

Discard in the 2002 and 2003 Groundfish Trawl Fisheries:  
A Comparison of MRAG and NW Fishery Science Center Analyses

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## Introduction

In July 2005, the report, *Wasted Resources: Bycatch and discards in U. S. Fisheries* (Harrington, et al. 2005), was released by MRAG Americas, Inc. This analysis (referred to as MRAG, hereafter) included estimates of discard for fisheries throughout the United States. Included in the report were estimates of discard in the west coast non-whiting groundfish trawl fishery for 2002 and 2003. The NWFSC has developed estimates of discard for these years which are significantly lower for several species than those contained in the MRAG report. The purpose of this report is to provide an overview and comparison of the methods used and to review the discard conclusions of each analysis.

## Overview

The 2005 MRAG analysis used amounts of discarded and retained fish published in the NWFSC's West Coast Groundfish Observer Program (WCGOP) Initial Data Report (WCGOP 2003) and summary fishery landings data to estimate the total discard weight of a variety of species caught in the limited-entry groundfish trawl fishery in 2002 and 2003. The NWFSC estimates of total trawl discard of these species was developed using raw data from WCGOP, logbook, and fish ticket programs. Fleet-wide estimates of discard from these analyses are presented in Table 4. The estimated combined discard for 18 species in the MRAG analysis was 50% higher for 2002 and three times higher for 2003 than the amounts estimated by the NWFSC. There are a number of significant differences between the methods used to estimate discards by the NWFSC and by MRAG which contributed to the disparity of these estimates.

These methodological differences are summarized as follows:

- 1. MRAG assumed that discard rates were constant from September 2001 to the end of 2003.** The discard rates used by MRAG were calculated from data collected between September 1, 2001 and August 31, 2002. Using these discard rates to determine discards for the 2002 trawl fishery is reasonable. However, significant changes in groundfish fishery management, such as the closing of conservation areas to fishing, were initiated in 2003 and the resulting changes in fishing behavior cannot be captured in data from the previous collection time period. The NWFSC estimates utilized data collected in 2003 for estimating the amount of discarded fish in 2003.
- 2. The NWFSC and MRAG methods utilized different data stratifications.** In the WCGOP Initial Data Report, observer data were summarized using five target fishing strategies: DTS, flatfish, shelf rockfish, slope rockfish, and non-groundfish. Each observed haul was assigned to a single strategy using decision rules based on retained species composition. In the NWFSC analysis of fleet discard outlined here, data were stratified using geographic area (North and South of 40° 10' N. latitude) and fishing depth, but not target strategy. The move away from using target-strategy categories is also reflected in the second Observer Program Report (WCGOP 2004), and was motivated primarily by the reduction in the diversity of available fishing strategies that has accompanied management efforts to rebuild numerous species. The data

stratification used by MRAG included the same geographic areas and the target strategy categories included in the Initial Data Report.

**3. Different approaches were used to expand observed discard to a fleet-wide level.**

MRAG chose selected species listed in the Initial Data Report to represent each target strategy. No species was chosen as a target species in more than one strategy. For the combined target species in each strategy, ratios of retained catch by the total versus observed fleets were used to expand observed amounts of discard within each strategy. In the NWFSC analysis, estimates of discard for species that were regarded as bycatch species, observed discard was expanded using the total retained catch of all target species, without reference to target fisheries. Since most of these species had very restrictive landing limits, reliable estimates of total discard are difficult to obtain without using the amount of effort directed towards other species to expand data from limited observations. For commonly targeted species estimates of total discard were based solely on retained and discarded catches of the individual species. Since trip limits for these species are far less restrictive and fisher groundfish income is reliant upon them, fleet-wide landed catches, at the individual species level, provide a reliable and more direct basis for expanding observer data.

**4. The manner in which MRAG assigned and used representative target species to expand observed discards was inconsistent with how target strategy designations were constructed for the WCGOP report.**

**4.A.** When applying the WCGOP decision rules to categorize each haul, the overall landings of an individual species were commonly distributed among several fishing strategies. For example, although retained catch of petrale sole was assigned principally to the Flatfish strategy, it is present in all strategies, and nearly 7% of the observed total is assigned to the DTS strategy. The MRAG analysis compared the fleet-wide landings of each designated target species to observed landings only within the single strategy it was chosen to represent.

**4.B.** Additionally, for most of the fishing strategies, the Initial Data Report does not provide data for all species used by the decision rule in assigning a strategy to a haul. As a result, the landings of species chosen by MRAG for expanding most strategies represent only a fraction of the poundage associated with all of the strategy's target species.

