23,562	15,473	18,233	34%
1983	32,062	20,996	27,969	35%
1984	29,785	17,475	18,765	41%
1985	13,526	11,066	12,490	18%
1986	25,292	11,621	17,861	54%
1987	21,023	7,865	12,167	63%
1988	17,171	9,960	14,624	42%
1989	2,677	1,717	3,158	36%
1990	9,101	3,794	5,134	58%
1991	16,075	6,068	7,960	62%
1992	11,910	5,002	7,148	58%
1993	22,904	6,494	8,831	72%
1994	17,725	6,703	9,328	62%
1995	16,308	3,326	5,421	80%
1996	18,994	6,997	9,820	63%
1997	20,027	7,167	11,866	64%
1998	22,086	6,979	12,477	68%
1999	21,378	4,107	8,366	81%
2000	25,384	7,801	16,468	69%
2001	28,187	5,294	11,637	81%
2002	16,674	3,262	8,008	80%
2003	20,532	4,559	11,638	78%
2004	20,336	4,316	10,966	79%
2005	25,806	4,027	10,867	84%
2006	21,400	3,950	10,589	82%
2007	20,732	3,108	9,256	85%
2008	22,897	2,350	8,134	90%
2009	24,085	1,806	5,987	93%
2010	23,722	1,501	5,108	94%
2011	21,559	1,840	5,954	91%
2012[b]	16,390	2,168	6,703	87%

[a] For 1981-2003 data are MRFSS, 2004-2012 are MRIP.

[b] Projected using proportion from 2011 MRIP data and 2012 MRIP wave 1-4 data (Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012).

Table 2. Summer flounder recreational catch and landings for waves 1-4, Maine through North Carolina, 1981-2012.

Year	Catch ('000 fish)	Landings ('000 fish)	Landings ('000 lb)	Mean Weight (lb)
1981	11,774	8,071	8,899	1.10
1982	20,108	12,599	15,289	1.21
1983	26,979	17,128	22,523	1.31
1984	26,355	14,614	15,245	1.04
1985	10,626	8,535	9,691	1.14
1986	21,321	8,885	13,274	1.49
1987	18,749	6,656	10,393	1.56
1988	13,906	7,918	11,728	1.48
1989	2,120	1,465	2,715	1.85
1990	7,277	3,025	4,125	1.36
1991	13,977	5,186	6,796	1.31
1992	9,830	3,992	5,688	1.42
1993	17,636	4,750	6,553	1.38
1994	15,052	5,499	7,603	1.38
1995	14,315	2,765	4,629	1.67
1996	17,206	6,175	8,685	1.41
1997	14,466	4,657	7,636	1.64
1998	19,015	5,944	10,568	1.78
1999	19,113	3,629	7,441	2.05
2000	22,131	6,867	14,148	2.06
2001	25,661	4,810	10,651	2.21
2002	14,442	2,842	7,008	2.47
2003	18,177	4,123	10,615	2.57
2004	17,998	3,931	10,047	2.56
2005	22,874	3,630	9,778	2.69
2006	20,515	3,685	9,863	2.68
2007	18,659	2,898	8,729	3.01
2008	21,792	2,277	7,937	3.49
2009	23,482	1,758	5,862	3.33
2010	22,725	1,428	4,904	3.43
2011	19,347	1,708	5,509	3.23
2012	14,654	1,996	6,086	3.05

Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012. For 1981-2003 data are MRFSS, 2004-2012 are MRIP.

Table 3. Summer flounder recreational landings ('000 fish) by state, waves 1-4, 2002-2012.

State	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ME	-	-	-	-	-	-	-	-	-	-	-
NH	-	<1	-	-	<1	-	<1	-	-	-	<1
MA	139	150	200	258	211	138	232	50	45	33	76
RI	168	198	241	153	261	173	203	71	118	152	103
CT	88	135	204	130	128	111	146	45	35	47	61
NY	659	1,447	1,017	1,082	743	844	609	298	331	349	488
NJ	888	1,597	1,507	1,187	1,475	1,040	752	817	551	719	929
DE	100	91	106	60	82	101	33	78	50	56	36
MD	47	39	36	98	32	44	34	64	14	10	17
VA	621	429	514	602	674	342	243	275	235	301	253
NC	133	36	106	61	77	104	25	59	50	40	32

Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012. For 1981- 2003 data are MRFSS, 2004-2012 are MRIP.

Table 4. Summary of Federal management measures for the summer flounder recreational fishery, 1993-2012, and potential 2013 and 2014 recreational harvest limits.

Measure	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Harvest Limit (m lb)	8.38	10.67	7.76	7.41	7.41	7.41	7.41	7.41	7.16	9.72	9.28
Landings (m lb)	8.83	9.33	5.42	9.82	11.87	12.48	8.37	16.47	11.64	8.01	11.64
Possession Limit	6	8	6/8	10	8	8	8	8	3	[b]	[b]
Size Limit (TL in)	14	14	14	14	14.5	15	15	15.5	15.5	[b]	[b]
Open Season	5/15 - 9/30	4/15 - 10/15	1/1 - 12/31	1/1 - 12/31	1/1 - 12/31	1/1 - 12/31	5/29 - 9/11	5/10 - 10/2	4/15 - 10/15	[b]	[b]

Measure	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Recreational ACL (land+disc)	-	-	-	-	-	-	-	-	11.58	10.23[c]	10.19[c]
Harvest Limit (m lb) - landings only	11.21	11.98	9.29	6.68	6.22	7.16	8.59	11.58	8.49	7.63[c]	7.59[c]
Landings (m lb)	10.97	10.87	10.59	9.26	8.13	5.99	5.11	5.95	6.70[a]	-	-
Possession Limit	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	-	-
Size Limit (TL in)	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	-	-
Open Season	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	-	-

[a] Projected using proportion from 2011 MRIP data and 2012 MRIP wave 1-4 data (Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012). [b] State-specific conservation equivalency measures. [c] Assumed value, subject to change.

Table 5. Summer flounder recreational management measures by state, 2011.

State	Minimum Size (inches)	Possession Limit	Open Season
Massachusetts	17.5	5 fish	May 22-September 30
Rhode Island	18.5	7 fish	May 1-December 31
Connecticut	18.5	3 fish	May 15-September 5
***At 40 designated Shore sites in CT**	17.0	1 fish	May 15-September 5
New York	20.5	3 fish	May 1-September 30
New Jersey	18.0	8 fish	May 7-September 25
Delaware	18.0	4 fish	January 1-October 23
Maryland	18.0	3 fish	April 16-November 30
PRFC	17.5	4 fish	All year
Virginia	17.5	4 fish	All year
North Carolina	15.0	6 fish	All Year

Table 6. Summer flounder recreational management measures by state, 2012.

<table>
<tr><th>State</th><th>Minimum Size (inches)</th><th>Possession Limit</th><th>Open Season</th></tr>
<tr><td>Massachusetts</td><td>16.5</td><td>5 fish</td><td>May 22-September 30</td></tr>
<tr><td>Rhode Island</td><td>18.5</td><td>8 fish</td><td>May 1-December 31</td></tr>
<tr><td>Connecticut*</td><td>18</td><td rowspan="2">5 fish</td><td rowspan="2">May 15-October 31</td></tr>
<tr><td>*At 44 designated Shore sites in CT</td><td>16</td></tr>
<tr><td>New York</td><td>19.5</td><td>4 fish</td><td>May 1-September 30</td></tr>
<tr><td>New Jersey</td><td>17.5</td><td>5 fish</td><td>May 5-September 28</td></tr>
<tr><td>Delaware</td><td>18</td><td>4 fish</td><td>January 1-October 23</td></tr>
<tr><td>Maryland</td><td>17</td><td>3 fish</td><td>April 14-December 16</td></tr>
<tr><td>PRFC</td><td>16.5</td><td>4 fish</td><td>All year</td></tr>
<tr><td>Virginia</td><td>16.5</td><td>4 fish</td><td>All year</td></tr>
<tr><td>North Carolina</td><td>15</td><td>6 fish</td><td>All Year</td></tr>
</table>

Table 7. Projected summer flounder recreational landings (in '000 of fish) relative to targets, by state for 2012.

State	2012 Target	2012 Landings[a,b]	Overage (+%)/ Underage (-%) Relative to 2012 Target
MA	153	135	-12%
RI	158	110	-30%
CT	104	61	-41%
NY	492	526	+7%
NJ	1091	951	-13%
DE	88	43	-51%
MD	82	27	-67%
VA	466	266	-43%
NC	156	48	-69%

[a] Projected using proportion from 2011 MRIP data and 2012 MRIP wave 1-4 data (Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012).
[b] Because prior year proportions are used, for states with more restrictive seasons in 2012, landings will be overestimated, and for those with less restrictive measures landings will be underestimated.

Table 8. Procedures for establishing summer flounder recreational management measures.

August

Council/Commission's Board recommend recreational harvest limit.

October

MRFSS data available for current year through wave 4.

November

Monitoring Committee meeting to develop recommendations to Council:
Overall % reduction required.
Use of coastwide measures or state conservation equivalency.
**Precautionary default measures.
**Coastwide measures.

December

Council/Board meeting to make recommendation to NMFS
State Conservation Equivalency
or
Coastwide measures.

State Conservation Equivalency Measures

Late December

Commission staff summarizes and distributes state-specific and multi-state conservation equivalency guidelines to states.

Early January

Council staff submits recreational measure package to NMFS. Package includes:
- Overall % reduction required.
- Recommendation to implement conservation equivalency and precautionary default measures (Preferred Alternative).
-Coastwide measures (Non-preferred Alternative).

States submit conservation equivalency proposals to ASMFC.

January 15

ASMFC distributes state-specific or multi-state conservation equivalency proposals to Technical Committee.

Late January

ASMFC Technical Committee meeting:
-Evaluation of proposals.
-ASMFC staff summarizes Technical Committee recommendations and distributes to Board.

February

Board meeting to approve/disapprove proposals and submits to NMFS within two weeks, but no later than end of February.

March 1 (on or around)

NMFS publishes proposed rule for recreational measures announcing the overall % reduction required, state-specific or multi-state conservation equivalency measures and precautionary default measures (as the preferred alternative), and coastwide measures as the non-preferred alternative.

March 15

During comment period, Board submits comment to inform whether conservation equivalency proposals are approved.

April

NMFS publishes final rule announcing overall % reduction required and one of the following scenarios:
-State-specific or multi-state conservation equivalency measures with precautionary default measures, or -Coastwide measures.

Coastwide Measures

Early January

Council staff submits recreational measure package to NMFS. Package includes:
-Overall % reduction required.
-Coastwide measures.

February 15

NMFS publishes proposed rule for recreational measures announcing the overall % reduction required and Coastwide measures.

April

NMFS publishes final rule announcing overall % reduction required and Coastwide measures.

**Precautionary default measures - measures to achieve at least the % required reduction in each state, e.g., one fish possession limit and 15.5 inch bag limit would have achieved at least a 41% reduction in landings for each state in 1999.
**Coastwide measures - measure to achieve % reduction coastwide.

Table 9. Summer flounder landings (number in thousands) by state for 1998, the 2012 projected landings (number in thousands), and the 2013 target (number in thousands) under the assumed recreational harvest limit of 7.63 million lb. The percent reduction necessary to achieve the 2013 recreational harvest limit relative to 2012 landings is also presented.

State	1998	2013 Target[a]	2012[b,c]	% Reduction
MA	383	137	135	0
RI	395	141	110	0
CT	261	93	61	0
NY	1,230	440	526	20
NJ	2,728	977	951	0
DE	219	78	43	0
MD	206	74	27	0
VA	1,165	417	266	0
NC	391	140	48	0

[a] Based on a 64.0% reduction in 1998 landings and mean weight of 3.05lb per fish.
[b] Projected using proportion from 2011 MRIP data and 2012 MRIP wave 1-4 data (Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012).
[c] Because prior year proportions are used, for states with more restrictive seasons in 2012, landings will be overestimated, and for those with less restrictive measures landings will be underestimated. If state-by-state or regional conservation equivalency is adopted, ASMFC staff will update the projections using MRIP 2012 wave 1-5 data.

Table 10. Number of summer flounder recreational fishing trips, harvest limit, landings, and fishery performance from Maine through North Carolina, 1993 to 2013.

Year	Number of Fishing Trips[a]	Percentage of Directed Trips Relative to Total Trips[a,b]	Recreational Harvest Limit (million lb)	Recreational Landings of Summer Flounder (million lb)[d]	Percentage Overage (+)/ Underage(-)
1993	4,671,638	17.4	8.38	8.83	5%
1994	5,769,037	20.1	10.67	9.33	-13%
1995	4,683,754	16.7	7.76	5.42	-30%
1996	4,885,179	17.5	7.41	9.82	33%
1997	5,595,636	18.4	7.41	11.87	60%
1998	5,268,926	20.0	7.41	12.48	68%
1999	4,219,909	16.5	7.41	8.37	13%
2000	5,802,215	16.4	7.41	16.47	122%
2001	6,130,383	16.3	7.16	11.64	63%
2002	4,564,011	14.5	9.72	8.01	-18%
2003	5,624,387	15.6	9.28[c]	11.64	25%
2004	4,864,356	13.9	11.21[c]	10.97	-2%
2005	5,845,890	15.6	11.98[c]	10.87	-9%
2006	4,991,476	13.3	9.29[c]	10.59	14%
2007	5,491,077	14.1	6.68[c]	9.26	39%
2008	4,932,811	13.0	6.21[c]	8.13	31%
2009	4,596,612	15.2	7.16[c]	5.99	-16%
2010	4,452,956	14.7	8.59[c]	5.11	-41%
2011	4,500,040	16.2	11.58[c]	5.95	-49%
2012	NA	NA	8.59[c]	NA	NA
2013	NA	NA	7.63[c,d,e]	NA	NA

[a] Estimated number of recreational fishing trips (expanded) where the primary target species was summer flounder, Maine through North Carolina. Source: Scott Steinback, NMFS/NER/NEFSC.
[b] Source of total trips for all species combined: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012.
[c] Adjusted for research set-aside.
[d] Source: Pers. Comm. with the National Marine Fisheries Service, Fisheries Statistics Division, October 18, 2012.
[e] Recreational harvest limit - assumed for 2013; subject to change. NA = Data not available.

Email Comments Received on Summer Flounder

From: Wong Richard A. (DNREC)
Sent: Monday, November 19, 2012 2:54 PM
To: Coakley, Jessica
Subject: RE: SFSCBSB MC Meeting - Rec Measures

Jess,

Just a question before you finalize the meeting comments. If I'm remembering correctly, for fluke, the MC recommended coastwide preferred measures of 18", 4 fish, May1-Sep30. Is this correct? If so, here's my comment for the record. If not, then could you relay what our rec was?

