Preliminary Report

Analysis of Total Fishing Mortality for Gulf of Mexico Red Snapper Contributed by Shrimp Trawl Bycatch and Commercial and Recreational Fisheries (Including Discards)

Note: calculations reported are preliminary and should not be cited without the author's permission.

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Executive Summary

1. The current fishing mortality rate for Gulf of Mexico red snapper is many times higher than the maximum sustainable fishing mortality rate and a key question is how conservation efforts should be directed at reducing the various components of fishing mortality.

2. Shrimp trawls account for about 93% of the annual total catch of red snapper between 1994 and 1997, and 89% in 1998.

3. Because shrimp trawls catch red snapper when natural mortality rates are high, they account for a much smaller proportion of the cumulative or total fishing mortality on a single cohort. This is approximately 47% of the cumulative fishing mortality from 1994-1997 and 35% in 1998 (due to the introduction of BRDs in 1998).

4. The recreational sector accounts for about 6% of the catch in 1998 but about 32% of the cumulative fishing mortality because it catches predominantly recruited fish.

5. The commercial sector accounts for about 3.5% of the catch in 1998 but about 29% of the total fishing mortality, because it catches an even larger fraction of older fish than the other fisheries.

6. Under the NMFS base case assumptions for release mortality from recreational and commercial fishing, the number of dead discards in 1998 accounts for about 1.5% of the total catch yet this source of mortality accounts for about 3% of the cumulative fishing mortality.

7. Under a revision to the NMFS base case assumptions for release mortality from recreational and commercial fishing based on a study by Wilson et al. (2003)[1], this source of mortality accounts for about 1.8% of the total catch but about 6-7% of the cumulative fishing mortality. A reduction in this source of mortality would thus help to a moderate extent to reduce total fishing mortality and stock recovery because it occurs on fish just before they recruit to the fishery. However, substantial reductions in shrimp trawl bycatch and red snapper TAC for the recreational and commercial fisheries are more essential for bringing the total fishing mortality rates down to a sustainable level.

8. A reduction in shrimp trawl bycatch and shrimp trawl fishing effort will result in no more than about a 30% reduction in cumulative fishing mortality rate of red snapper, down to 70% of the pre-1998 levels.

9. Combined reductions in shrimp trawl bycatch, shrimp trawl effort, and targeted red snapper TAC from about 9 to 6 million pounds are computed to result in a decrease in total fishing mortality rate to about 62% of the pre-1998 level.

10. Combined reductions in shrimp trawl bycatch, shrimp trawl effort, and targeted red snapper TAC from about 9 to 6 million pounds and an elimination of discard mortality in the recreational and commercial fisheries are computed to result in a decrease in cumulative fishing mortality rate to about 56% of the pre-1998 level under the revised discard mortality assumptions. Given the Schirripa and Legault (1999) estimates of cumulative fishing mortality this is still not enough to reduce the fishing mortality rates to below the MSY reference level.

11. Spreadsheet evaluations using data in Schirripa and Legault (1999) indicate that the proportion of discards from commercial catches of red snapper between 1993 and 1998 ranged between 12% in 1993 and 30% in 1996. The plausibility of these estimates of the fraction discarded from commercial fisheries need to be cross-checked with independent observer studies. If these are too low, then estimates of contributions to total fishing mortality of commercial discards will be too low.

12. It should be noted that if a constant or lower TAC is maintained, then the fishing effort from the recreational and commercial fisheries will need to be scaled back considerably as stock size increases, in order to maintain the catches at TAC levels; otherwise the combined fishing mortality rate from these two fisheries will continue to be far in excess of the MSY fishing mortality rate. Depending on how fishing effort is reduced, discard mortality could grow considerably over current levels and this would need to be taken into account.

[1] This study indicated higher commercial fishery discard mortality rates than the base case of 33%. It did not study recreational discards. However, in this analysis, an increase in recreational discard mortality similar to that found in the commercial discard mortality in Wilson et al. (2003) was evaluated as a plausible scenario.

