Appendix VI
ANALYSES OF OPTIONS CONSIDERED FOR THE BLUEFIN TUNA TIME/AREA CLOSURE

Material and Methods

The following is a brief description of the methods used to analyze the pelagic longline logbook database, maintained by NMFS' Southeast Fisheries Science Center, to determine which time/areas would most effectively minimize discards of bluefin tuna while minimally impacting target fishing practices.

A. The Data

Data were separated into three time frames in order to examine historic and current fishing conditions. The first and second time frames consisted of sets from 1997 and 1996, respectively. These years are the most current data available at this time. The third time frame consisted of the combination of sets from 1992 through 1995. This time frame represents the historic fishery and includes data from both before the target catch requirements were implemented and after. Discard data were analyzed as **total** discards which includes all discards both dead and alive. Throughout this discussion and in following sections, references to discards means **total** bluefin tuna discards (i.e., alive and dead) unless otherwise noted.[1]

All data indicated a proportionally large number of bluefin tuna, in relation to the number of bluefin tuna discarded in other areas, were reported discarded between 37 and 41° N and 66 and 74° W (Figure 1). This area was divided into eight blocks, each consisting of two degree by two degree square areas (numbered zero through seven) and was defined as the study area for purposes of this analysis (see Figure 2). The surrounding areas to the south and east (from 30° N and 60° W) were divided into areas labeled "8" and "9" (see Figure 2). Areas 8 and 9 were used for determining impacts when displacement of vessels was considered from time/area closures. Either the entire area (Blocks 0 to 9) or just the study area (Blocks 0 to 7) is specifically mentioned throughout the analyses.

For all time frames, three different time periods (year-round, quarterly, and monthly) and three different block sizes (the study area consisting of blocks 0 through 7, two by eight degree blocks, and eight two by two degree blocks) were considered. Based on comments received during the comment period, NMFS re-analyzed some of the blocks for the month of June and analyzed a block similar to the one suggested by commenters. This analysis found a discrepancy in the original analysis that was fixed for the final analyses. Thus, ten different options were examined. For each option, the number of hooks set, bluefin tuna discarded (dead or alive), bluefin tuna landed, other tuna (yellowfin, bigeye, etc.), swordfish, large

[1] Total bluefin tuna discards were analyzed to ensure NMFS conducted a broad, comprehensive analysis of the data set. Specific analyses could be done at latter stages to examine dead versus alive discards if necessary. Regardless of whether NMFS examines just dead discards or all discards, the relative, qualitative assessment of where and when discards occur should remain the same.

coastal sharks landed, billfish caught, other fish (dolphin, oilfish, etc.), and turtles caught in each area (zero to nine) were calculated. The catch of each species per 10,000 hooks (CPUE) was also calculated. The data for areas 0 to 7 were sorted by the number of bluefin tuna discarded per 10,000 hooks (DPUE). For areas 8 and 9 the average CPUE for each species and the DPUE were calculated.

B. The Models

Data were analyzed and results presented using two models: a No-Displacement Model and a Displacement Model. In the No-Displacement Model, effort and landings for particular times/areas were simply subtracted from the database. This assumes that if a time/area is closed then all fishery effort and landings from that time/area would no longer occur and fishermen would stay at port and not fish or displace to other areas. Under this model there is no offsetting increase in catch and discards due to displaced effort. Thus, all impacts to the stocks would be measured as decreases in landings and reductions in discards. Although this is an unrealistic assumption, it does provide a “worst-case” scenario in terms of economic impacts to target fisheries and a “best-case” scenario in terms of reductions in discards. This model provides a basic overall understanding of the magnitude of the catch in the different areas for different time periods as well as a baseline for assessments of the status quo. This model was not examined for the new blocks suggested during the comment period.

