**PRELIMINARY METHODOLOGY FOR ACHIEVING F THRESHOLD AND TARGET FOR ATLANTIC MENHADEN**

**February 1, 2012**

## Introduction

At its November 2011 meeting, the Atlantic Menhaden Management Board approved a new fishing mortality threshold ($F_{15\%MSP}$ = 1.32) and target ($F_{30\%MSP}$ = 0.62). The Board requested that the Technical Committee (TC) explore methods to account for the uncertainty in the terminal year fishing mortality estimate ($F_{2008}$) as it relates to achieving the new fishing mortality reference points. The Board also requested that the Technical Committee explore landings scenarios to achieve 1) the new fishing mortality threshold immediately, and 2) the new fishing mortality target over a range of 1 to 5 years. Based on that charge, a projection analysis was initiated. Decisions regarding the structure and inputs for the projection analysis were discussed by the TC during a meeting on January 9, 2012. The documentation and methods below reflect those decisions. The program used to complete these projections is called "Constant landings projections 17 Jan 12.r".

## Methods

Data inputs and outputs from the base run of the Beaufort Assessment Model (BAM) were used as the basis for all of the projections within this document. The starting conditions of the projection analysis include initial numbers-at-age, which were the estimated numbers-at-age, $N_a$, for the start of 2009 (i.e., end of 2008) from the BAM plus variability. The variability in the initial numbers-at-age was incorporated based on estimated variability within the BAM during 1990 to 2007. The years 1990 to 2007 were used for consistency with other data sources (see discussion below).

Recruitment was projected without an underlying stock-recruitment function and was based on the median recruitment observed ($R_{med}$=13.22) from the BAM. Variability was incorporated into recruitment as a nonparametric bootstrap based on the annual deviations from the median in the base run of the BAM during the specified time period (1990 to 2007), which reflects variability in the more recent years. The final year of the BAM (2008) was not used, because recruitment tends to be poorly estimated in the terminal year. With variability included, the median recruitment was approximately 8.5 billion age-0 fish, which reflects the lower recruitment observed in the final years of the BAM data set (1990 to 2007) as estimated by the juvenile abundance index from the state surveys.

The median age varying natural mortality and weight vectors from 1990-2007 were projected into the future. Selectivity was constant across time for the base run of the BAM model and was thus constant in the projections. Selectivity was the weighted average selectivity from the bait and reduction fisheries.

Landings levels were input for each year of the simulation and the fishing mortality rate, $F$, was solved for within the model. Each projection incorporated the observed reduction landings for 2009, 2010, and 2011 of 143.754, 183.085, and 174.021 thousands of metric tons, respectively. Landings for 2012 was input as 186 thousand metric tons and was based on a preliminary landings forecast, which uses a multiple linear regression model that relies on projected effort for the 2012 fishing year and historical catch and effort (Smith 1991). Observed landings for the bait fishery for 2009 and 2010 were 38.9 and 43.8 thousands of metric tons, respectively. Bait landings for 2011 and 2012 were estimated at 43.5 thousand metric tons, which was the average bait landings during 2008-2010.

Starting in 2013, management was instituted with a constant level of total landings, which was projected for 5 years. Total projected landings included 75, 100, 125, 150, 175, 200, and 225 thousand metric tons. Total landings were allocated such that 75% were allocated to the reduction fishery and 25% were allocated to the bait fishery. This allocation was based on the proportion of bait landings to the total coastwide landings of Atlantic menhaden for the most recent five years (this decision will likely be revisited as additional years of landings data become available). The allocation presented here (75:25) is for illustrative purposes only; the question of allocation between the reduction and bait fisheries is a question that managers will need to address and provide guidance to the TC.

Numbers at age after the initial year were calculated as:

$$N_{a+1,y+1} = N_{a,y}e^{-Z_{a,y}}$$

where Z is age and year specific mortality and equals natural mortality for each age for that year plus the fishing mortality rate times the selectivity at age.

Each constant landings value was simulated 2,000 times. Outputs included the median and 5$^{th}$ and 95$^{th}$ percentiles for spawning stock size (ova) over time, F over time, recruitment over time, and landings over time. Spawning stock size for each year was the number of fish in each age times the median reproductive vector from 1990-2007. The reproductive vector was the product of the proportion female, the maturity vector, and the median fecundity vector. Fecundity (mature ova) was determined by weight as described in the stock assessment document (ASMFC 2010). Landings (1000s mt) over time was a model input, as discussed above. Additional outputs included the probability of *F* being less than the specified target of 0.620 and less than the specified threshold of 1.324 over time given the constant landings input.

**Results**

As expected, the higher the landings, the lower the probability of *F* being less than the threshold and target (Table 1; Figures 1-5). However, the range in *F* was fairly broad for a given level of constant landings (Figures 6-19). In some cases, the *F* could not be estimated or was estimated at an extremely high value, sometimes even hitting the bound of 25. The high values of *F* demonstrate the inability of the model to account for such high landings during the period of 2009 to 2012 (when observed and forecasted landing are being used; for example in Figures 7, 9, 11, 13, 15, 17, and 19). One explanation for why the observed landings could not be achieved may be because predicted recruitments were lower than actual recruitments. Variability in recruitment was a major driving factor for these projections meaning that recruitment was one of the most uncertain components of the projections and that recruitment uncertainty carried through all of the results.

**Future directions**

In order to address uncertainty in the numbers-at-age for the terminal year and the terminal value of *F*, the TC would like to explore using the Monte Carlo/bootstrap runs (MCB) as the set of initial conditions for each of the projection runs. This method would account for uncertainty in the base run of the model (as specified in the assessment document). The intention is to produce code to use the individual MCB runs as starting points for the projection runs; however, sufficient time was not available to do so with the short turnaround time of the current charge.

Another potential method that would be useful for setting annual landings specifications would be to use the relationship between the observed JAI and estimated numbers at age-0 from BAM. That relationship along with the observed JAI value for another year (in this case, the JAI value from 2009) would be used to project recruitment forward one year. This method was explored as an option for this analysis, but it exaggerated the observed results of not being able to fit landings due to very large values of *F* as seen above. The projected recruitment using this method was low, and when uncertainty was included, the results produced unrealistic values of *F*, which were incapable of producing the observed landings. However, this method has the advantage of incorporating new information on recruitment into projections between assessment years, and the TC would like to further explore it as a potential option.

## Important notes to managers

Before the Amendment can be finalized, the Atlantic Menhaden Board needs to determine the acceptable level of risk for a given year in order to determine what level of landings would be appropriate to reduce overfishing. In addition, the Atlantic Menhaden Board needs to decide how landings will be allocated between the reduction and bait fisheries, a decision that has impacts on the selectivity and estimated *F* for a given constant landings value.

All results from this analysis are conditional on the assumptions made about management/implementation uncertainty. Management uncertainty was assumed to be zero because no information is available for the Atlantic menhaden fishery on this type of uncertainty. If the assumption of zero uncertainty is violated, there will be effects on the projection results.

The projections included many sources of uncertainty, and there are plans to incorporate more sources of uncertainty (see Future directions above); however, these projections did not include structural uncertainty. Therefore, results are conditional on the functional forms and assumptions made regarding population dynamics, selectivity, recruitment, etc. One major assumption that is highly uncertain is the projection of recruitment based on deviations from the median using the most recent years. If recruitment is affected by environmental or ecological conditions, stock trajectories may be affected. Additionally, if allocations between the two fisheries are different in the future, then the weighted selectivity vector will also be different, which will affect projection results.

## Literature cited


Atlantic States Marine Fisheries Commission (ASMFC). 2010. Atlantic menhaden stock assessment and review panel reports. ASMFC stock assessment report no. 10-02, 325 p.

Smith, J. W. 1991. The Atlantic and gulf menhaden purse seine fisheries: origins, harvesting technologies, biostatistical monitoring, recent trends in fisheries statistics, and forecasting. Marine Fisheries Review 53: 28-41.

Table 1. The probability of the fishing mortality rate (F) being less than the THRESHOLD over time for given constant landing scenarios

| Landings (1000s mt) | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|
| 75 | 0.00 | 0.00 | 0.00 | 0.01 | 0.56 | 0.89 | 1.00 | 1.00 | 1.00 |
| 100 | 0.00 | 0.00 | 0.00 | 0.01 | 0.40 | 0.74 | 0.93 | 0.99 | 1.00 |
| 125 | 0.00 | 0.00 | 0.00 | 0.01 | 0.28 | 0.55 | 0.78 | 0.91 | 0.96 |
| 150 | 0.00 | 0.00 | 0.00 | 0.01 | 0.17 | 0.37 | 0.56 | 0.73 | 0.84 |
| 175 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.22 | 0.35 | 0.47 | 0.56 |
| 200 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.11 | 0.17 | 0.22 | 0.28 |
| 225 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.05 | 0.07 | 0.08 | 0.09 |

Table 2. The probability of the fishing mortality rate (F) being less than the TARGET over time for given constant landing scenarios.

| Landings (1000s mt) | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|
| 75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.62 | 0.91 | 0.99 | 1.00 |
| 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.35 | 0.66 | 0.88 | 0.96 |
| 125 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.15 | 0.38 | 0.59 | 0.76 |
| 150 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.14 | 0.27 | 0.40 |
| 175 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.07 | 0.11 |
| 200 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 |
| 225 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