Thinking about this over the w/e, it seems very risky. It wasn't long ago that we had persistent problems trying to corral NY's landings and overages. At the same size & bag & similar season in 2006, NY landed over 800,000 fish. Their 2013 target is 440k. 18", 4 fish, May1-Sep30 is definitely appealing to most states in the unit. It wouldn't surprise me if it was selected by the Board. If so, I'd expect a 2013 coastwide overage. I'd much prefer to go with a 18", 2 bag, May1-Sep30 season for the coastwide preferred recommendation.

Best regards,

Rich

Delaware Division of Fish and Wildlife
3002 Bayside Dr.
Dover, DE 19901
(302) 735-2975
(302) 739-6780 fax

From: Robert Allen
Sent: Tuesday, November 27, 2012 4:09 PM
To: Coakley, Jessica
Cc: Jessica Coakley
Subject: Webinar comment

---- Jessica Coakley

The meeting today of the AP was well done and informative and should assist the Council in their deliberations.

I liked the fact that we stayed at home and did not travel long distance for the meeting.

Dr. Bob Allen   Hampton VA

From: Roman Jesien
Sent: Tuesday, November 27, 2012 5:10 PM
To: Coakley, Jessica
Subject: RE: Reminder : Your Webinar is on Tuesday, November 27, 2012 1:00 PM - 4:30 PM EST

Jessica, would you mind sending me the meeting write-up from the sea bass ap meeting? Also, thanks for the webinar format of the meeting, makes life a lot simpler. To tell you the truth it is getting very frustrating to keep bringing up the same issues regarding data inaccuracies year after year, only to hear, the same "yea we know but its the best we got". Thanks,

Roman Jesien
Maryland Coastal Bays Program
Ocean City, MD

From: Bill Shillingford
Sent: Tuesday, November 27, 2012 10:44 AM
To: Toni Kerns
Subject: Re: RE: Upcoming AP meeting for SF, S, BSB- WITH LINK

Toni only thing i would comment on is flounder population in south jersey had good population of 18 inch fish but serious Loss of 13-17inch fish over past several years

Evaluation of Management and Regulatory Options for the Summer Flounder Recreational Fishery

John Wiedenmann, Michael Wilberg, Eleanor Bochenek, John Boreman, Bruce Freeman, Jason Morson, Eric Powell, Brian Rothschild, Pat Sullivan

Questions have been raised about the overall effectiveness of management for the summer flounder (*Paralichthys dentatus*) recreational fishery, both in terms of the how regulations are set from year to year, and also the impacts that specific regulations have on the population and the recreational fishery. To avoid exceeding their harvest limit for the summer flounder recreational fishery, states annually modify their bag (creel) limits, minimum size limits, and fishing season, and the general trend over the past decade has been for more restrictive regulations (smaller bag limit, larger minimum size, shorter season) to allow for the rebuilding of the stock. Increasing the minimum size limit has resulted in a greater number of fish being discarded for every fish kept, with over 90% of the total catch (landings + discards) being discarded in recent years. Increased minimum size limits also results in a disproportionate harvest of females in the population, as summer flounder females reach a larger asymptotic size and are larger, on average, at a given age.

One method for evaluating the expected effectiveness of potential management options is through management strategy evaluation. Management strategy evaluation involves the development of a computer simulation model of the fish population, stock assessment process, management implementation, and subsequent effects on the fishery and fish population. The model tracks how well fishery objectives are achieved by calculating performance measures such as average harvest, variability in the harvest, and variability in the regulations. The models are run many times for each set of management options, which results in a distribution of potential outcomes. Management options are then compared based on how well they are predicted to meet the fishery objectives.

Our objectives for this project are to evaluate how well alternative sets of management options for the recreational summer flounder fishery are expected to achieve fishery goals. We have worked closely with the scientific and management community for summer flounder to develop the model, management options, and performance measures.

Methods

To explore the management and regulatory options in the summer flounder recreational fishery we developed a computer simulation model to 1) evaluate the effectiveness of the current and alternative methods for setting annual regulations that achieve high harvests without exceeding the catch limit, and 2) evaluate the effects of different regulations (e.g. a minimum size limit compared to a slot size limit) on the summer flounder population and on the recreational fishery. The model is age- and sex-structured to account for differential sizes at age between the sexes, vulnerability to the fishery, and also to account for different rates of natural mortality (higher for males). The model includes two spatial areas, with the Atlantic Coast divided into north-south regions (split by Hudson Canyon). These regions are meant to capture the broad pattern of larger fish being more common in the northern areas. Within the model recreational and commercial fisheries operate seasonally, with the bulk of commercial harvest occurring in the fall and winter, and recreational harvest occurring during the spring and summer. An assessment process was simulated using an autoregressive process, and the results of the simulated assessment are used to specify annual catch limits (ACL). Each year, the commercial fishery achieves its sector ACL, while regulations are adjusted annually in the recreational fishery, with the annual adjustments dependent upon rules that are specified for the particular management scenario being explored (e.g., adjust the bag limit only to achieve the target, or modify both the bag and slot size limits).

Operating Model

The model projects the population dynamics of summer flounder over a 30-year period for each of the management and regulatory options being tested. This model was based on a model developed for exploring management and regulatory options in the king mackerel (*Scomberomorus cavalla*) recreational fishery (Wilberg et al. 2009; Miller et al. 2010). There were 15 age classes for both males and females, with the final age class being an aggregation for ages 15 and older (i.e. a plus-group). Each year within the model represented a calendar year (Jan-1 through Dec 31), and was divided into 3 periods. The first time period represented the first quarter of the year (Jan-Mar). During this period, summer flounder are aggregated offshore, and are harvested by the commercial fishery only. The second period occurred over half the year (Apr -Sep) and represented the inshore phase. At the start of this period summer flounder migrate inshore to either the North or South regions (delineated by Hudson Canyon), where they are harvest by both the commercial and recreational fisheries. During the final period (Oct-Dec) summer flounder migrate offshore to spawn, and are harvested by the commercial fishery only. Migration is considered a pulse event in the fall and spring.

The population is assessed annually, the acceptable biological catch (ABC) determined using the Mid-Atlantic Fishery Management Council (MAFMC) P* control rule (Federal Register, October 31, 2011; 76 FR 60606), and annual catch limits (ACL) were allocated to the commercial and recreational sectors (ACL = 60% and 40% of the ABC, respectively) to match current management (Figure 1). For the commercial fishery, the regulations were fixed (14 inch minimum size) and the ACL is removed throughout the year, with the amount removed each period based on average landings in each period during . For the recreational fishery, the ACL was allocated between the northern and southern regions by summing the current state-based allocations within each region (32.5% and 67.5%, respectively). An annual catch target (ACT) was set for each region (≤100% of the ACL) using several levels of buffer size and converted from weight to numbers; recreational regulations (bag limit and minimum or slot size limits) were adjusted in each region achieve the ACT. The size of the buffer used when setting the ACT, the type of regulations used and the manner in which the regulations were determined encompass the suite of management and regulatory options explored in the model. At the end of the 30-year period, we summarized the performance of each management / regulatory option by calculating a range of performance metrics.

Population Dynamics

The detailed dynamics of the operating model are, with variables defined in Table 1, equations defined in Table 2, and parameters defined in Table 3. In the text, equations are referred to by table and number, such that Eq.T2.1 is the first equation in Table 2. At the start of each year, numerical abundance by sex and age was determined from the abundance of that cohort in the final period $s = 3$ of the previous year, discounted by total mortality during that period (Eq. T2.1). Abundance at the start of the later periods during the year (i.e., $s \neq 1$) was determined from the abundance during the previous period discounted by total mortality (Eq. T2.2). At the start of the second period the population has migrated to either the northern or southern area, with migration to each region sex- and age-dependent (Eq. T2.3), with the proportion migrating by age and sex to each region based in an analysis of the Northeast Fishery Science Center (NEFSC) bottom trawl dataset (Figure 2).

In the summer flounder stock assessment spawning was assumed to occur in early November (or approximately 83% of the way through the calendar year; Terceiro 2011). In our model, this corresponds to the midpoint of the final period (*s*=3). We assumed that recruitment followed the Beverton-Holt stock recruitment relationship (Eq T2.4) using female spawning biomass only (Eq. T2.5), with an assumed sex ratio at recruitment of 65% male and 35% female (Powell and Morson 2008). The steepness of the stock recruitment relationship was randomly drawn for each model run (where it was fixed over all years in that run) from a lognormal distribution with a mean h = 0.8 and , σ_h=0.2 (values drawn above 1 were set to 1). The mean steepness value was based on the median estimate for flatfish from Myers et al. (1999), and also the work of Maunder (2012) who noted that steepness was likely very high, but by assuming h = 0.8 (if it was actually > 0.8) resulted in a small loss of yield and a higher equilibrium biomass. Virgin spawning biomass was calculated using the mean estimate of spawning biomass across years from the assessment (Terceiro 2011), adjusted by two random variables to account for mean female spawning biomass being less than the sex-aggregated estimate (drawn from a uniform between 0.35 and 0.65), and that the mean biomass being some fraction of the unfished level (drawn from a uniform between 0.1 and 0.4; Eq. T2.6). Virgin recruitment was calculated to ensure that the resulting stock recruitment curve went through the mean estimates recruitment and female spawning biomass from the stock assessment (Terceiro 2011; Eq. T2.7; Figure 3).

The model was also structured by size with distributions of lengths for each sex and age class. We used sex-specific von-Bertalanffy growth curves estimated using data from the NEFSC trawl survey (Eqn T2.8; analysis conducted by Pat Sullivan). This analysis revealed significant differences in mean length-at-age, with females being larger on average at a given age (Figure 4). For each age and sex class we assumed that possible length values ranged between ± 15 cm (in 1 cm bins) from the mean estimated from the von-Bertalanffy growth model (Eq. T2.8; resulting in 31 length bins for each age and sex class). The probability of having a particular length was determined from a discretized normal distribution (Eqs. T2.9 and T2.10). Weight at length (in kg) followed a power function (Eq. T2.11), and sex-specific maturity at length followed a logistic function (Eq. T2.12). Age-based values for weight and maturity (and other length-based quantities introduced below) were used in the population dynamics model equations (Eq. T2.5, for example), and were calculated as weighted averages of the length-based values. Eq. T2.13 shows the calculation for weight, but the same equation is used for maturity, vulnerability, and retention probability.

Fishery Dynamics

The model contained both recreational and commercial fisheries, each with distinct selectivity patterns at age and sex. Selectivity represents the relative effect of fishing mortality on a given age- and sex-class, and it was a function of the vulnerability to the fishery and the retention probability. Vulnerability accounts for the possibility that specific summer flounder of certain ages and sexed may be more or less available to a particular fishery. For example, younger fish that inhabit coastal nurseries may not be vulnerable to the commercial fishery that typically operates offshore. In contrast, retention refers to the fraction of fish caught that are kept, and depends (at least in part) on size limits. Thus, the vulnerable fish represented those that could be caught, and the retained fish were those that were kept (i.e., not discarded).

Vulnerability at length was assumed to follow a logistic function, and we allowed for region-, sex- and fishery-specific vulnerability curves (Eq T2.14). Retention probability at length was assumed knife-edged, with all fish at or above the minimum size retained, and all fish below discarded (Eq. T2.15). Vulnerability and retention at age were calculated using a weighted average as was weight-at-age (Eq. T2.13), and they influenced the age-specific estimates of fishing mortality (Eq. T2.16). Total mortality was the sum of sex-specific rate of natural mortality and the age-specific rates of fishing mortality of retained and discarded fish across fisheries (Eq. T2.17 and T2.18). Natural mortality was assumed fixed across ages for a given sex, with M = 0.2 and 0.3 for females and males, respectively under the base model (an additional set of runs used different values; see the *Sensitivity Runs* section below). These values were chosen because they bracketed the current sex-aggregated estimate of 0.25 used in the assessment (Tercerio 2011). Fishing mortality in the model was separated into the mortality of retained fish (Eq. T2.17), and the mortality of fish discarded that did not survive (Eq. T2.18). We assumed 10% discard mortality for fish released in the recreational fishery and 80% mortality in the commercial fishery (Terceiro 2011). The total numbers of fish harvested and discarded were calculated using the Baranov catch equation (Eq. T2.19 and T2.20).

The age-specific rates of fishing mortality of retained and discarded fish were controlled by the maximum total mortality rate (ϕ) in each region and fishery (Eq. T2.17

and T2.18), determined by solving Eqs. T2.19 and T2.20 numerically to achieve the observed harvest or catch in each fishery in each period. For the commercial fishery, the observed catch was the commercial ACL (i.e., no implementation error in the commercial fishery; see *Management Model* below). In contrast, the recreational fishery was modeled with implementation error to reflect the large uncertainty in realized harvest given a set of recreational regulations. The observed harvest in each region in the recreational fishery was determined from the number of angler trips and the average harvest-per-angler trip in each region, which we estimated from data of summer flounder recreational harvests between 2004-2011 from the Marine Recreational Information Program (MRIP; http://www.countmyfish.noaa.gov).

For each year in each region, the total number of angler trips was determined in 1 of 3 ways to allow for an exploration of differential angler responses to regulations. Under the first scenario, recreational effort was not influenced by regulations and was drawn randomly from a normal distribution (Eq. T2.21) with a mean and variance based on the observed number of angler trips during 2004-2011 (Eq. T2.22). In the second and third scenarios, angler effort had a positive relationship with the regional bag limits (Eq. T2.23). This relationship was based on a comparison of the regional estimates of angler effort from MRIP to the mean regulations within a region (minimum size and bag limits; Figure 5). Annual regulations by region were calculated as the catch-weighted average (in numbers) of the state-specific regulations within each region. In the second scenario angler effort was random in the southern region (Eq. T2.21), while in the northern region it responded in a piecewise function to the bag limit, increasing linearly within a particular bag limit range, or fixed at minimum or maximum value at lower or higher bag limits, respectively (Eq. T2.23; Figure 5). In the third scenario, effort in both the northern and southern regions followed the same piecewise function (Eq T2.23; Figure 6).

Estimates of the mean harvest per angler trip was estimated from the trip data from MRIP, but these data are influenced in part by the imposed bag limit. To determine the mean harvest per angler in the absence of a bag limit, we followed the approach of Wilberg (2009), assuming estimates of harvest per angler followed a truncated negative binomial distribution, and we estimated the parameters (the mean λ and overdispersion parameter k) for each region and year using a maximum likelihood approach (Figure 7). Estimates of k showed no trend or relationship with the mean regulations, so k was drawn randomly from a normal distribution with a mean and standard deviation equal to the observed estimates (Eqs. T2.24 and T2.25). Estimates of λ, however, showed a declining trend over time (Figure 8), and were negatively correlated with the mean minimum size limit in each region (Figure 9). Therefore, we used a piecewise function to calculate the mean λ from the minimum size (Eq. T2.26), and used this mean to draw a random lambda from a normal distribution (Eq. T2.27). The mean harvest per angler under a bag limit or in the absence of a bag limit was then calculated using these parameters (Eqs. T2.28 and T2.29, respectively), and the observed harvest (in numbers) was the product of the number of anglers and the mean harvest per angler (Eq. T2.30).