Introduction

The current fishing mortality rate for Gulf of Mexico red snapper is many times higher than the maximum sustainable fishing mortality rate (Schirripa and Legault 1999, Fig. 39) and a key question is how conservation efforts should be directed at reducing the various components of fishing mortality. For example, how important is it to push for new measures to reduce commercial and recreation fishery discards for red snapper? Is it sufficient to rely solely on bycatch reduction devices (BRDs) and effort reduction in the shrimp trawl fishery? To what extent are reductions in the commercial and recreation fishery total allowable catches (TACs) necessary? This paper attempts to address these questions by quantifying the relative contributions to total fishing mortality of these various sources of red snapper fishing mortality and by taking into account potential underestimates of commercial and recreational fishery discard mortalities in the 1999 stock assessment.

Recent new studies on the potential survival rate of red snapper released from commercial fishing operations (Wilson et al. 2003) indicate that the discard mortality rates assumed in recent stock assessments might be too low. For example the 1999 stock assessment assumes the discard mortality from recreational gear is 20% and the discard mortality from commercial gear is 33%. Wilson et al.'s (2003) study suggests that about 69% of released fish were dead or near death and over 80% of released fish showed signs of stress upon release. Additionally, recent assessments assume that fish of younger than three years are not susceptible in recent years to discard mortality from commercial gear. However, estimated commercial gear selectivity patterns in the 1999 assessment indicate susceptibility of fish younger than 3 years. The Wilson et al. (2003) study also indicates that two-year-olds make up a fairly large proportion of the captured and released fish. The importance of discard mortality thus appears to be not fully taken into account in the 1999 assessment and in the stock rebuilding options.

The draft rebuilding document (NOAA 2003) indicates that prior to 1998, shrimp trawls may have accounted for about 90% of the total red snapper catch. The rebuilding strategies thus acknowledge that a considerable reduction in shrimp bycatch is necessary to help achieve the rebuilding of the snapper stock. Given an expected decline in shrimp fishing effort, some of the rebuilding options suggest relying entirely on BRDs and reduction in shrimp effort to achieve stock rebuilding. The issues of release mortality by recreational and commercial fishermen, however, do not appear to be accounted for in the rebuilding plan options.

This current report evaluates the relative contributions to total fishing mortality by the three sources of discard mortality and by the commercial and recreational fisheries. The impacts on the relative contributions to total fishing mortality from differing assumptions about recreational and commercial discard mortality are considered. Inputs to the analyses are taken out of Schirripa and Legault (1999).

Methods

Estimates of dead discards by age for each type of fishing gear have been taken from page 81 of (Schirripa and Legault 1999). Estimates of landed catch by age for recreational and commercial gear have been taken from p. 80 and 81 of (Schirripa and Legault 1999). Estimates of base case total fishing mortality at age have been taken from p. 85 of (Schirripa and Legault 1999). Base case discard mortality fractions in this report are assumed to be 0.20 for recreational gear and 0.33 for commercial gear. Higher alternative values for these two mortality rates are also considered in the analyses.

Because a detailed analysis is not of interest at this stage, the statistics for the three different commercial gears were combined for the spreadsheet calculations done for this analysis.

The fishing mortality rates by age and major gear type for the years 1994-1998 were computed by portioning the total F by age and year by the relative total catch plus discard mortality by gear (g), age (a) and year (y).

F(y,a,g) = F(y,a) * Catch(y,a,g) / Catch(y,a)

The total number of fish discarded by gear, year and age was reconstructed using the base case discard mortality rates.

D(y,a,g) = DD(y,a,g)/Mg

where D(y,a,g) is the total number of discards, and DD(y,a,g) is the total number of dead discards in year y, age a and gear g, and Mg is the discard mortality fraction by gear g.

This then enabled the computation of alternative values for dead discards by age, gear and year.