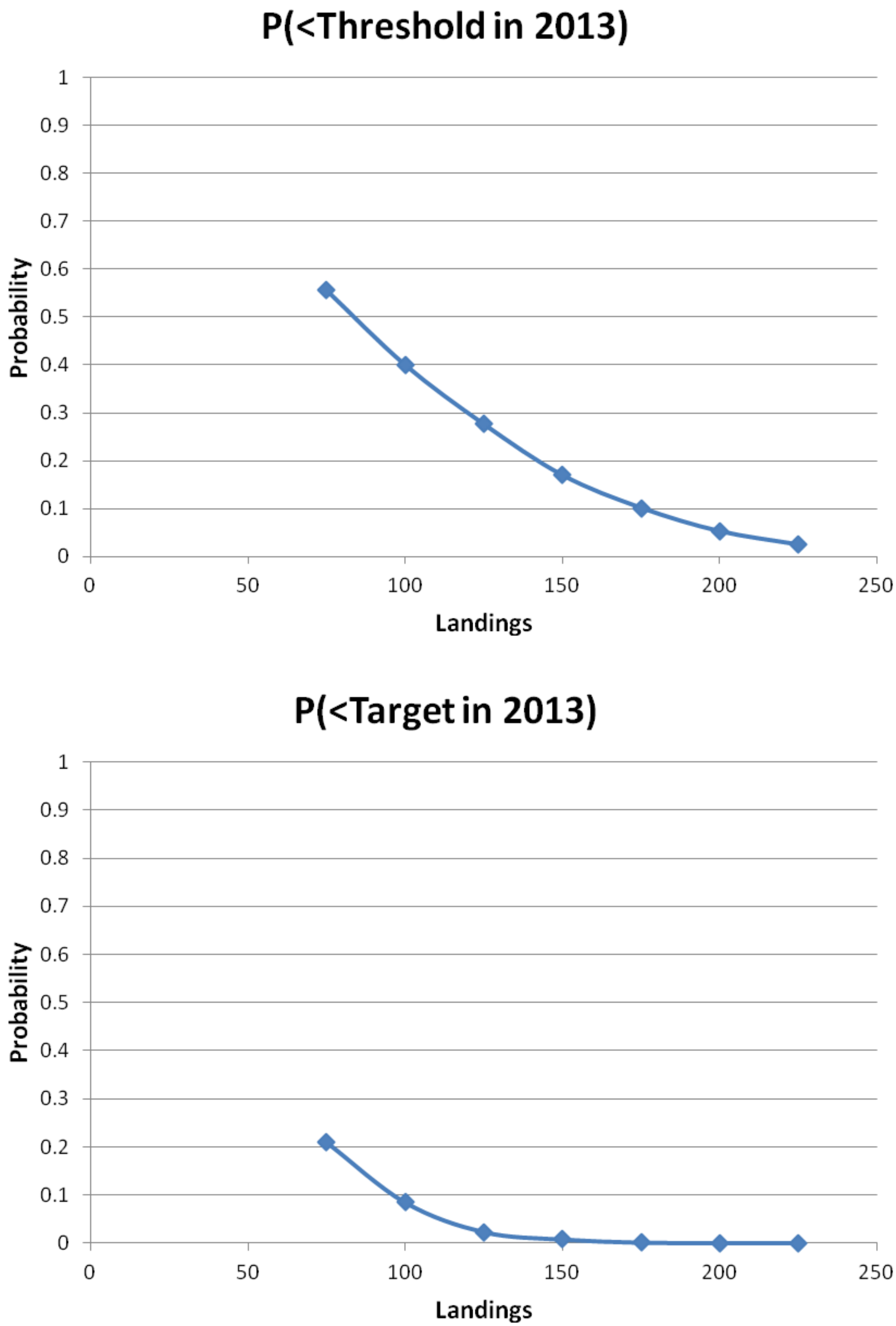



Figure 1. Probability of the fishing mortality rate being less than the threshold (upper panel) and target (lower panel) across a series of constant landings values for the year 2013.

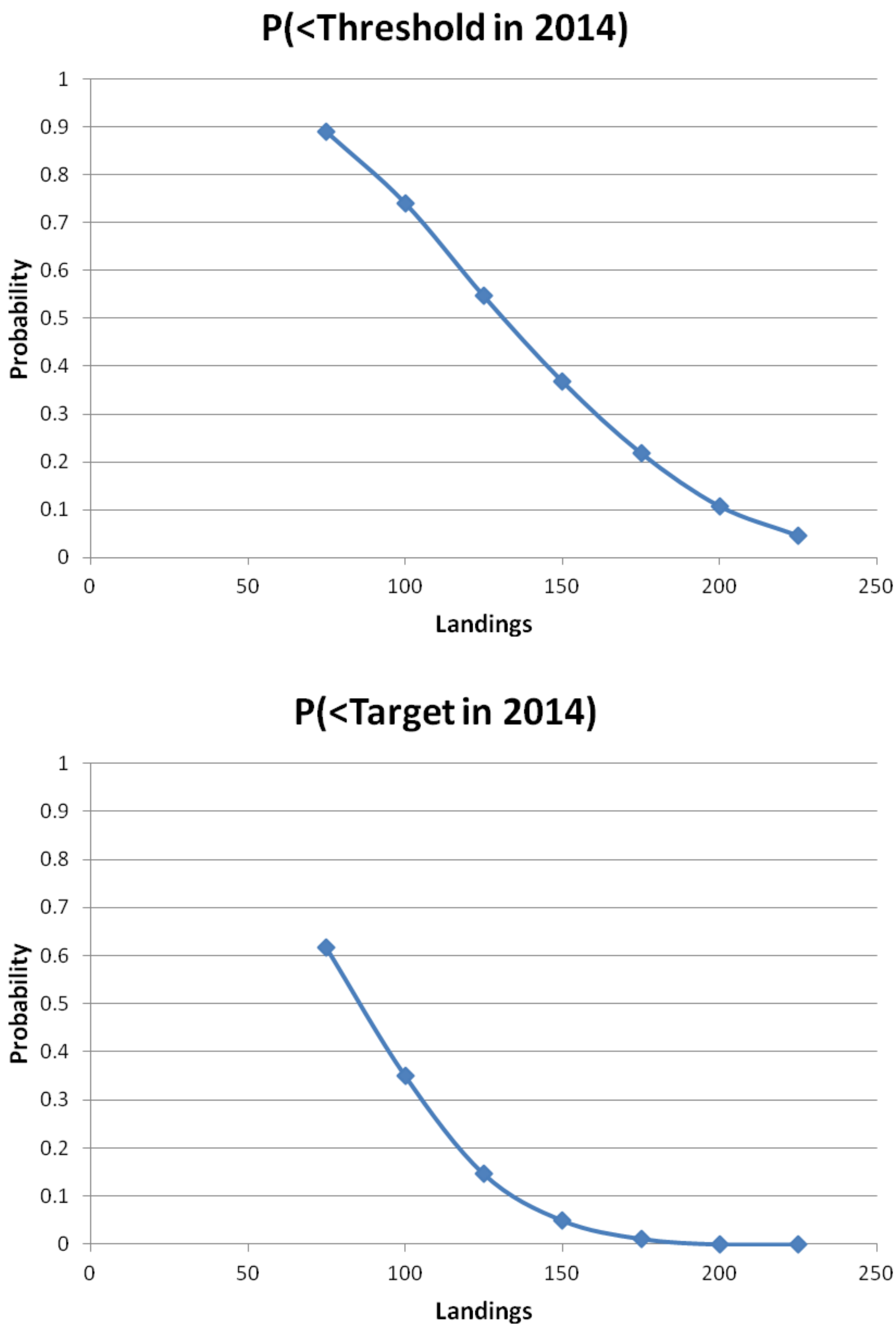
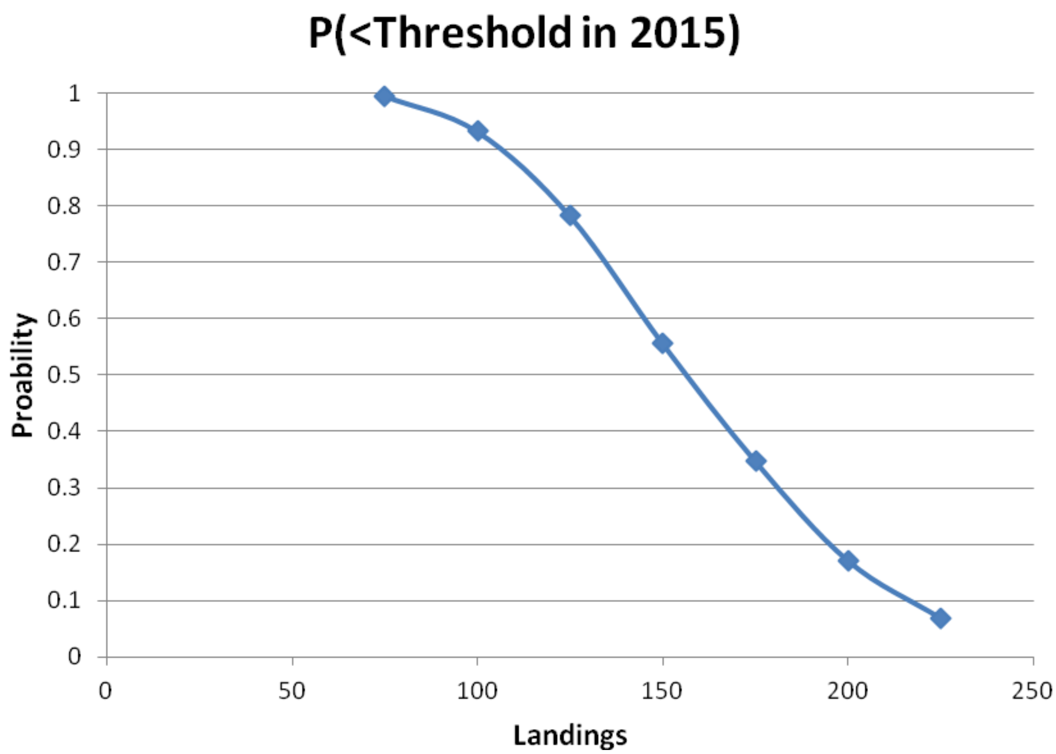



Figure 2. Probability of the fishing mortality rate being less than the threshold (upper panel) and target (lower panel) across a series of constant landings values for the year 2014.



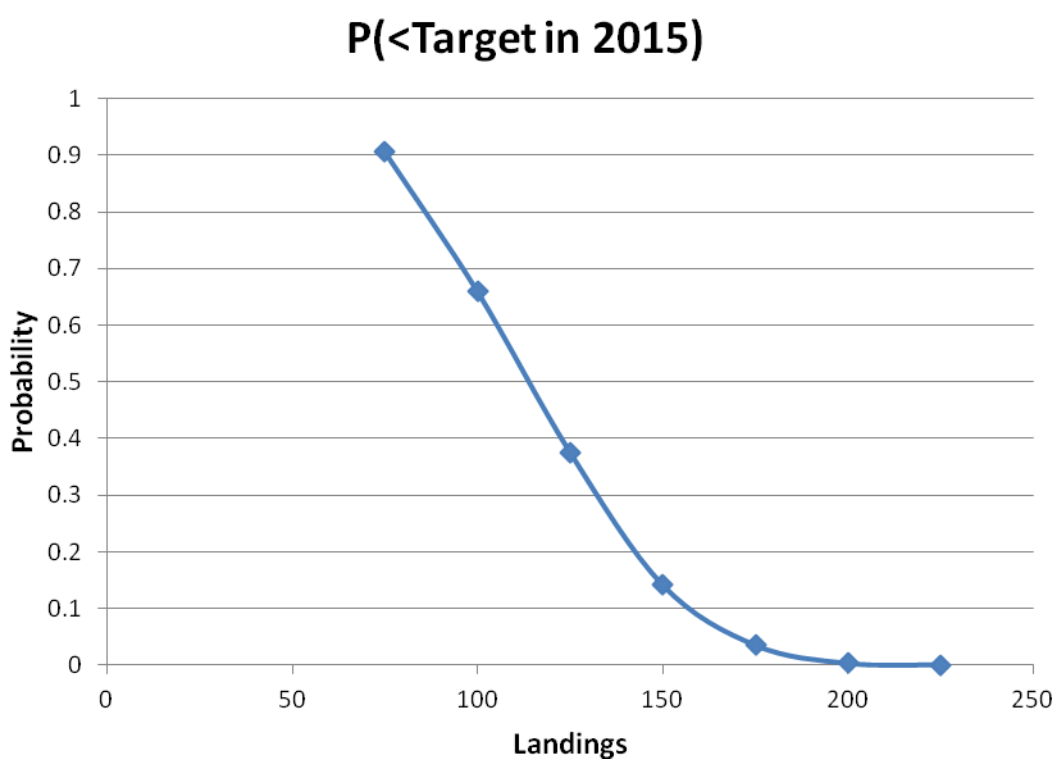




Figure 3. Probability of the fishing mortality rate being less than the threshold (upper panel) and target (lower panel) across a series of constant landings values for the year 2015.

