#4

New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
John Pappalardo, *Chairman* | Paul J. Howard, *Executive Director*

MEMORANDUM

DATE: August 5, 2011

TO: Groundfish Oversight Committee

FROM: Groundfish Plan Development Team (PDT)

SUBJECT: **FW 47 Development**

1. The PDT held conference calls on July 11 and August 2, 2011 (see attachment (a) for participation in these calls). The PDT focused its efforts on developing rebuilding strategy alternatives for GB yellowtail flounder and accountability measures for ocean pout, windowpane flounder, SNE/MA winter flounder, Atlantic halibut, and Atlantic wolffish.

Georges Bank Yellowtail Flounder Rebuilding Strategy

2. FW 45 revised the rebuilding strategy for GB yellowtail flounder, targeting an ending date of 2016 with a 50 percent probability of success. At the time FW 45 was adopted the fishing mortality rate needed to fulfill the strategy was estimated as 0.138.

3. Two events suggest a revised strategy is in order.

a. First, the International Fishery Agreement Clarification Act (IFACA) was adopted. This statute removes the requirement that rebuilding be completed within ten years for stocks subject to the US/Canada Resource Sharing Understanding. Based on this change, in June the Council accepted the Committee's recommendation to consider revising the rebuilding strategy. While IFACA does provide flexibility in designing a rebuilding period for GB yellowtail flounder, the PDT's understanding is the following requirements remain and must be considered when developing a strategy.

1) For FY 2012 and beyond, a rebuilding period must be defined - an end date must be specified.

2) There must be at least a median probability that rebuilding will be achieved by the end date.

3) Rebuilding must be accomplished as quickly as possible, but the provisions of the Understanding should be considered when evaluating this requirement.

4). Catch levels must be set such that overfishing does not occur. In effect, this bounds any rebuilding program by F_{MSY}.

b. The second event is that the Transboundary Resource Assessment Committee (TRAC) assessed GB yellowtail flounder in June, 2011. The stock is overfished. The results indicate the stock cannot be rebuilt by 2016 in the absence of all fishing mortality. These assessment results have not yet been presented to the Council.

4. The PDT developed several possible rebuilding strategies for the Committee's consideration. Before reviewing these strategies, there are some important points from the assessment to note.

a. A retrospective pattern has returned to the assessment. This pattern over-estimates SSB and under-estimates fishing mortality in the terminal year of the assessment. Failure to take this pattern into account when developing a rebuilding strategy and setting catch levels may lead to an optimistic end date for rebuilding that will not be realized. This in turn could lead to restrictive catch limits in the future as the stock falls behind the rebuilding program and the end date approaches. The PDT is uncertain if IFACA would allow a modification of the rebuilding plan in such a situation.

b. Reference points are only re-estimated at benchmark assessments. Estimates of SSB_{MSY} depend on assumptions about recruitment, maturity, weights at age, selectivity, etc. that can change over time. The TRAC report indicates that fishing at F_{MSY} will not achieve SSB_{MSY} because current values for many of these parameters differ from those used to establish the current reference point. It is not clear if the recent changes are temporary divergences that should not result in an adjustment to the biomass target or represent a change to prevailing conditions that should be reflected with a change in SSB_{MSY}. This is beyond the purview of the PDT so the existing reference point is used as the basis for the strategies identified.

5. The PDT investigated five possible rebuilding strategies. All strategies were evaluated using the median stock size/probability of success, consistent with the existing strategy. Catch streams and SSB_{MSY} trajectories for the strategies are shown in Figure 1. The Committee should decide which of these strategies it wishes to consider in the framework action, or should suggest other strategies for analysis.

a. F=0: This strategy would be expected to rebuild by 2017 if the retrospective pattern is not considered, 2018 if the pattern is considered. It is included here only to indicate that the current strategy is not likely to be achieved.

b.75%FMSY: The default ABC control rule would be expected to rebuild by 2021 if the retrospective pattern is not considered, 2023 if the pattern is considered.

c. F_{MSY}: F_{MSY} would not achieve the current SSB_{MSY}.

d. Largest F that achieves SSB_{MSY}: This mortality rate is 0.21. It is nearly identical to the mortality rate that will average a 10 percent growth in SSB from current stock size to SSB_{MSY} (0.209). This would be expected to rebuild by 2032 whether or not the retrospective pattern is considered.

e. Fishing mortality that will average a 10 percent annual growth in SSB. Results are similar to the strategy that is based on the largest F that will achieve SSB_{MSY}.

6. The net present values to the groundfish fishery of the catch streams from the strategies were evaluated (Table 1). Unlike previous NPV analyses this version accounted in part for changes in price that may result from increased landings. The results show relatively small differences among the alternatives to No Action. The F_{MSY} alternative provides the highest net present value (but does not achieve SSB_{MSY}). The differences between 75%FMSY and the largest mortality that achieves SSB_{MSY} are small. The analyses are described in more detail in attachment (b).

Table 1 – Net present value estimates for various rebuilding approaches

Terminal year	Discount rate	Value	F=0	75%Fmsy	TRAC_2011 Fmsy=0.25	Fto43200	F10%
		5% CI	*159.9*	*178.9*	*198.5*	*188.5*	*188.1*
2032	3%	*Mean*	**199.3**	**221.6**	**246.4**	**233.4**	**233.0**
		95% CI	*230.9*	*257.2*	*285.7*	*270.9*	*270.4*
			F=0	**75%Fmsy**	**Rho ADJUSTED Fmsy=0.25**	**Fto43200**	**F10%**
		5% CI	*144.0*	*160.6*	*177.3*	*165.4*	*166.1*
2032	3%	*Mean*	**179.4**	**198.6**	**219.7**	**205.0**	**205.8**
		95% CI	*207.9*	*230.6*	*255.0*	*237.9*	*238.9*

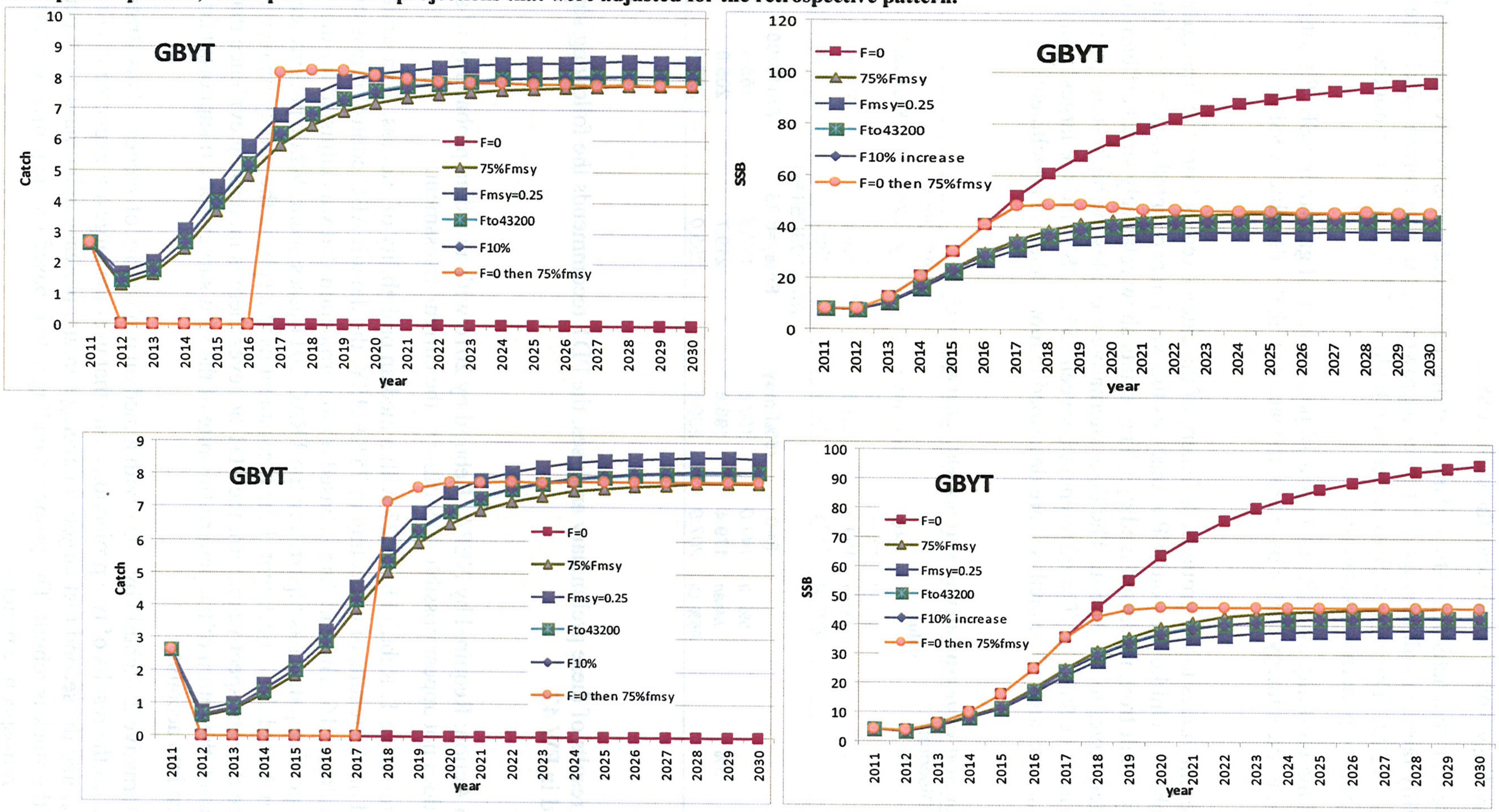
7. Given the results of these preliminary analyses, the PDT recommends the following strategies be considered in FW 47.

a. No Action: Required by NEPA. Rebuild by 2016 with a median probability of success. This does not appear possible according to the current assessment.

b. Alternative 1: Rebuild by 2023 with a median probability of success. This strategy is based on the results of projecting at 75%FMSY, the default ABC control rule adopted in Amendment 16. The end date is based on the projection that was adjusted for the retrospective pattern as reported in the TRAC 2011 assessment. While past projections have not used this adjustment if the assessment used a split in the survey time series to reduce the retrospective pattern, the PDT believes there is increasing evidence that for this stock the return of the pattern (in spite of the split survey series) supports taking this pattern into account.

c. Alternative 2: Rebuild by 2032 with a median probability of success. This strategy is based on the results of two projections: one that uses the largest F expected to achieve SSB_{MSY} and the second that targets an average annual increase in biomass of 10 percent until the stock is rebuilt. The proposed ending date is based on the projections that adjust for the retrospective pattern.

Figure 1 – Catch (left) and SSB (right) for GB yellowtail flounder rebuilding strategies. Upper panel is for projections that were not adjusted for the retrospective pattern; lower panel is from projections that were adjusted for the retrospective pattern.



8. Alternative 2 considers a strategy that under current conditions would allow use of a fishing mortality larger than authorized by the default ABC control rule. The Committee may want to consider the following issues when deciding whether to include this as an option in the framework.

a. IFACA was passed to foster coordinated management with Canada of stocks covered by the US/Canada Resources Sharing Understanding. Canada does not at present use biomass targets or formal rebuilding periods when managing its resources. The difference between U.S. and Canadian management regimes has at times complicated negotiations under the Understanding. A longer rebuilding period would take full advantage if IFACA and increase the likelihood that agreement on catch levels will be reached as the stock rebuilds.

b. Cooperative management of transboundary Georges Bank (GB) stocks with Canada, in accordance with the U.S./Canada Transboundary Resources Sharing Understanding (Understanding) results in unique considerations when developing a rebuilding plan for Georges Bank yellowtail flounder. On an annual basis, the U.S. members of the Transboundary Management Guidance Committee (TMGC) negotiate a shared catch level with Canadian members, based upon scientific information from the Transboundary Resources Assessment Committee (TRAC), and make a recommendation to the New England Fishery Management Council. The strategy for setting the shared TACs is to maintain a low to neutral risk of exceeding the fishing mortality rate that is sustainable on a rebuilt stock (Freference, aka, Fmsy). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. The Magnuson-Stevens Act requirement to rebuild stocks within a defined time period limits the flexibility of the U.S. in the range of harvest levels it may agree to with Canada. In contrast, Canadian law and the U.S./Canada Understanding provide flexibility with respect to how conservative a TAC may be set in order to promote stock rebuilding. The GB yellowtail flounder catch recommended is based upon the scientific information and in consideration of the requirements of the Northeast Multispecies Fishery Management Plan (FMP), Magnuson Act, and the International Fisheries Agreement Clarification Act (IFACA). The rebuilding plan of the FMP results in a maximum fishing mortality level that constrains the maximum level of catch that the U.S. can agree to. Although the IFACA enables a rebuilding period longer than 10 years, *and* allows the shared catch for GB yellowtail flounder to be inconsistent with the catch level required by the fishery management plan, this flexibility is conditional: overfishing must be ended immediately, the fishing mortality level ensures rebuilding within a time period for rebuilding that is specified, and catch levels are consistent with the understanding. The fact remains that the lower the rebuilding fishing mortality required under the rebuilding period is (as a result of a shorter rebuilding period or higher probability of rebuilding), the range of catch levels that the U.S. may consider is more narrow, and agreement with Canada may be more difficult. A longer rebuilding period would facilitate the continued success of the process of setting shared catch levels because it results in a higher required fishing mortality rate that in term provides more flexibility for negotiations. Without agreed upon harvest levels, the conservation and economic benefits of cooperative management will be lost and there will be increased uncertainty in the fishery. With each country independently setting catch levels for their regions, there would be a greater probability that combined U.S. and Canadian catch would exceed the appropriate science based catch level for the transboundary stock and undermine rebuilding progress. Alternatively, if the U.S. fishing industry were to unilaterally set relative low U.S. catch levels in order to compensate for anticipated Canadian catch and meet rebuilding objectives (for the whole stock), the U.S. fishing industry would be disadvantaged.

c. There are small (some might say imperceptible) increases in the net present value of the revenue stream that results from this alternative when compared to Alternative 1. As such, it could be argued this alternative better considers the needs of fishing communities.

d. Fishing at the maximum mortality that will rebuild is effectively the same as selecting the longest permissible rebuilding period. As such it may conflict with the M-S Act requirement to rebuild as quickly as possible. While IFACA says that this requirement should be interpreted consistent with the Understanding, it could be argued that this approach delays improvements in stock status. Given the uncertainty in the assessment, there may be an interest in making a more positive effort to rebuild the stock to levels that might improve recruitment and lead to higher catches, , especially considering the reemergence of a retrospective pattern in which biomass is overestimated and F is underestimated. Further, recent year classes have been well below average (2007 - 2009 year classes were among the poorest in the time series), and that recent recruitment levels have been below the long-term average since 2002 according to the most recent TRAC report.

d. Amendment 16 suggests that deviations from the fault control rule may be appropriate when scientific uncertainty can be accurately evaluated. The recent performance of this assessment suggests uncertainty is not well defined.