Management Model

The dynamics of the commercial and recreational fisheries depend on the target harvest level for each year, and in the recreational fishery, the regulations set to achieve this target. Both the target harvest and recreational regulations for each year were determined in the management model, and the first step in this process was to mimic the stock assessment process to estimate population status and management reference points.

Each year the coastwide stock is assessed to determine the stock status and management reference points that are used in the determination of the ABC for the following year. We included a two year lag in the assessment, such that an assessment done in 2013 estimates biomass through 2011. We adopted the approach of Punt et al. (2008) and Irwin et al. (2008) in place of a full statistical catch at age model to reduce the amount of computer time necessary for the analysis. Under this approach, the estimated spawning biomass was drawn randomly based on the true biomass and an auto-correlated error (Eqs. T2.31 and T2.32). Auto-correlation in this approach was incorporated to account for the serial correlation in the error of stock assessment estimates over time, such that if the population biomass is overestimated in one year, it will likely be overestimated in subsequent years. We assumed a moderately high degree of autocorrelation ($\gamma = 0.75$ in Eq. T2.32, as this value is between those used by Punt et al. 2008 and Irwin et al. 2008) for all model runs. The equations shown are for the estimation of total spawning biomass (male + female), mimicking the current approach of a sex-aggregated assessment. We applied the same relative error (Eqs. T2.31 and T2.32) to estimate total biomass (mature and immature) at the beginning of the calendar year as was used for spawning biomass. Therefore, if the spawning biomass were overestimated by 20% in a given year, the total biomass would also be 20% over in that same year. Given an estimate of total biomass, biomass-at-age was estimated by multiplying the total estimated biomass by the true proportional age structure in the population. Estimated abundance at age was calculated by dividing the estimated biomass at age by the true mean weight at age in the population.

Biological reference points (BRPs) for summer flounder are based on the spawning potential ratio (SPR) of the population (Tercerio 2011). The overfishing threshold (F_{lim}) is the fishing mortality rate that reduces SPR to 35% of the unfished value ($F_{35\%}$), and the target spawning biomass (S_{targ}; a proxy for S_{MSY}) is calculated by multiplying the spawning biomass-per-recruit (when fishing at F_{lim}) by the estimated mean recruitment (Terceiro 2011). We replicated this SPR-based approach in our management model, using sex-aggregated inputs of natural mortality, weight-, selectivity-, and maturity-at-age, and mean recruitment in the calculation of spawning biomass per recruit. Natural mortality was set to 0.25, the value currently assumed in the assessment. Weight- and maturity-at-age were set at the true values, and selectivity-at-age was calculated as the catch-weighted average of the individual selectivities of the commercial and recreational harvests and dead discards. The mean recruitment was calculated using an expanded time series of recruitment estimates, where estimates from 1982 to 2010 are based on the assessment-estimated values (Terceiro 2011), and from 2011 to the current assessment year in the model using estimates from this model.

With estimates of current biomass and F_{lim}, the harvest at F_{lim} , or the overfishing limit (OFL), was estimated using the Baranov catch equation with the same weight- and selectivity-at-age and natural mortality rates used in the BRP calculation. We then applied the mid-Atlantic ABC control rule for a level 3 stock (Federal Register, October 31, 2011; 76 FR 60606) by selecting the catch associated with a specific percentile of the OFL distribution assuming a lognormal distribution with a median of the distribution equal to the estimated OFL and a coefficient of variation of 100%. The percentile (≤ 40%) was chosen to correspond with the target probability of overfishing ($P*$) determined by biomass relative to the target biomass. The coastwide ABC was then allocated between the commercial and recreational fisheries (60-40 split). For both fisheries we set the sector-specific annual catch limits (ACLs) equal to the equal to the ABC. For the commercial fishery, the amount removed each period was based on the mean commercial landings during each period (47%, 30% and, 23% for periods 1, 2, and 3, respectively; Figure 10). During the second period, total commercial removals are split 17 and 13% between the northern and southern areas.

For the recreational fishery, the coastwide ACL (in weight) was converted to numbers of fish by dividing the ACL by the mean weight of the recreational harvest from the previous year. The numerical ACL was then allocated between the northern and southern regions according to the current statewide allocation: 32.5% for the northern region (NY,CT,RI, and MA), and 67.5% for the southern region (NJ,DE,MD,VA, and NC). Each region then set the annual catch target (ACT; Eq T2.34) using the accountability measures in the summer flounder management plan and a buffer. If the mean estimated harvest for a region over a 3-year period exceeded the mean ACL, then the mean overage was removed from the current ACL (Eq. T2.35). To simulate observation error in the observed recreational removals from MRIP, estimated recreational harvest was drawn randomly from a normal distribution with a mean equal to the true value and standard deviation based on the observed level of uncertainty in annual MRIP estimates (Eq. T2.36). The penalized harvest was then multiplied by a buffer (Table 4) to set the regional ACT (Eq. T2.34). It was in the model possible for very large overages to result in the penalty exceeding the ACL for a region. In such cases, the ACT was set to 0 and the recreational fishery was closed for the year in that region.

With an ACT for a region, regulations for the recreational fishery were then adjusted to achieve the target. We explored two approaches for setting regulations, with the first approach approximately replicating what is currently done by most (herein called the status quo approach). An important caveat to the status quo approach is that it does not account for changes in the mean weight and harvest per angler that are associated with changing the minimum size limit. That is, by lowering the minimum size, the mean weight of landed fish will decrease while the harvest per angler will increase, and vice-versa. We therefore developed an alternative approach (herein called the alternative approach) for setting regulations that takes into account the effects of changing the minimum size limit on the mean weight and harvest per angler.

The status quo approach in our model relied on randomly drawn distributions of harvest per angler and length-frequency from the fishery to adjust the bag and minimum (or slot) size limits, respectively, mimicking the information available to the states from MRIP or a volunteer angler program. The information used to determine the regulations varied in the model, depending upon whether or not more liberal or conservative regulations were needed. For each year we generated a random distribution of the harvest per angler, as well as length distributions of the harvest (landed fish) and of the catch (landed + discarded fish). When a more conservative bag limit was needed, we generated a distribution of harvest per angler by drawing 500 samples (similar to the number of targeted summer flounder trips sampled in each region during 2004-2011) from a negative binomial distribution with λ and k equal to the true values (Eq. T2.37), and all values above the regional bag limit for that year were set to the bag limit. When more a more liberal bag limit was needed, we followed the same approach, but with λ and k randomly drawn (and therefore not necessarily based on the true values), adding uncertainty to predicting the effects of higher bag limits that may not have been used for many years. When more conservative size limits were required, we generated of length distribution of the harvest from the previous year (replicating the information available from MRIP). The length distribution of the harvest was generated by drawing 500 samples from a multinomial distribution, with the possible lengths between the minimum and maximum size limits in the fishery from the previous year (Eq. T2.38). The probability of having a particular length in the harvest was calculated as harvest-weighted probability of having a particular length for a given sex and age class, summed across both sexes and all ages (Eq T2.39). When more liberal size limits were required, we generated a length distribution of the catch (harvest + discards) because lengths outside the current limits would not be observed in the harvest. For this distribution, 500 samples were drawn, and all lengths of vulnerable fish were possible. The probability of having a particular length in the catch was calculated as the catch-weighted probability of having a particular length for a given sex and age class, summed across both sexes and all ages.

With distributions of harvest per angler and length frequencies in the harvest or catch, the predicted harvest under new regulations was estimated by assuming the effects of the bag and size limits were independent (Eq. T2.40 and T2.41). The new regulations for a region were those that resulted in a predicted harvest closest to the ACT without exceeding it.

The alternative approach we developed deviated from the status quo approach by explicitly accounting for the effects of changing the minimum size on the mean harvest per angler and on the mean weight of the landed fish. This approach used length-based information on abundance, vulnerability and retention in the recreational and commercial fisheries. Estimates of abundance at age from the assessment were converted to abundance at length. We used the true length-based vulnerabilities in each fishery (Eq. T2.14), as well as the true retention at length in the commercial fishery. Retention at length in the recreational fishery was calculated over all possible minimum size limits (and maximum size limits if slot limits were used) assuming knife-edged retention, and the resulting numerical harvest and discards were calculated assuming fishing mortality was equal to that estimated from the previous year (Eqs. T2.42, T2.43, and T2.44). The mean catch per angler was then estimated by dividing the estimated catch by the estimated number of angler trips from the previous year (Eq. T2.45). We then estimated the proportional effect of a new bag limit (relative to the current bag limit), and multiplied this effect to the total catch under a new size limit to determine the total catch under new bag and size limits (Eq. T2.46). As with the status quo approach, the new regulations were those that result in the total catch closest to the target without exceeding it.

Model Runs

The model was projected for 30 years, starting in the year 2010. The total harvest in 2010 and 2011 were set to the observed values, and regulations for each region were set to the average regulations (determined as the catch-weighted average of the individual states within a region). Starting in 2012 regulations in the recreational fishery were adjusted to achieve the ACT for that region. We explored a range of model scenarios of potential regulation options and buffer sizes for setting the ACT. For each scenario, this 30 year period was repeated 1000 times to account for stochasticity introduced throughout the operating and management models (Table 4). At the end of run, a range of performance measures were calculated to summarize the effects of the different scenarios on the summer flounder population, the recreational fishery, and management success (Table 5). Performance measures were calculated either as the mean of a particular quantity over the 28 year period (omitting the first 2 years because harvests were fixed), such as the mean recreational harvest, or as the proportion of years where some condition was met, such the proportion of years when the harvest exceeded the target (Table 5).

Sensitivity Runs

In addition to the base model described above, the model was developed to be flexible to allow for a set of sensitivity runs. Although not yet explored, we will conduct sensitivity runs of the model to different assumed values of *M* for males and females (based in Maunder and Wong 2011), different target SPR% (<35%) when calculating BRPs, and a Ricker stock-recruitment relationship (instead of Beverton-Holt). Higher values of M require higher estimated recruitments to keep total biomass consistent, so we used the relationship between *M* and recruitment (Figure 11) determined by changing the mean *M* in the assessment model and estimating recruitments.

Results

Figures 12-22 show a range of performance measures (a subset of those listed in Table 5) calculated in using the base model under the parameter values shown in Table 3.

Performance is shown across all scenarios listed in Table 4, and are split into coastwide (Figures 12-17) and regional summaries (18-23).

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Table 1. Indices and variables used in this model.

	Description
Index	
t	Year
a	Age
x	Sex (1 = male, 2 = female)
l	Length bin
g	Region (1 = North, 2 = South)
f	Fishery (1=commercial, 2=recreational)
Variable	
N	Numerical abundance
R	Recruitment
B	Total Biomass
S	Spawning biomass
L	Length
w	Weight
m	Proportion mature
S_0 , R_0	Unfished spawning biomass and recruitment
p	Probability of having a particular length
Ω	Normal density used to calculate p
v	Proportion vulnerable to fishing
r	Proportion retained in fishery
Z	Total instantaneous mortality rate
F	Instantaneous mortality rate of retained fish
E	Instantaneous mortality rate of discarded fish
ϕ	
H	Harvest (retained fish) in wt
D	Discarded fish that die in wt
C	Total fish caught
H_N, D_N, C_N	Harvest, dead discard and catch in numbers
A	Angler trips
$\tilde{H}_N$	Harvest per angler trip (number)
b	Bag limit
l_{min} , l_{max}	Min. and max. size limits
S_{est}, B_{est} , N_{est}	Estimated spawning and total biomass and abundance in assessment
ABC	Acceptable biological catch
ACL, ACT	Annual catch limit and target
P	Penalty for overage in the harvest
H_{est} , D_{est}	Estimated harvest and discards
$H_N^{'}$ $D_N^{'}$	Predicted number of harvest and discards under proposed regulations (b', l_{min}', and l_{max}')
χ	Relative change in harvest under new size limits

Table 2. Equation used in the model.

Eqn	Equation	Description
	Life history and population dynamics	
1	$N(t,s=1,x,a)=\begin{cases} R(t,x) & a=1 \\ N(t-1,3,x,a-1)e^{(-Z(t-1,3,x,a-1))} & 1<a<a_{max} \\ N(t-1,3x,a-1)e^{(-Z(t-1,3,x,a-1))}+ & a=a_{max} \\ \quad N(t-1,3,x,a)e^{(-Z(t-1,3,x,a))} & \end{cases}$	Abundance at sex and age at the start of the year
2	$N(t,2,x,a)=N(t,1,x,a)e^{(-Z(t,1x,a))}$ $N(t,3,x,a)=\sum_g N(t,2,g,x,a)e^{(-Z(t,2g,x,a))}$	Abundance at the start of period within a year
3	$N(t,2,g,x,a)=\rho(g,x,a)N(t,2,x,a)$	Abundance in each region at the start of period 2
4	$R(t,x)==\rho_x\dfrac{4hR_0S(t-1)}{S_0(1-h)+S(t-1)5(h-1)}e^{\varepsilon_y}$	Recruitment
5	$S(t)=\sum_a N(t,3,2,a)e^{(-0.5Z(t,3,2,a))}\cdot$ $\sum_l p(l\mid 2,a)m(2,l)w(l)$	Spawning biomass (female only; x = 2)
6	$S_0=\dfrac{\Upsilon\mu_S}{\Theta}$ $\Upsilon\sim U[0.35,0.65]$ $\Theta\sim U[0.1,0.4]$	Virgin spawning biomass
7	$R_0=\dfrac{\mu_R\left(S_0(1-h)+\Upsilon\mu_S(5h-1)\right)}{4hS_0\Theta}$	Virgin recruitment
8	$L(x,a)=L_\infty(x)\cdot\left(1-e^{-K(x)\cdot(a-t_0(x))}\right)$	Mean length in the population (by sex, and age)
9	$p(l\mid x,a)=\dfrac{\Omega(l,x,a)}{\sum_l\Omega(l,x,a)}$	Probability of having a particular length at age
10	$\Omega(l,x,a)=\dfrac{1}{2\sigma(x,a)\pi^{0.5}}e^{\left(\frac{(L(x,a)-l)^2}{2\sigma^2(x,a)}\right)}$	Normal probability density function
11	$w(l)=\alpha l^\beta$	Weight at length l
12	$m(x,l)=\dfrac{1}{1+e^{-(l-\omega_{mat}(x))/\tau_{mat}(x)}}$	Sex-specific maturity at length, l
13	$w(x,a)=\sum_l p(l\mid x,a)w(l)$	Weight at sex and age converted from length

Fishing Mortality Dynamics

14	$v(g,x,f,l)=\frac{1}{1+e^{-\left(l-\omega_v(g,x,f)\right)/\tau_v(g,x,f)}}$	Length-based vulnerability in a particular fishery
15	$r(t,f,l)=\begin{cases}0 & l<l_{\min}(t,g,f)\\ 1 & l\ge l_{\min}(t,g,f)\end{cases}$	Knife-edged retention probability
16	$Z(t,g,x,a)=M(x)+\sum_f F(t,g,x,a,f)+\sum_f E(t,g,x,a,f)$	Total mortality
17	$F(t,s,g,x,a,f)=\phi(t,s,g,f)v(x,a,f)r(t,g,a,f)$	Fishing mortality of retained fish
18	$E(t,s,g,x,a,f)=\phi(t,s,g,f)v(x,a,f)(1-r(t,g,a,f))d(f)$	Fishing mortality of discarded fish
19	$H(t,g,f)=\sum_x\sum_a\left(\frac{F(t,g,x,a,f)}{Z(t,g,x,a)}N(t,g,x,a)\cdot\left(1-e^{(-Z(t,g,x,a)}\right)\right)$	Harvest (numbers)
20	$D(t,g,f)=\sum_x\sum_a\left(\frac{E(t,g,x,a,f)}{Z(t,g,x,a)}N(t,g,x,a)\cdot\left(1-e^{(-Z(t,g,x,a)}\right)\right)$	Discards (numbers)

Recreational Fishery Dynamics

21	$A(t,g)\sim N(\mu_A(t,g),\sigma_A)$	Number of angler trips
22	$\mu_A(g)=\frac{1}{8}\sum_{t=2004}^{t=2011}A_{obs}(t,g)$	Mean number of angler trips based on the observed mean
23	$u_A(t,g)=\begin{cases}A_{min} & b<b_{low}\\ yb(t,g)+z & b_{low}\le b_{min}\le b_{up}\\ A_{max} & b>b_{up}\end{cases}$	Mean number of angler trips as a function of the regional bag limit
24	$k(t,g)\sim N(\mu_k(t,g),\sigma_k)$	Overdispersion parameter for the harvest per trip distribution
25	$u_k(t,g)=\frac{1}{8}\sum_{t=2004}^{t=2011}k_{obs}(t,g)$	Mean overdispersion parameter for the harvest per trip distribution
26	$u_\lambda(t,g)=\begin{cases}\tilde{H}_{min} & l_{min}<l_{low}\\ y_H l_{min}(t,g)+z_H & l_{low}\le l_{min}\le l_{up}\\ \tilde{H}_{max} & l_{min}>l_{up}\end{cases}$	Mean relative harvest as a function of the regional minimum size limit.