The Displacement Model calculated the estimated reduction in numbers of target fish caught and bluefin tuna discarded for the different time/area closures as follows: the area and time combination with the highest DPUE was closed first. Effort (i.e., hooks) from that area and time were assumed to move into areas 8 and 9. In reality, fishermen would probably switch effort to areas with the next highest CPUE. However, it is difficult to predict which species CPUE fishermen would try to maximize and how much effort would go to which area in order to maximize the CPUE of that species. The number of additional fish caught in areas 8 and 9 due to the closure of the high DPUE area, was estimated using the average CPUE for each species in areas 8 and 9 and the number of hooks from the closed block. Although it is unknown whether vessels would actually displace to, and fish in, areas 8 and 9, (i.e., if closer areas are open), the average CPUE values from areas 8 and 9 provide a reasonable estimate of possible CPUE values regardless of where the displaced vessels actually conduct fishing operations. The values for displaced catches were added to the number of fish actually caught in areas 8, 9, and any remaining open blocks, in order to estimate the number of fish caught for that time/area closure. The percent reduction was calculated. This was repeated for each time/area combination in order of decreasing DPUE. Once an area and time combination was closed, the model assumed it remained closed. This method still allows calculation of each individual option by subtracting the percent reduction of one time/area combination from the next one.

Unlike the No-Displacement Model, it is possible under the Displacement Model to actually predict an increase in landings and/or discards of certain species. This could occur when areas 8 and 9 have higher CPUE for that particular species that the closed area(s).

Results

Table 2 provides a summary of the impacts of each time/area closure option in terms of estimated changes in landings of target species and discards of bluefin tuna. Table 2(a) summarizes the impacts of assuming displacement to areas 8 and 9. Table 2(b) summarizes the impacts with no displacement.

Final Action: June closure; south half of blocks 0, 1, and 2 (one by six degree block; 39 to 40° N and 68 to 74° W)

Displacement Model: Closing the south half of blocks 0, 1, and 2, a one by six degree block, during June only, is predicted to reduce the number of bluefin tuna discarded by approximately 55 percent.[2] The change (increase and decrease) in landings for other target species, including other tuna, is predicted to be less than six percent. The model predicts that turtle catches could decrease by nine percent or increase by six percent under this action. This prediction is variable due to the small numbers of turtles reported in the data.

Conclusion: Of all the options examined, this option seems to minimize the impact on fishermen and producers while maximizing the percent reduction of bluefin tuna discarded and not significantly altering bycatch of turtles. In addition, comments received during the comment period urged NMFS to move the proposed southern boundary to 39° N for safety reasons and due to the lack of bluefin tuna discards in that area. Based on these reasons, this option was selected.

Rejected Options for time/area closure

Rejected Option: Year-round closure; all eight two by two degree blocks

Displacement Model: This option would close the study area (blocks 0 to 7) year round, and thus would have the greatest impact in terms of reductions of target species landings and discards. This option predicts a decrease in the number of bluefin tuna discarded by over 85 percent, as well as a decrease in the number of bluefin tuna landed by approximately 24 to 46 percent. There is a chance the number of bluefin tuna landed could increase. This model also predicts that the number of large coastal sharks, swordfish, and other fish landed could substantially increase if effort was switched out of the study area and displaced to areas 8 and 9.

No-Displacement Model: The predicted number of bluefin tuna discards would drop by over 90 percent. Thus, under the assumption of no-displacement, bluefin tuna discards are only reduced an additional five percent when compared to the displacement model. Impacts to target fisheries may be particularly pronounced in the tuna fishery (over 40 percent in 1996 and 100 percent in 1997), including the landings of incidentally caught bluefin tuna (over 65 percent in 1996 and earlier and 98 percent in 1997).

[2] In 1997, the pelagic longline fleet discarded a total of 37.1 mt ww dead bluefin tuna in the Atlantic and Gulf of Mexico, 30.7 mt ww of which were discarded dead in the northwest Atlantic. If the anticipated 55 percent reduction in bluefin tuna discards in the northwest Atlantic is applied to the 1997 figures, NMFS estimates that the total amount bluefin tuna dead discards for the pelagic longline fleet in 1997 would have been 20 mt ww.