Accountability Measures

7. The PDT continued its development of AMs for windowpane flounders, ocean pout, halibut, and wolffish. As proposed, SNE/MA winter flounder would be allocated to the groundfish fishery and managed as are other stocks. Catches by sectors will be managed using a sub-ACL/quota as is the case for other allocated stocks, and common pool vessels will have their catches restricted through effort controls.

8. The Committee's chosen approach for developing AMs was to develop area restrictions that could be implemented to reduce catches of these species if ACLs are exceeded/approached. The area restrictions could take the form of closures or gear restrictions/requirements. A general outline for implementing this approach was developed by the PDT.

a. Where should the measures be applied – what area or areas are defined? The design of areas should consider the effectiveness of the proposed measure as well as the impacts of effort shifts after the measure is imposed.

b. Who should the restrictions apply to? This relates to the question of who is catching the stock that needs an AM. Restrictions on groundfish vessels may not be enough for an effective AM and sub-ACLs and AMs for other fisheries may need to be considered. Given the information presented in an earlier paragraph an AM for windowpane flounder or ocean pout might only be needed to reduce catches by large mesh otter trawls (and perhaps scallop dredges). For halibut and wolffish a broader range of gears need to be addressed and area closures, rather than area restrictions, may be necessary.

c. What restrictions should be applied in the areas? Areas could be closed or gear restrictions could be required. While there may be many alternatives for trawl vessels since there are several approved selective gears, in the case of sink gillnet and longline vessels closures may be the only option.

d. Should the measures be in-season or take effect the following fishing year? The National Standard Guidelines suggest in-season AMs if data are available as they are more likely to prevent overfishing before it occurs. But in-season AMs complicate planning for fishermen, increase monitoring requirements, and may lead to derby effects. AMs implemented in the following year reduce derby effects, simplify monitoring, and help facilitate planning by fishermen at the cost of a delayed reaction to an ACL overage.

Gears

9. When developing and evaluating AMs it is necessary to know what gears are catching the species. While assessments usually estimate landings and discards by gear, the GARM III assessments only have data through 2007. The recently completed three-year report for the SBRM provides estimates of catches of these species (not stock specific) by fishing mode for the last three SBRM reporting years (2008/2009/2010, July 1 – June 30). While not used in the assessments or for catch monitoring these estimates give a more recent overview of what commercial fishing modes are discarding these species. Fishing modes are not always specific to a single fishery (for example, large mesh otter trawls are used in both the groundfish and fluke fisheries). Since all of these species are groundfish, they should only be landed by groundfish fishing vessels. The plots provided in the report are attached (attachment (d)).

a. In the case of windowpane flounder, the majority of the catch is discarded and most discards are by large mesh otter trawl vessels. There are, however, relatively large proportions discarded by scallop dredge vessels (both limited access and general category) in some years. Preliminary catch information provided by NERO indicates that in FY 2010 the scallop dredge fishery caught over 300 mt of SNE/MA windowpane flounder. If this estimate is verified it means that the scallop dredge fishery accounted for roughly 70 percent of the total removals. The scallop fishery catches alone exceeded the FY 2010 ABC (237 mt) and nearly exceeded the OFL (317 mt). This is an issue that must be addressed because it will be nearly impossible for an AM that applies only to the groundfish fishery to account for catches of this magnitude. Even if a sub-ACL is not developed the removals will have to be considered when setting ACLs and may require accounting for a larger amount of management uncertainty.

b. Nearly all of the ocean pout catch is discarded, particularly in recent years, and over three-quarters of the discards are from large mesh otter trawl vessels. This suggests that gear restrictions could be used as an AM to reduce catch by the predominant gear catching this species. Other modes discarding ocean pout vary by year in the SBRM report, but account for 19-30 percent of recent discards. Upwards of 20 percent has been recently discarded by small mesh otter trawl vessels alone, with smaller amounts discarded by limited access scallop vessels and even vessels using longline gear.

c. Prior to SBRM year 2011, about half the wolffish that is caught was landed. Given the prohibition on landings that was implemented May 1, 2011, future catches should be due to discards. The modes discarding wolffish seem vary by year in the SBRM report, probably due to low encounter rates. Discards are primarily by large mesh otter trawls but there are significant discards by sink gillnet, longline, and on occasion scallop dredge vessels. . This indicates that area closures, rather than gear restrictions, would be more effective at reducing catch of this species, particularly considering that there are no gear modifications that currently exist for gillnets, longlines, or scallop dredges that are designed to reduce the bycatch of wolffish.

d. About half the catches of halibut are discarded, primarily by large mesh otter trawl vessels with a small portion discarded by sink gillnet vessels, gear that is predominantly used by the groundfish fishery. This suggests that an AM affecting only the groundfish fishery may be sufficient to address potential overages of the halibut ACL. Given Maine's small longline fishery for halibut, the absence of discards by longline vessels may be an artifact of a lack of observer coverage in this particular state fishery. Therefore, any AM developed as part of FW 47 for federal fisheries may be slightly less effective than expected.

Defining AM Areas

10. Designing area-based restrictions for species that are typically discarded is a daunting task. The PDT pursued two different types of analyses to identify areas. Observer reports were the main data source used by the PDT to tackle this task and to date only windowpane flounder and ocean pout have been addressed. The analytic approach for these two stocks is reported here for the Committee's information. The basic approach is still under development and the PDT has plans for additional work to improve the method. The analyses are briefly described below and preliminary results are provided to give the Committee a sense of what the final results may look like.

11. GIS identification of discard hotspots: All data in this analysis were from years CY 2008 - 2010 and were pooled. Observed large-mesh otter trawl discards of windowpane flounder and ocean pout were binned by ten-minute square, and the ratio of discards to total kept were calculated for each square, giving a d/kall ratio for each square with observed tows. Reported total landings for large mesh otter trawls were binned by ten-minute square. The estimated discards from each square were calculated as the product of the landings times the d/kall. Using geo-statistical techniques, the ten-minute squares with discards that are hot spots were identified. Hot spots are ten-minute squares with discards that are large both in relation to the area as a whole and in relation to nearby squares. This approach places a high reliance on the accuracy of catch locations as recorded in the landings (dealer) database and the PDT urges caution in its

interpretation. Because of these errors the Committee should not overemphasize the precision of the locations – they should be considered indicators of general areas rather than precise blocks. Preliminary results for windowpane flounder and ocean pout are shown in attachment (e), which provides additional details on the analysis. Further work on this approach will include:

- Bin the data at a larger scale (e.g. 30-minute squares) due to concerns over accuracy of the reported catch locations.
- Since hot spots were identified by comparison to all observed data, but AMs will be assigned by stock area, rerun the analyses on a stock-by-stock basis to see if this affects results.

12. A second approach applied regression tree analyses to the same data set. In simple terms this analysis examines whether there are differences in a response variable that are due to latitude and longitude. Response variables that were examined included the presence or absence of windowpane flounder in observed tows as well as the log-transformed discards per tow. The method and results are described in detail in attachment (f). While the spatial resolution of this method is at a larger area than the GIS method, it identifies similar areas for high windowpane flounder discards.

Example AM for Windowpane Flounder Stocks

13. To give an example how the process described in paragraph 8 could be applied, the PDT developed an example AM for windowpane flounder stocks (see attachment (c)). This example is intended to foster discussion between the PDT and the Committee on how to proceed with development of these options. The example focuses on large mesh otter trawl gear as that gear discards most of the windowpane flounder. Actual AMs for these two stocks may need to consider other gears as well. The areas shown are based solely on windowpane flounder; it may be possible to identify different areas that can be used for several stocks rather than have specific areas for each stock.

Other Issues

14. The PDT briefly discussed the ABC/ACL process for FY 2012 – 2014. NERO is evaluating all catches of groundfish for FY 2010 to determine if ACLs were exceeded. Initial reports are that the total ACLs may have been exceeded for Northern and Southern windowpane flounder. It is also possible that while the total ACL for a stock may not have been exceeded, a sub-component may have been exceeded. Final results of this evaluation are not expected until September. The results may suggest that changes are needed in the distribution of the ABCs. These could be relatively minor (such as shifting small amounts of the ABCs between existing sub-ACLs or sub-components, or adjusting management uncertainty quantities), or could be complicated (such as specifying a scallop fishery sub-ACL for southern windowpane flounder and implementing a scallop fishery AM for that stock). There may be little time to consider such issues between the data release date and the November Council meeting.

Attachments

a. PDT conference call participation
b. Net present value for GB yellowtail flounder rebuilding strategies
c. Example AM for windowpane flounder stocks
d. Figures extracted from SBRM
e. GIS hotspot analysis
f. Regression tree analysis of windowpane flounder discards

Attachment (a)
Groundfish PDT Conference Call Participation

	July 11, 2011	August 3, 2011
Tom Nies	X	X
Anne Hawkins	X	X
Tom Warren	X	X
Doug Christel		X
Sarah Heil	X	X
Melissa Vasquez	X	X
Dan Caless		X
Kohl Kanwit		
Steve Correia	X	X
Chad Demarest	X	X
Paul Nitschke	X	X
Sally Roman	X	

Attachment (b)
Net Present Value for GB Yellowtail Flounder rebuilding Strategies

Comparison of alternative benefit streams over time requires discounting future benefits to convert all benefit streams to a present value. For this purpose, a discount rate of 3% was selected as recommended by NOAA to reflect the social rate of time preference (NOAA 1999). Net present values are calculated through 2032, the approximate terminal rebuilding date for the longest-recovery duration option.

The NPV analysis translates the potential landing streams into future revenues, discounted as appropriate, by applying an average price to the potential Georges Bank yellowtail flounder landings. To calculate this average price, a Monte Carlo approach was used. Because fish prices are elastic--that is, price varies with quantity--a range of potential prices was generated using the average monthly yellowtail flounder prices from 1996-2010 based on NMFS dealer data (Figure 2). From this range of prices one value is randomly drawn for each iteration of a given quantity and year, with the following decision rule: if the quantity is above 4K mt's, the price is randomly drawn from the bottom half of the observed price distribution; if the catch is below 4K mt's the price is drawn from the top half of the distribution. Results are based on 500 random draws and the mean value and 5% and 95% confidence intervals are reported.

Of the analyzed rebuilding approaches, the Fmsy strategy provides the highest landed net present value based on this analysis. However, this strategy fails to achieve the biomass rebuilding target. Of the approaches analyzed that achieve the biomass rebuilding target, both the F_43200 and F_10% strategies provide the highest NPV, roughly $233 million ($205 million under the Rho-adjusted approaches) in 2032. This is approximately 5% higher than the NPV of the default control rule (75%Fmsy) approach for both the non-Rho and Rho-adjusted options.

Figure 2 – Price and quantity relationship for yellowtail flounder, 1996-2010 (NMFS dealer data)

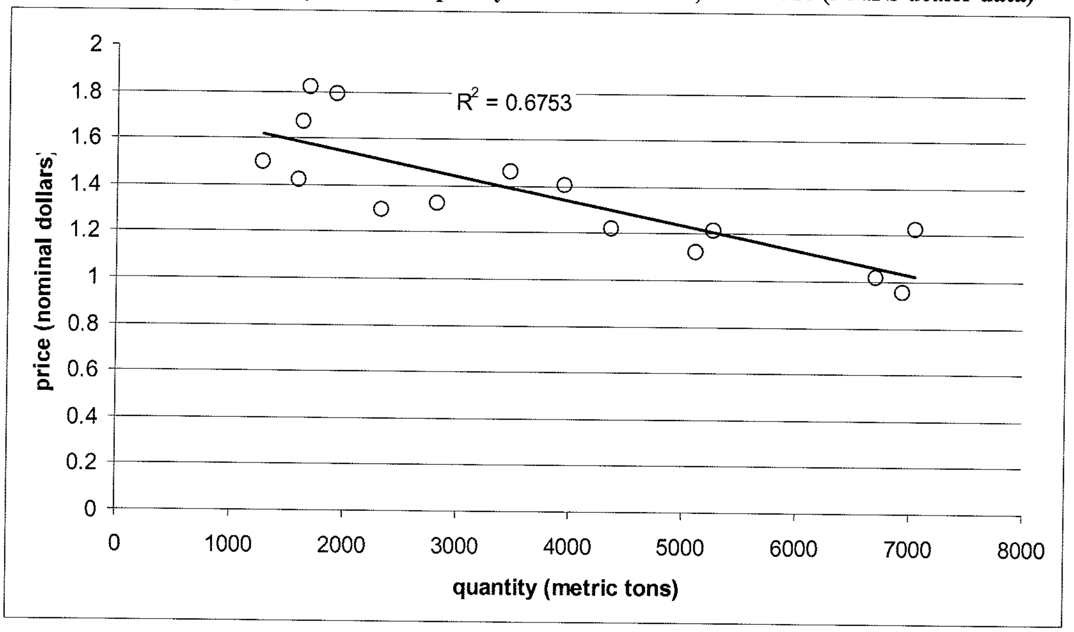
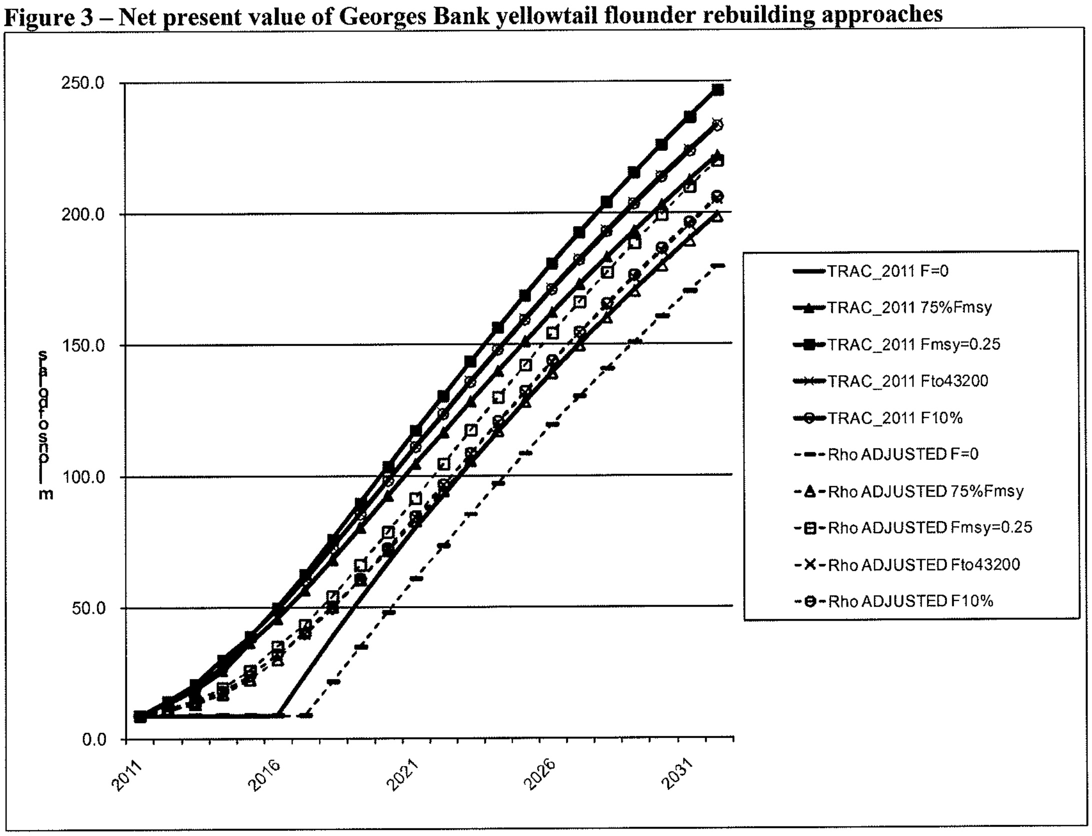