26	$u_{\lambda}(t,g)=\begin{cases}\tilde{H}_{min} & l_{min}<l_{low}\\ y_H l_{min}(t,g)+z_H & l_{low}\le l_{min}\le l_{up}\\ \tilde{H}_{max} & l_{min}>l_{up}\end{cases}$	Mean relative harvest as a function of the regional minimum size limit.
27	$\lambda(t,g)\sim N(\mu_{\lambda}(t,g),\sigma_{\lambda})$	Mean harvest per trip from the negative binomial distribution harvest
28	$\tilde{H}_N(b,\lambda,k)=\sum_{i=0}^{b} i\frac{\Gamma(i+k)}{\Gamma(k)i!}\left(\frac{\lambda}{\lambda+k}\right)^{i}\left(1+\frac{\lambda}{k}\right)^{-k}+\sum_{i=b+1}^{\infty} b\frac{\Gamma(i+k)}{\Gamma(k)i!}\left(\frac{\lambda}{\lambda+k}\right)^{i}\left(1+\frac{\lambda}{k}\right)^{-k}$	Relative harvest (in numbers) under bag limit
29	$\tilde{H}_N(\lambda,k)=\sum_{i=0}^{\infty} i\frac{\Gamma(i+k)}{\Gamma(k)i!}\left(\frac{\lambda}{\lambda+k}\right)^{i}\left(1+\frac{\lambda}{k}\right)^{-k}$	Relative harvest in absence of a bag limit
30	$H_N(t,g)=A(t,g)\cdot\tilde{H}_N(t,g)$	Harvest in numbers
	Assessment and Management	
32	$S_{est}(t)=S(t)e^{\delta(t)-0.5\sigma_{SA}^{2}}$	Estimated spawning biomass
33	$\delta(t)=\gamma_{SA}\delta(t-1)+\sqrt{1-\gamma_{SA}^{2}\varphi(t)}$ $\varphi(t)\sim N(0,\sigma_{SA})$	Autocorrelated error in assessment estimates
34	ACT(t,g) = B (ACL(t,g) – $P(t,g)$)	Annual catch target
35	$P(t,g)=\max\left(0,\frac{1}{3}\sum_{t-4}^{t-1}H_{est}(t,g)-\frac{1}{3}\sum_{t-4}^{t-1}ACL(t,g)\right)$	Harvest penalty for overages
36	$H_{est}(t,g,f)\sim N(H(t,g,f),\sigma_f)$	Estimated harvest
37	$\tilde{H}_{est}(t,j)\sim NB(\lambda(t),k(t))$	Random sample of harvest per angler trip
38	$\tilde{C}_H(l,j)\sim MN(\mathbf{l},\mathbf{p})$ $\mathbf{l}=l_{\min},\ldots,l_{\max}$ $\mathbf{p}=p(l=l_{\min}),\ldots,p(l=l_{\max})$	Random length of a fish harvested in the recreational fishery
39	$p(l)=\sum_x\sum_a p(l\mid x,a)\frac{H_N(t,x,a)}{\sum_x\sum_a H_N(t,x,a)}$	Probability of having a length = l
40	$H_N^{'}(t,g,b^{'},l_{\min}^{'},l_{\max}^{'})=A(t-1,g)\tilde{H}_N(b^{'})\chi(l_{\min}^{'},l_{\max}^{'})$	Predicted harvest under new bag and size limits

41	$$\chi(l'_{\min}, l'_{\max}) = \frac{\sum_{l'_{\min}}^{l'_{\max}} \tilde{C}(l)}{\sum_{l_{\min}(t-1)}^{l_{\max}(t-1)} \tilde{C}(l)}$$	Relative change in harvest predicted from changing size limits.
42	$$H'_N(t,g,l'_{\min},l'_{\max}) = \sum_{l_{\min}}^{l_{\max}} \frac{v(l,f)r(l,f)F(t-1,g,f)}{Z(t-1,g,l)} N(t-1,g,l) \cdot w(l)\left(1-e^{-Z(t-1,g,l)}\right)$$	Estimated harvest in numbers under the alternative approach
43	$$D'_N(t,g,l'_{\min},l'_{\max}) = \sum_{l_{\min}}^{l_{\max}} \frac{d_f v(l,f)(1-r(l,f))F(t-1,g,f)}{Z(t-1,g,l)} \cdot N(t-1,g,l)w(l)\left(1-e^{-Z(t-1,g,l)}\right)$$	Estimated discards under the alternative approach
44	$$Z(t-1,g,l) = \sum_f v(l,f)r(l,f)F(t-1,g,f) + \sum_f v(l,f)(1-r(l,f))F(t-1,g,f)d_f$$	Total mortality at length
45	$$\lambda' = \frac{H'_N(t-1,g,l'_{\min},l'_{\max}) + D'_N(t-1,g,l'_{\min},l'_{\max})}{A(t-1)}$$	Mean harvest per angler under new size limits
46	$$C'_N(t,g,b',l'_{\min},l'_{\max}) = (H'_N(t,g,l'_{\min},l'_{\max}) + D'_N(t,g,l'_{\min},l'_{\max})) \cdot \frac{\tilde{H}_N(b',\lambda',k)}{\tilde{H}_N(b,\lambda',k)}$$	Catch (harvest + discards) under new bag and size limits

Table 3. Parameter values used in the model

Parameter	Value(s)	Description
$L_\infty(x)$	(73,80.2)	Sex-specific maximum length in cm (male, female)
$K(x)$	(0.13,0.18)	Growth rate (male, female)
$t_0(x)$	(-3.6,-1.96)	Age at length = 0 (male, female)
α	3.89 x10^{-6}	Length-weight intercept
β	3.253	Length – weight exponent
$M(x)$	(0.35,0.25)	Sex-specific natural mortality rate (male, female)
$\rho(x)$	(0.65,0.35)	Recruitment sex ratio (male, female)
$\omega_{mat,1}(x)$	(26,33)	Length at 50% maturity in cm (male, female)
$\tau_{mat,2}(x)$	(0.5, 0.5)	Controls how rapidly maturity saturates (male, female)
$\omega_v(f=1)$	28	Length at 50% vulnerability (cm) in commercial fishery
$\omega_v(g,x,f=2)$	North (20,35) South (35,20)	Length at 50% vulnerability in recreational fishery by region and sex (male, female)
$\tau_v(f=1)$	0.5	Vulnerability saturation (commercial)
$\tau_v(f=2)$	0.5	Vulnerability saturation (recreational)
$d(1)$	0.8	Discard mortality in commercial fishery
$d(2)$	0.1	Discard mortality in recreational fishery
μ_S	28,993	Mean spawning biomass (mt; 1982-2010)
$\mu_A(g)$	(2187.2, 3149)	Mean number of angler trips x 1000 (North / South)
σ_A	(533873,166015)	Standard deviation (s.d.) of angler trips (North / South)
$\mu_\lambda(g)$	(0.214,0.266)	Mean catch per angler trip (2004-2011; North/South)
σ_λ	(0.066,0.091)	s.d. of harvest per angler trip
A_{min}	1623	Minimum number of angler trips (x 1000)
A_{min}	3149	Maximum number of angler trips (x 1000)
y_b	1081	Slope of bag limit and trip regression (x 1000)
z_b	-2816	Intercept of bag limit and trip regression (x 1000)
$\tilde{H}_{min}$	0.08	Minimum harvest per angler trip
$\tilde{H}_{\max}$	0.4	Maximum harvest per angler trip
y_H	(-0.041, -0.115)	Slope of min. size and μ_λ regression(North / South)
z_H	(0.999, 2.27)	Intercept of min size and μ_λ regression (x 1000)
$\mu_k(g)$	(0.188, 0.228)	Mean overdispersion parameter of negative binomial (2004-2011; North / South)
σ_k	(0.042,0.047)	s.d. of overdispersion parameter (North / South)
M_{SA}	0.25	Assumed M (sex-aggregated) in BRP estimation
γ_{SA}	0.75	Autocorrelation in assessment estimates
σ_{SA}	0.15	Variability in stock assessment estimates
σ_R	0.18	Lognormal standard deviation in recruitment
$\sigma_{rec}(t)$	$H_{rec}(t)$•0.08	s.d. of harvest estimates in recreational fishery
$\sigma_{com}(t)$	$H_{com}(t)$•0.04	s.d. of harvest estimates in commercial fishery

Table 4. Scenarios explored in the model. For all scenarios the bag limits were adjusted in each region. Size limit type refersto whether a minimum or slot size limit was used, and size limit dynamics refers to whether or not they were fixed or adjusted. When the size limit was fixed, it was fixed coastwide. Setting approach refers to how the regulation were determined each year (see text), and the buffer size indicates the size of the buffer used when setting the ACT (Eq. T2. 34)

Scenario	Bag Limit	Size Limit Type	Size Limit Dynamics	Setting Approach	Buffer Size (*B*)
1	Adjusted	Min.	Fixed (17 in)	Status Quo	1.0
2	Adjusted	Min.	Adjusted	Status Quo	1.0
3	Adjusted	Min.	Adjusted	Alternative	1.0
4	Adjusted	Slot	Adjusted	Status Quo	1.0
5	Adjusted	Slot	Adjusted	Alternative	1.0
6	Adjusted	Min.	Fixed (17 in)	Status Quo	0.9
7	Adjusted	Min.	Adjusted	Status Quo	0.9
8	Adjusted	Min.	Adjusted	Alternative	0.9
9	Adjusted	Slot	Adjusted	Status Quo	0.9
10	Adjusted	Slot	Adjusted	Alternative	0.9
11	Adjusted	Min.	Fixed (17 in)	Status Quo	0.8
12	Adjusted	Min.	Adjusted	Status Quo	0.8
13	Adjusted	Min.	Adjusted	Alternative	0.8
14	Adjusted	Slot	Adjusted	Status Quo	0.8
15	Adjusted	Slot	Adjusted	Alternative	0.8

Table 5. Performance measures calculated at the end of each model run for each scenario.

Category	Performance Measure
Population Dynamics / Status	Mean Spawning Biomass Mean Female Spawning Biomass Mean age in the population Mean recruitment Proportion of years overfished
Recreational Fishery	Mean harvest (in wt and numbers) Mean discards (dead) (in wt and numbers) Mean ratio of total discards to catch (numbers) Mean female harvest (wt) Mean harvest per angler Variability in harvest (by wt) Mean bag limit Mean minimum size limit
Management Success	Proportion of years with overages Proportion of years with penalties Mean ratio of the harvest+discards : ACL Mean penalty (as a proportion of the ACL) Proportion of years with closures

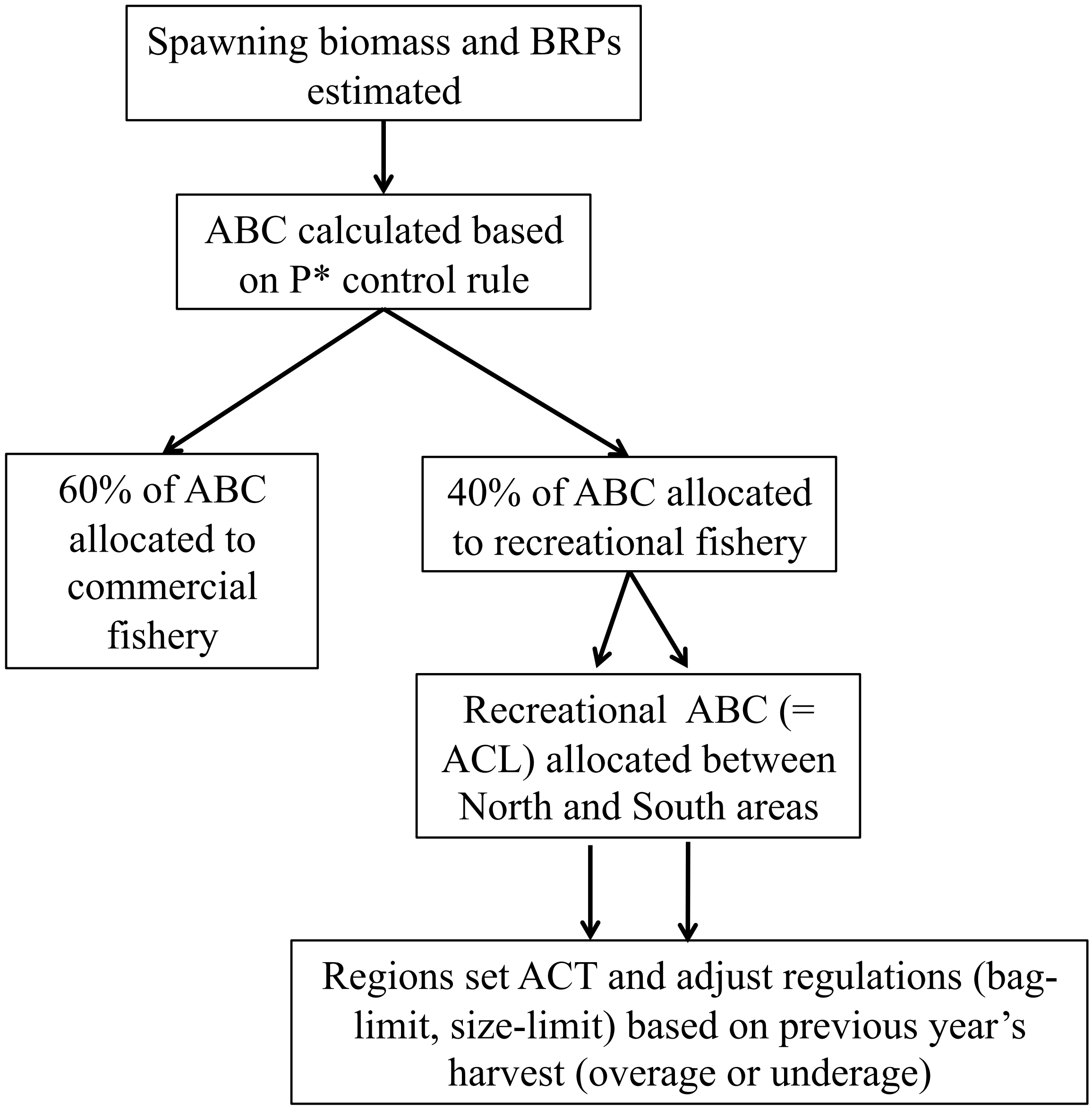

Figure 1. Schematic of the assessment and catch allocation in the management model.