Conclusion: Overall, due to the large temporal and spatial nature of this option, and the relatively high impact of this option in terms of landings foregone, this option was not selected.

Rejected Option: Year-round closure; two by eight degree blocks

Displacement Model: Under this alternative the two by eight block on the northern end of the study area (blocks 0, 1, 2, and 3 in Figure 2) has the greatest reduction in bluefin tuna discards in all time frames examined. This two by eight degree block contains the most activity in terms of landings and discards and achieves similar levels of reductions in discards and landings as closing the entire area, as considered in Option 1. In particular, this option predicts a decrease in the number of bluefin tuna discarded of over 76 percent, a decrease in the number of bluefin tuna landed by over 40 percent, an increase in the number of large coastal sharks landed, and, in one of the time frames (1996), a possible increase in turtle bycatch.

No-Displacement Model: This model predicts the decrease in the number of bluefin tuna discarded to be over 85 percent together with significant decreases in landings of other tuna, swordfish, and sharks as well catches of billfish and turtles.

Conclusion: The possible positive ecological benefits obtained with this option, were not large enough, as compared to the other options, to account for the large negative economic impacts on fishermen and fishing communities who rely on these fisheries. For these reasons, this option was not chosen.

Rejected Option: Year-round closure; two by two degree blocks

Displacement Model: A year round closure of a two by two degree block would not consistently encompass areas of high discards. For example, area 2 contained the bulk of bluefin tuna discards in 1996 and 1997 but from 1992 to 1995 the model did not predict a large reduction in bluefin tuna discards in any one particular time and area combination. It would be difficult to determine from year to year which two by two degree area would be optimal to close without an observer program similar to the Canadian program. In addition, closing a combination of different two by two degree blocks over different times would be complex for the industry and difficult to administer.

No-Displacement Model: As in the displacement model, reductions in discards of bluefin tuna and landings of BAYS tuna are predicted to be relatively high in different two by two blocks over different years. However, only low reductions in the landings of target species (less than 10 percent) are predicted.

Conclusion: This option was not chosen for two reasons: 1) a year-long closure may be considered overly harsh especially as bluefin tuna are not likely to stay in so small an area for an entire year; and 2) the model was unable to predict a closure for the same block for all three time frames.

Rejected Option: Quarterly closure; all eight two by two blocks

Displacement Model: Closing the entire study area for only the three months of April through June is predicted to reduce the number of bluefin tuna discarded by over 55 percent. However, closing this entire area may have a significant impact on fishermen who may need to spend time traveling to other areas and producers who may rely on fishing activities in that area. In addition, the model predicts a ten-percent or greater increase in large coastal shark landings. Although this increase in landings may offset the increase in cost of fishing, but it may also cause the large coastal sharks fishery to close earlier thus increasing the race for the fish (decreased safety at sea) and increasing large coastal sharks bycatch.

No-Displacement Model: This model estimates reductions in bluefin tuna discards and bluefin tuna landings of approximately 58 and 21 percent, respectively. Landings of other target species are relatively low (less than ten percent).

Conclusion: This closure may be overly harsh for some fishermen and producers. This closure may also have a negative impact on the rebuilding of large coastal sharks, safety at sea, and bycatch. For these reasons, this option was not chosen.

Rejected Option: Quarterly closure; two by eight degree blocks

Displacement Model: Closing the northern half of the study area for the second quarter is predicted to decrease bluefin tuna discards by over 55 percent. Although the number of bluefin tuna landed may be reduced by 30 percent, the number of other species is not predicted to change (increase or decrease) beyond ten percent.

No-Displacement Model: As with the displacement model, this model predicts bluefin tuna discards will be reduced by less than 73 percent while bluefin tuna landings will be reduced by less than 32 percent. Landings of target species is predicted to be less than eight percent.