Table 2 – Net present value estimates for various rebuilding approaches

Terminal year	Discount rate	Value	F=0	75%Fmsy	TRAC_2011 Fmsy=0.25	Fto43200	F10%
		5% CI	*159.9*	*178.9*	*198.5*	*188.5*	*188.1*
2032	3%	*Mean*	**199.3**	**221.6**	**246.4**	**233.4**	**233.0**
		95% CI	*230.9*	*257.2*	*285.7*	*270.9*	*270.4*
					Rho ADJUSTED		
			F=0	**75%Fmsy**	**Fmsy=0.25**	**Fto43200**	**F10%**
		5% CI	*144.0*	*160.6*	*177.3*	*165.4*	*166.1*
2032	3%	*Mean*	**179.4**	**198.6**	**219.7**	**205.0**	**205.8**
		95% CI	*207.9*	*230.6*	*255.0*	*237.9*	*238.9*

Figure 3 – Net present value of Georges Bank yellowtail flounder rebuilding approaches



Attachment (c)
Example Accountability Measure for Windowpane Flounder Stocks
(for discussion only)

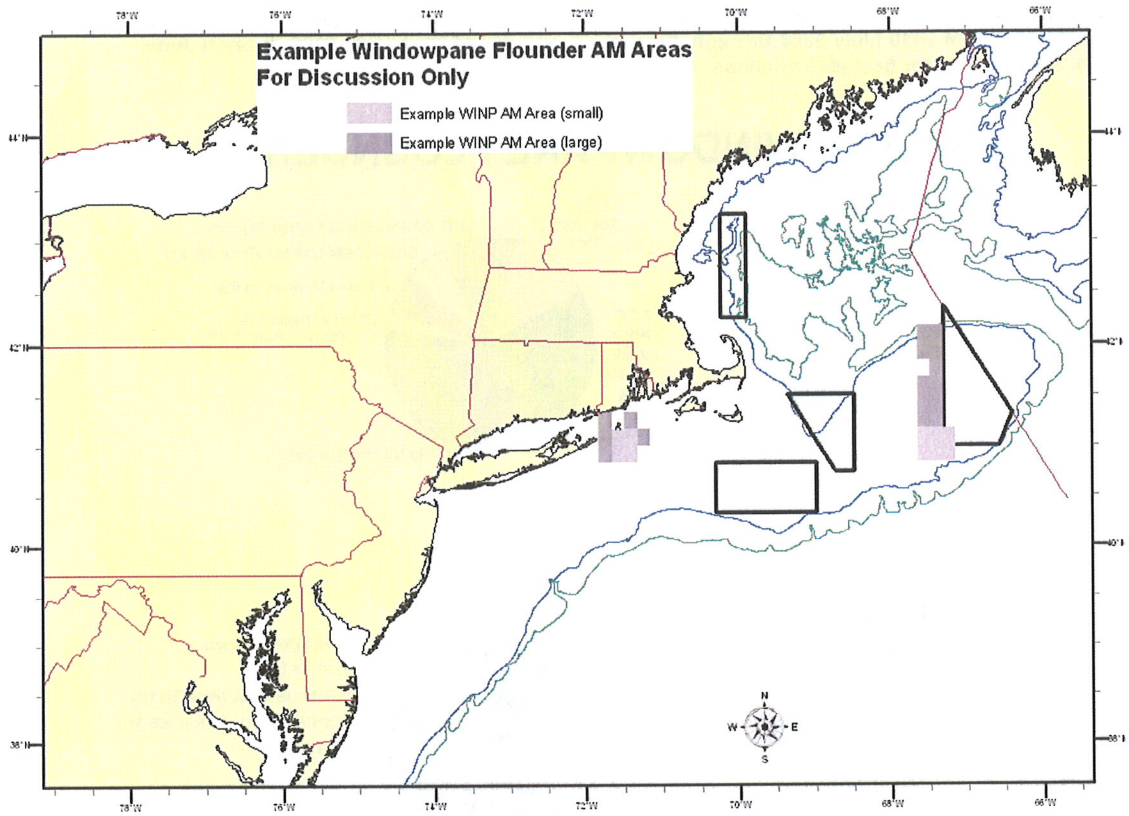
If the ACL for a windowpane flounder stock is exceeded, gear restrictions will be implemented in defined areas in the following year to prevent overfishing. The restrictions will apply to trawl vessels on groundfish trips.

Gear: If the AM is implemented trawl vessels must use an approved selective trawl gear that reduces the catch of flounders. Approved gears include the separator trawl, Ruhle trawl, mini-Ruhle trawl, rope trawl, and other gear authorized by the Council in a management action or approved for use consistent with the process defined in 50 CFR 648.85 (b)(6). There are no restrictions on longline or gillnet gear.

Areas: The applicable areas where gear restrictions will apply are shown in Figure XXX. The areas are designed to be stock specific – the areas on GB are implemented only if the ACL for northern windowpane flounder is exceeded; the areas in SNE are implemented only if the southern windowpane flounder ACL is exceeded. The size of the areas for the restrictions is based on the amount of the overage. In each case the smaller area is implemented for overages of five percent to 20 percent; both the smaller and larger areas area implemented for overages of more than 20 percent.

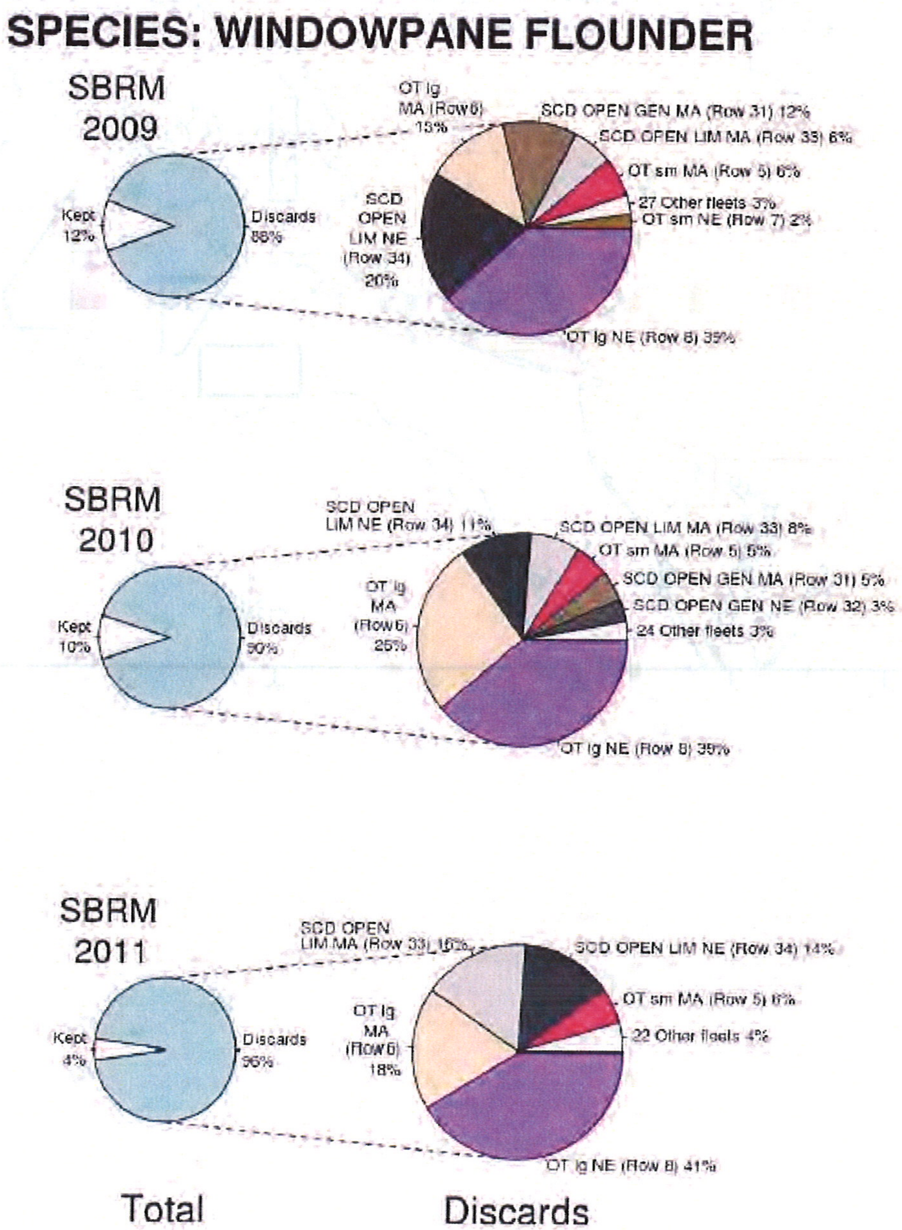
Timing: An overage in year 1 will lead to implementation of the AM in year 2.

Figure 4 - Example AM areas for Northern and Southern Windowpane Flounder



Attachment (d) Figures extracted from SBRM

Figure 6B, continued. Percentage of Vessel Trip Report landings (kept) and estimated discards (Total, left pie) and the percentage of estimated discards by fleet (Discards, right pie) for individual species comprising the 14 SBRM species groups for SBRM 2009 (July 2007 through June 2008), SBRM 2010 (July 2008 through June 2009), and SBRM 2011 (July 2009 through June 2010). See Table 14 for fleet abbreviations.



338

Figure 6B, continued. Percentage of Vessel Trip Report landings (kept) and estimated discards (Total, left pie) and the percentage of estimated discards by fleet (Discards, right pie) for individual species comprising the 14 SBRM species groups for SBRM 2009 (July 2007 through June 2008), SBRM 2010 (July 2008 through June 2009), and SBRM 2011 (July 2009 through June 2010). See Table 14 for fleet abbreviations.