DD'(y,a,g) = D(y,a,g) * M'g

where ' indicates some value different from the base case.

The total fishing mortality rate across ages was taken as a reference value. Within a cohort, the total fishing mortality rate for that cohort is the summation of the fishing mortality rates for each year as the cohort ages:

TotF(c) = sum over each age of the cohort the fishing mortality rates, Fa

However, in the last few years, which are of most interest, the full cohorts are mostly incomplete. To obtain an index of the total mortality rate that a cohort might experience, for the cohorts present during the last few years from 1994-1998, the fishing mortality rates were summed across ages for each year:

TotF(y) = sum over each age a for year y

The values between 1994 and 1997 were averaged to obtain an approximation of the the expected total fishing mortality rate for a cohort under recent fishing conditions.

The relative contribution to the total F by a given gear type and by the various sources of discard could then be approximated. This can then provide an indication of the relative importance of this source of fishing mortality and its priority in directed conservation efforts.

For a reference value for the total fishing mortality rate across cohorts, the total F associated with the MSY F was evaluated by multiplying the FMSY of 0.067 under the Schirripa and Legault (1999) base case by the selectivity at age for the combined sources of fishing mortality (using 1998 values for F(a) (Table 28) and the selectivity value for age 1 in Figure 38) and summing the result over ages. This crude approximation of the total (or cumulative) F at MSY came to about 0.61. It is clear from the results in the tables below that total F values for the 1990s are far in excess of this MSY reference point and this is in agreement with the results in Schirripa and Legault (1999), e.g., Figure 39.

Results

<u>Fraction discarded from Commercial and Recreational Gear in Recent Years</u>

Although many detailed outputs were provided in Schirripa and Legault (1999), some aspects of interest were not. In the text of this stock assessment report, e.g., Fig. 22, it is indicated that about 47-62% of the recreational catch has been discarded between 1994 and 1998. No such figure is produced for the commercial fisheries. The stock assessment model calculations produce estimates of total commercial discards but none are presented. With the dead discard at age table and the commercial catch-age tables in Schirripa and Legault (1999) and the assumed base case commercial dead discard rate the estimates of fractions of commercial catch discarded for years 1993-1998 are provided in Table 1.

Table 1. Estimated fraction of commercial catch that is discarded for years 1993 to 1998 based on stock assessment data in Schirripa and Legault (1999).

Year	Fraction of Commercial Catch Discarded
1993	0.12
1994	0.26
1995	0.25
1996	0.30
1997	0.24
1998	0.21

The values range from a low value of 12% in 1993 to a high value of 30% in 1996. These estimates are based on aggregating the commercial catch in the Schirripa and Legault (1999) report and ignore individual gear type selectivities so they may not exactly replicate the results that might have been produced by the stock assessment report. However, the values should still be fairly accurate representations of the fractions released implied in the Schirripa and Legault (1999) assessment.

Based on the assumed discard mortality fraction of 0.2 for the recreational fishery and the same types of stock assessment information in the Schirripa and Legault 1999 report, the model-based estimates of recreational discard as shown in Table 2.

Table 2. Estimated fraction of recreationall catch that is discarded for years 1993 to 1998 based on stock assessment data in Schirripa and Legault (1999).

Year	Fraction of Recreational Catch Discarded
1993	0.47
1994	0.50
1995	0.59
1996	0.62
1997	0.51
1998	0.47

These values are the same as the values shown in Figure 21 of Schirripa and Legault 1999.