Conclusion: This option accomplishes the goal of minimizing bluefin tuna discards without having a large impact on other target fisheries. However, due to possible high impact of this three month closure on fishermen and producers in the surrounding areas, in contrast to other possible options, this option was not chosen.

Rejected Option: Quarterly closure; two by two degree blocks

Displacement Model: As with the option that would close two by two degree blocks year round, this model was not able to predict a closure for the same two by two degree block in all three time frames.

No-Displacement Model: As with the option that would close two by two degree blocks year round, the model was not able to predict a closure for the same two by two degree block in all three time frames.

Conclusion: Even though this option also appears to accomplish the goal of minimizing discards, the fact that the two by two degree block may switch from year to year, does not make the option as viable as others. In addition, a three month long closure may be unduly harsh on fishermen and fishing communities.

Rejected Option: Monthly closure; all eight two by two degree blocks

Displacement Model: Closing the entire area for the month of June only, may reduce the number of bluefin tuna discarded by approximately 60 percent. The impact on other species may be less than ten percent.

No-Displacement Model: June is consistently the month with highest discards over the entire study area. During this month tuna landings and discards are relatively high, although catches of other species are less than five percent.

Conclusion: This option was not chosen due to the relatively high impact (compared to the option below) on surrounding producers and fishermen.

Rejected Option: Monthly closure; two by eight degree block

Displacement Model: Closing the northern half of the study area, a two by eight degree block, during June only, is predicted to reduce the number of bluefin tuna discarded by approximately 60 percent. The change (increase and decrease) in landings for other target species, including other tunas, is predicted to be less than ten percent.

No-Displacement Model: Landings and discards of bluefin tuna are relatively high in the north portion of the study area. In addition, reductions of target species are less than five percent.

Conclusion: This option was not chosen because the final action is nearly equivalent in terms of reducing the number of bluefin tuna discarded, has less of an impact on target catch, and addresses fishermen's concerns about the size of the area. Based on these reasons, this option was selected as preferred.

Rejected Option: Monthly closure; two by two degree blocks

Displacement Model: Similar to other options comparing two by two degree blocks, the optimal areas for closure under this option are not the same for both time frames. From year to year a different two by two degree block would have to be closed in different months to achieve a uniform percent reduction of bluefin tuna discarded. This would be confusing to implement and enforce and may not be effective if the migration pattern of bluefin tuna changes due to environmental factors.

No-Displacement Model: Closing different two by two degree squares for different years in June is estimated to reduce bluefin tuna discards up to almost 60 percent and reduce landings of target species by seven percent or less.

Conclusion: As with the other options that compared two by two degree blocks, the model was not able to predict a closure for the same area consistently for all three time frames. For this reason, this option was not chosen.

Table 1 Times and areas analyzed by NMFS for possible closure

Times	Areas
Yearly	2 by 2 degree blocks (8 total)
Quarterly	2 by 8 degree blocks (2 total)
Monthly	4 by 8 degree block (1 total)

Table 2A Displacement Model Summary Table

Percent reductions estimated if only one block is closed at a time for each alternative assuming fishers switch effort from closed area to areas 8 and 9.

Negative percentages indicate possible increase.

Times and areas shown below are combination for each option which predicts the greatest reduction of bluefin tuna discarded.

For two by eight degree blocks: Area 1 = Areas 0, 1, 2, and 3 of the two by two degree blocks
Area 2 = Areas 4, 5, 6, and 7 of the two by two degree blocks