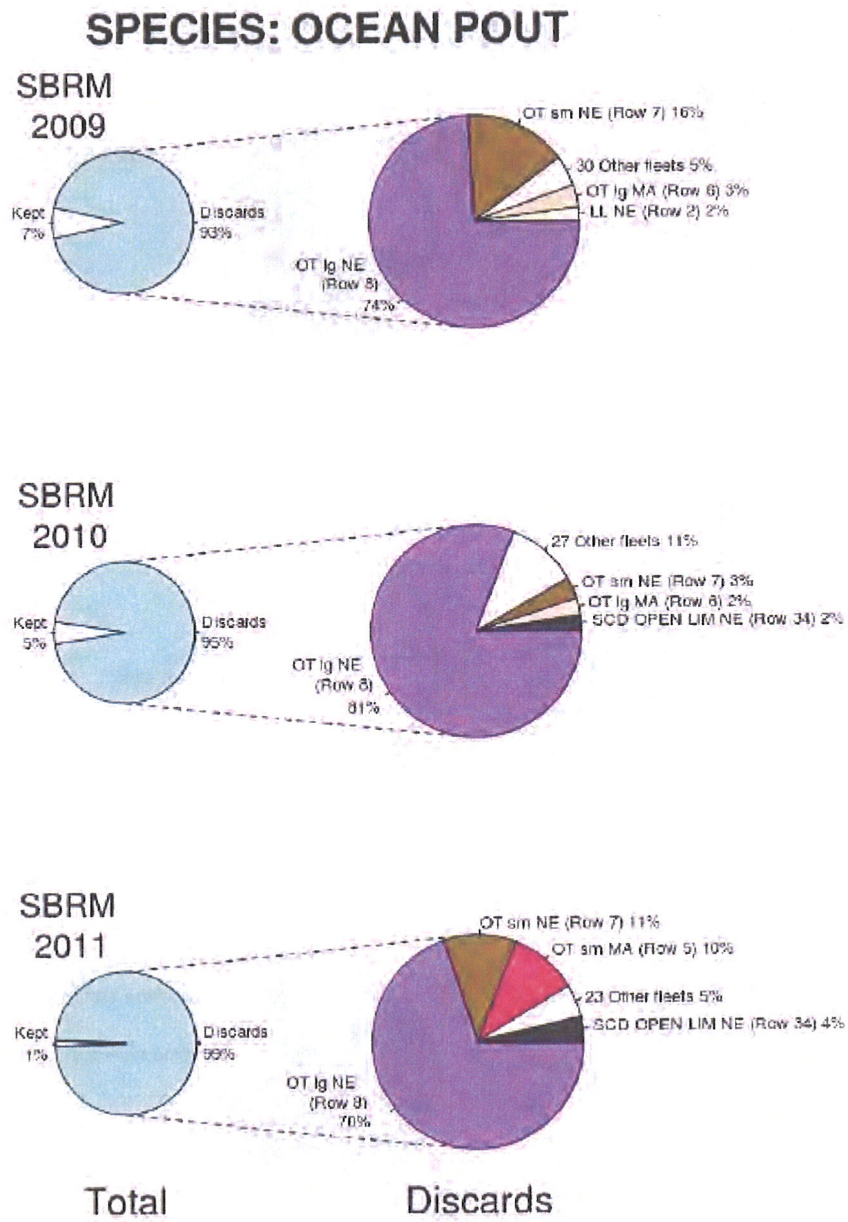
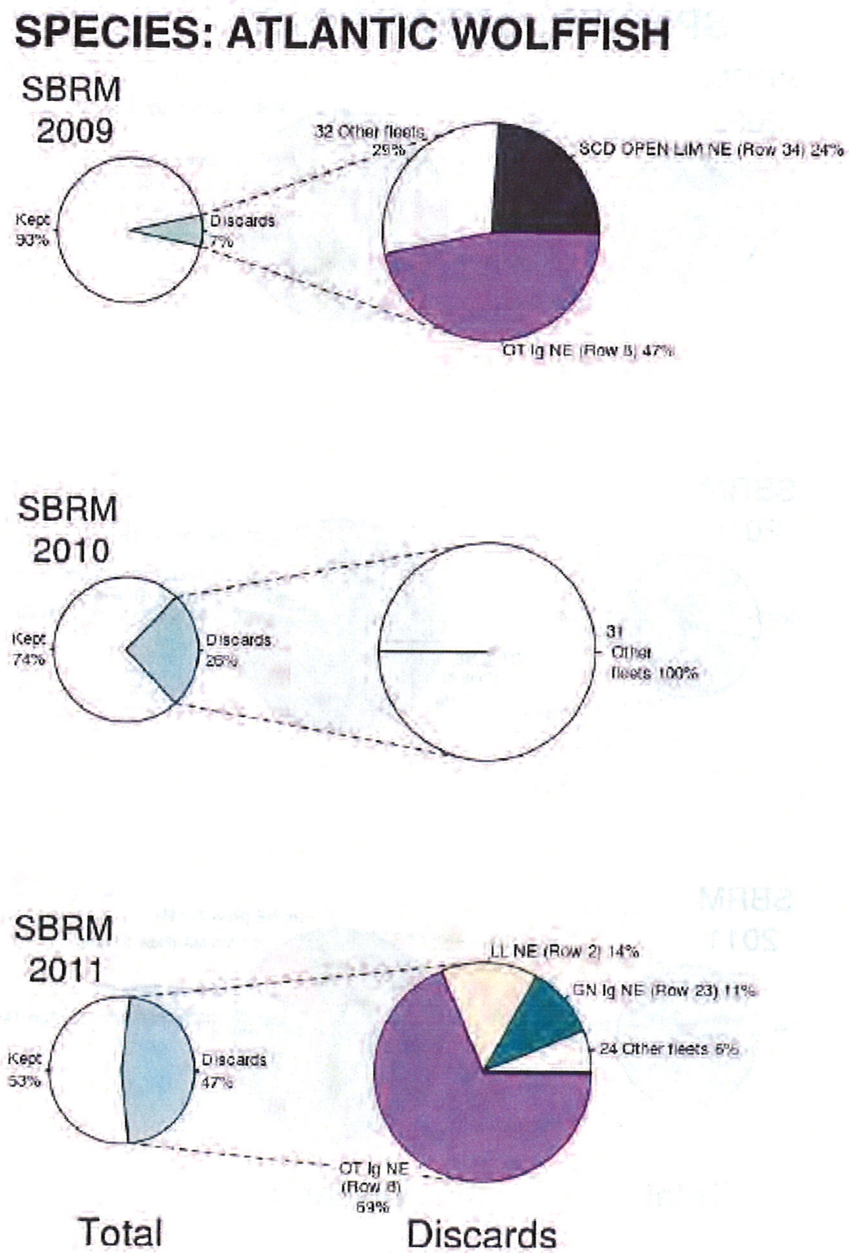
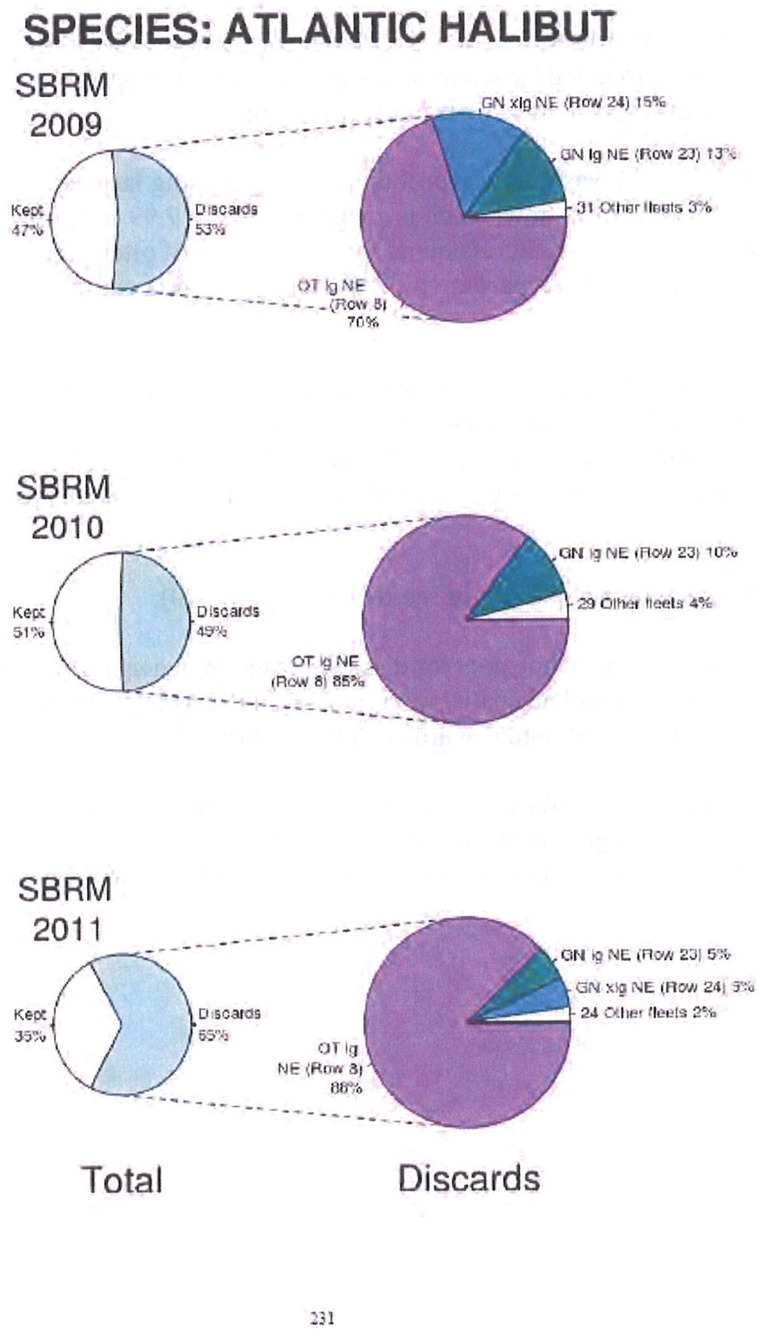


Figure 6B, continued. Percentage of Vessel Trip Report landings (kept) and estimated discards (Total, left pie) and the percentage of estimated discards by fleet (Discards, right pie) for individual species comprising the 14 SBRM species groups for SBRM 2009 (July 2007 through June 2008), SBRM 2010 (July 2008 through June 2009), and SBRM 2011 (July 2009 through June 2010). See Table 14 for fleet abbreviations.



332

Figure 6B, continued. Percentage of Vessel Trip Report landings (kept) and estimated discards (Total, left pie) and the percentage of estimated discards by fleet (Discards, right pie) for individual species comprising the 14 SBRM species groups for SBRM 2009 (July 2007 through June 2008), SBRM 2010 (July 2008 through June 2009), and SBRM 2011 (July 2009 through June 2010). See Table 14 for fleet abbreviations.



Attachment (e)
Overview of GIS Analysis for Discard Hotspots

Large mesh (>5.75 in. – 7.00 in)) bottom otter trawl (negear 050) tows were plotted for the years 2008 – 2010. They were aggregated by ten minute square. For each square, a d/kall ratio was calculated for windowpane, ocean pout, wolffish, and halibut.

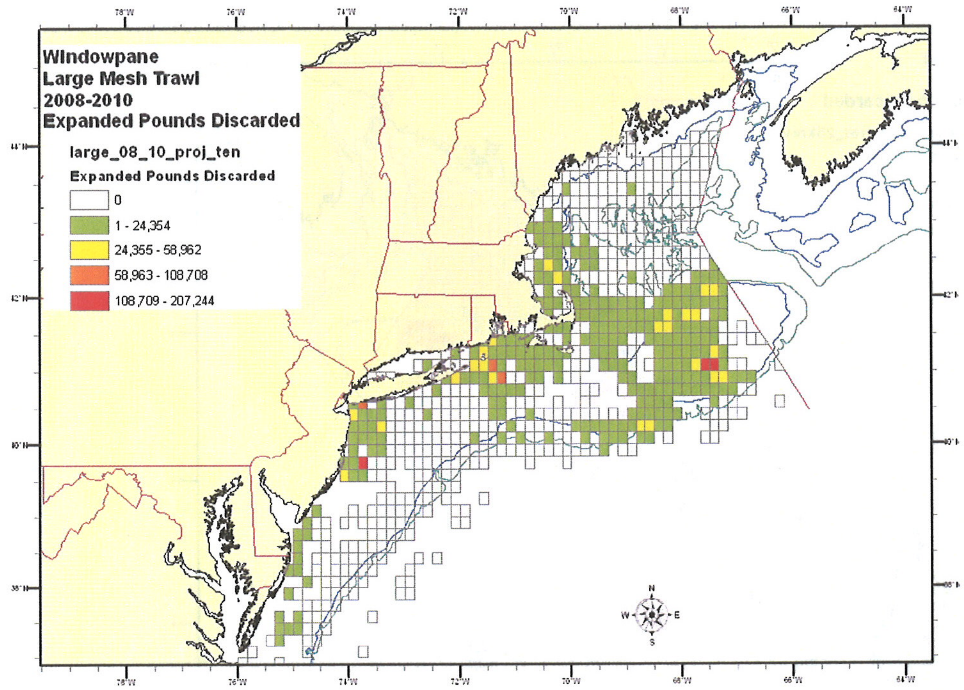
Dealer data (cfdettXXXXAA) was queried for total trip weight using large mesh otter trawls (> 5.75 in; less than 1 percent of otter trawl catch is caught by gear > 7.99 in.). Only trips with both a position and mesh size were used; this accounts for ~70 percent of otter trawl landed weight in each year during 2008 – 2010. The trips were plotted and then aggregated to ten-minute squares and merged with observer data.

For each ten minute square, the square's d/k was multiplied by the total landings from that square to get an estimate of expanded discards from that square. The total discards were compared to available estimates from the NEFSC to see if they were consistent – they tend to be roughly 30- 35 pct low, which makes sense since about 25-30 pct of the landings cannot be plotted.

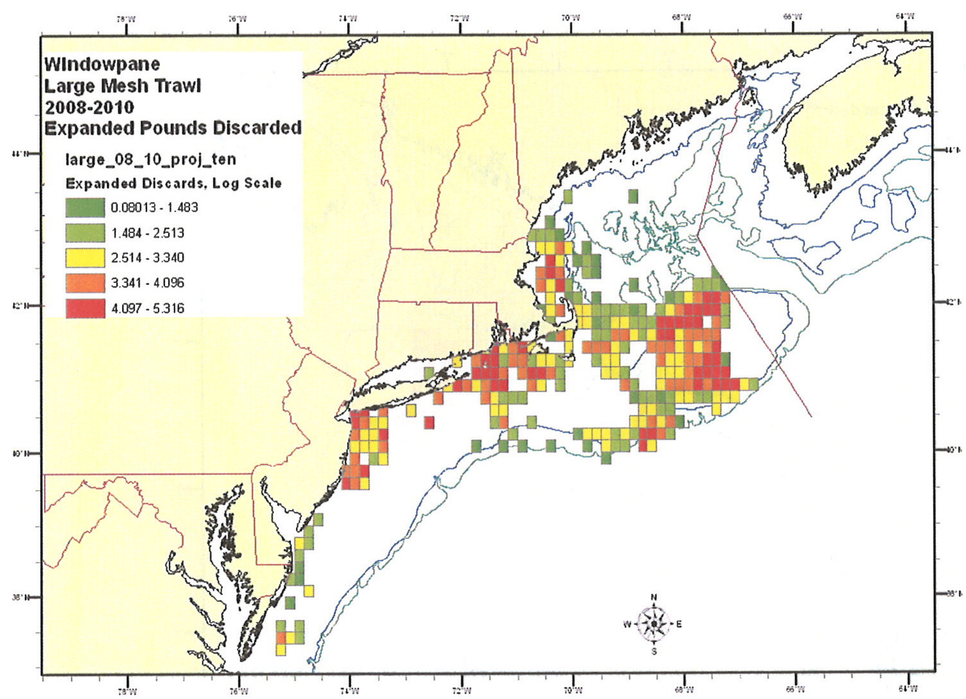
The discard estimate was transformed (log(discard+1)) (log base 10).

Getis Ord Gi* was used to identify hotspots for discards based on a neighborhood of 25000 m, fixed distance. This tests for complete spatial randomness; high-z (hot) areas identify areas that are highly correlated and represent high discards in a neighborhood of high discards.