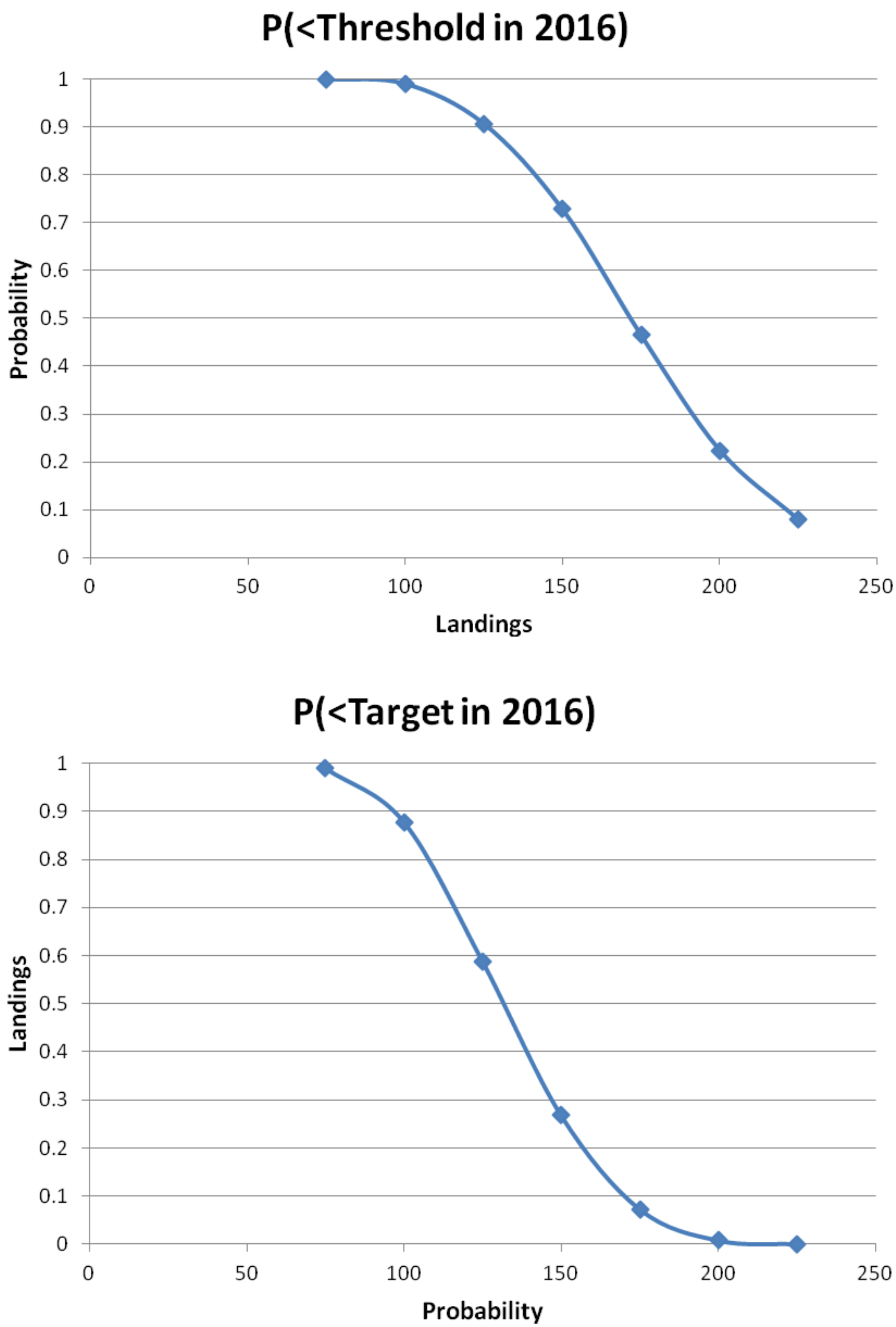



Figure 4. Probability of the fishing mortality rate being less than the threshold (upper panel) and target (lower panel) across a series of constant landings values for the year 2016.

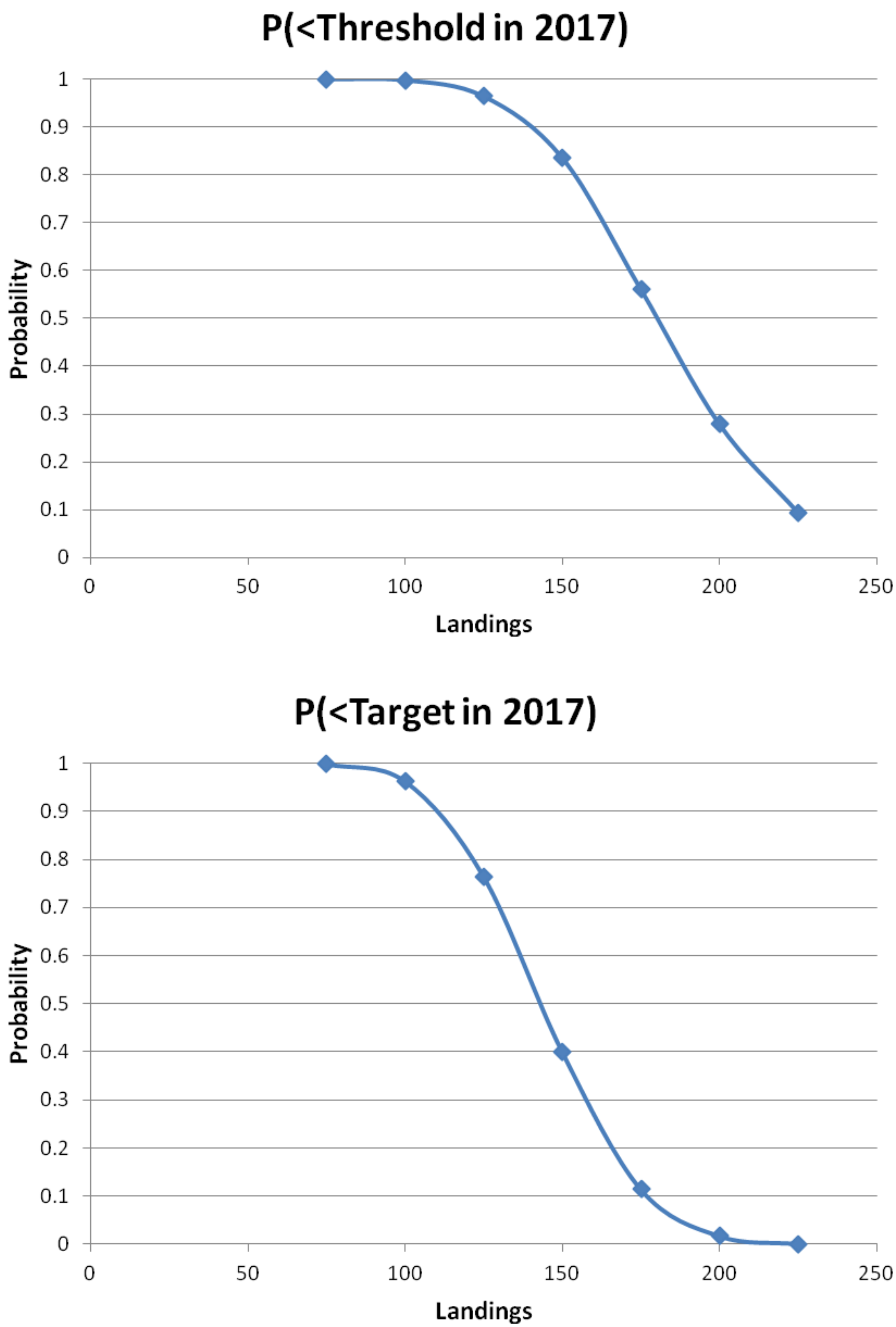



Figure 5. Probability of the fishing mortality rate being less than the threshold (upper panel) and target (lower panel) across a series of constant landings values for the year 2017.

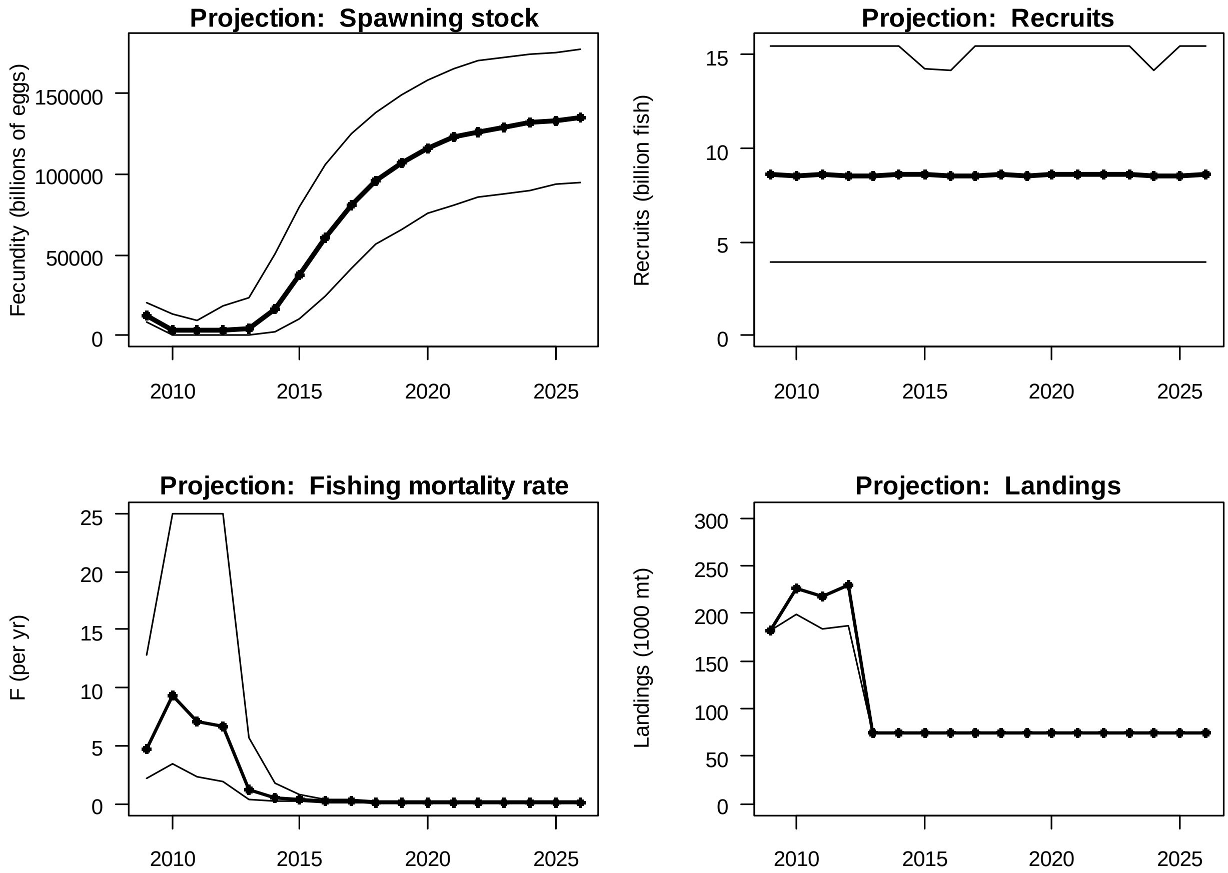



Figure 6. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 75,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