Alternative	Year(s)	Time	Area	BFT discards	BFT landed	TUNA landed	SWO landed	LCS landed	BILL caught	Fish landed	Turtles landed
Monthly; southern half of blocks 0, 1, and 2	1997	Year	All	54%	18%	0%	-1%	-3%	-2%	0%	9%
	1996	Year	All	56%	24%	2%	-5%	-6%	-3%	-2%	-6%
Year-round; blocks 0-7	1997	Year	All	81%	-69%	66%	27%	-215%	20%	-197%	-105%
	1996	Year	All	85%	46%	8%	-42%	-32%	3%	-41%	-14%
	1992-1995	Year	All	88%	24%	24%	-45%	-98%	-20%	-63%	50%
Year-round; 2x8 block	1997	Year	1	76%	43%	37%	-31%	-77%	7%	-68%	57%
	1996	Year	1	83%	43%	2%	-26%	-16%	-7%	-26%	-6%
	1992-1995	Year	1	83%	22%	17%	-34%	-75%	-20%	-49%	47%
Year-round; 2x2 block	1997	Year	2	55%	18%	18%	-15%	-34%	0	-27%	19%
	1996	Year	2	76%	36%	3%	-12%	-15%	-2%	-9%	-6%
	1992-1995	Year	3	39%	6%	1%	-1%	-14%	0%	-8%	10%
Quarterly; blocks 0-7	1997	2nd	All	56%	24%	2%	-4%	-11%	-3%	-5%	10%
	1996	2nd	All	74%	34%	3%	-8%	-10%	-2%	-6%	-9%
	1992-1995	2nd	All	72%	16%	-1%	-5%	-14%	-4%	-5%	10%
Quarterly; 2x8 block	1997	2nd	1	55%	20%	1%	-3%	-7%	-3%	-3%	9%
	1996	2nd	1	72%	29%	2%	-7%	-8%	-4%	-4%	-7%
	1992-1995	2nd	1	68%	13%	-1%	-3%	-10%	-4%	-5%	8%
Quarterly; 2x2 block	1997	2nd	2	52%	15%	1%	-2%	-5%	-2%	-2%	9%
	1996	2nd	2	67%	28%	2%	-6%	-8%	-3%	-4%	-7%
	1992-1995	2nd	3	25%	4%	0%	-1%	-3%	-1%	-1%	4%
Monthly; blocks 0-7	1997	June	All	54%	19%	1%	-2%	-8%	-2%	-3%	9%
	1996	June	All	64%	31%	2%	-8%	-9%	-2%	-5%	-8%
	1992-1995	June	All	66%	13%	0%	-4%	-10%	-3%	-4%	9%
Monthly; 2x8 block	1997	June	1	53%	18%	1%	-2%	-6%	-2%	-3%	9%
	1996	June	1	61%	27%	2%	-6%	-8%	-3%	-4%	-7%
	1992-1995	June	1	63%	11%	0%	-3%	-8%	-4%	-4%	8%
Monthly; 2x2 block	1997	June	2	51%	14%	1%	-1%	-5%	-2%	-2%	10%
	1996	June	2	58%	26%	2%	-6%	-7%	-3%	-3%	-6%
	1992-1995	June	3	22%	4%	0%	0%	-3%	1%	-1%	4%