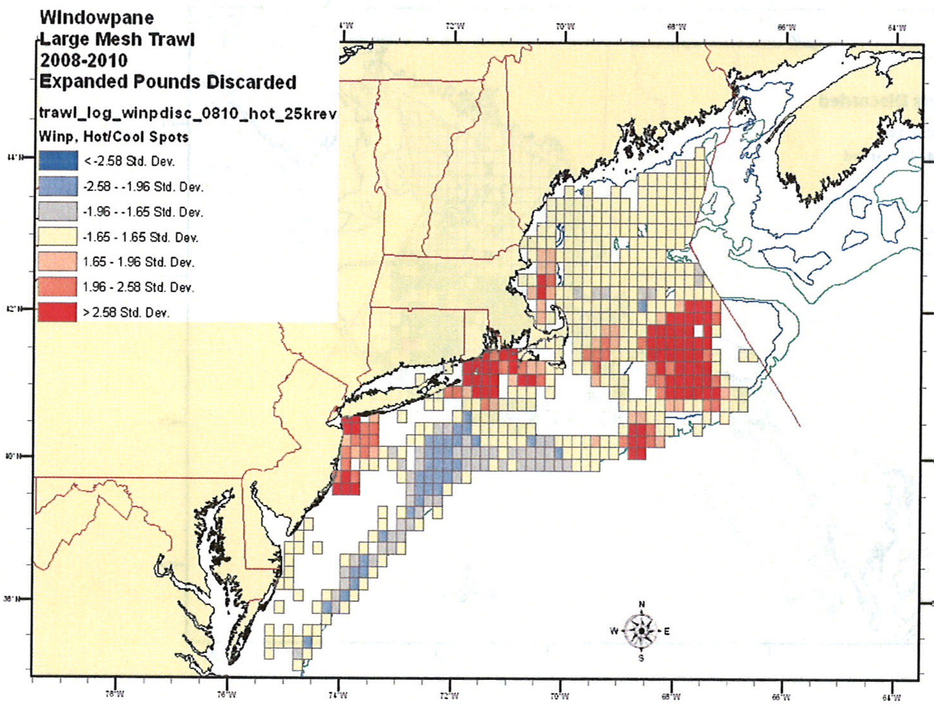
Up to this point, no modifications/allowances were made for number of observed tows in a square. So Getis Ord Gi* was again to see if the results change when ten-minute squares with few observed tows (minimum of 10 observed tows) are dropped from the analysis.



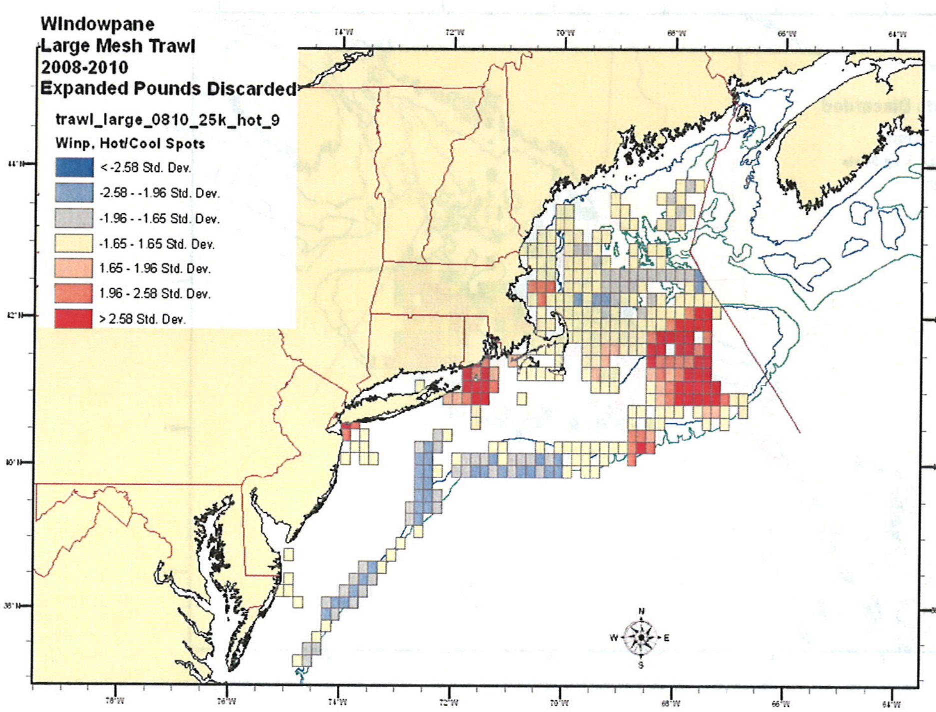
Windowpane
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
large_08_10_proj_ten
Expanded Pounds Discarded
0
1 - 24,354
24,355 - 58,962
58,963 - 108,708
108,709 - 207,244



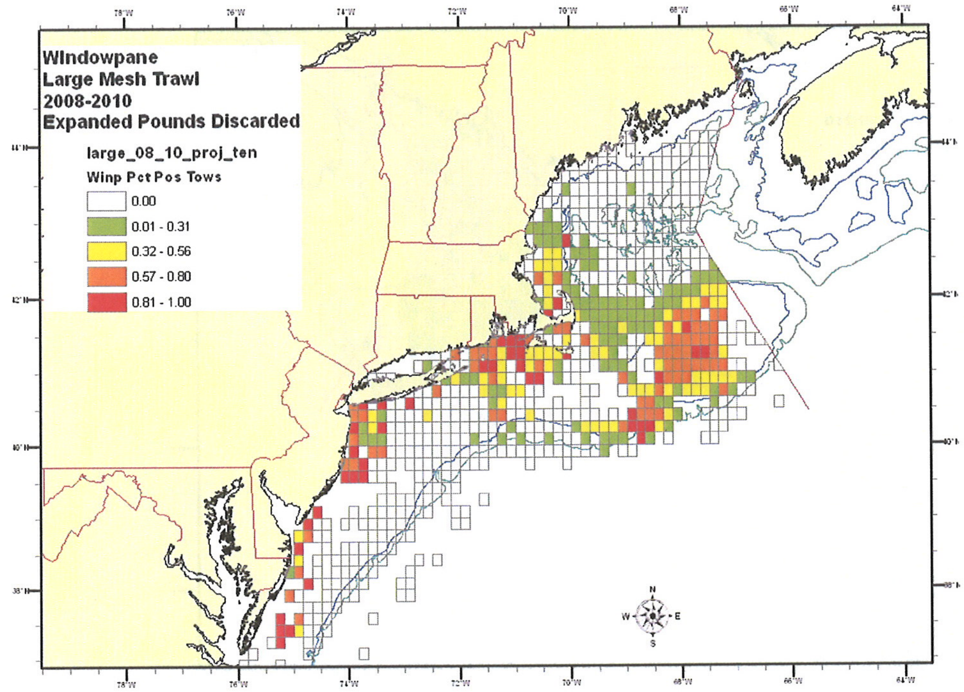
Windowpane
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
large_08_10_proj_ten
Expanded Discards, Log Scale
0.08013 - 1.483
1.484 - 2.513
2.514 - 3.340
3.341 - 4.096
4.097 - 5.316

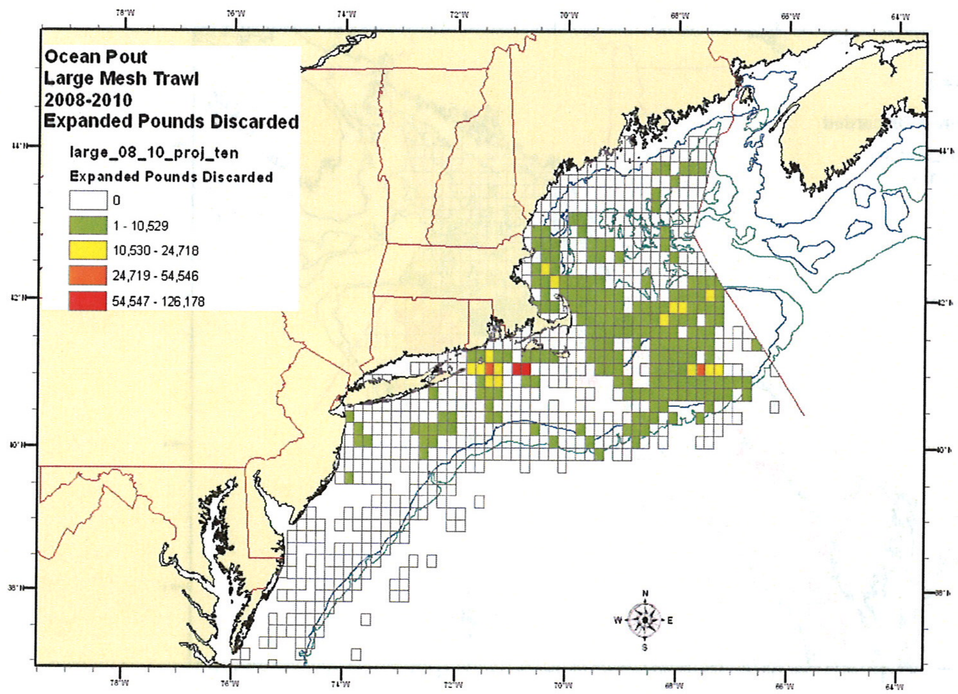


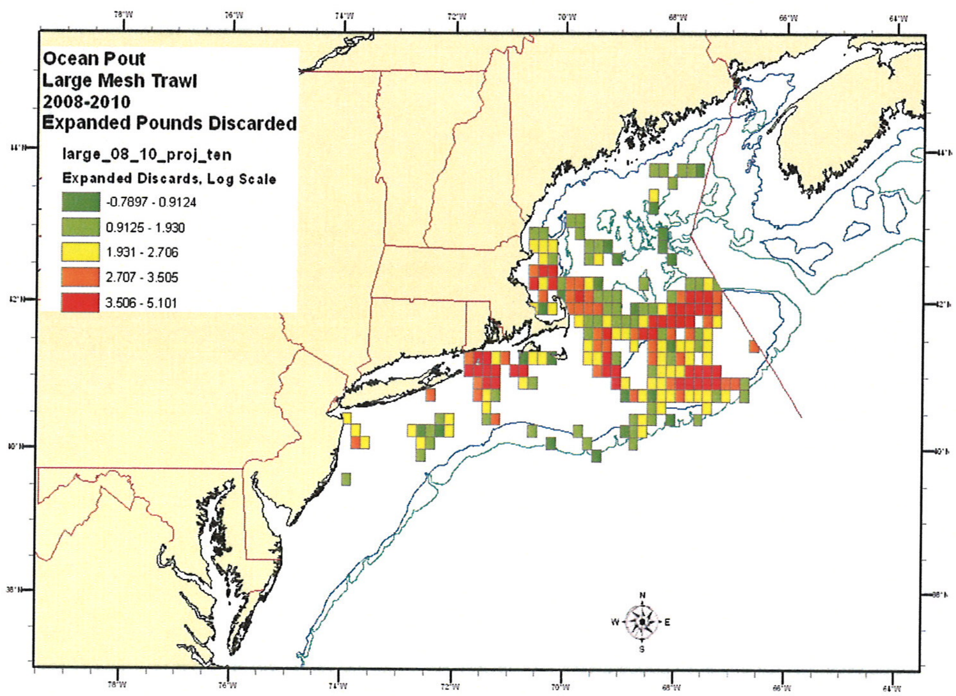
Windowpane
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
trawl_log_winpdisc_0810_hot_25krev
Winp, Hot/Cool Spots
< -2.58 Std. Dev.
-2.58 - -1.96 Std. Dev.
-1.96 - -1.65 Std. Dev.
-1.65 - 1.65 Std. Dev.
1.65 - 1.96 Std. Dev.
1.96 - 2.58 Std. Dev.
> 2.58 Std. Dev.