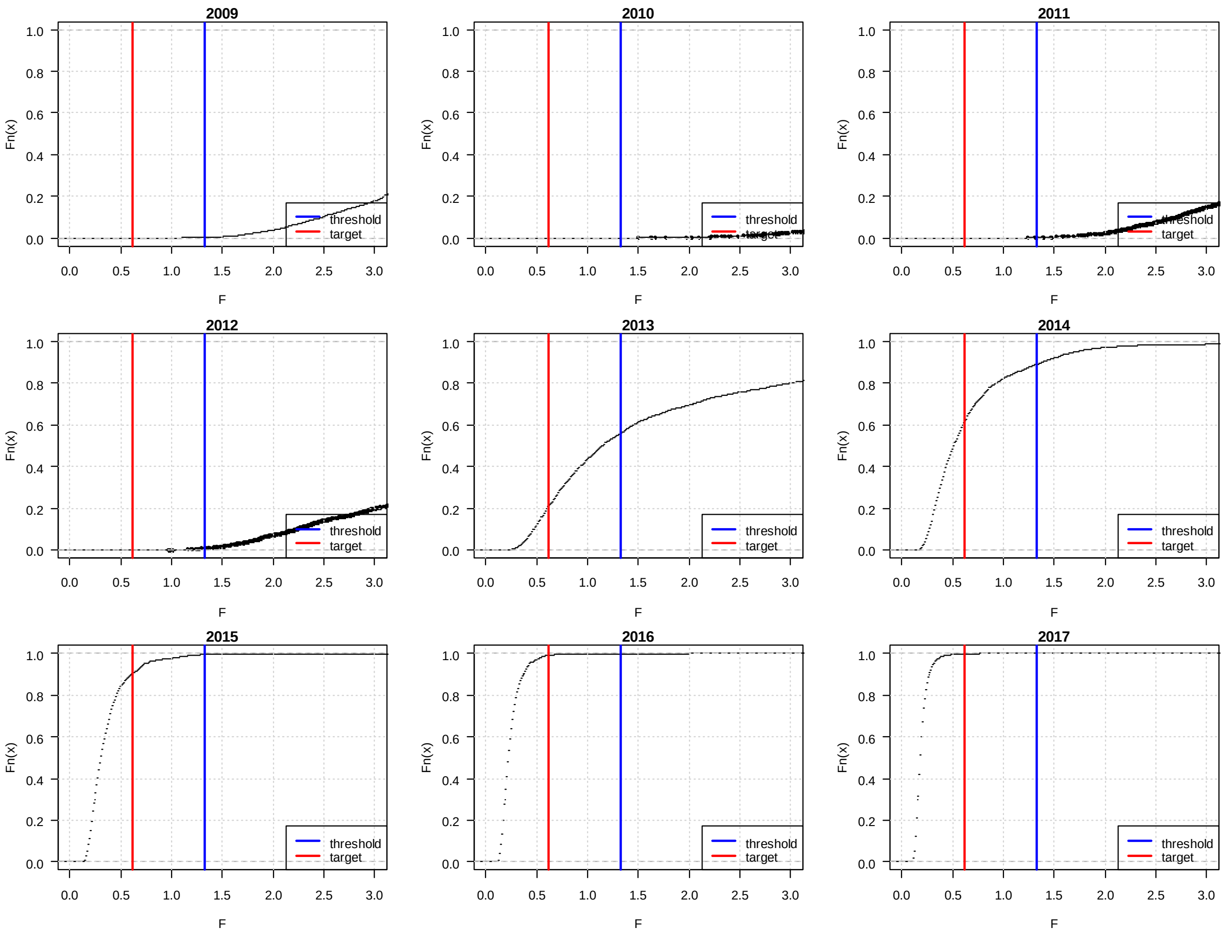



Figure 7. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 75,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified *F* in that year.

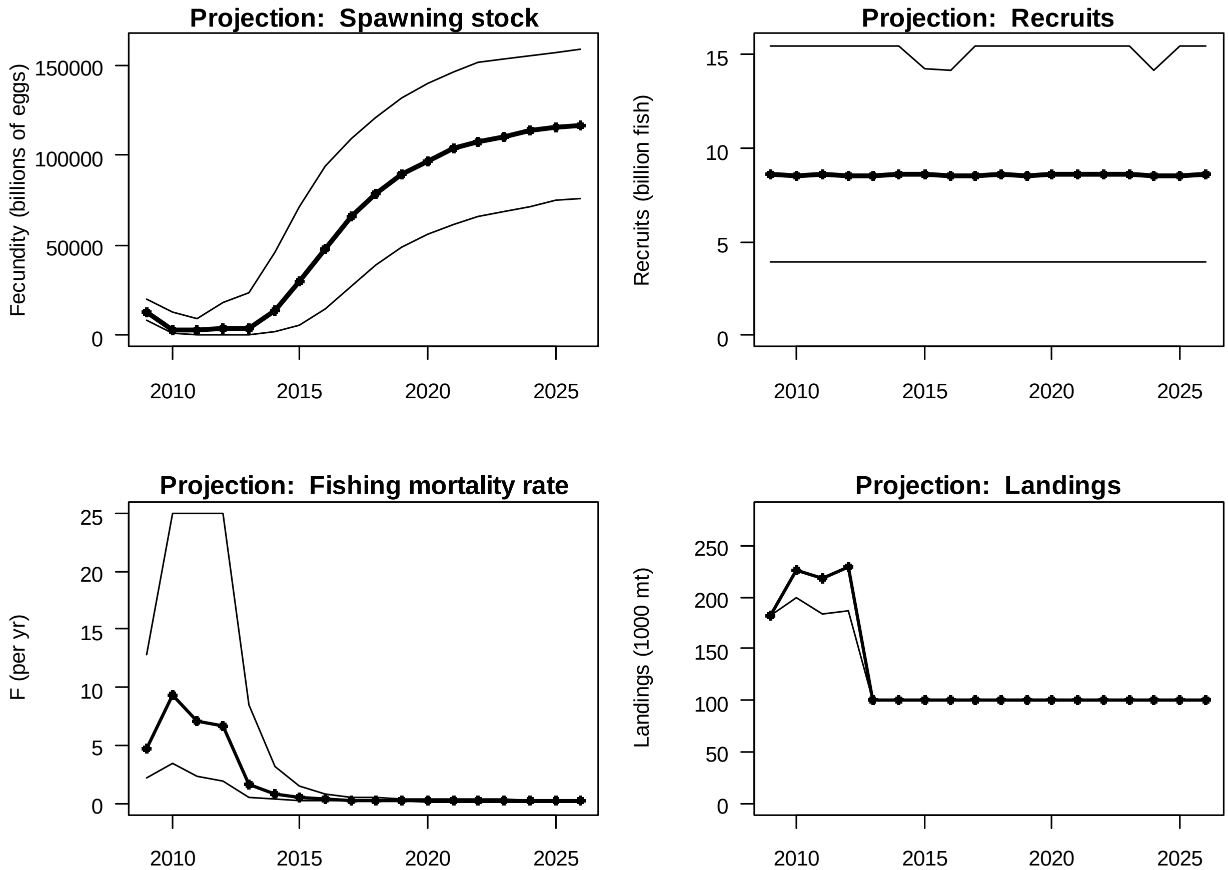



Figure 8. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 100,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

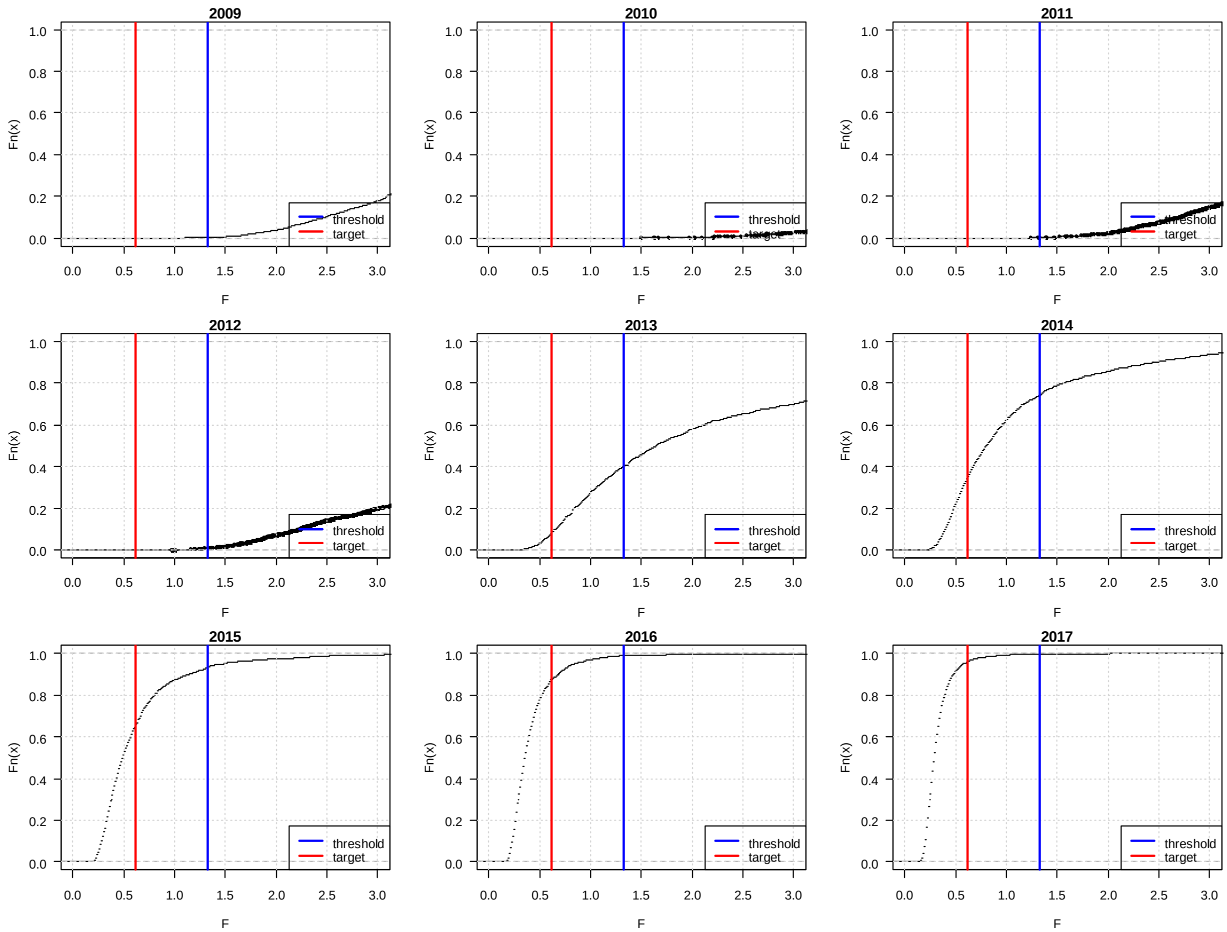



Figure 9. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 100,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified $F$ in that year.