Total Catch versus total F by Each Gear Type in Recent Years

In the stock rebuilding plan document (NOAA 2003), it is mentioned that about 90% of the total catch comes from the shrimp trawl fishery. However, because this catch comes from mainly age 0 and 1 individuals when natural mortality rates are highest, the relative contribution to total fishing mortality on a cohort will not be that large. In this section the total catches from each major source of fishing mortality for red snapper are compared with base case fishing mortality rates. The results are shown in Table 3. The total caught from shrimp bycatch makes up about 93% of the catch between 1994 and 1997. 1998 is not included in this average because of the introduction of by catch reduction devices (BRDs) in 1998. The total fishing mortality rate from shrimp bycatch however makes up 47% of the total fishing mortality. This drops to 35% in 1998. The retained recreational catch makes up 3% of the landings but 27% of the total fishing mortality. The retained commercial catch makes up 3.5% of the total catch but 22% of the total fishing mortality rate. This high contribution to fishing mortality rate despite the low percentage of landings is mainly because commercial gear tends to target older fish and is spread over more of the older age classes. The percentage contribution to total number killed of recreational releases is small, 0.8% but still contributes about 2% to total fishing mortality. The percentage contribution to total number killed of commercial releases is also small, 0.3% but still contributes about 1% to total fishing mortality. Based on these figures and assumptions, measures to reduce shrimp bycatch, recreational and commercial catch will contribute substantially to reducing total fishing mortality rates. In combination, recreational and commercial landed catch have made up about 49% of the total fishing mortality rate. After 1998, and under similar total allowable catch regimes, these two gears will make up even more of the total fishing mortality rates (61%) because of the reduced shrimp bycatch from BRDs. However, under base case assumptions, measures to reduce the number of discards from recreational and commercial fishing will have relatively little overall impact on the total fishing mortality rates due to their low contributions to total fishing mortality. When combined the contribution to the total mortality rate is about 3% both before and during 1998.

Table 3. Estimates of total numbers of killed red snapper under base case assumptions in the Schirripa and Legault (1999) stock assessment by each gear type and the total estimated fishing mortality rate for years 1994 to 1998.

	Shrimp Trawl		Recreational				Combined Commercial			
			Landed		Discarded Dead		Landed		Discarded Dead	
Year	Total Catch	Total F	Total Catch	Total F	Number	Total F	Total Catch	Total F	Number	Total F
1994	40,858,979	1.96	1,737,063	1.38	309,149	0.09	847,448	0.80	100,160	0.05
1995	43,077,731	1.96	1,221,992	1.05	242,258	0.08	681,784	0.78	76,977	0.03
1996	35,123,870	1.87	1,127,341	1.02	324,700	0.09	1,075,054	1.11	154,687	0.06
1997	39,169,010	2.35	1,600,470	1.30	526,714	0.13	1,114,733	1.21	114,341	0.04
1998	25,956,925	1.42	1,669,248	1.27	347,469	0.11	1,013,391	1.18	86,824	0.03
1998 values as %age	89%	35%	5.7%	32%	1.2%	2.8%	3.5%	29%	0.3%	0.8%
94-97 av.	39,557,397	2.04	1,421,717	1.19	350,705	0.10	929,755	0.98	111,541	0.04
94-97 av. as %age	93%	47%	3%	27%	0.8%	2%	2%	22%	0.3%	1.0%

<u>Updated estimates of the contributions to total fishing mortality rates using larger estimates of discard mortality rates for commercial and recreational discards</u>

The study by Wilson et al. (2003) indicates that the fraction of discards dying when released from commercial gear could be about 69% or 84%. These alternative mortality values for commercial discards were applied instead of the base case value of 33%. Wilson et al. (2003) did not study discard mortality from recreational catches but their results suggest that the base case value of 20% mortality in recreational discards might also be too low. For this exploratory analysis, the base case mortality value for recreational discards of 20% was thus replaced with increased values using the same multipliers in the two updated commercial discard mortality values. The two alternative values for recreational discard mortality that were applied were 42% and 51%.