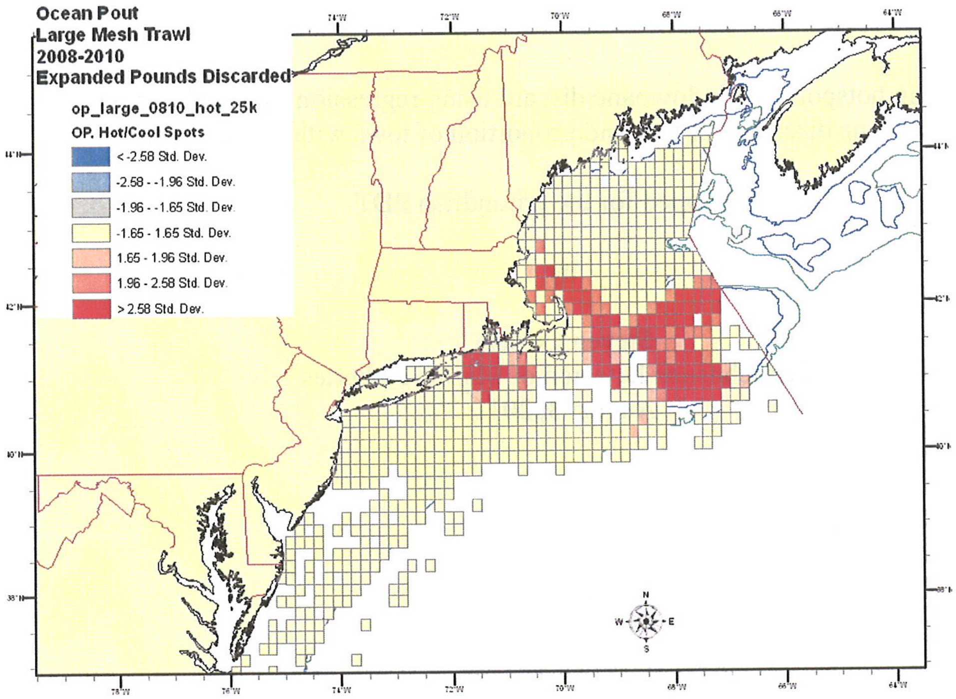


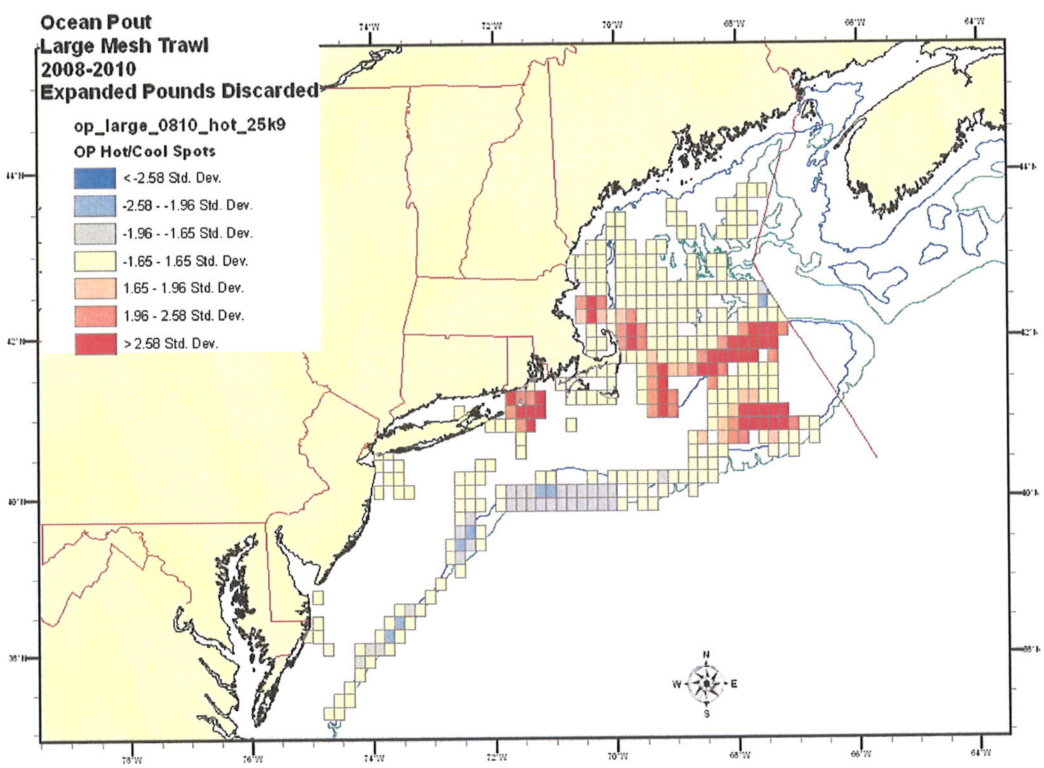
Windowpane
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
trawl_large_0810_25k_hot_9
Winp, Hot/Cool Spots
< -2.58 Std. Dev.
-2.58 - -1.96 Std. Dev.
-1.96 - -1.65 Std. Dev.
-1.65 - 1.65 Std. Dev.
1.65 - 1.96 Std. Dev.
1.96 - 2.58 Std. Dev.
> 2.58 Std. Dev.


Windowpane
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
large_08_10_proj_ten
Winp Pct Pos Tows
0.00
0.01 - 0.31
0.32 - 0.56
0.57 - 0.80
0.81 - 1.00
N
W
E
S


Ocean Pout
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
large_08_10_proj_ten
Expanded Pounds Discarded
0
1 - 10,529
10,530 - 24,718
24,719 - 54,546
54,547 - 126,178
N
W
E
S


Ocean Pout
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
large_08_10_proj_ten
Expanded Discards, Log Scale
-0.7897 - 0.9124
0.9125 - 1.930
1.931 - 2.706
2.707 - 3.505
3.506 - 5.101
N
W
E
S


Ocean Pout
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
op_large_0810_hot_25k
OP. Hot/Cool Spots
< -2.58 Std. Dev.
-2.58 - -1.96 Std. Dev.
-1.96 - -1.65 Std. Dev.
-1.65 - 1.65 Std. Dev.
1.65 - 1.96 Std. Dev.
1.96 - 2.58 Std. Dev.
> 2.58 Std. Dev.
N
W
E
S


Ocean Pout
Large Mesh Trawl
2008-2010
Expanded Pounds Discarded
op_large_0810_hot_25k9
OP Hot/Cool Spots
< -2.58 Std. Dev.
-2.58 - -1.96 Std. Dev.
-1.96 - -1.65 Std. Dev.
-1.65 - 1.65 Std. Dev.
1.65 - 1.96 Std. Dev.
1.96 - 2.58 Std. Dev.
> 2.58 Std. Dev.
N
W
E
S

Attachment (g)

Identifying hotspots of windowpane discard using regression tree analyses on windowpane discards per tow and proportion of tows with windowpane

Developed for the groundfish PDT

by

Steven Correia
Massachusetts Division of Marine Fisheries
August 3, 2011

Introduction
I used regression trees to identify geographic areas with high and low proportion of tows with windowpane. I also modeled log10 discards of windowpane per tow using tree regression. Tom Nies provided the dataset of observed tows used in his spatial statistics analysis. I based the analysis on observed tows and results were not expanded by total effort. Total discards per tow were estimated by multiplying the discard rate (discard (species)/ (kept all) by the kept hailweight. Tow observations were treated as independent, that is the correlation of tows within trips was ignored. All analyses were completed on at tow level, and the distribution of observed effort or fleet effort was not taken into account in this analysis.

Regression tree models work by a binary recursive partitioning of the predictor variables in order to minimize the variance of the response variable within each split and maximize the difference in means of the response variable between the two splits. The use of latitude and negative longitude as variables results in the creation of rectangles that maximize among area variation in discards.

Proportion of tows with windowpane.
Tows were coded as having windowpane (1) or no windowpane(0). The overall proportion of tows with windowpane over the entire study area was 0.30. The proportion of tows with windowpane is plotted against latitude and negative longitude (Figure 2 and Figure 3). The plot suggests that the highest proportion of positive tows with windowpane occur between 41 and 42 degrees north latitude and west of 70 degrees longitude and east of 69 degrees longitude.

I applied a regression tree to the presence/ absence of windowpane in observed tow with negative longitude and latitude as predictor variables. The full tree was pruned using 10-fold cross-validation (90% used for training set, and 10% used for testing) and a complexity parameter chosen using the 1 standard deviation rule on the average error from cross-validation. The pruned tree is shown in Figure 3 and explains 29.9% of the deviance. Fitted proportions were derived using an area grid defined by latitude 35.5 to 44.3 in 0.1 degree increments and longitude (-75.7 to -63.6, in 0.1 degree increments. Note that portions of this area do not contain observed trips.
The fitted proportion positive tows are shown as a level plot in Figure 4. Tow locations are shown in Figure 5. Areas with relatively high proportion of tows with windowpane are western Georges Bank, Southern New England near Long Island and the Nantucket Light ship area and inshore western Gulf of Maine.

Catch of windowpane weight per tow
Windowpane are generally caught in small quantities, and 75% of tows with windowpane discards are 38 lb or less. However, the distribution is highly skewed right and tows with large amount of windowpane occur but are relatively rare. For example, the 90th quantile is 94 lb, the 99th quantile is 363, and the 99.9th quantile is 1,018 lb. Boxplots of the windowpane catch by bins of latitude and longitude are shown in Figure 6 and Figure 7.

The large contrast in the median or interquartile range is not apparent among the bins of either latitude or longitude. Bins with larger number of observations do tend to have more observations on the right tails (larger discards) than bins with fewer observations. I used a regression tree to log10 windowpane discards using the same method applied to the proportion of tows. This analysis included tows with zero observations. The pruned tree is shown in Figure 8 and explains 29.9% of the deviance. Fitted discards were derived using gridded area defined by latitude 35.5 to 44.3 in 0.1 degree increments and longitude (-75.7 to -63.6, in 0.1 degree increments. Note that portions of this area do not contain observed trips. An attempt to fit a regression tree to only tows with windowpane was unsuccessful, likely a result of lack of contrast in the observations.

The back-transformed fitted discards per tow are shown as level plots in Figure 9. Tow locations are shown in Figure 5. Results are similar to areas identified with proportions. Given the lack of contrast in distribution of discards in the positive tows and skewness in the distribution, the proportion of zero tows is having a large influence on the analysis. The fitted values are highest off Long Island (7.0 lb per tow) and Southern Georges (5.7 lb per tow) and Georges Bank (3.7).

Transformed Fitted values Log10 (discards +1) lb	Back-transformed geometric mean (lb)	Bias-corrected back transformed estimate of arithmetic mean (lb)	Observed Mean (lb)	Observed Standard Deviation
0.0418	0.1	2.5	0.7	9.2
0.1097	0.3	3.1	3.1	22.9
0.2097	0.6	4.1	4.6	24.8
0.2669	0.8	4.8	6.3	28.3
0.4438	1.8	7.8	7.6	25.5
0.6765	3.7	14.0	19.7	57.2
0.8247	5.7	20.1	36.1	117.6
0.9023	7.0	24.3	31.2	61.9

Table 1. Predicted estimates (log10 lb), back-transformed (lb), bias-corrected back transformed (lb), and observed mean (lb) for terminal nodes from pruned tree.

Comparison with spatial statistics analysis.

These areas identified as high and low discards generally correspond to area's identified Tom Nies's high-low clustering analysis using Getis-Ord G statistics.

Implications for using area management as an accountability measure.

The regression tree analyses identified areas with high and low proportion of tows with windowpane and also areas with high and low discard per tow. These results would need to be scaled by expected effort in order to be useful for defining areas to use as accountability measure. Additionally, the effects of redistributing effort to non- AM on windowpane discards needs consideration. The lack of contrast in the distribution of discarded windowpane suggests that areas may need to be larger rather than smaller to reduce windowpane discards and may reduce the economic yield from other groundfish species.

Attachment (g)

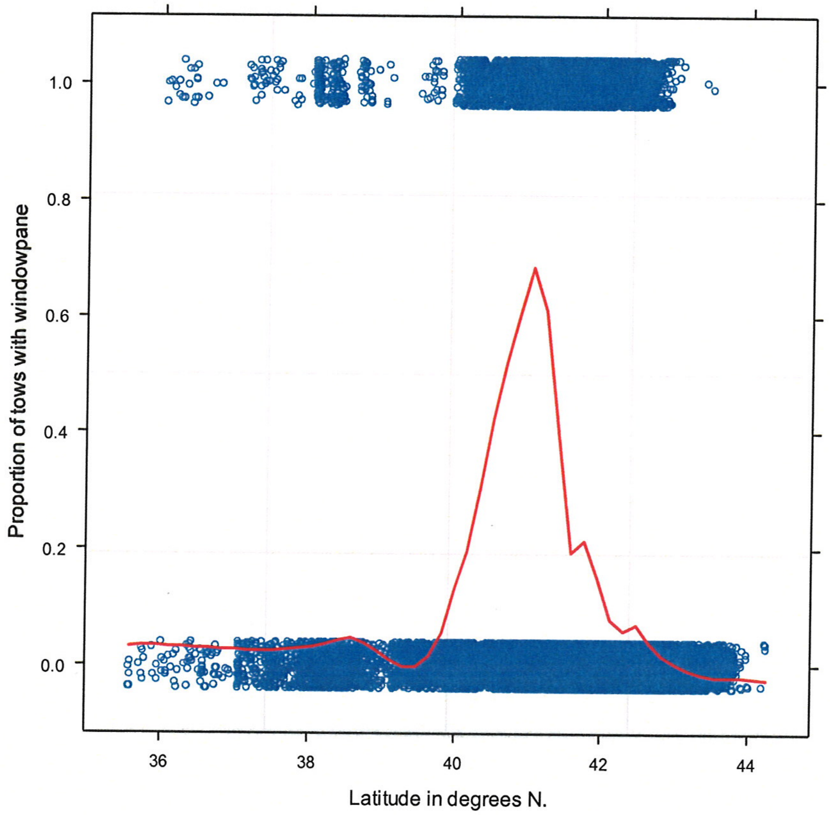


Figure 1. Proportion of tows with windowpane against beginning latidue.. Red line is loess with span=0.2 and degree=1 and represents proportion positive tows. Blue dots are jittered presence (1)/ absence (0) of windowpane in tows.

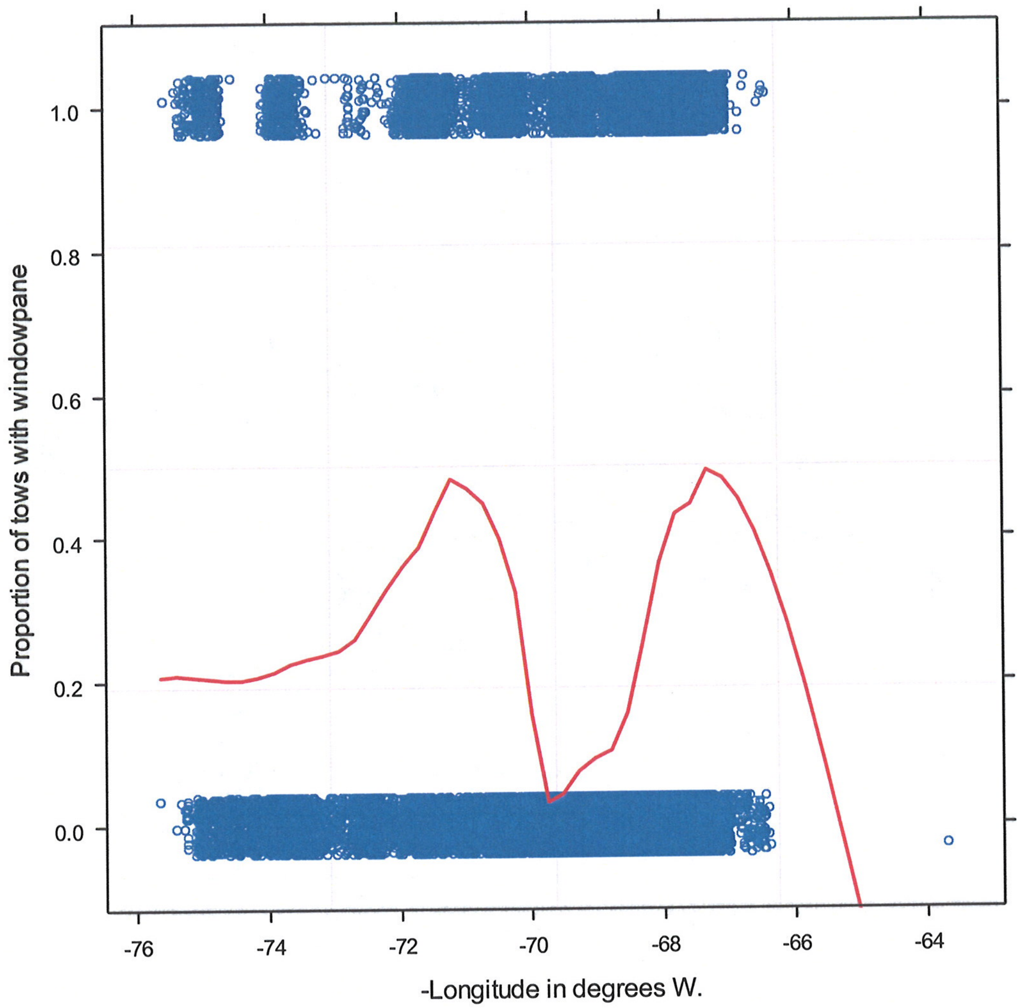


Figure 2. Proportion of tows with windowpane against beginning longitude. Red line is loess with span=0.2 and degree=1 and represents proportion positive tows. Blue dots are jittered presence (1)/ absence (0) of windowpane.