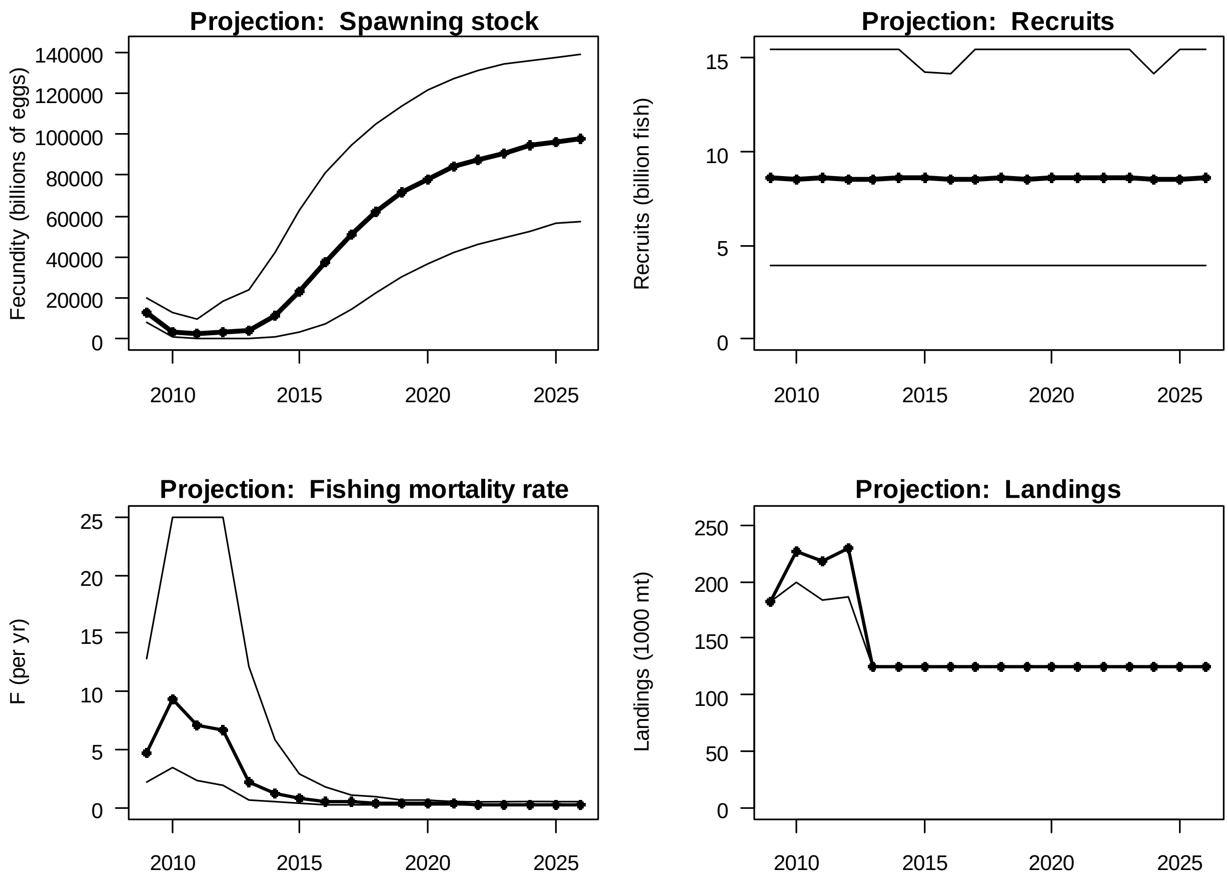



Figure 10. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 125,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

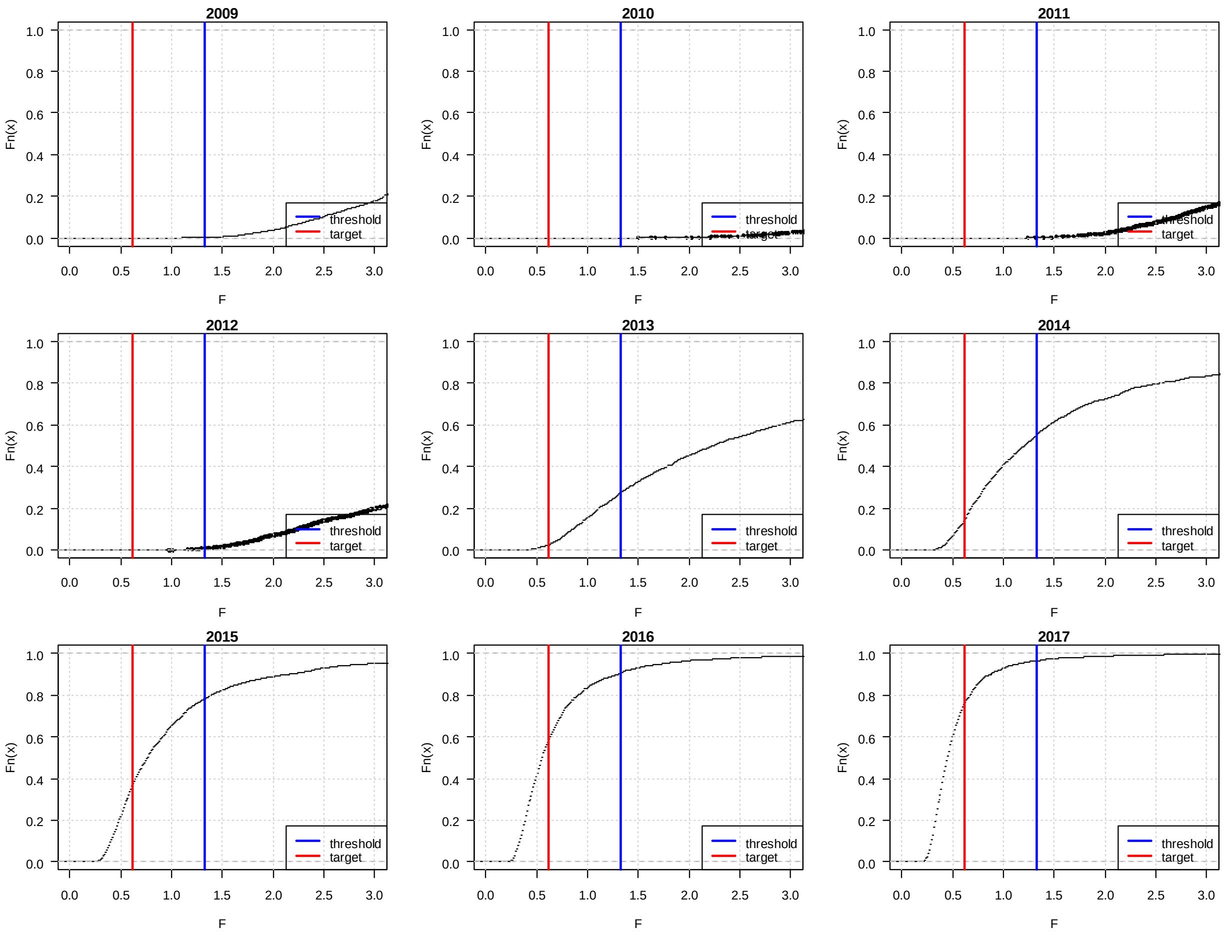



Figure 11. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 125,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified $F$ in that year.

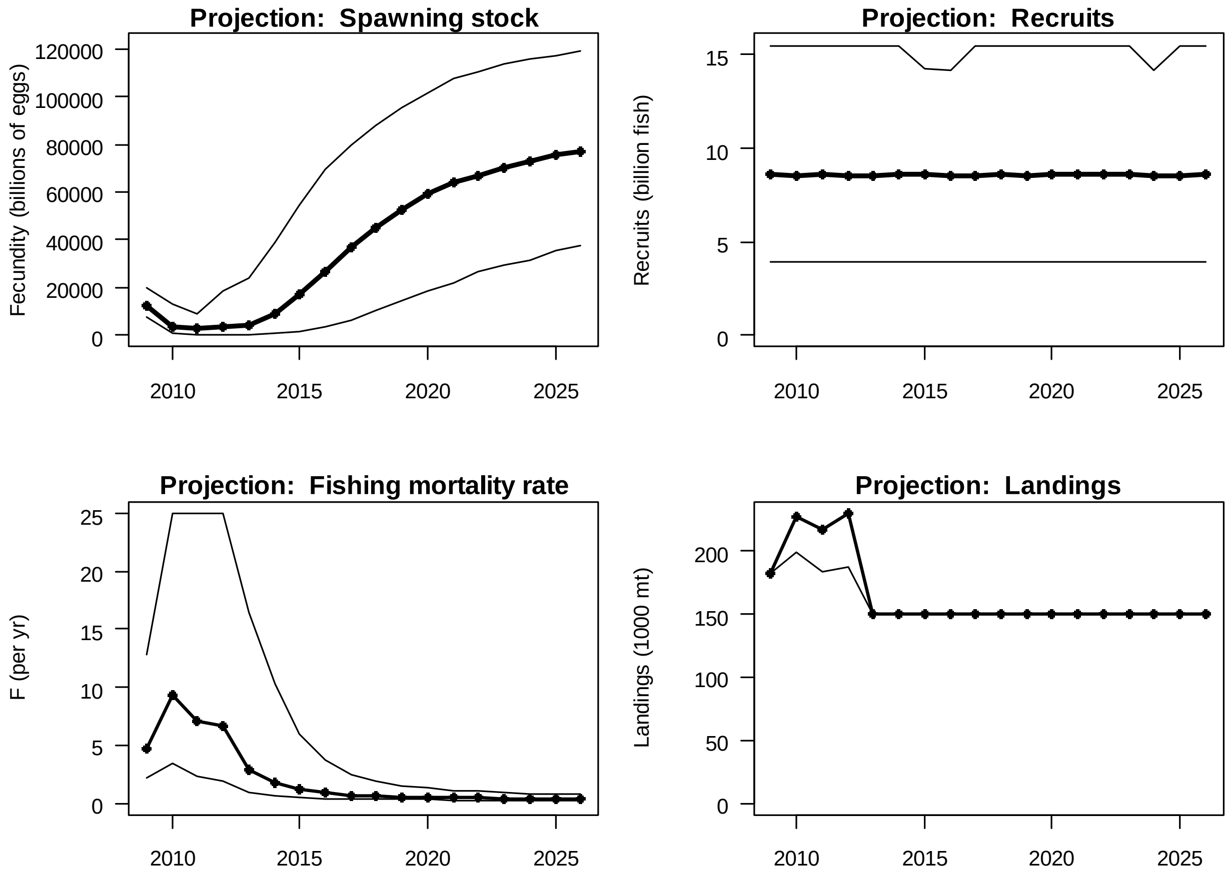



Figure 12. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 150,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