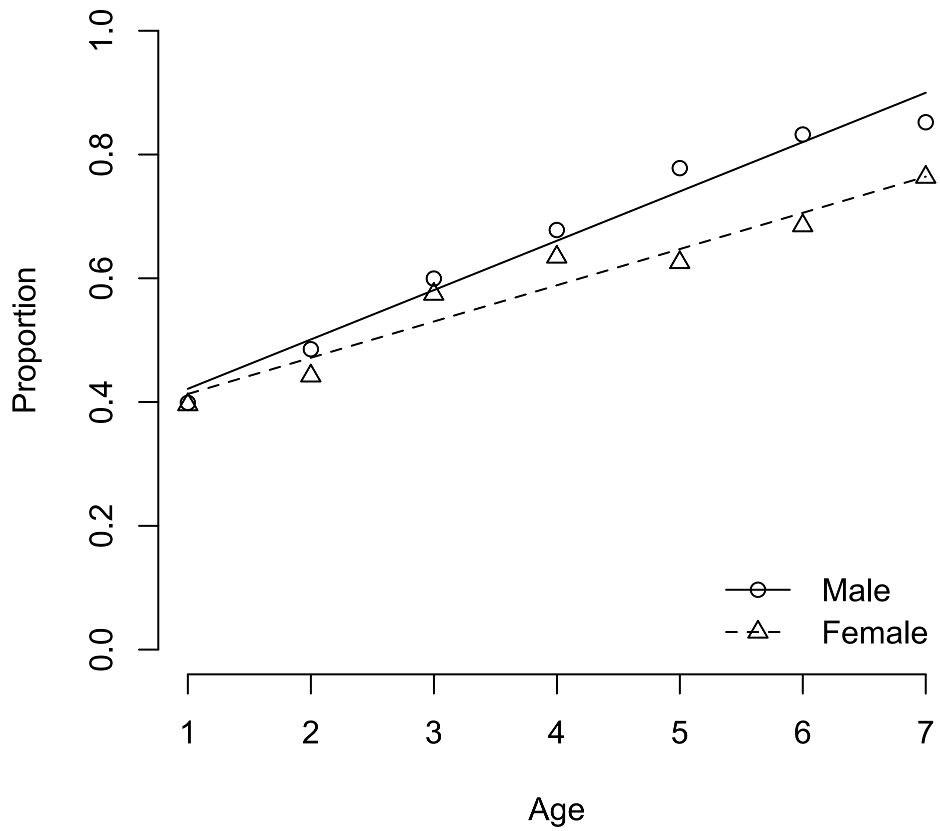

Figure 2. Proportion of each age and sex-class migrating inshore to the northern region each year. Points indicate observed values from the NMFS trawl survey during 2009-2010, and lines represent fits of simple linear regressions. The simulation model used estimates of proportion migrating to the northern region by age and sex from these regressions.

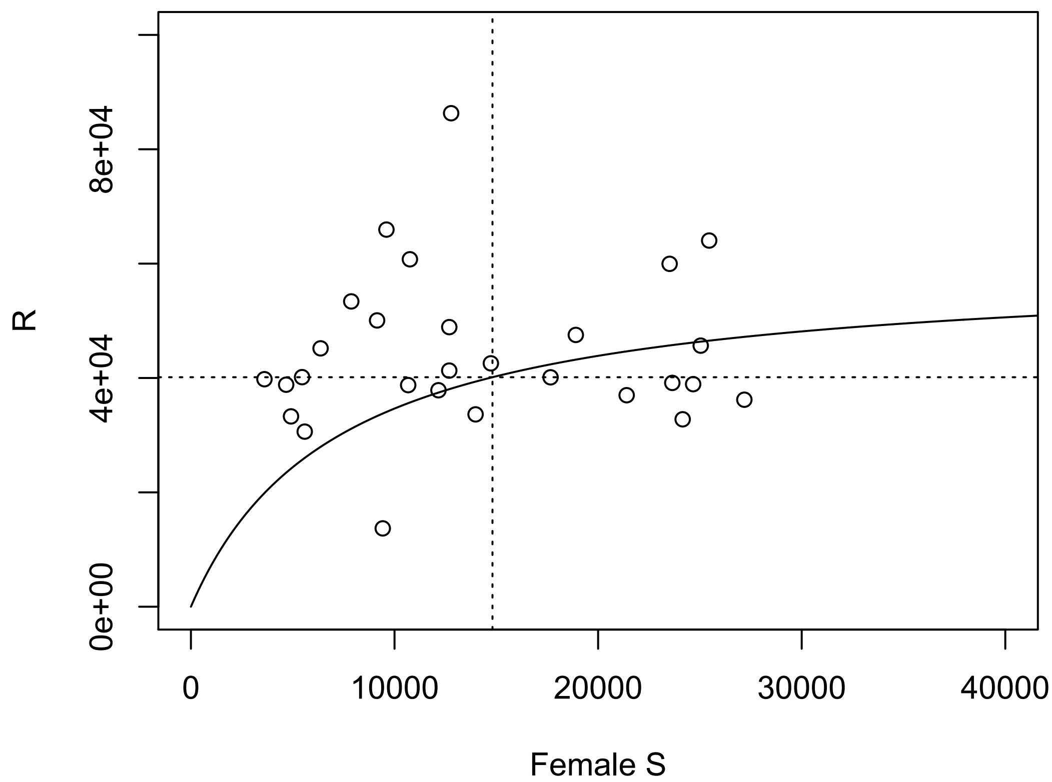

Figure 3. An example stock-recruit fit (solid line) showing how the curve goes through the estimated mean recruitment and spawning biomass (dashed lines). The points represent the estimated recruitments from Tercerio (2011).

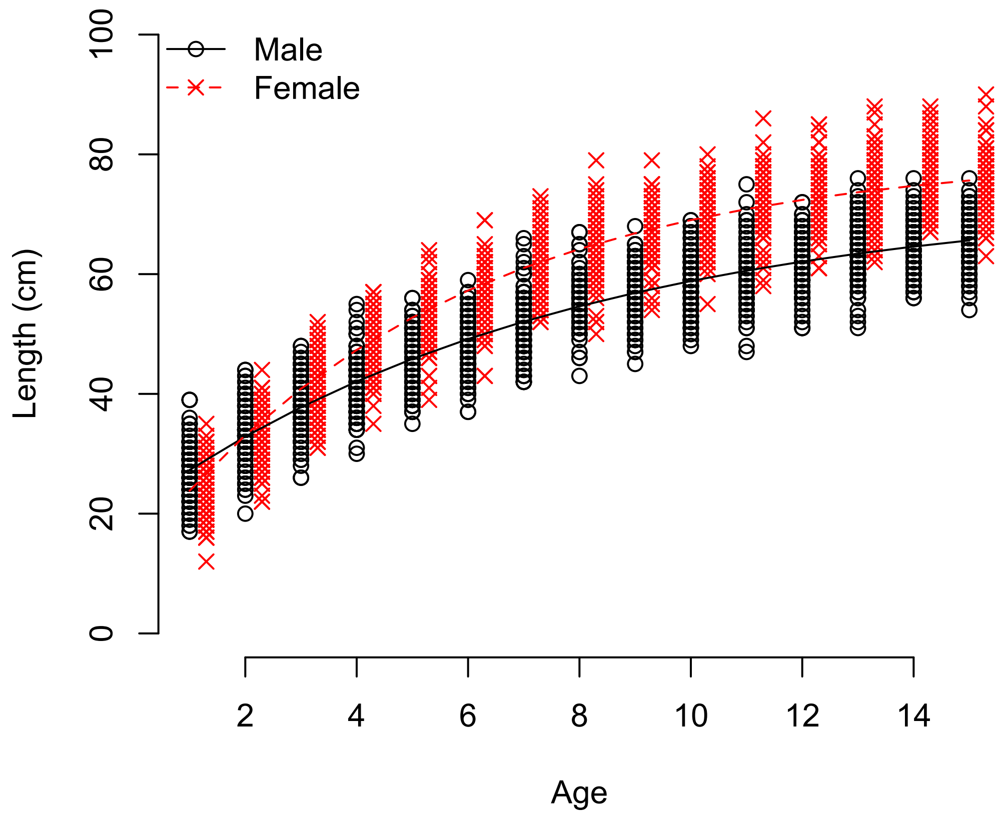

Figure 4. Sex-specific growth curves at age, and the random sample of potential lengths at age to show the range of lengths modeled.

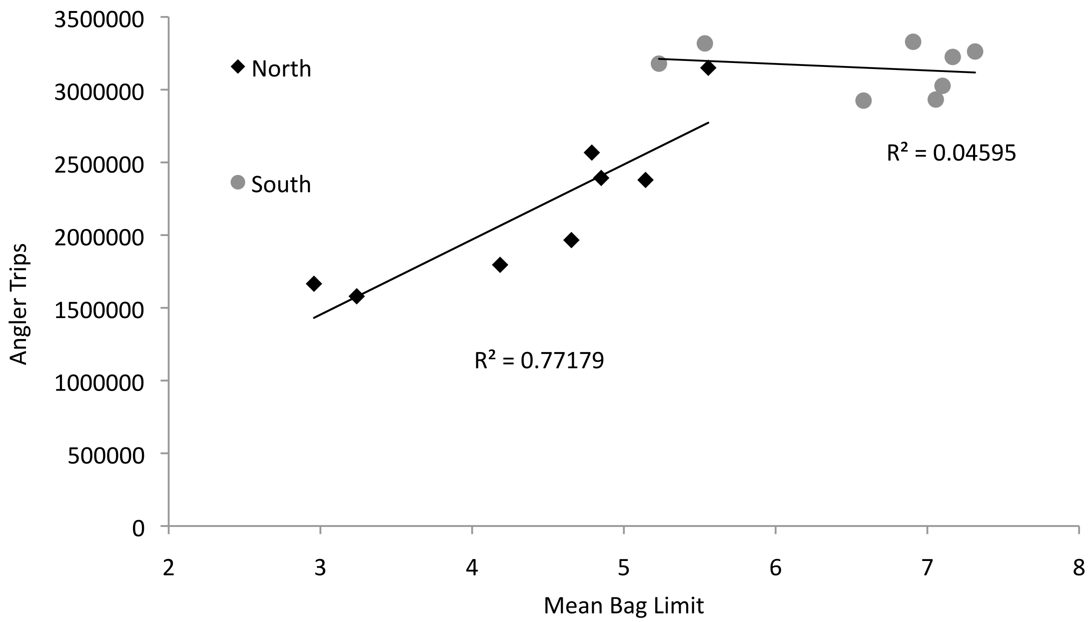

Figure 5. The observed number of angler trips (2004-2011) in relation to the mean bag limit in the northern and southern regions.

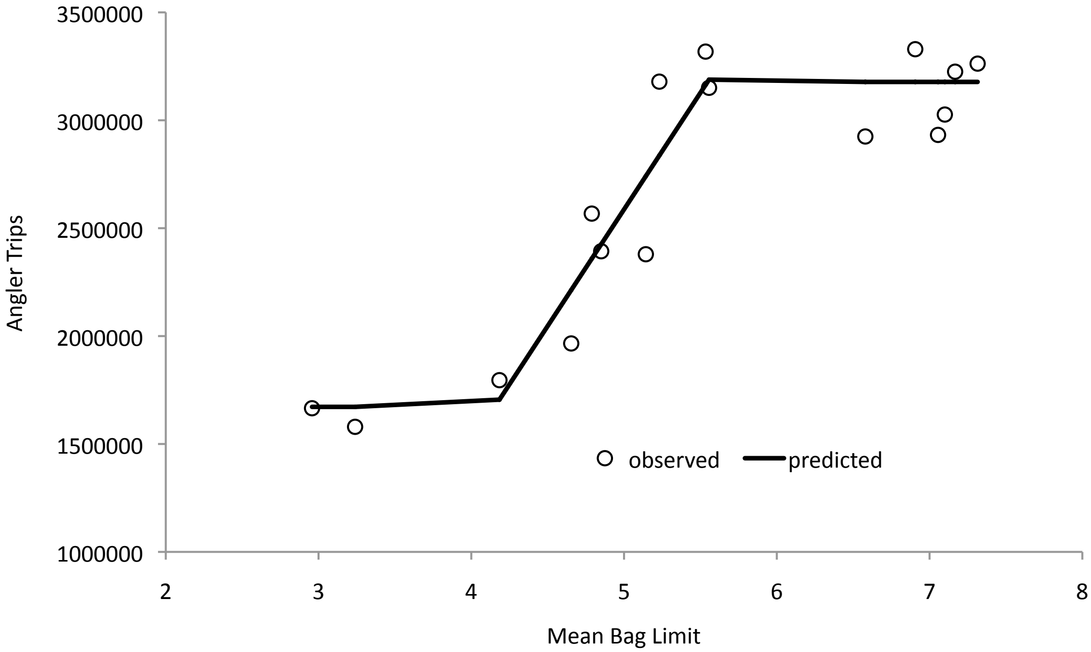

Figure 6. The observed number of angler trips (2004-2011) in relation to the mean bag limit with a piecewise model fit the coastwide data.