Table 2B No-Displacement Model Summary Table

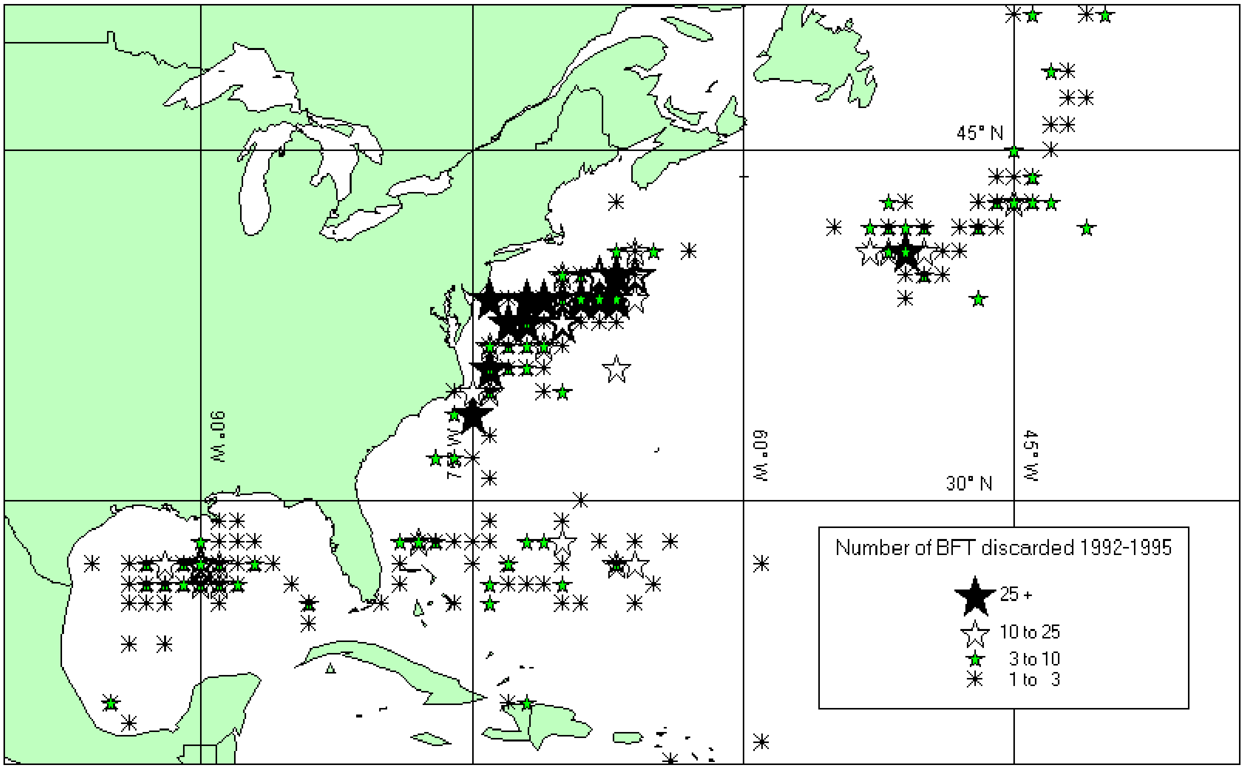
Percent reductions estimated if only one block is closed at a time for each alternative assuming fishers do not switch effort

Times and areas shown below are combination for each option which predicts the greatest reduction of bluefin tuna discarded.

For two by eight degree blocks: Area 1 = Areas 0, 1, 2, and 3 of the two by two degree blocks
Area 2 = Areas 4, 5, 6, and 7 of the two by two degree blocks

Alternative	Year(s)	Time	Area	BFT discards	BFT landed	TUNA landed	SWO landed	LCS landed	BILL caught	Fish landed	Turtles landed
Year-round; blocks 0-7	1997	Year	All	100%	98%	100%	99%	97%	99%	97%	98%
	1996	Year	All	91%	67%	43%	12%	18%	40%	13%	29%
	1992-1995	Year	All	94%	65%	65%	34%	10%	45%	26%	77%
Year-round; 2x8 block	1997	Year	1	85%	64%	56%	31%	9%	46%	12%	75%
	1996	Year	1	87%	56%	25%	9%	17%	17%	9%	23%
	1992-1995	Year	1	88%	55%	49%	28%	8%	31%	19%	68%
Year-round; 2x2 block	1997	Year	2	58%	26%	26%	10%	1%	16%	5%	26%
	1996	Year	2	78%	42%	13%	4%	0%	9%	7%	6%
	1992-1995	Year	3	39%	12%	7%	9%	0%	9%	4%	14%
Quarterly; blocks 0-7	1997	2nd	All	58%	27%	4%	4%	0%	2%	5%	12%
	1996	2nd	All	76%	38%	10%	2%	0%	5%	6%	0%
	1992-1995	2nd	All	73%	21%	4%	5%	0%	4%	6%	14%
Quarterly; 2x8 block	1997	2nd	1	56%	22%	3%	3%	0%	1%	3%	11%
	1996	2nd	1	73%	32%	8%	2%	0%	2%	4%	0%
	1992-1995	2nd	1	69%	17%	3%	4%	0%	2%	3%	10%
Quarterly; 2x2 block	1997	2nd	2	52%	17%	2%	2%	0%	0%	2%	11%
	1996	2nd	2	68%	31%	8%	2%	0%	2%	4%	0%
	1992-1995	2nd	3	26%	6%	1%	2%	0%	1%	2%	5%
Monthly; blocks 0-7	1997	June	All	54%	21%	3%	3%	0%	2%	4%	11%
	1996	June	All	65%	35%	9%	2%	0%	5%	5%	0%
	1992-1995	June	All	67%	17%	3%	4%	0%	3%	4%	11%
Monthly; 2x8 block	1997	June	1	53%	19%	3%	2%	0%	1%	3%	11%
	1996	June	1	62%	30%	7%	2%	0%	2%	4%	0%
	1992-1995	June	1	64%	14%	3%	3%	0%	2%	3%	10%
Monthly; 2x2 block	1997	June	2	51%	15%	2%	2%	0%	0%	2%	11%
	1996	June	2	59%	29%	7%	2%	0%	2%	4%	0%
	1992-1995	June	3	22%	5%	1%	2%	0%	1%	2%	5%