The main effect of these alternative recreational and commercial discard mortality values is to approximately double the percentage contribution for commercial and recreational discards to the total fishing mortality (fishing mortality summed across ages to reflect the total fishing mortality that a cohort would experience under recent fishing conditions) to about 6-7% (Tables 4 and 5). This is still a relative small fraction of the total mortality rate but because it occurs just before fish recruit to the fishery, these values start to become more import. For example, under the largest release mortality scenario, the relative increase in catch of age 2 fish is 82% over the base case. For age 3 fish this increase is 26% over the base case. Approximate average fishing mortality rates for age 2 and 3 fish increase from 0.07 and 029 under the base case to about 015 and 0.42 with the revised discard mortalities. However, when viewing the 1998 results with the effects of the shrimp BRD included, the largest contributions to total fishing mortality are still the retained catches from the recreational and commercial sectors combined (59-60%). In 1998, the shrimp bycatch contributed 34% of the total fishing mortality. Please note that these estimates are only very approximate based on spreadsheet calculations using inputs from Schirripa and Legault (1999) and were not made by re-doing the catch-age analyses, due to the lack of time available.

Implications of potential reductions in fishing mortality from the various contributing sources

The estimates of the relative contributions to total fishing mortality were used to model the total relative reduction in fishing mortality that could be obtained by various approaches to reducing fishing mortality from the various contributing sources. These calculations were done first for the base case estimates of discard mortalities and then with the revised values suggested by Wilson et a. (2003). The initial conditions are assumed to be those in the years just before 1998 when BRDs were introduced into the shrimp trawl fishery. The impacts of the introduction of BRDs and potential reductions in shrimp trawl effort are also included. Tables 6 and 7 demonstrate that relying only on reductions in F from BRDs or BRDs and reduced shrimp fishing effort would reduce the total fishing mortality rates by only about 30% of the pre-1998 levels. Reduction of the red snapper TAC is required for more substantial reductions in total F. This in combination with a reduction in shrimp effort and with the BRDs in place would result in a reduction to 61% of the pre-1998 total fishing mortality rate. If bycatch from the recreational and commercial fisheries was only 3% under the base case discard mortality assumption, then an elimination of discard mortalities would reduce the total mortality by another 3% down to 58%. If the discard mortality was 6% of the total then a reduction of this discard mortality together with a reduction in TAC, and reduction in shrimp trawl effort would put the total fishing mortality rate down to 56% of the pre-1998 total F.

Conclusions

Overall, very large reductions in fishing mortality rate are required to bring the cumulative fishing mortality rate to below the MSY level. Current estimates of cumulative F are about 4.5 (Schirripa and Legault 1999) and all different sectors contribute substantially to this cumulative F. The cumulative F under MSY, however, is about 0.6. Because the relative contributions to total fishing mortality are almost equally large between the three biggest contributors, conservation efforts that rely primarily on reductions in fishing mortality from only one or two of these sectors will fail. The same percentage reduction in the most heavily contributing sectors, i.e., shrimp trawl bycatch, and recreational and commercial landed catch (which each contribute approximately 30% to the total mortality rate) will count far more to achieving reductions in fishing mortality than achieving the same percentage reductions in commercial and recreational discards which even with the increased estimates of discard mortality contribute only about 6-7% of the cumulative mortality rate. Nonetheless, reductions in even the smallest contributor to cumulative fishing mortality will be of help. Thus, big reductions in shrimp trawl bycatch, recreational catch, commercial catch as well as recreational and commercial discards are required to bring the cumulative fishing mortality rate down to below that at MSY.

A strategic approach to achieving reductions in the Gulf of Mexico red snapper fishing mortality rate, thus requires among other things, cognisance of the current relative contributions of each different sector to the cumulative fishing mortality rate and their relative importance as targets for conservation efforts. If the relative size of the current contribution to cumulative fishing mortality rate is an indication of how much conservation effort is needed, then about 90% of the effort should be divided equally to the shrimp trawl fishery, and the recreational and commercial TACs. No more than about a 10th of the effort should be directed at the reduction of discard mortality from the recreational and commercial fisheries. No doubt, the relative ease with which the reductions in each of the different sources of fishing mortality can be achieved is also an important consideration but will not be considered here.