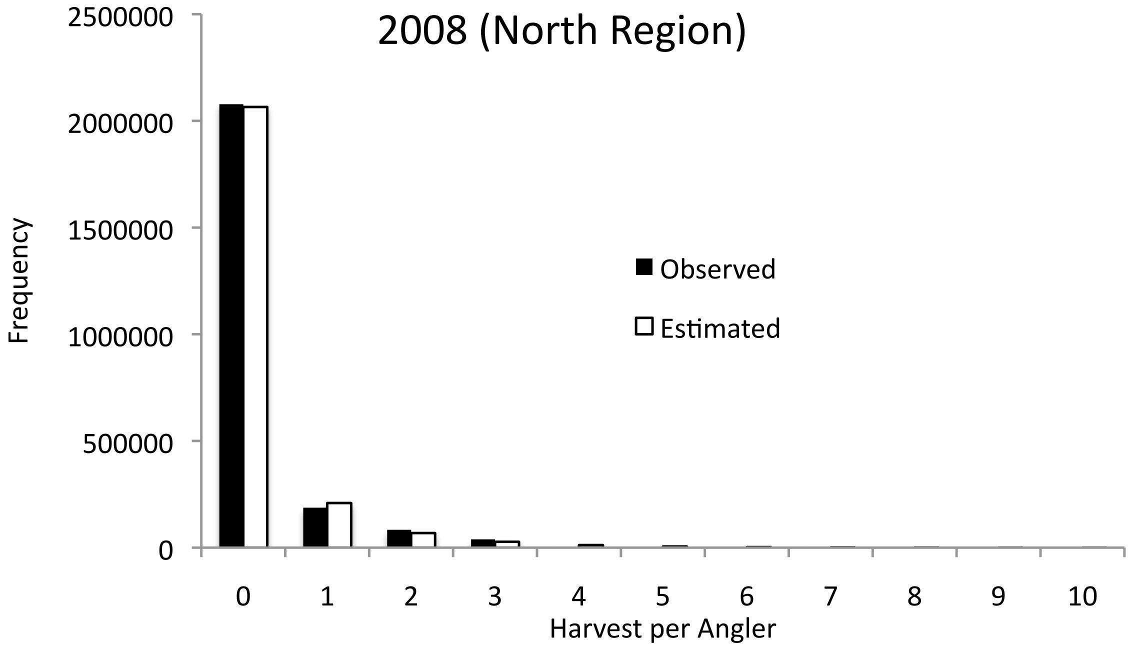

Figure 7. An example of the distribution of harvest per angler trip estimated with a maximum likelihood approach, assuming a negative binomial distribution.

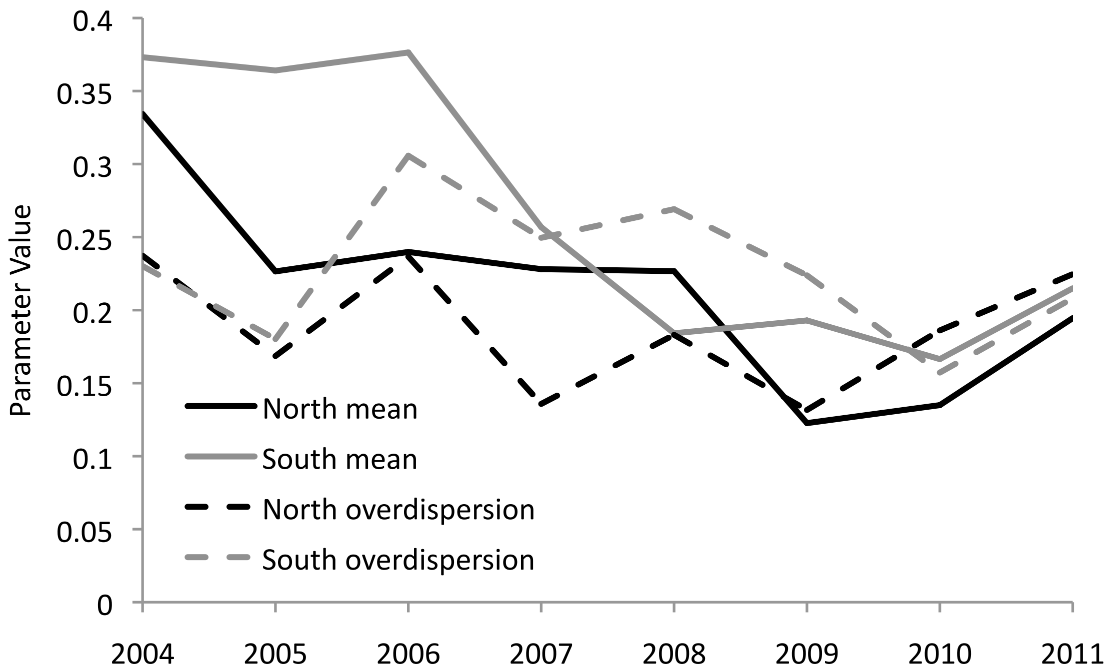

Figure 8. Region-specific estimates of the parameters of the negative binomial distribution (the mean and overdispersion parameters) of harvest per angler trip across years.

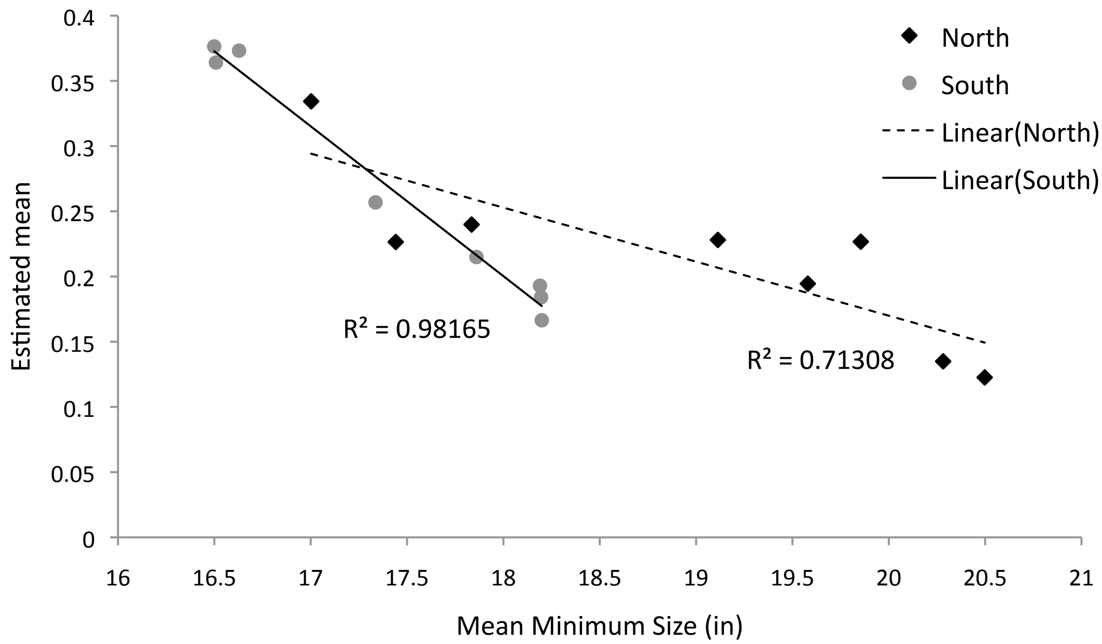

Figure 9. Relationship between the mean harvest per angler trip and minimum size by region.

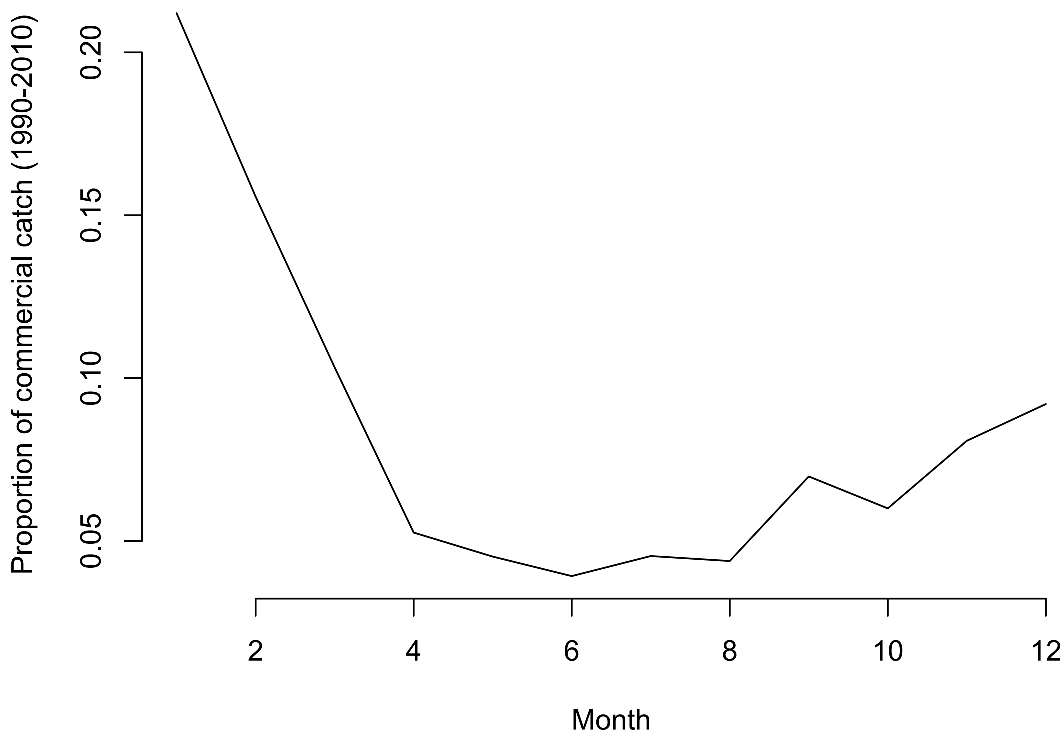

Figure 10. The average proportion of the commercial landings by month between 1990 and 2010.

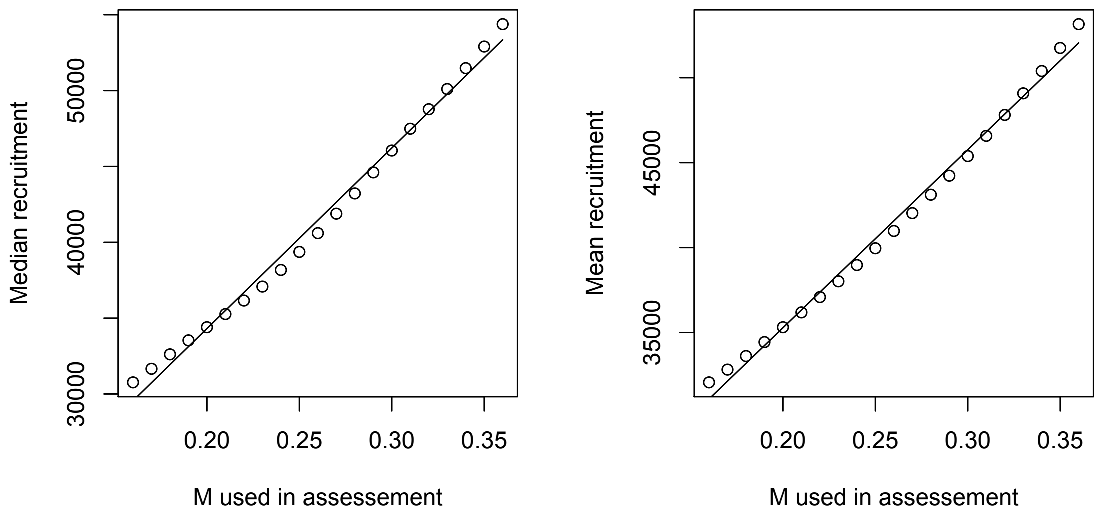

Figure 11. Relationship between the mean *M* assumed in the assessment and the mean and median estimated recruitment.

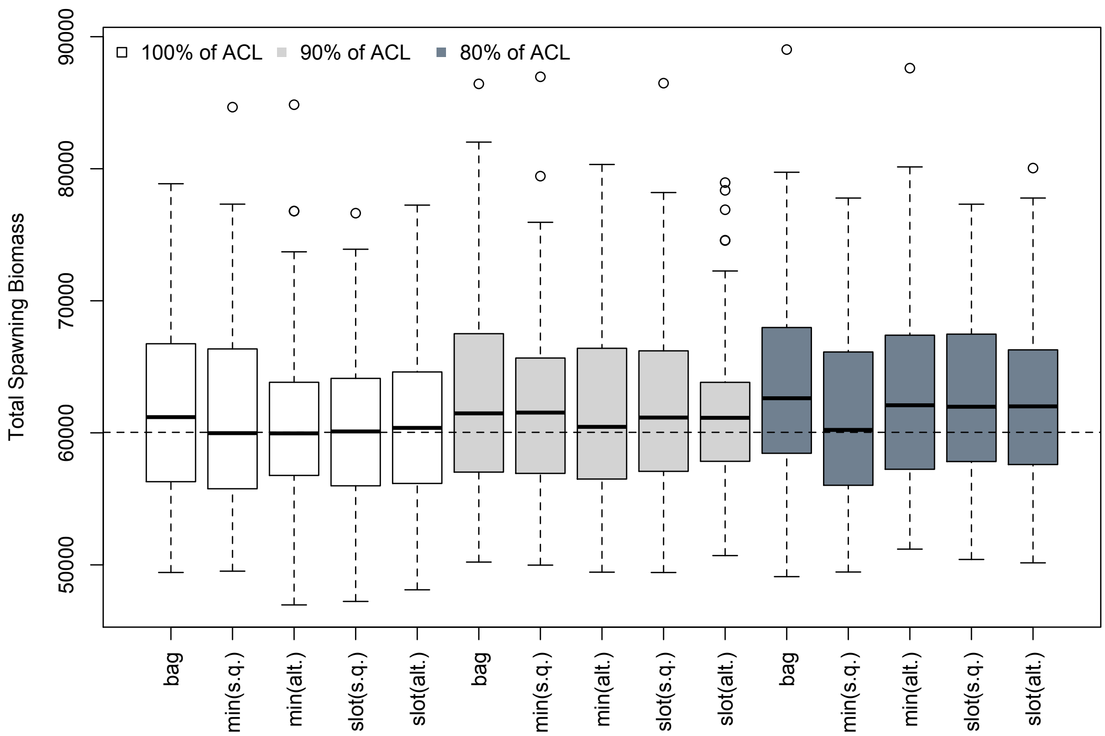

Figure 12. Boxplot of the mean total spawning biomass over the 30 year period over 1000 runs for the scenarios explored (Table 4). The horizontal dotted line is the estimated S_{MSY} from Terceiro (2011). Bag refers to the runs where only the bag limit is adjusted and the minimum size is set to 17 in. coastwide. Min (s.q.) and min(alt.) refers to runs where both the minimum size and bag limit are adjusted by region, with regulations determined using the status quo or alternative approach, respectively. Slot (s.q.) and slot(alt.) refers to runs where both the slot size and bag limit are adjusted by region, with regulations determined using the status quo or alternative approach, respectively.