Attachment (g)

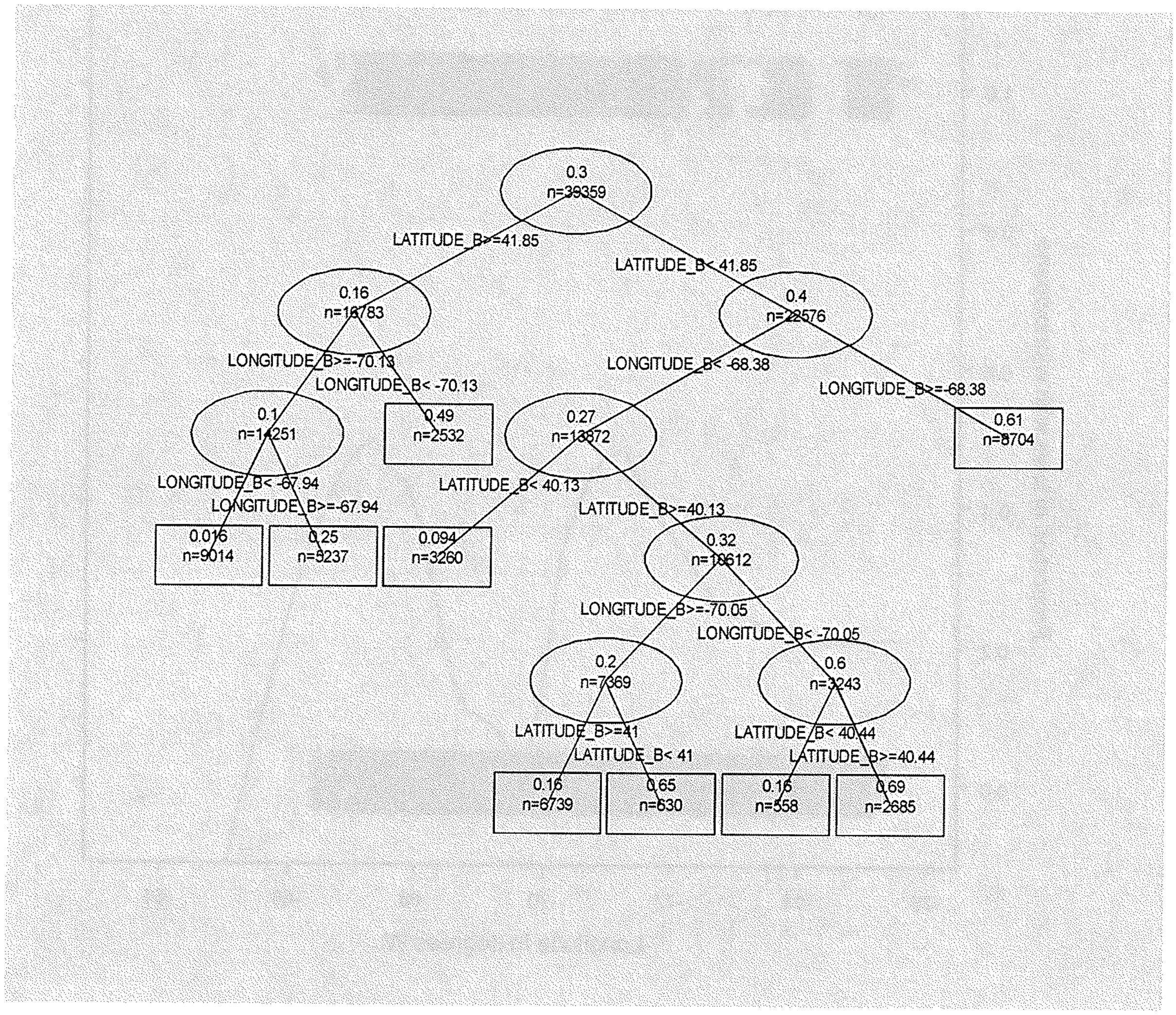


Figure 3. Partition tree for presence/absence (proportion) of windowpane in observed tows. Pruned tree using xerror+1 standard deviation as cut off criterion. Numbers at end of splits are fitted proportion of tows with windowpane.

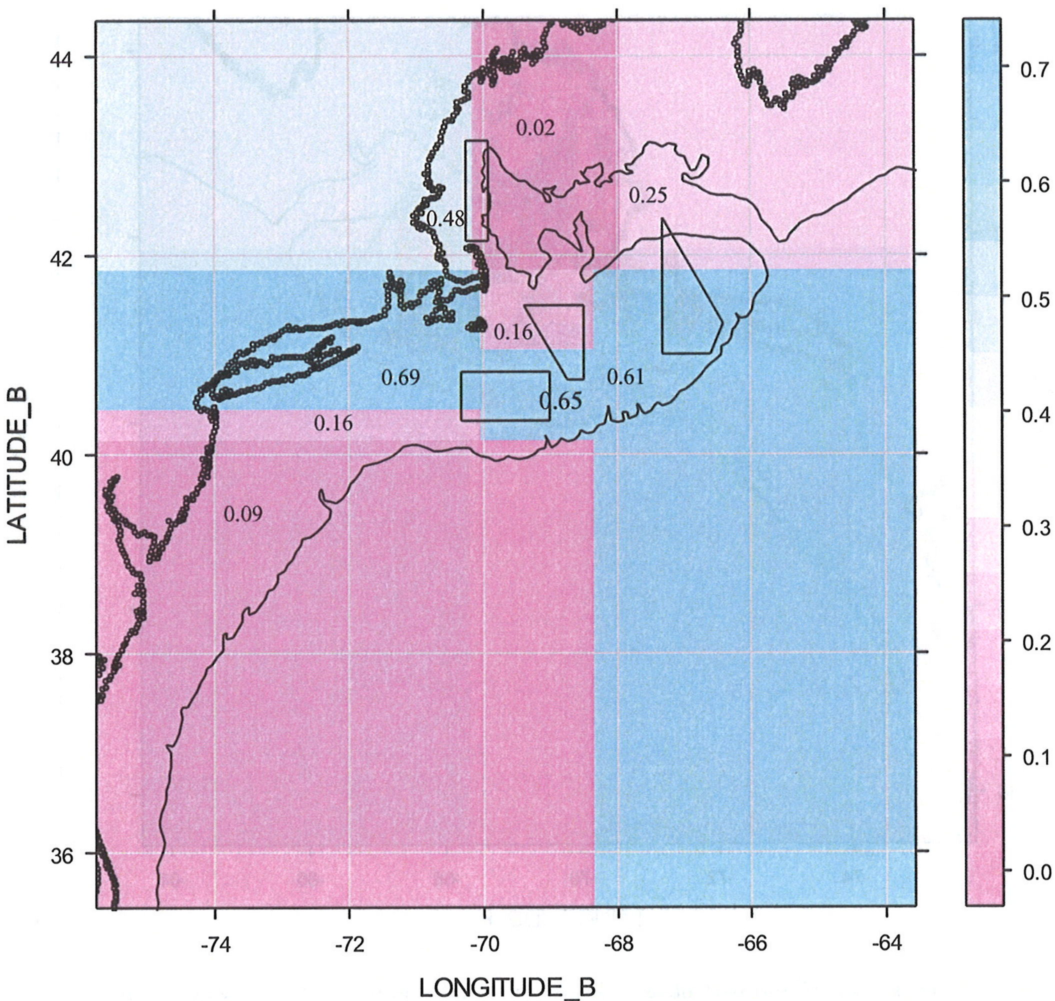


Figure 4. Level plot of predicted proportion positive tows from tree regression based on latitude and longitude. Number within shaded area is proportion positive tows. Note that predicted values for areas without data should be ignored (see Figure 5 for location of tows).

Attachment (g)

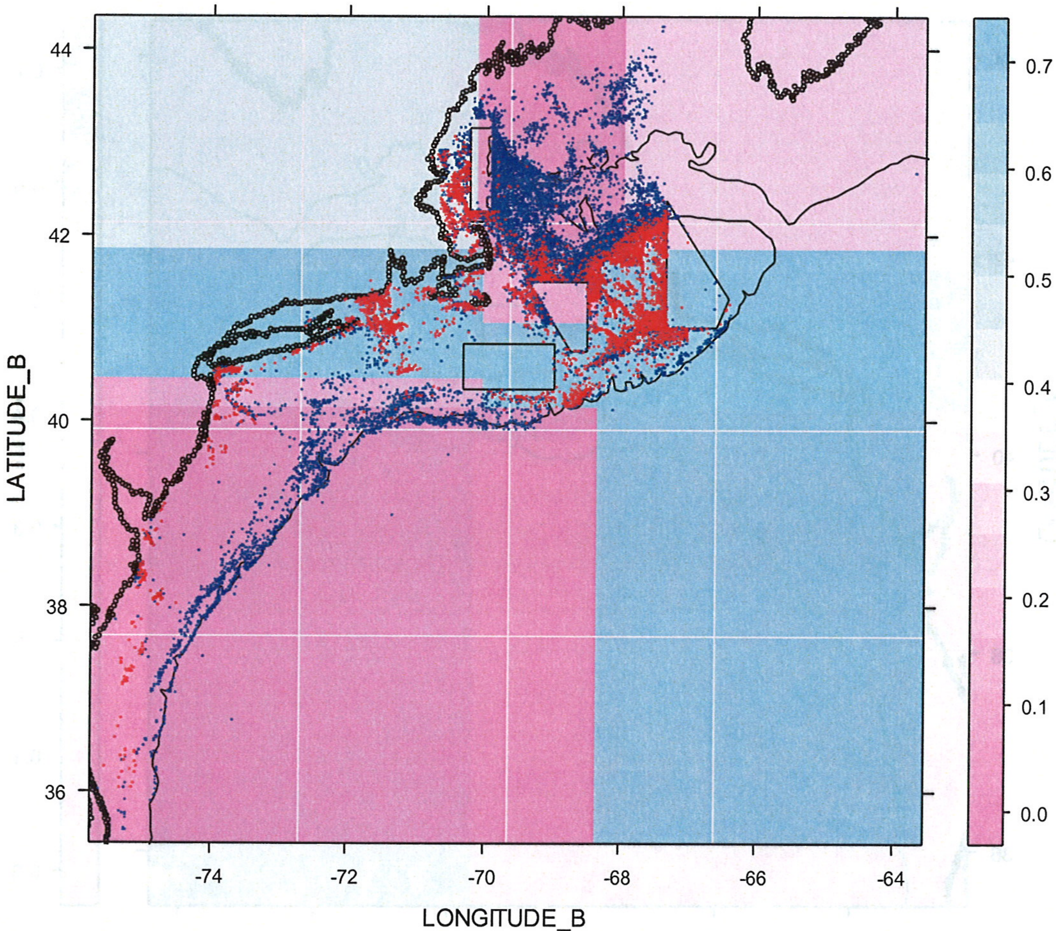


Figure 5. Same as Figure 3 but with observed tows (blue=no windowpane, red=windowpane observed). Colored regions coded to represent proportion of tows with windowpane (see scale on right).

Attachment (g)

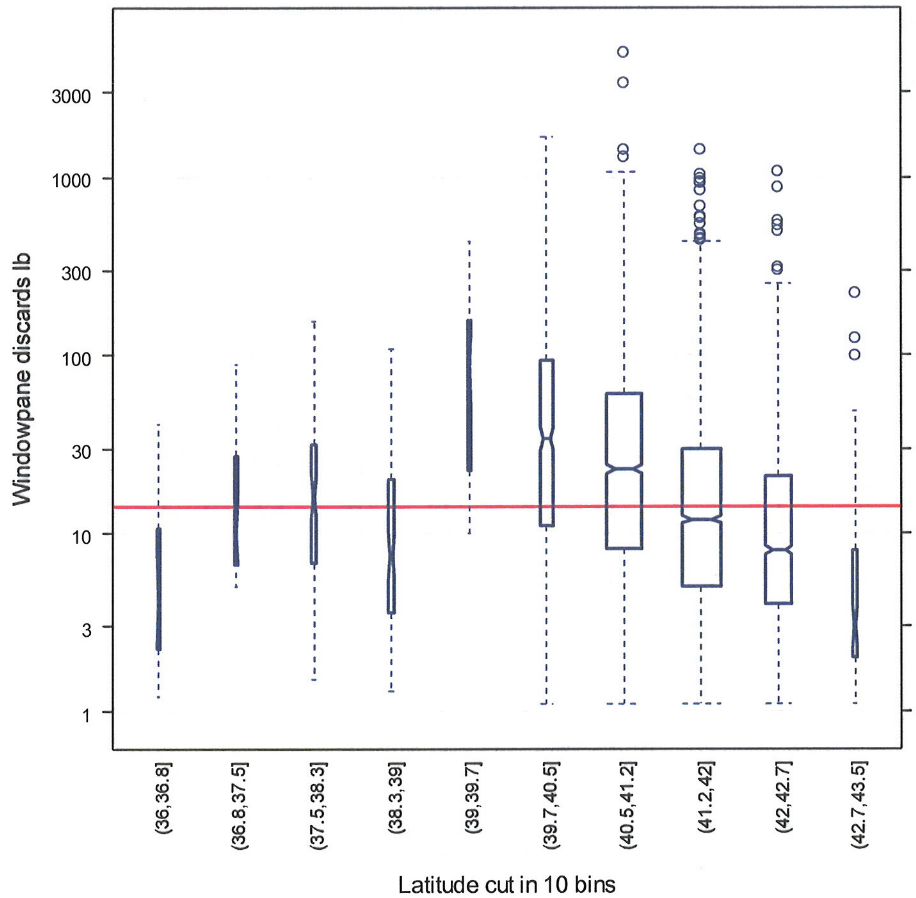


Figure 6. Boxplots of windowpane catch per tow (lb) by 10 bins of latitude. Zero tows not included. Width of box is proportional to square root of the number of observations. Red line is overall median. Note that y axis scale is logarithmic.