Table 4. Estimates of total numbers of killed red snapper under altered discard mortality rates but otherwise base case assumptions in the Schirripa and Legault (1999) stock assessment by each gear type and the total estimated fishing mortality rate for years 1994 to 1998. Recreational release mortality is set at 0.41 and Commercial release mortality is set at 0.69.

	Shrimp Trawl		Recreational				Commercial			
			Rec retained		Rec disc		Com ret		com disc	
Year	Total Catch	Total F	Total Catch	Total F	Number	Total F	Total Catch	Total F	Number	Total F
1994	40,858,979	1.96	1,737,063	1.39	504,860	0.17	847,448	0.81	100,160	0.10
1995	43,077,731	1.97	1,221,992	1.06	530,118	0.14	681,784	0.78	76,977	0.07
1996	35,123,870	1.87	1,127,341	1.01	415,416	0.15	1,075,054	1.10	154,687	0.12
1997	39,169,010	2.35	1,600,470	1.30	556,784	0.22	1,114,733	1.21	114,341	0.08
1998	25,956,925	1.42	1,669,248	1.27	903,191	0.18	1,013,391	1.18	86,824	0.07
1998 values as %age	88%	34%	5.7%	31%	1.2%	4.5%	3.4%	29%	0.6%	1.7%
94-97 av.	39,557,397	2.04	1,421,717	1.19	350,705	0.17	929,755	0.98	222,886	0.09
94-97 av. as %age	93%	46%	3%	27%	0.82%	4%	2%	22%	0.52%	2%

Table 5. Estimates of total numbers of killed red snapper under altered discard mortality rates but otherwise base case assumptions in the Schirripa and Legault (1999) stock assessment by each gear type and the total estimated fishing mortality rate for years 1994 to 1998. Recreational release mortality is set at 0.41 and Commercial release mortality is set at 0.69.

	Shrimp Trawl		Recreational				Commercial			
			Rec retained		Rec disc		Com ret		com disc	
Year	Total Catch	Total F	Total Catch	Total F	Number	Total F	Total Catch	Total F	Number	Total F
1994	40,858,979	1.96	1,737,063	1.40	588,108	0.20	847,448	0.81	100,160	0.13
1995	43,077,731	1.97	1,221,992	1.06	617,532	0.16	681,784	0.78	76,977	0.09
1996	35,123,870	1.87	1,127,341	1.01	483,916	0.17	1,075,054	1.10	154,687	0.14
1997	39,169,010	2.35	1,600,470	1.29	648,595	0.25	1,114,733	1.21	114,341	0.09
1998	25,956,925	1.42	1,669,248	1.27	1,052,123	0.21	1,013,391	1.18	86,824	0.08
1998 values as %age	88%	34%	5.6%	31%	1.2%	5.1%	3.4%	28%	0.7%	2.0%
94-97 av.	39,557,397	2.04	1,421,717	1.19	350,705	0.20	929,755	0.98	271,340	0.11
94-97 av. as %age	92%	45%	3%	26%	0.82%	4%	2%	22%	0.63%	3%

Table 6. Evaluation of the relative effects of reductions in the various components of total fishing mortality rate on total fishing mortality rate relative to pre 1998 values under base case assumptions for discard mortality from commercial and recreational fishing. Snapper targeted F is the relative F for both the commercial and recreational landed catch combined. The TAC reduction is assumed to be by about 33%.