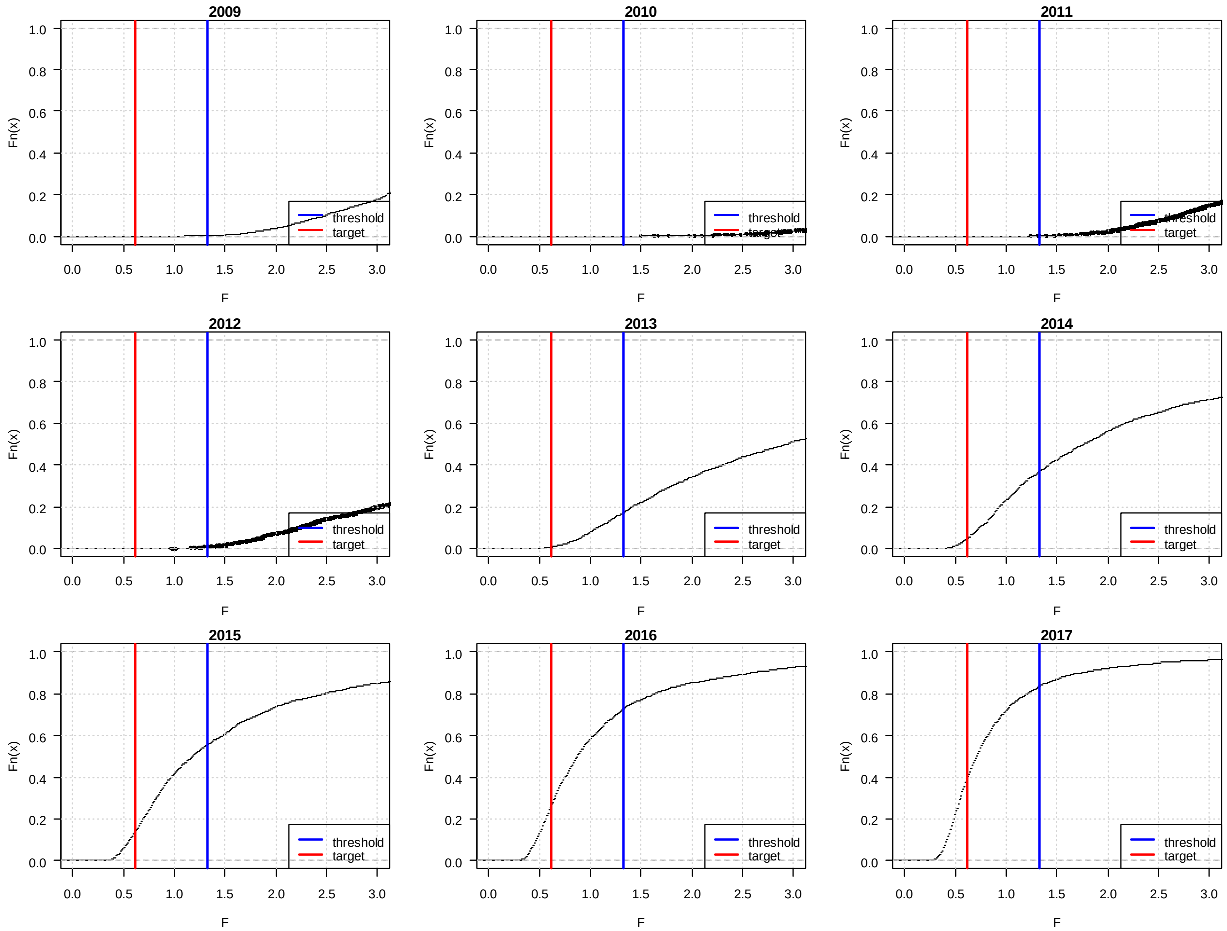


Figure 13. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 150,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified *F* in that year.

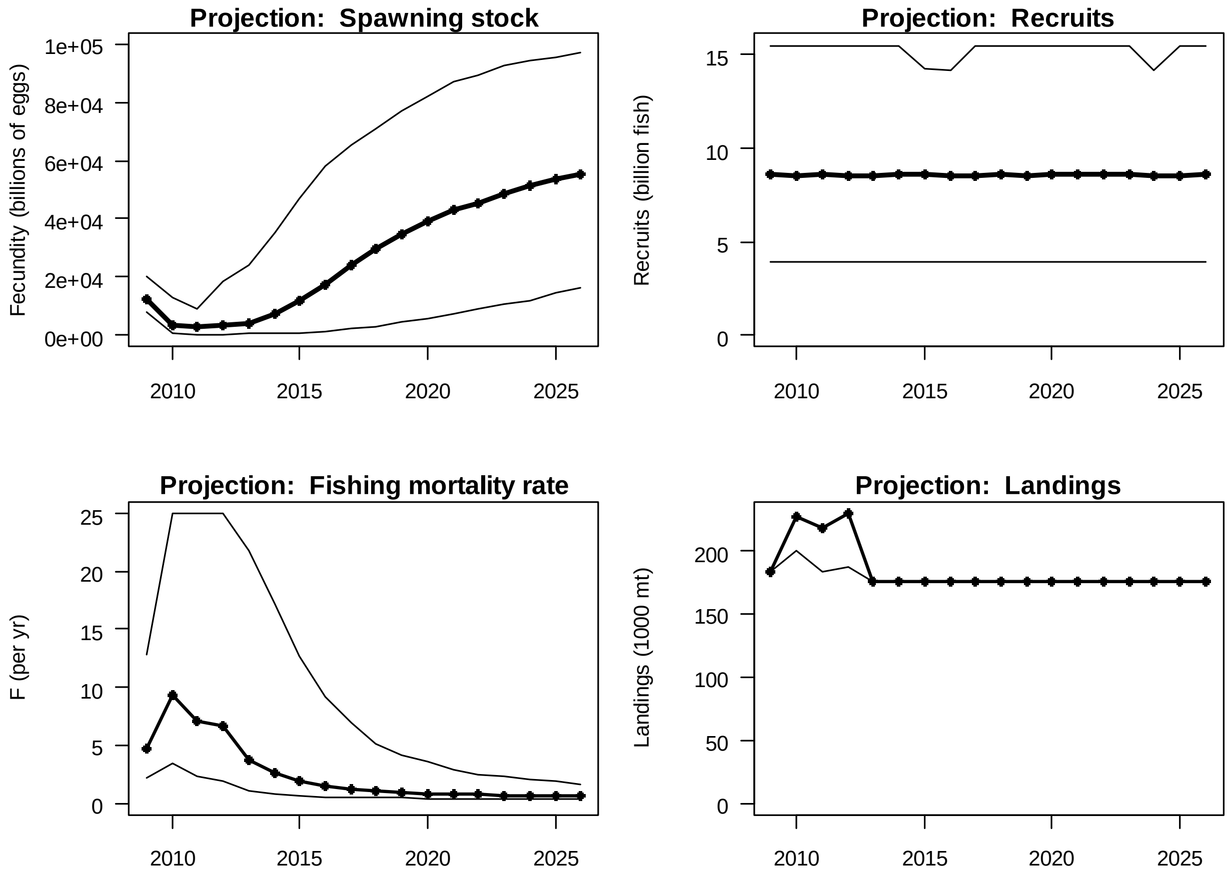



Figure 14. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 175,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

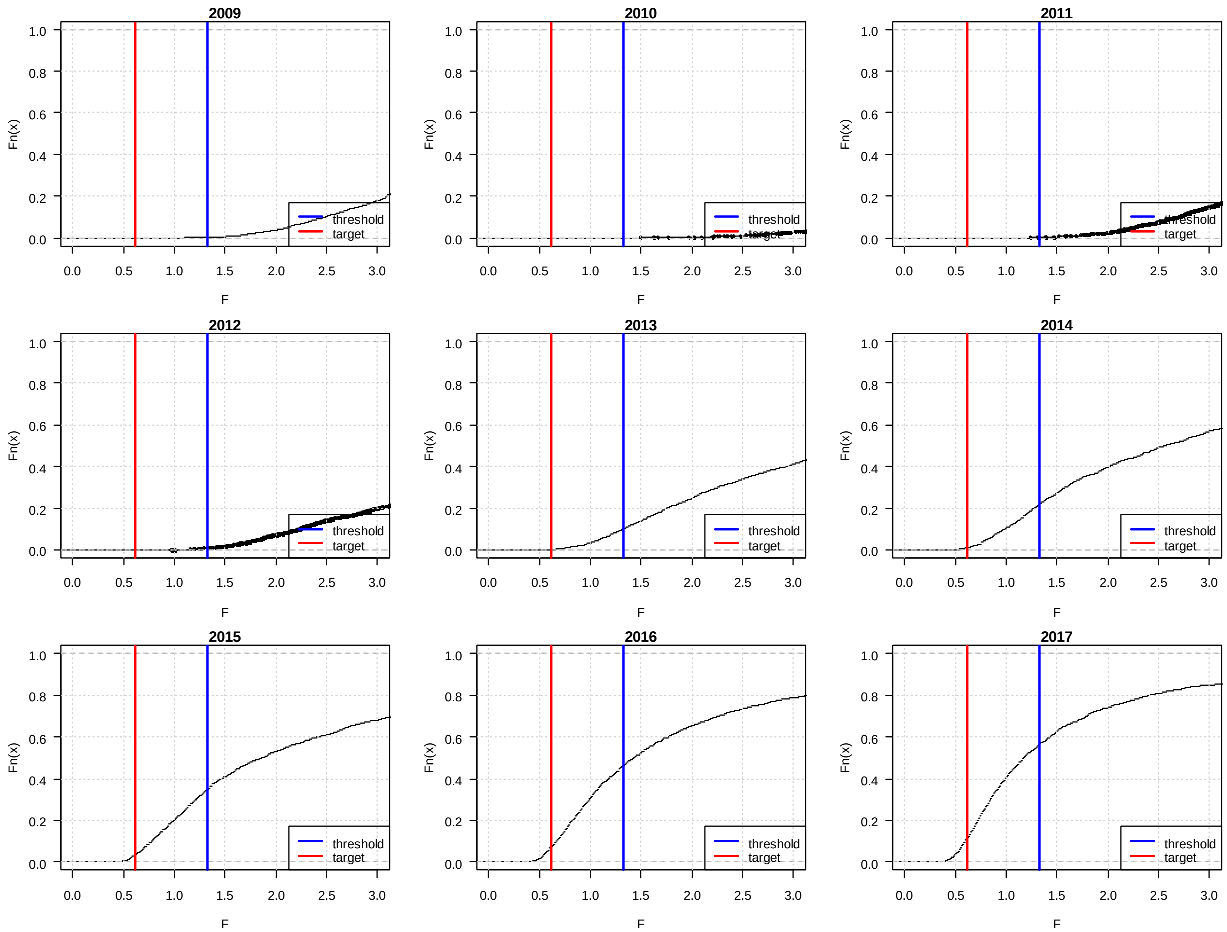



Figure 15. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 175,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified *F* in that year.