Attachment (g)

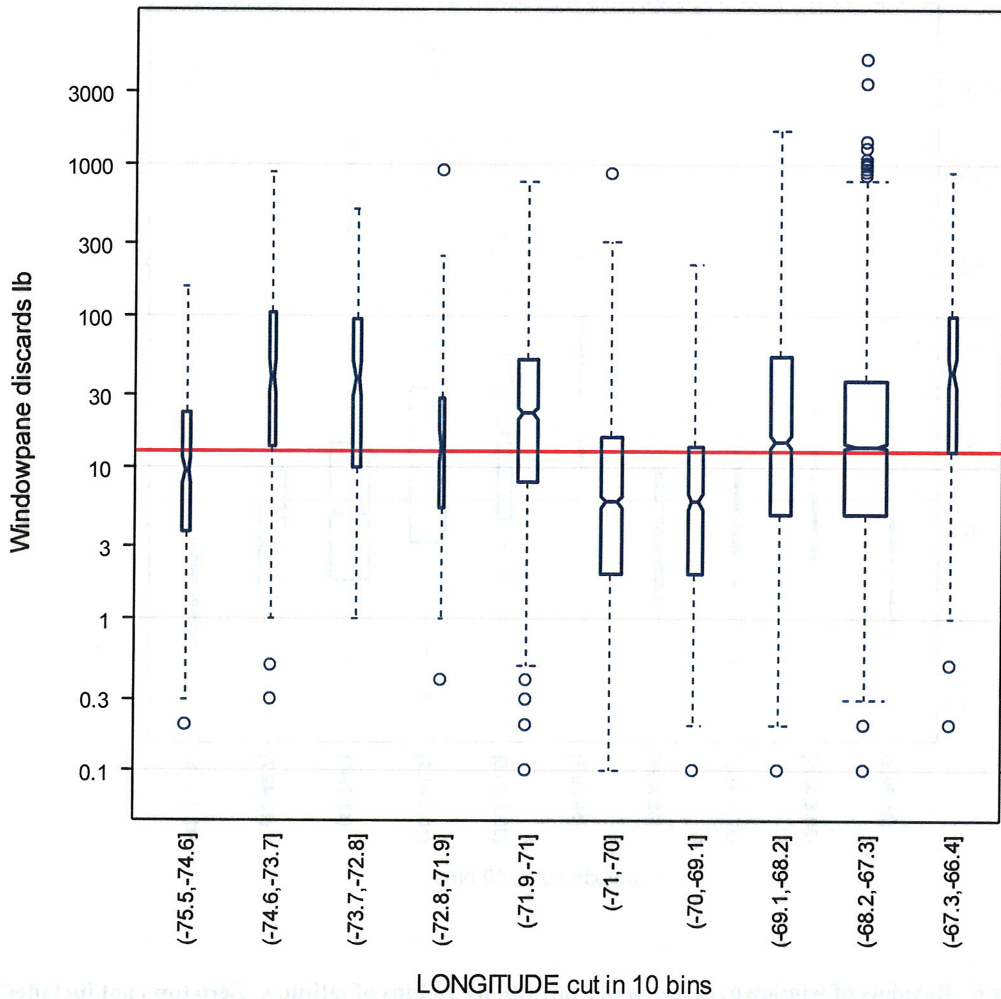


Figure 7. Boxplots of windowpane catch per tow (lb) by 10 bins of negative longitude. Zero tows not included. Width of box is proportional to square root of the number of observations. Red line is overall median. Note that y axis scale is logarithmic.

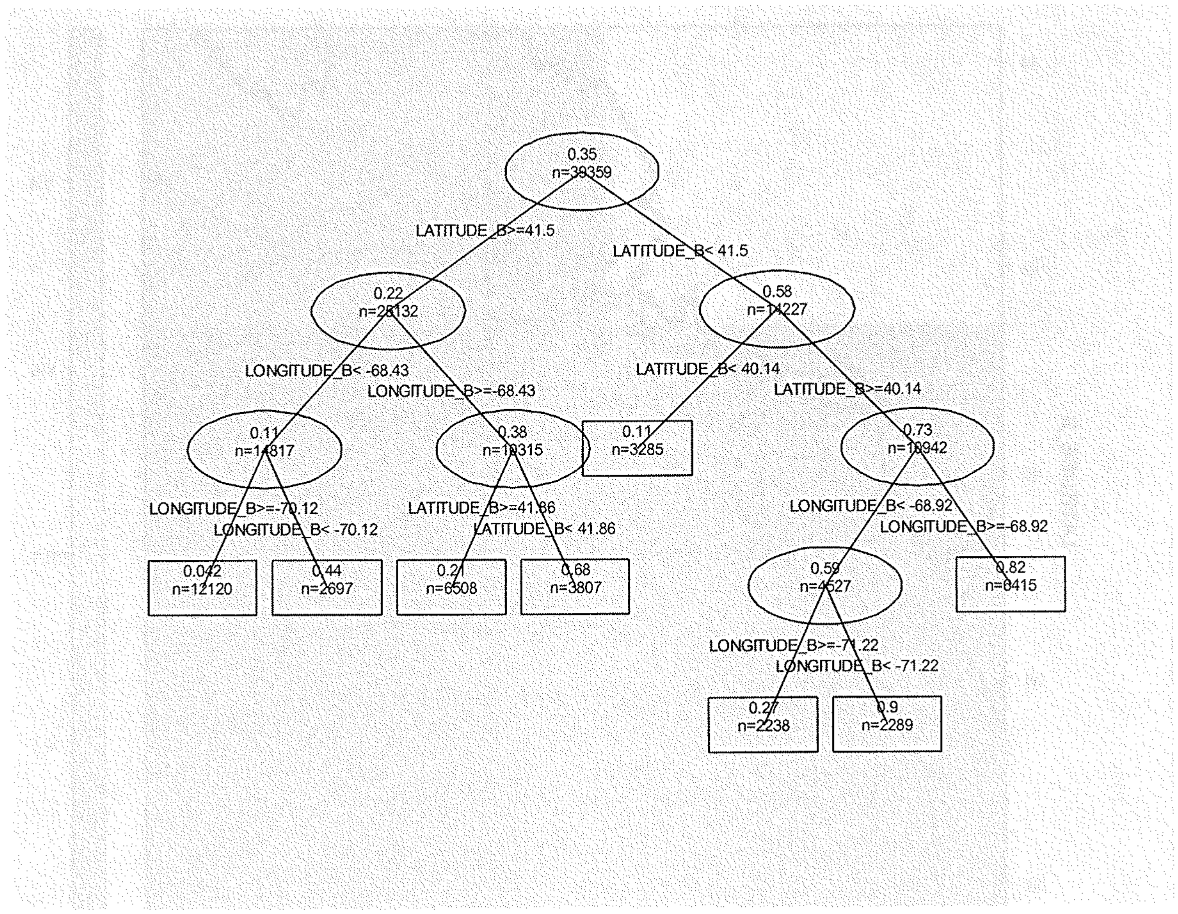


Figure 8. Pruned tree from regressing log10 windowpane discards against negative longitude and latitude. Numbers at end of leaves are log10 windowpane discards in lb.

Attachment (g)

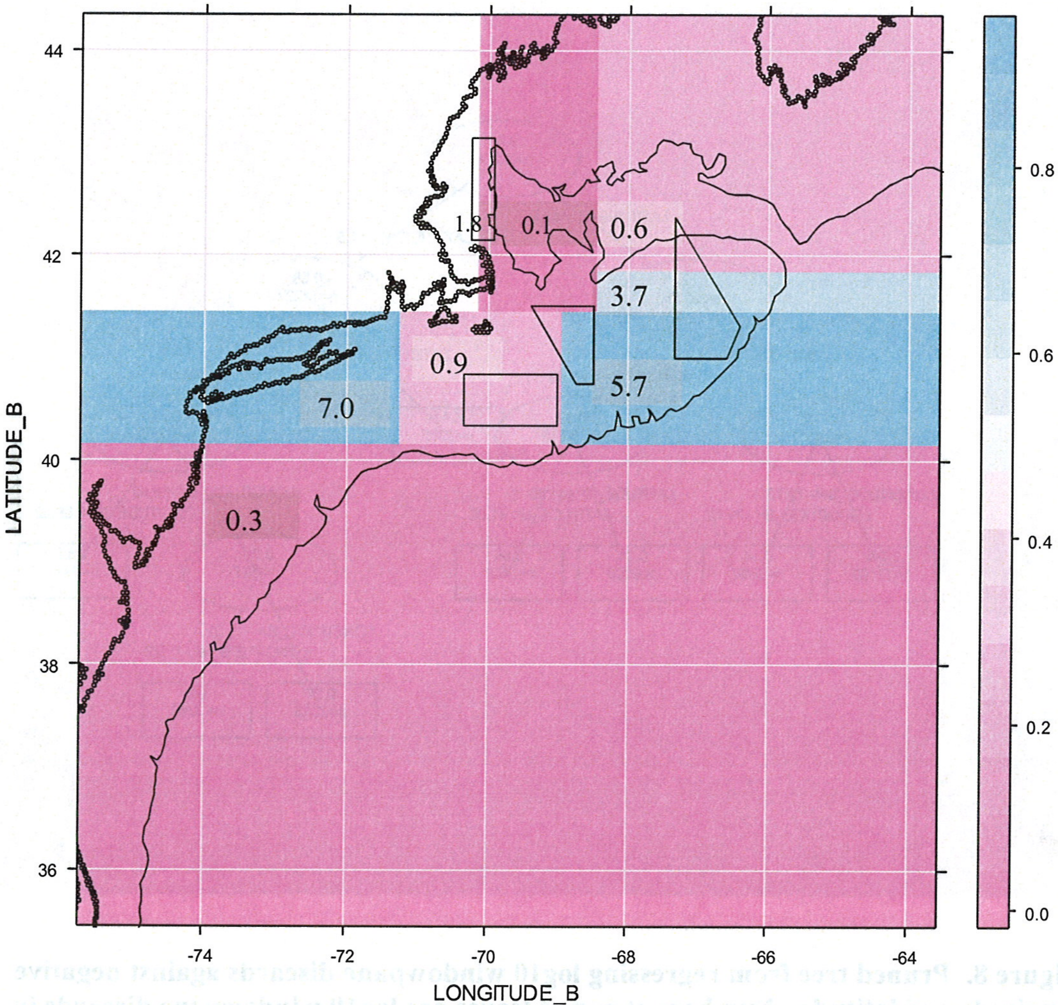


Figure 9. Level plot of fitted values from regression tree of log10 windowpane dk* hailwt +1 lb. Numbers within the chart are the back-transformed geometric mean catch (lb). Scale on right bar is in common logs. Note that predicted values for areas without data should be ignored (see Figure 5 for location of tows).

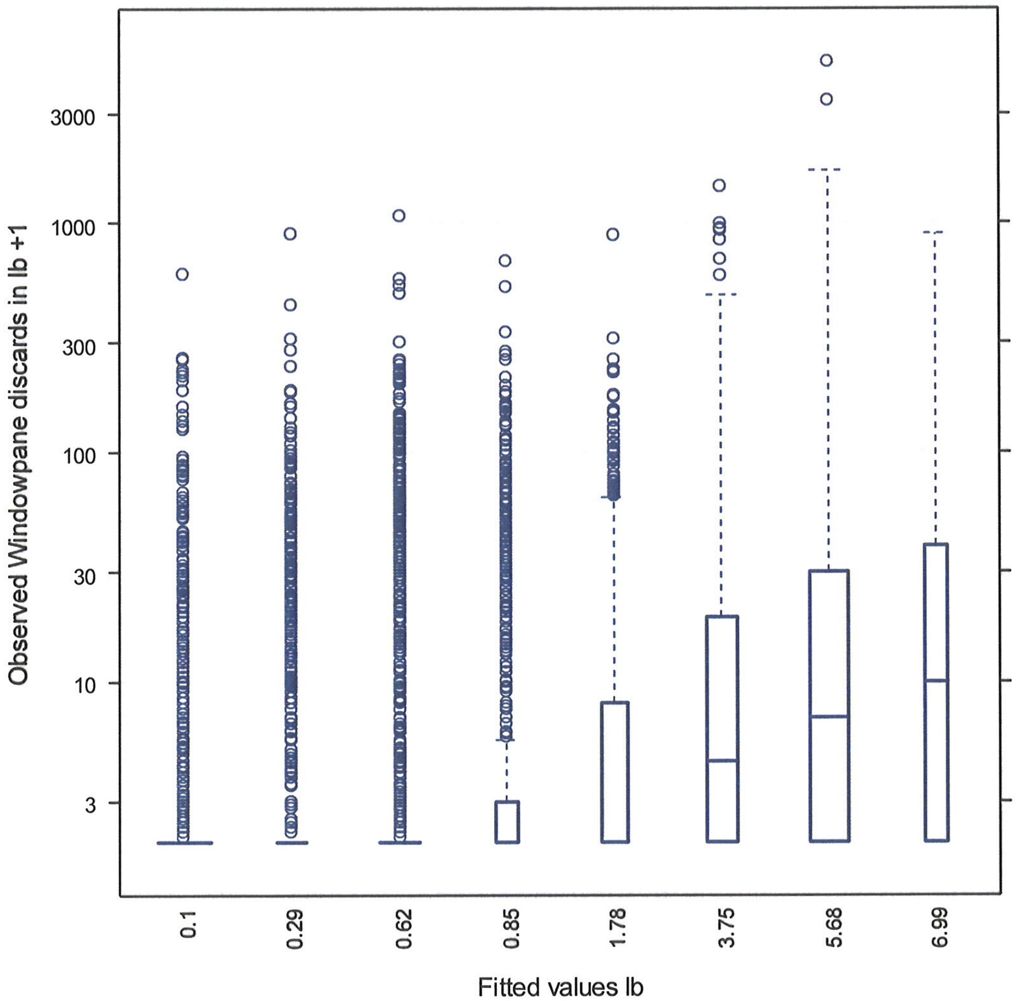


Figure 10. Boxplots of observed windowpane discards and back-transformed fitted values from the regression tree. Note that y-scale axis is logarithmic. Boxwidth is proportional to square root of the number of observations.