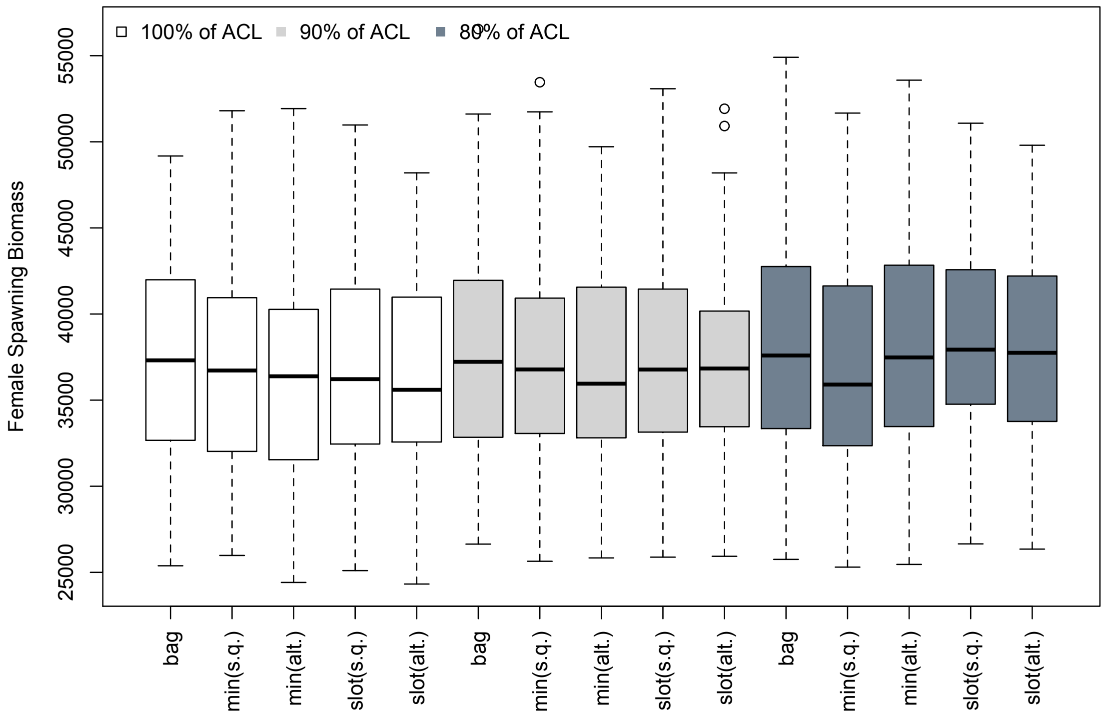

Figure 13. Similar to Figure 12, but for total female spawning biomass.

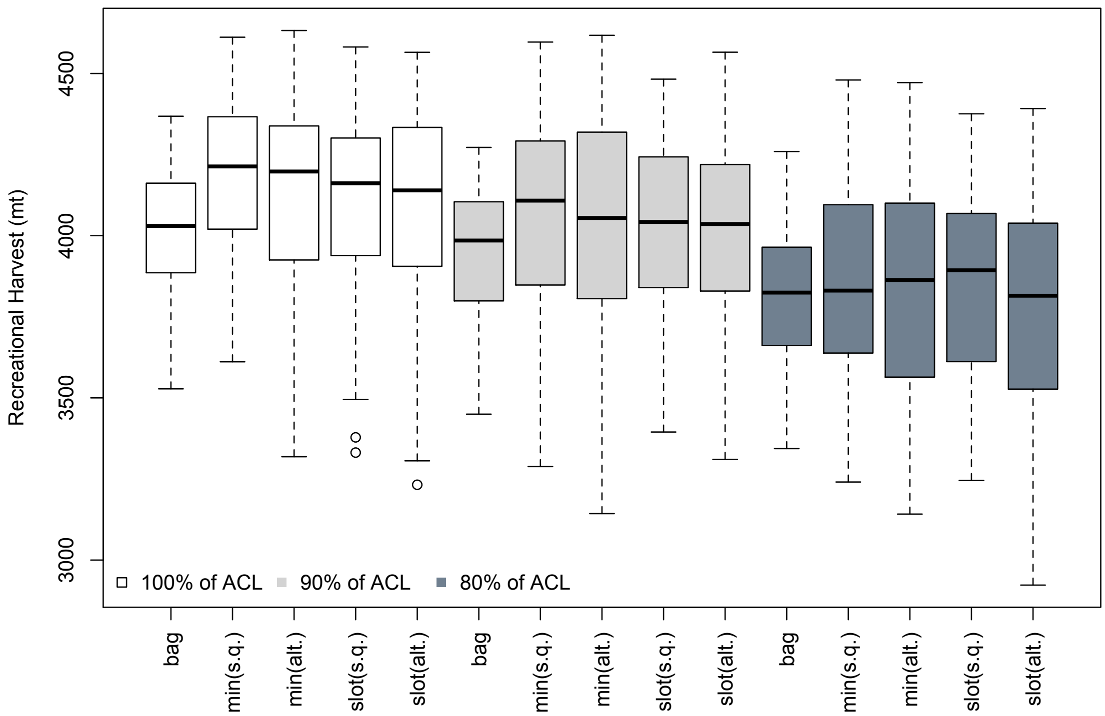

Figure 14. Similar to Figure 12, but with the mean harvest in the recreational fishery.

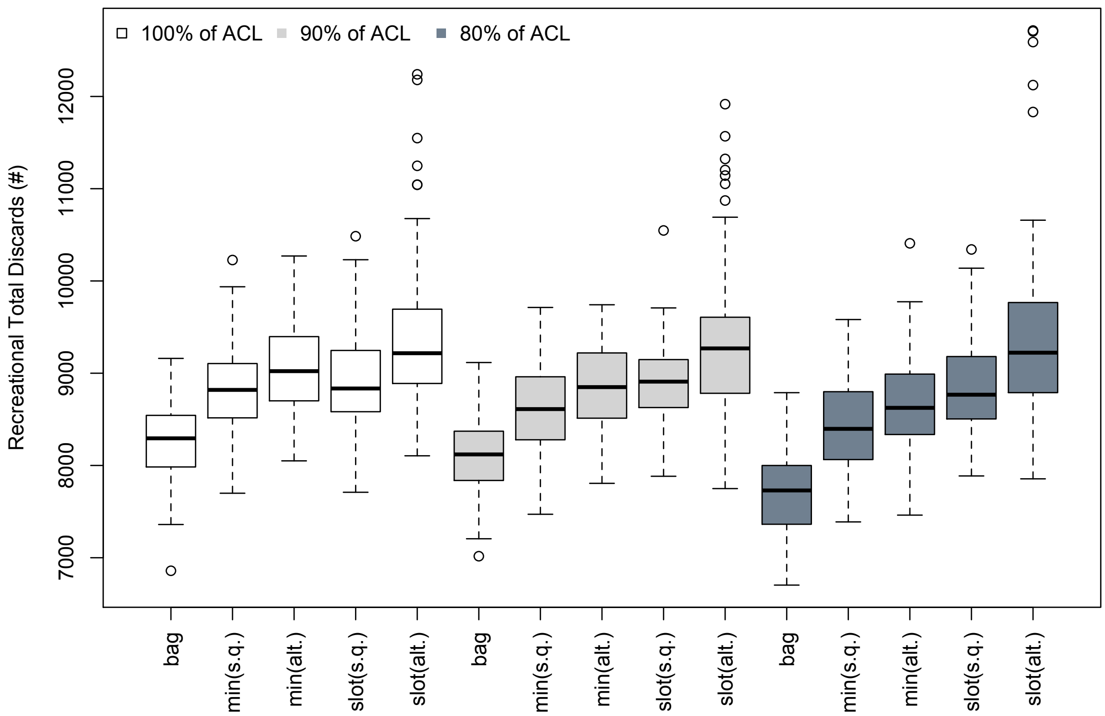

Figure 15. Similar to Figure 12, but showing the recreational discards in numbers.

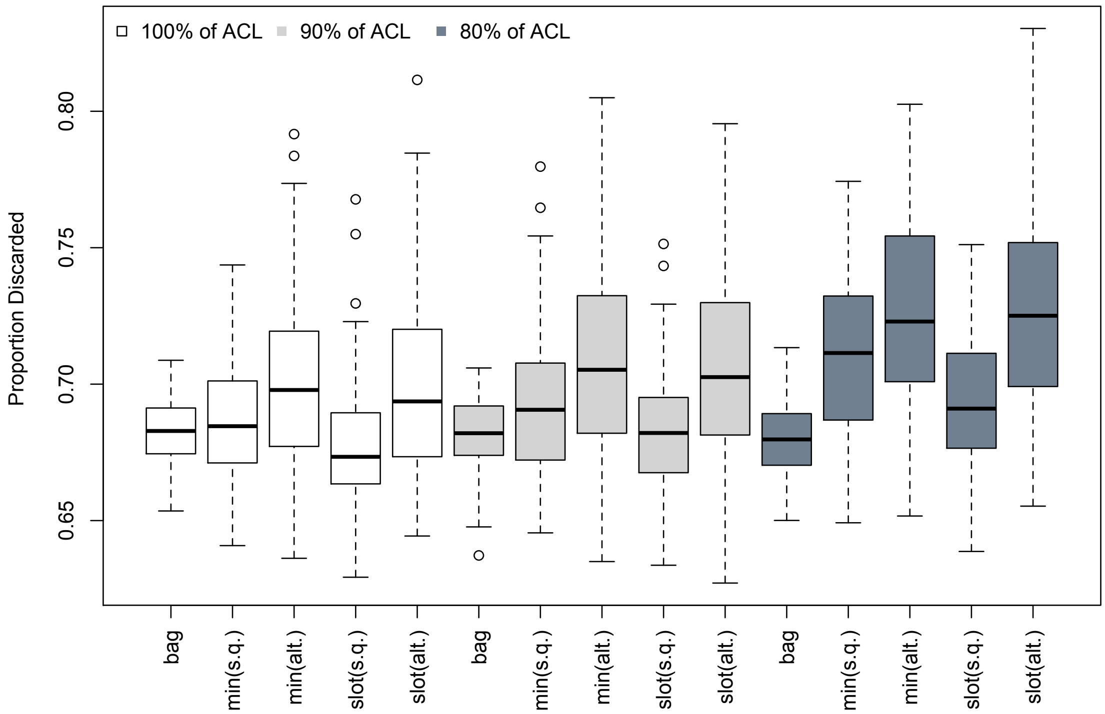

Figure 16. Similar to Figure 12, but showing the proportion of fish catch that are discarded.

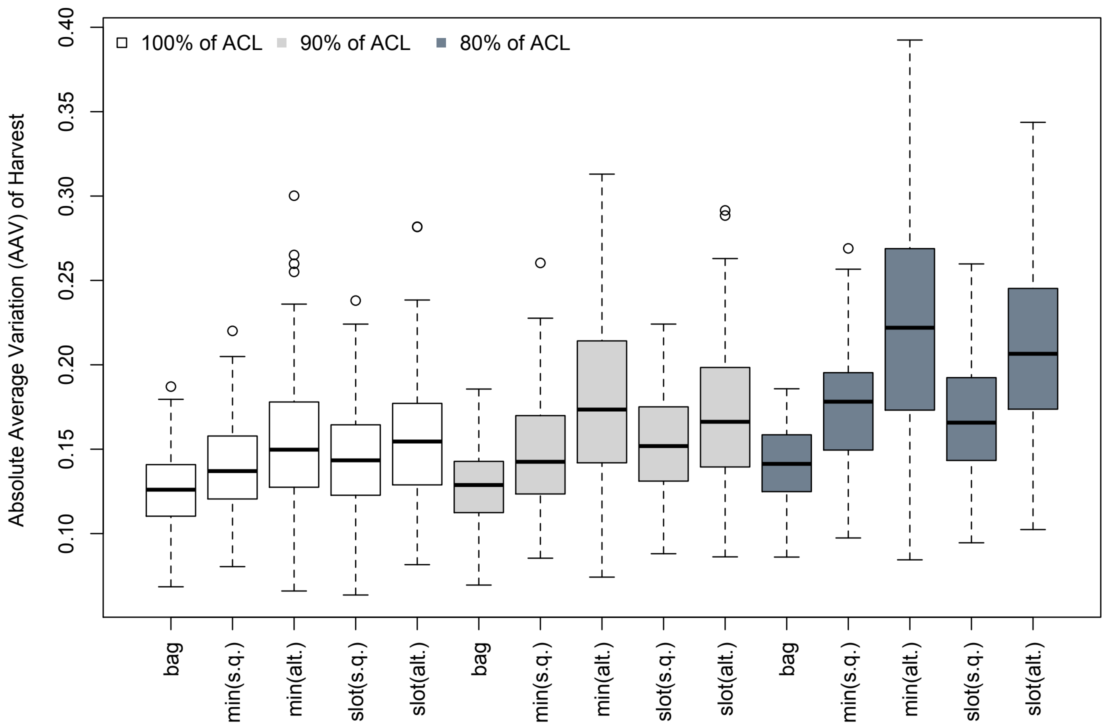

Figure 17. Similar to Figure 12, but showing the average annual absolute variation (AAV) in harvest in the recreational fishery. AAV is a measure of the change in harvest from year to year, with higher values indicating more frequent and larger changes between years (Punt et al. 2008).

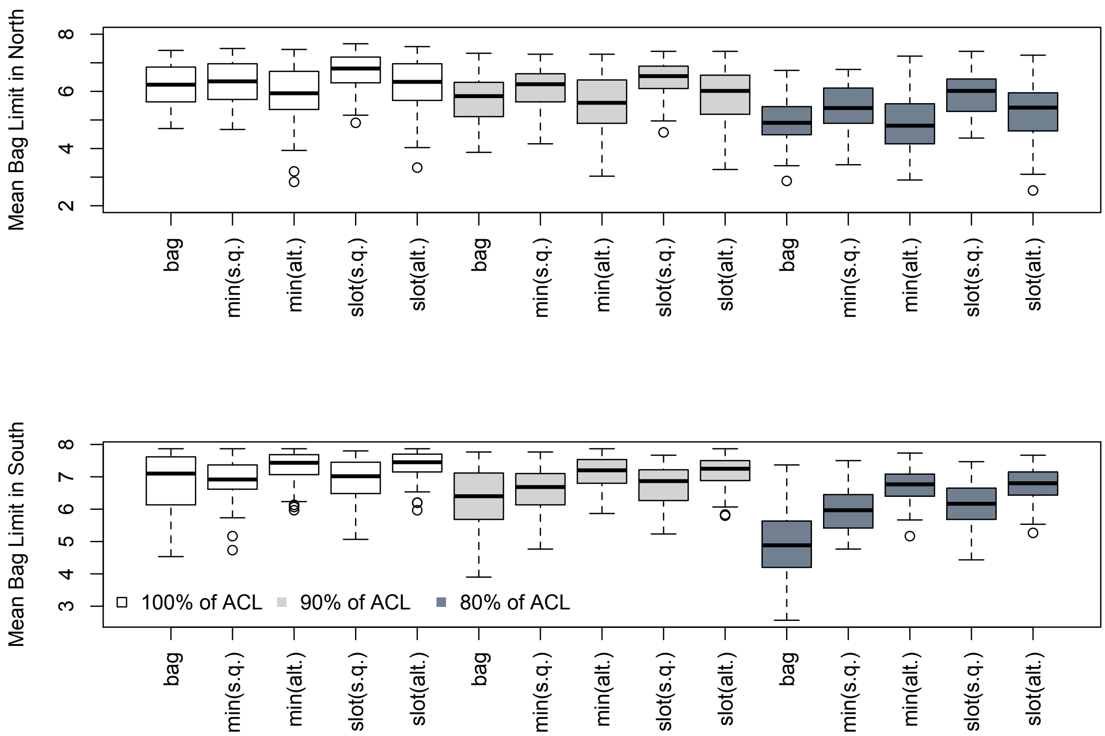

Figure 18. Region-specific estimates of the mean bag limit in the North (top) and South (bottom).