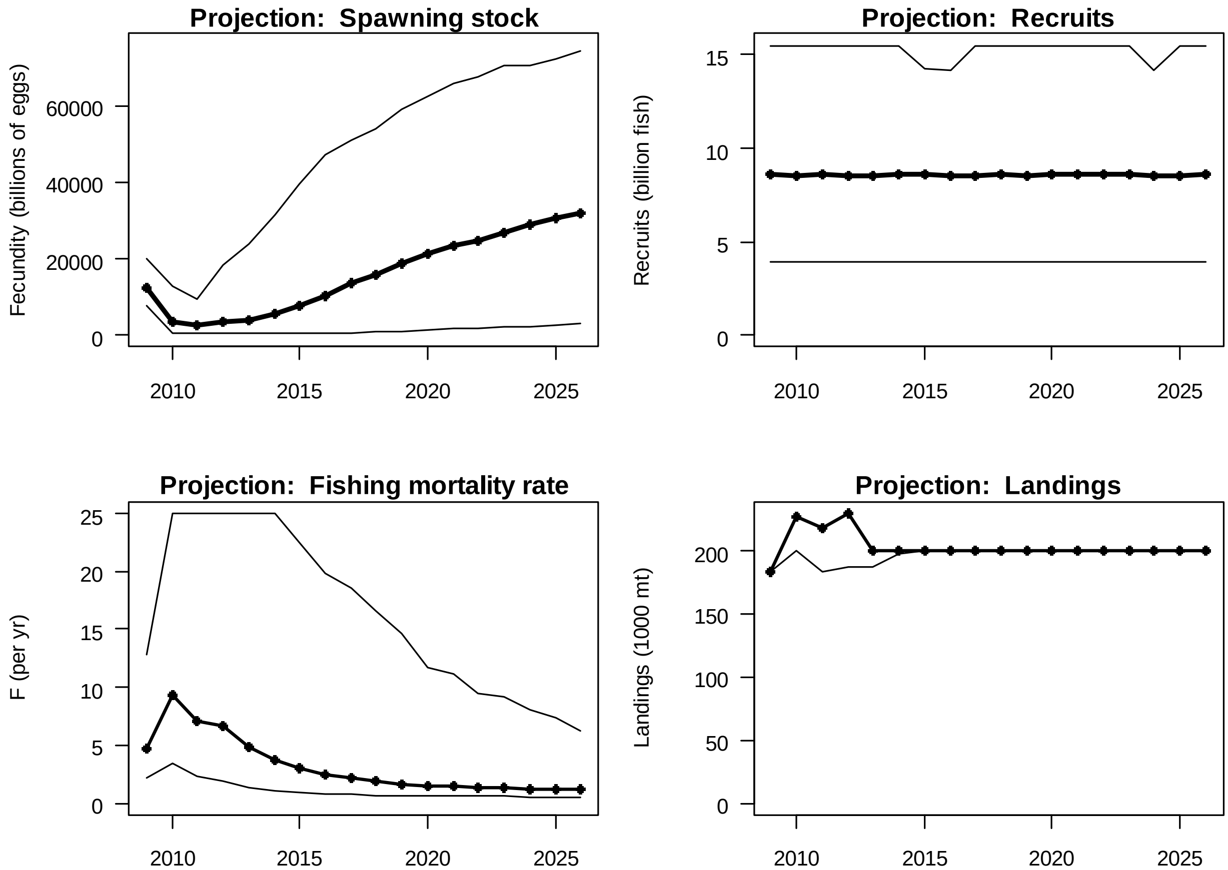



Figure 16. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 200,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

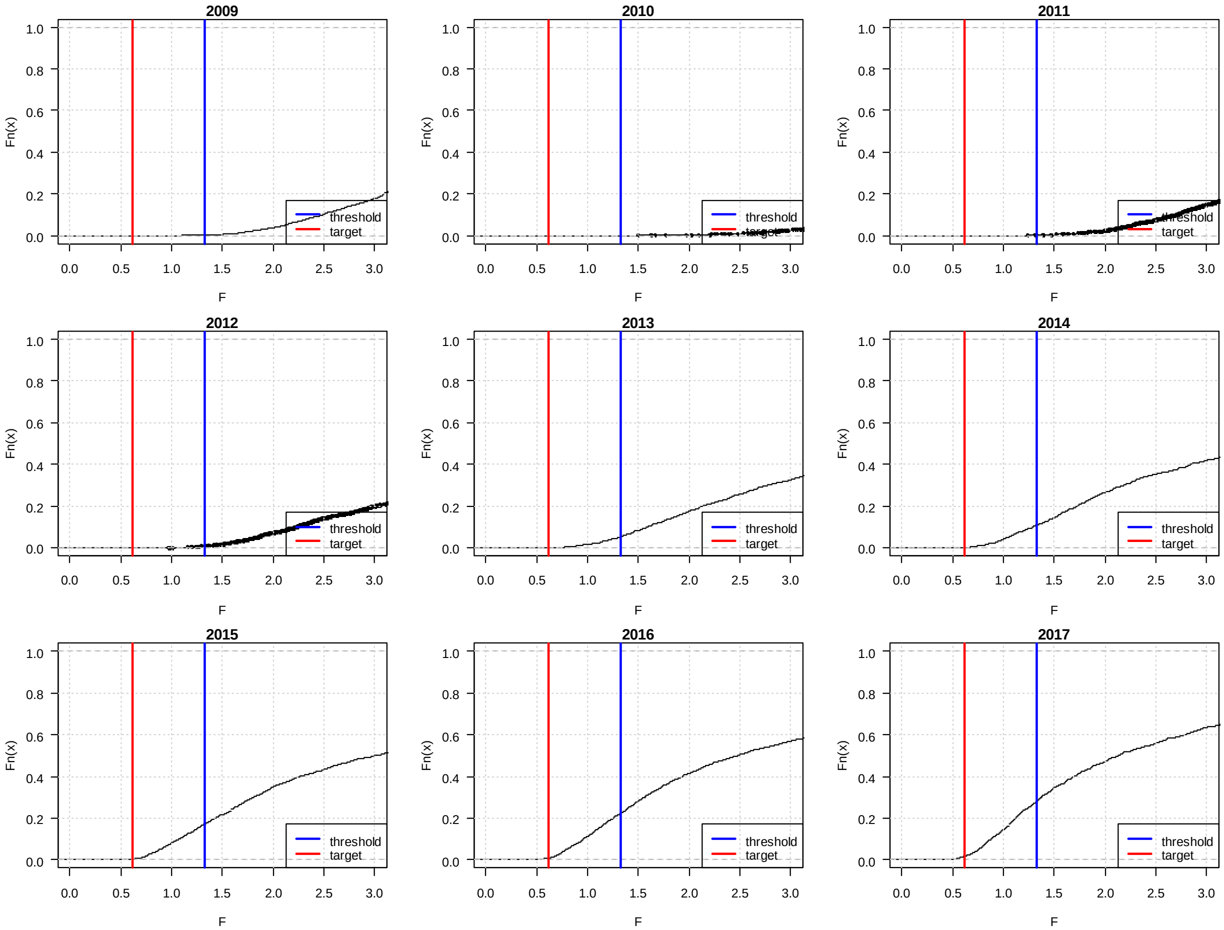



Figure 17. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 200,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified *F* in that year.

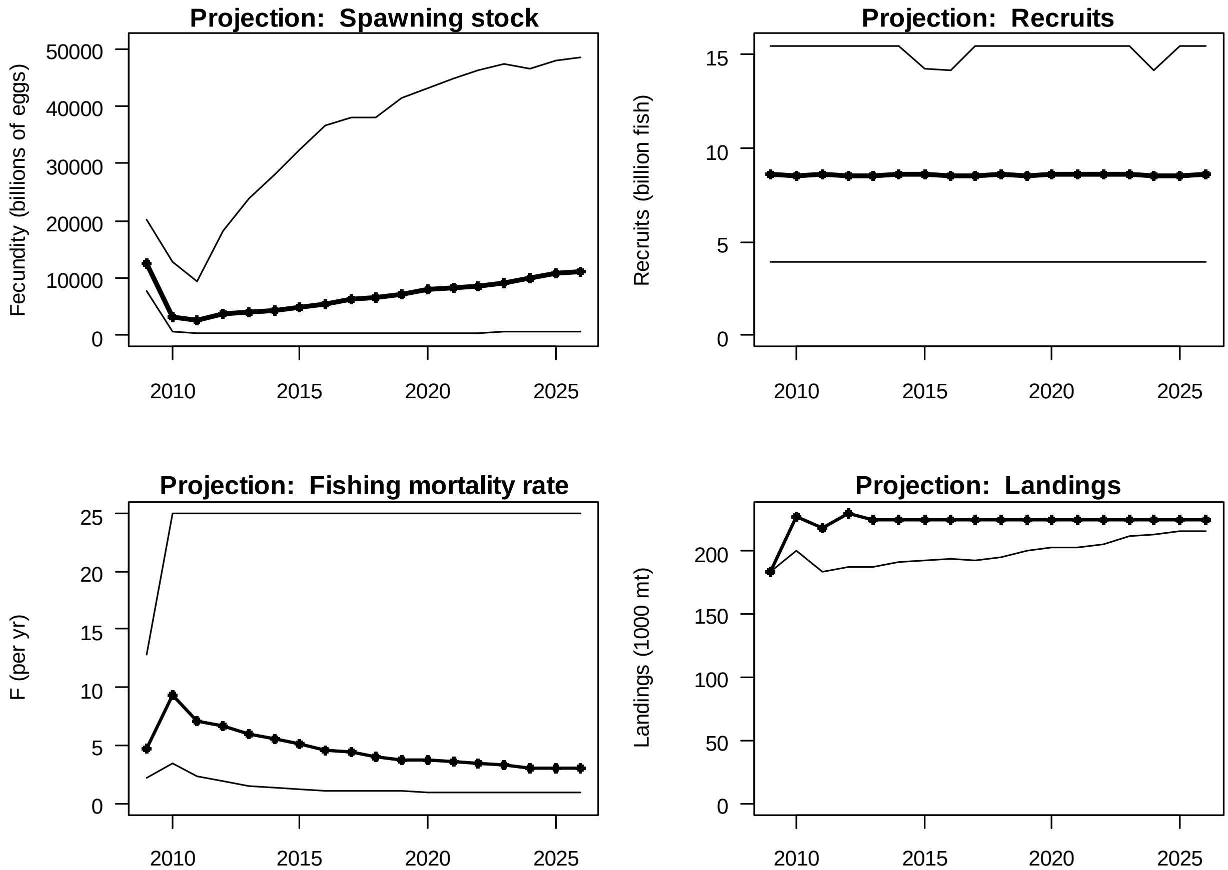



Figure 18. Fecundity, recruits, fishing mortality (F), and landings over time based on constant landings of 225,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery.