Figure 1
A) Number of bluefin tuna discarded in 1992 through 1995



B) The number of bluefin tuna discarded in 1996

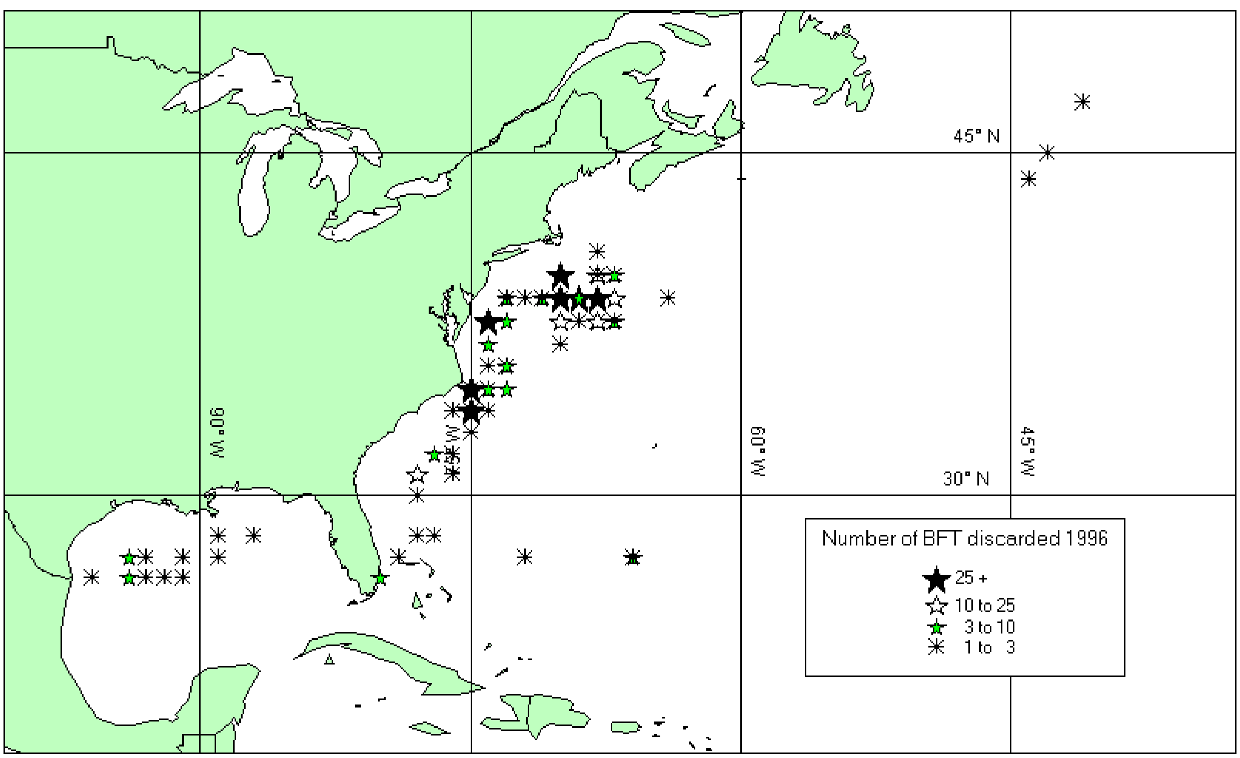


Figure 1 (continued)
C) The number of bluefin tuna discarded in 1997