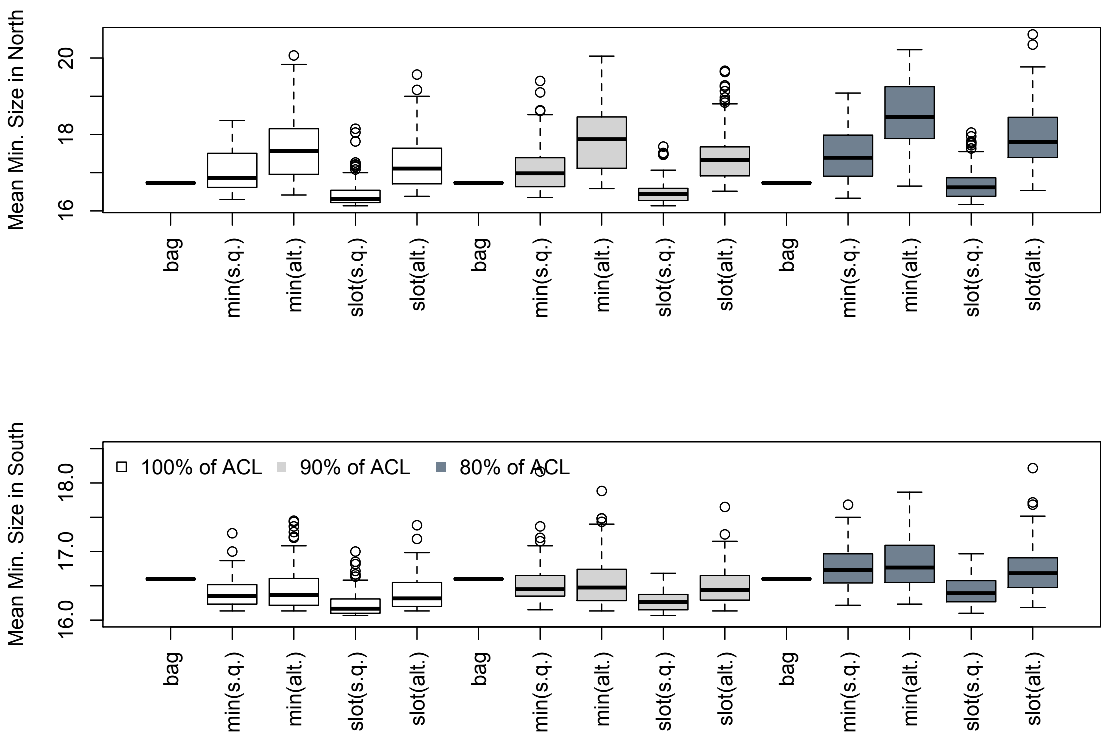

Figure 19. Region-specific estimates of the mean minimum size in the North (top) and South (bottom).

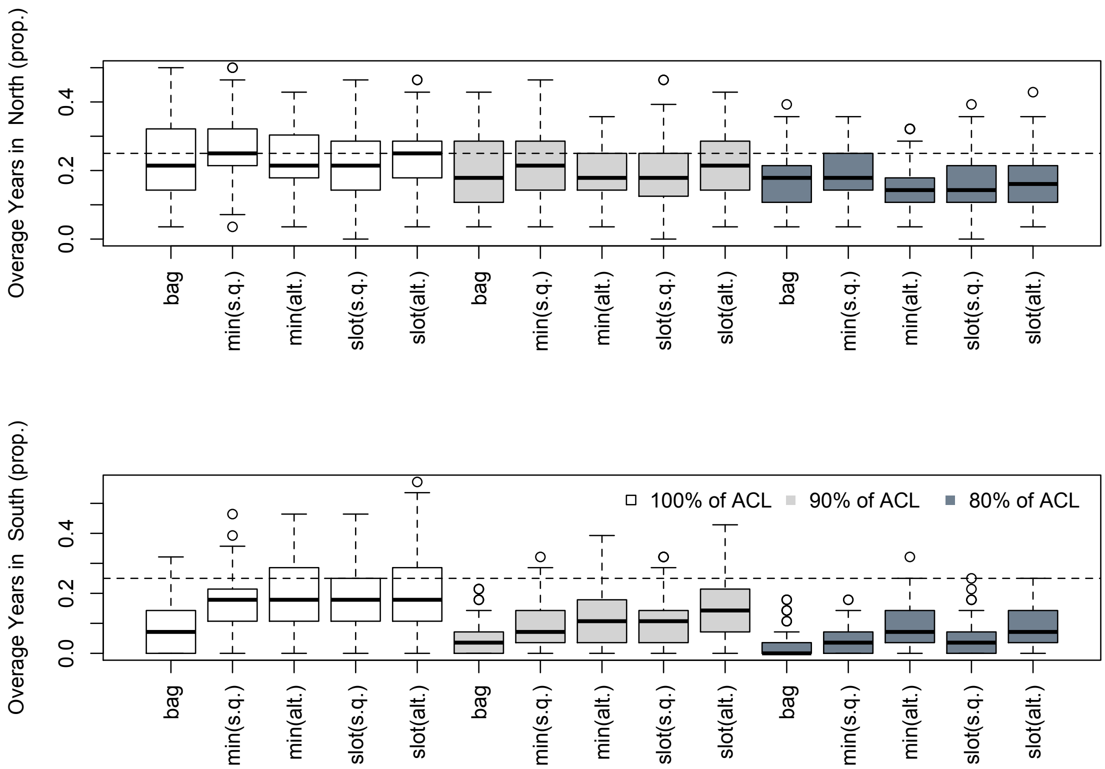

Figure 20. Region-specific estimate of the proportion of years when the harvest + discards exceeded the ACL (in weight). The dashed horizontal line at 0.25 is meant to highlight the target of not exceeding the ACL in more than 1 in every 4 years.

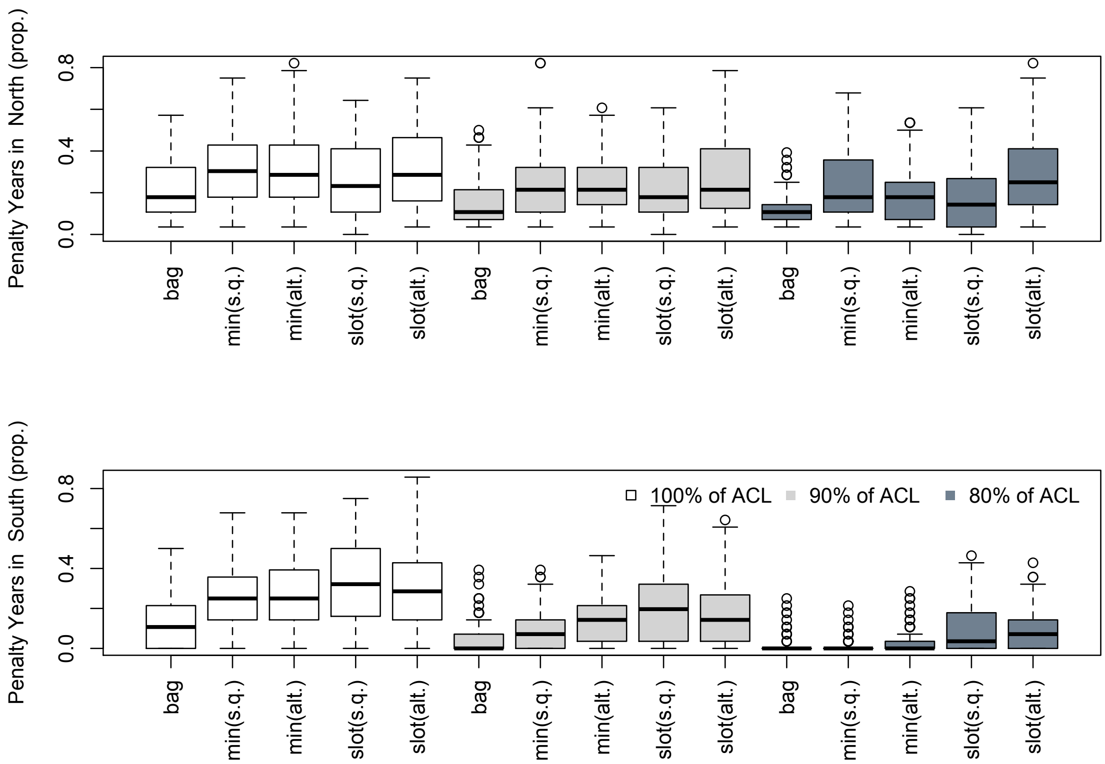

Figure 21. Proportion of years when harvest penalties were removed by region.

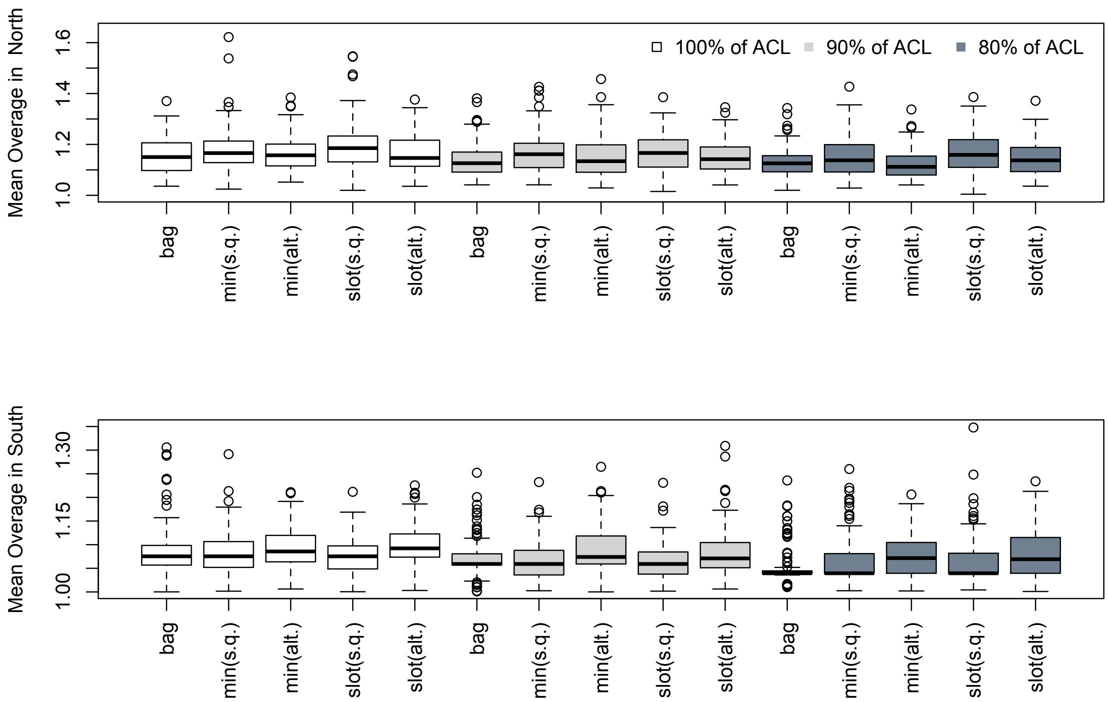

Figure 22. The mean overage ratio (calculated as the harvest + discards / ACL in years when there was an overage) by region.

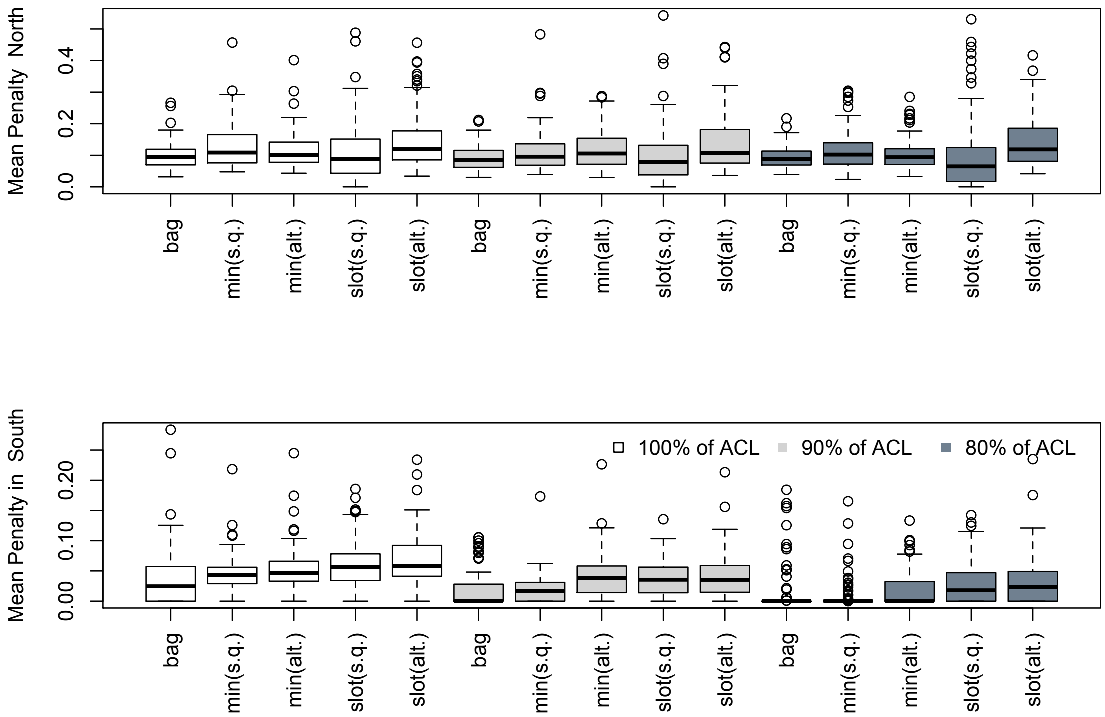

Figure 23. The mean penalty (as a proportion of the ACL that it is deducted from) by region.