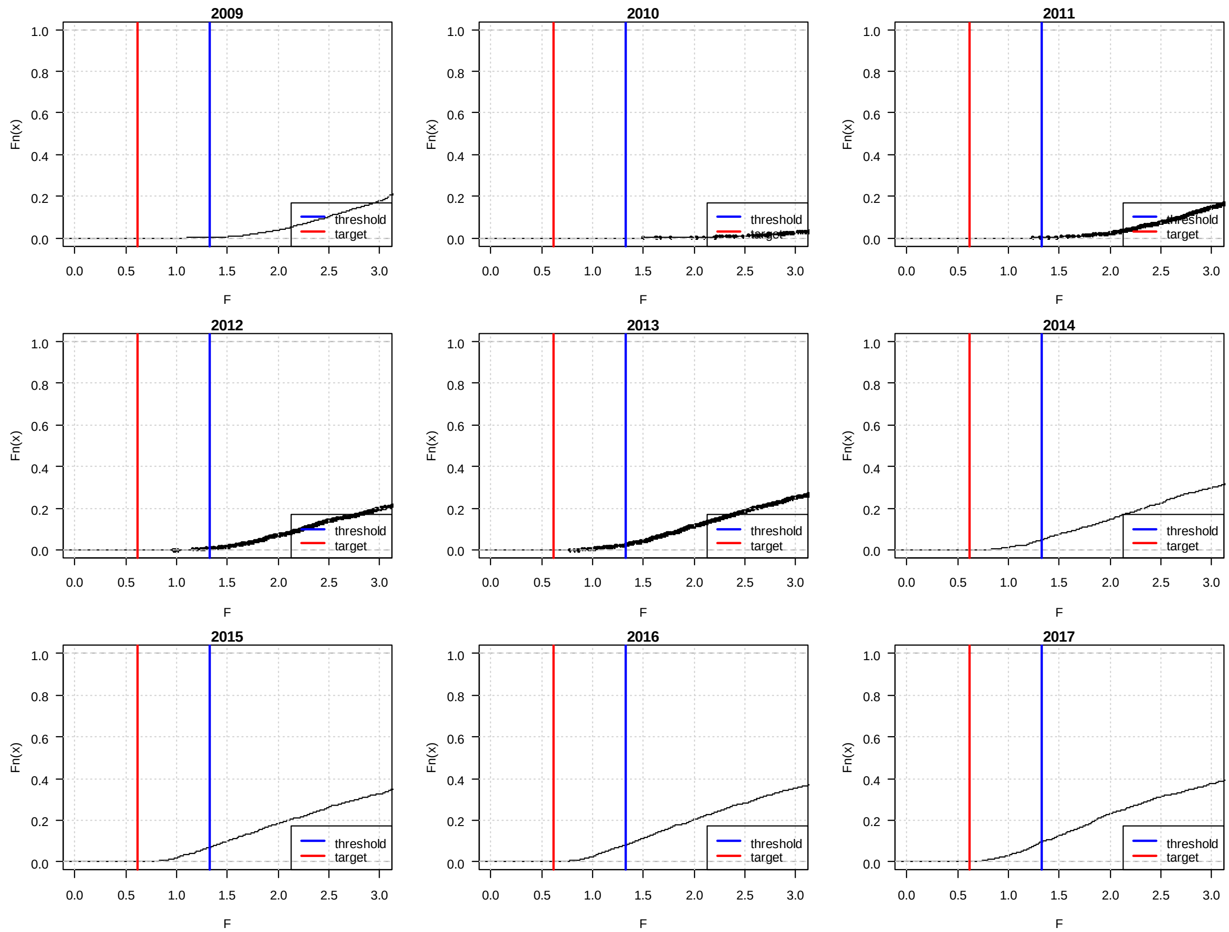



Figure 19. Cumulative distribution of fishing mortality rates for 2009 to 2017 based on constant landings of 225,000 mt with 25% allocated to the bait fishery and 75% allocated to the reduction fishery. The blue line denotes the threshold and the red line denotes the target, and where the lines cross the distribution is the probability that the given landings will be below a specified *F* in that year.

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*Healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015*

January 30, 2012

To: Atlantic Menhaden Management Board
From: Atlantic Menhaden Advisory Panel
RE: Advisory Panel Report to the Board on the Draft Public Information Document

The Advisory Panel met via conference call on January 26, 2012 to make recommendation to the Board on the Draft Public Information Document for Amendment 2 the ISFMP for Atlantic Menhaden. Panel members in attendance represented the conservation community, commercial harvesters (for bait and reduction), bait dealers, and recreational fishermen. The following is a summary of the meeting.

**Attendees**

*Advisory Panel Members*

Bill Windley (MD), Chair
Ron Lukens (VA)
Jimmy Kellum (VA)
Jeff Kaelin (NJ)
Ed Cherry (NJ)
Don Swanson (NH)
Jennie Bichrest (ME)
Ken Hinman (VA)
Melissa Dearborn (NY)
Tom Ogle

*ASMFC Staff*

Mike Waine

*Public*

Charlie Hutchinson
Frank Harney
Alison Fairbrother

**Draft Public Information Document**

**<u>Issue 1: Achieving the Target</u>**

Some members suggested that information about the timeframe for achieving the threshold is missing, and was not well defined by the Board.

Other members thought Addendum V clearly stated that the threshold would be achieved immediately to end overfishing.

Some AP members requested a detailed description of the status of other ASMFC species, and the way they are being managed. More specifically, they are interested in which species are managed at the threshold F, and which species are managed at the target F.

*PDT drafted text to address AP recommendations*

- Currently the terminal year estimate of fishing mortality exceeds the threshold level, resulting in overfishing. The Atlantic Menhaden FMP states that if overfishing is occurring the Board will take steps to reduce F to the target level. Therefore, through Amendment 2, the Board will take actions to end overfishing immediately. However, because the reductions in F are more substantial to achieve the F target, the Board is considering a one, three, and five year schedule to reduce F to the target level.

- *If tasked, the PDT can perform an analysis of species currently managed by the Commission to provide information regarding stock status relative to biological reference points. However, there was not enough time to complete this task before the February Board Meeting.*

**<u>Issue 2: Catch reporting</u>**

Some members requested more information regarding the reduction fishery and the use of Captain's Daily Fishing Reports with open port sampling. The addition of this text would help the public understand what the current reporting is in the reduction fishery.

It was also suggested that more information be included on the bait fishery reporting. Most specifically, the AP requested information on the frequency and method of reporting in each state within the management unit.

*PDT drafted text to address AP recommendations*
*The following text was updated from addendum II and is suggested as an appendix.*

- *Purse-Seine Reduction Fishery*

  • Landings - Daily vessel unloads (in thousands of standard fish) are emailed daily to the NMFS Beaufort Laboratory.

  • Age Compositions – An NMFS port agent samples purse-seine catches at dockside in Reedville, VA, throughout the fishing season (May through December). Specimen ages are determined (via scales) at NMFS Beaufort.

  • Removals by Area - Areal removals of Atlantic menhaden by the purse-seine reduction fleet are estimated using the Captains Daily Fishing Reports (CDFRs). CDFRs are deck logbooks maintained by Virginia reduction purse-seine vessels. Fleet compliance is 100% (about 10 vessels in 2011). Vessel captains complete CDFRs and itemize number of daily purse-seine sets. Among other things, data recorded for each set include time and location of set, distance from shore, and the 'at-sea' estimated catch (in thousands of 'standard' fish).

  CDFRs from the Reedville menhaden fleet are used to estimate 'in-season' removals from Chesapeake Bay ("the Chesapeake Bay Cap"). Total removals by area are calculated at the end of the fishing season. 'At sea' catches from the CDFRs are summed by vessel, and compared to total vessel unloads from company catch records. Individual 'at sea' sets are then multiplied by an adjustment factor (company records / 'at sea' estimates). Adjusted catches by set are converted to metric tons, and accumulated by fishing area. Catch totals are reported by ocean fishing areas (NJ, DE, and MD in the EEZ, VA and NC), while catches inside and outside Chesapeake Bay are delineated by the Chesapeake Bay Bridge Tunnel.

*Purse-Seine Bait Fishery*

• Landings - Landings of Atlantic menhaden for bait by purse-seine gear occur mostly in Virginia and New Jersey. In recent years only minor purse-seine landings for bait have occurred in Rhode Island or Massachusetts. However, on a few occasions in recent summers, 'run boats' have delivered menhaden for bait to New England ports from purse-seine sets made off the New Jersey coast.

Since 1998, bait purse-seine vessels in VA (about 4-5 vessels), also called 'snapper rigs', maintain CDFR forms (and as per 2001 Addendum I requirements)(also see Smith. 2011. Mar. Fish. Rev. 73:1-12). CDFRs are accumulated onboard during the fishing season (usually May – November). A NMFS port agent collects the CDFRs for the entire fishing season in late November. CDFR data are scanned at NMFS Beaufort. Estimates of total catch by Virginia bait vessels are available in January.

Landings of Atlantic menhaden by purse seine for bait in New Jersey are compiled by the NJDFW. All purse-seine bait fishermen are permitted and required by regulation to submit monthly harvest reports on forms supplied by NJDFW. The information on the monthly harvest reports include landings each day and the area of State waters from which the fish were harvested. Harvest reports are summarized monthly and seasonally to document landings from pre-defined areas of the State's marine waters and port of landings.

• Age Compositions - A NMFS port agent samples purse-seine catches for bait at dockside in Northern Neck, VA, area throughout the fishing season; the same agent also samples menhaden from pound nets in Northern Neck, VA, mostly during spring.

• Removals by Area - Purse-seine vessels fishing for bait are generally smaller (< 100 ft long) than the reduction vessels, hence, bait vessels range shorter distance from their home ports than the reduction vessels. Menhaden for bait catches by purse seine in the Virginia portion of Chesapeake Bay are concentrated near Smith Point (62%) and adjacent fishing areas near the mouth of the Rappahannock River (18%) and Pocomoke Sound (17%) (Smith. 2011. Mar. Fish. Rev. 73:1-12). Menhaden for bait catches by purse seine in New Jersey are probably concentrated in northern New Jersey and around Cape May.

*Atlantic Menhaden for Bait Landings by Other Gears*

• A majority of Atlantic menhaden for bait landings by gear other than purse seines comes from the pound net fisheries of Virginia, Maryland, and the Potomac River. Pound net landings are acquired by various state fisheries agencies, then reported to the NMFS General Canvass Survey. Pound net landings of Atlantic menhaden are generally available in spring after the year in which the landings were made.

• North Carolina accounts for significant bait fishery landings from a variety of gears. Minor quantities of Atlantic menhaden for bait are landed in other East coast states by miscellaneous gears such as gill nets and trawl.

• Menhaden for bait landings by gears other than purse seine are annually compiled from compliance reports and presented to the Technical Committee.

**Issue 3: Recreational Fishery Management Tools**

The AP recommended also discussing the timeline for the assessment update and amendment at the beginning of the document (at the end of Issue 1).

The AP recommended clarifying the intent of reporting in the recreational fishery. Adding that reporting under recreational fishery will only apply to fish that are immediately caught and not menhaden that were purchased for bait.

The AP also requested adding a gear restriction option to the list of recreational fishery management tools.

*PDT drafted text to address AP recommendations*

- Insert assessment timeline under issue 1.

- Add option 6 Gear Restrictions
  Under this option gear modifications are used to restrict the amount of catch (e.g., mesh size, net size).

**Issue 4: Commercial Fishery Management Tools**

The AP recommended providing better information on each state's landings to understand the potential of a state specific quota management system.

Some members suggested that an overage or underage text be added to the quota option.

*PDT drafted text to address AP recommendations*

- Add overage and or underage as e.) under option 6.

**Summary of Stock Status**

The AP recommended adding text that specifies there is not a well defined stock recruitment relationship, and that lower landing levels do not necessarily increase spawning stock biomass. However, there is a possibility that the stock may be able to take greater advantage of favorable environmental conditions if a larger percentage of spawning adults remain in the population.