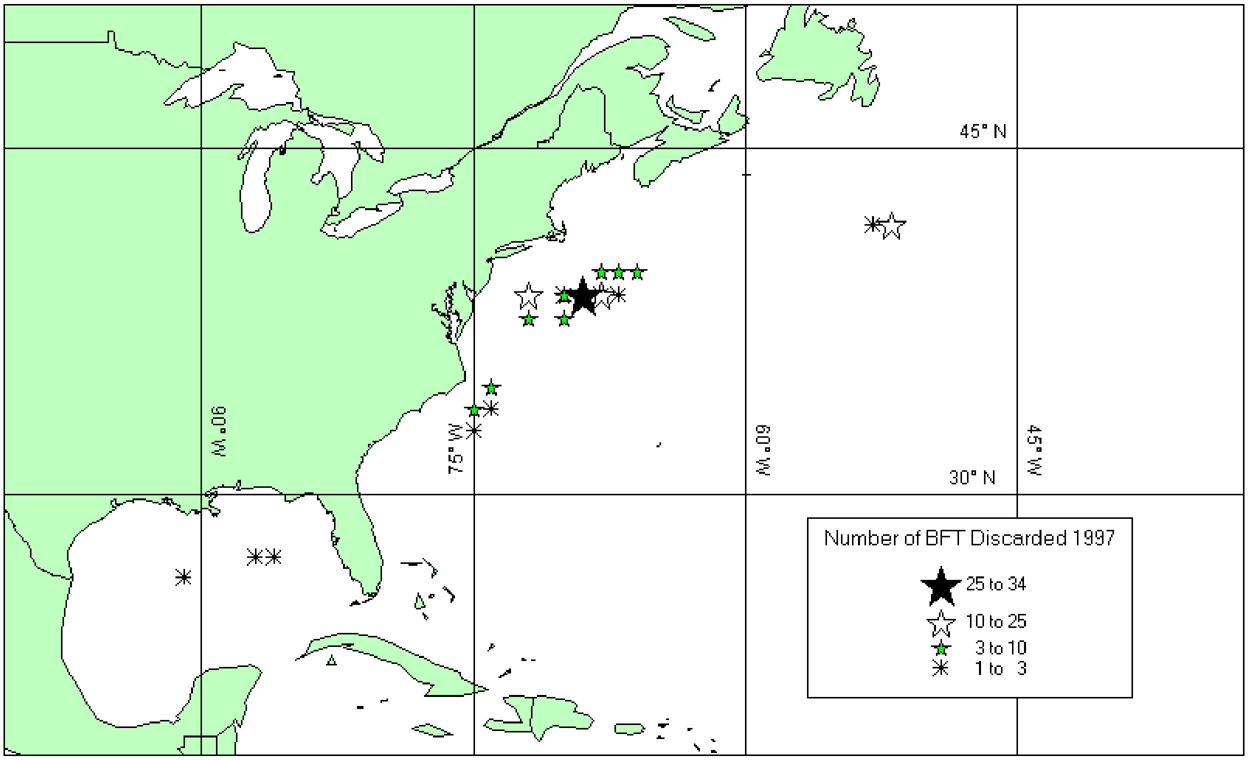


Figure 2 The Study area blocks. The final action closes the southern half of blocks 0, 1, and 2 (i.e., 39 to 40° N and 68 to 74° W) for the month of June.