Time + situation	Snapper targeted F	Snapper Bycatch F	Combined total target and non-shrimp bycatch F	Snapper target percent tot F	Fshrimp (pre 99 with no BRD)	BycatchReduction Factor	Shrimp Effort Reduction factor	Shrimp F product	Shrimp bycatch percent F	Total F relative to pre-98
before 1998	0.5	0.03	0.53	53	0.47	1	1.0	0.47	47	1.00
1998 + after BDR	0.5	0.03	0.53	65	0.47	0.6	1.0	0.28	35	0.81
1998 + after BDR + effort reduction	0.5	0.03	0.53	70	0.47	0.6	0.8	0.23	30	0.76
1999 + after BDR + effort reduction	0.5	0.03	0.53	73	0.47	0.6	0.7	0.20	27	0.73
1998 + after BDR + effort reduction	0.5	0.03	0.53	76	0.47	0.6	0.6	0.17	24	0.70
1998 + after improved BDR + effort reduction	0.5	0.03	0.53	76	0.47	0.5	0.7	0.16	24	0.69
1998 + after improved BDR + effort reduction	0.5	0.03	0.53	79	0.47	0.5	0.6	0.14	21	0.67
1998 + after improved BDR + effort reduction	0.5	0.03	0.53	80	0.47	0.4	0.7	0.13	20	0.66
1998 + after BDR +lower TAC	0.35	0.03	0.38	57	0.47	0.6	1.0	0.28	43	0.66
1998 + after BDR + effort reduction+lower TAC	0.35	0.03	0.38	63	0.47	0.6	0.8	0.23	37	0.61
1998 + after BDR + effort reduction+lower TAC	0.35	0.03	0.38	69	0.47	0.6	0.6	0.17	31	0.55
1998 + after BDR + effort reduction+eliminate bycatch	0.5	0.00	0.5	69	0.47	0.6	0.8	0.23	31	0.73
1998 + after BDR + effort reduction+eliminate bycatch+reduce TAC	0.35	0.00	0.35	61	0.47	0.6	0.8	0.23	39	0.58

Table 7. Evaluation of the relative effects of reductions in the various components of total fishing mortality rate on the total fishing mortality rate relative to the pre-1998 values under revised assumptions for discard mortality from commercial and recreational fishing.

Time + situation	Snapper targeted F	Snapper Bycatch F	Combined total target and non-shrimp bycatch F	Snapper target percent tot F	Fshrimp (pre 99 with no BRD)	Bycatch Reduction Factor	Shrimp Effort Reduction factor	Shrimp F product	Shrimp bycatch percent F	Total F relative to pre-98
before 1998	0.48	0.06	0.54	54	0.46	1	1.0	0.46	46	1.00
1998 + after BDR	0.48	0.06	0.54	66	0.46	0.6	1.0	0.28	34	0.82
1998 + after BDR + effort reduction	0.48	0.06	0.54	71	0.46	0.6	0.8	0.22	29	0.76
1999 + after BDR + effort reduction	0.48	0.06	0.54	74	0.46	0.6	0.7	0.19	26	0.73
1998 + after BDR + effort reduction	0.48	0.06	0.54	77	0.46	0.6	0.6	0.17	23	0.71
1998 + after improved BDR + effort reduction	0.48	0.06	0.54	77	0.46	0.5	0.7	0.16	23	0.70
1998 + after improved BDR + effort reduction	0.48	0.06	0.54	80	0.46	0.5	0.6	0.14	20	0.68
1998 + after improved BDR + effort reduction	0.48	0.06	0.54	81	0.46	0.4	0.7	0.13	19	0.67
1998 + after BDR +lower TAC	0.34	0.06	0.4	59	0.46	0.6	1.0	0.28	41	0.68
1998 + after BDR + effort reduction+lower TAC	0.34	0.06	0.4	64	0.46	0.6	0.8	0.22	36	0.62
1998 + after BDR + effort reduction+lower TAC	0.34	0.06	0.4	71	0.46	0.6	0.6	0.17	29	0.57
1998 + after BDR + effort reduction+eliminate bycatch	0.48	0.00	0.48	68	0.46	0.6	0.8	0.22	32	0.70
1998 + after BDR + effort reduction+eliminate bycatch+reduce TAC	0.34	0.00	0.34	61	0.46	0.6	0.8	0.22	39	0.56

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