**5. MRAG applied discard rates to a broader group of fishing vessels, including those fishing under different regulations or with different gear.**

For example, trawl tows conducted under Exempted Fishing Permits (EFPs) were not included in the WCGOP Initial Data Report utilized by MRAG. EFP fishing operates under different regulations than regular limited-entry trawl management. For example, several recent EFPs have required full retention of some species. Thus, applying discard rates from the limited-entry trawl fleet to EFP trips, or visa-versa, may not be appropriate. There were two bottom trawl EFPs conducted in 2002 and two EFPs in 2003. The catch landing summaries used by MRAG included all fish landed under EFPs as well as regular

landings. In the NWFSC analysis, EFP fishing was separated from regular trawl fishing in circumstances where retention requirements would affect the rates at which species were discarded.

- 6. The MRAG report does not differentiate between discard and discard mortality, implying that all discarded fish are expected to die.** In contrast, the Council has assumed that a substantial portion of the sablefish and lingcod that are discarded survive.

## Methods

### *MRAG methods used to estimate discards in the 2002 and 2003 non-whiting trawl fisheries*

The following is a summary of our understanding of how the analyses by MRAG were conducted. We have developed this summary based on communications with J. Harrington, the senior author of the work. We appreciate the time that the author has taken to explain the details of their analysis.

The MRAG analysis of discard in the west coast groundfish trawl fishery was based on observations conducted in this fishery between September 2001 and August 2002, as summarized in the report, “West Coast Groundfish Observer Program Initial Data Report and Summary Analyses January 2003”. In the Initial Data Report, amounts of discarded and retained catch are summarized for numerous species, according to depth, season, area, and target fishery strata.

The target strategies included in the Initial Data Report consisted of: DTS, flatfish, shelf rockfish, slope rockfish, and non-groundfish. Each observed haul was assigned to one of these target strategies, using an algorithm based on retained species composition. The catch of all species from a haul was assigned to the same target strategy. Therefore, retained and discarded amounts of sablefish, for example, were associated with nearly all target strategies, even though the presence of retained sablefish was only used in determining whether a DTS designation would be applied to a haul.

For the MRAG analysis, data associated with each non-whiting target fishery were combined across depth and season strata, yielding 12-month totals for discarded and retained catch for each reported species within each area and target fishery/strategy classification (Harrington, pers. comm.). Next, observed amounts of discard were expanded within each fishing strategy. From the set of individual species identified in the Initial Data Report, key species within each target strategy were assigned by MRAG to represent fishing effort. The key species assigned to each target strategy were:

- DTS: Dover sole, shortspine and longspine thornyheads, and sablefish
- Flatfish: petrale sole and arrowtooth flounder
- Shelf rockfish: bocaccio, chilipepper, canary, cowcod, widow, yellowtail, and yelloweye rockfishes
- Slope rockfish: darkblotched and splitnose rockfish and Pacific ocean perch
- Non-groundfish: sharks and skates

For the combined target species in each strategy, trawl landings in 2002 and 2003 were summarized for northern and southern areas, using data obtained from the Pacific Fishery Information Network (PacFIN). Next, expansion factors were constructed by dividing these annual area totals by the combined retained amounts of each strategy's target species, as compiled from the Initial Data Report. Strategy- and area-specific estimates of discard were computed by multiplying these expansion factors by the observed discards of all reported species within each area and target strategy. These estimates were then summed across fishing strategies to produce the area-wide discard estimates provided in the MRAG report.

An example which illustrates the derivation of the MRAG discard estimate for sablefish in the area north of 40°10' N. Lat. is presented in Table 1. Column A lists the pounds of sablefish discard observed, for the NMFS-defined target strategies and depth intervals. In Column B, these amounts are combined across depths for each strategy, and converted to metric tons in Column C. Column D summarizes the observed retained tonnage of the "target" species which were selected by MRAG to represent each strategy, for purposes of expanding the observed discard. Column E reports the entire trawl fleet's 2002 landed catch, in the northern area, of MRAG's selected target species. Dividing Column E by Column D yields the expansion factors shown in Column F. These expansion factors are then multiplied by the observed sablefish discard amounts in Column C, producing the strategy-specific estimates of sablefish discard (Column G) that are summed to obtain an estimate for all trawl discard of sablefish in the northern area. Columns H, I, and J provide comparable data to Columns E, F, and G for use in deriving estimated sablefish discard in 2003. It should be noted that this derivation of the discard amounts in Column G (or J) is equivalent to calculating a discard ratio by dividing Column C by Column D, and multiplying that ratio by the fleet landings in Column E (or H).

### ***Methods used by the NW Fisheries Science Center to estimate discards in the 2002 and 2003 non-whiting trawl fisheries***

The approach used by the NWFSC is based on methods developed and reviewed by the SSC for projecting catch and discards in the trawl fishery. Amounts of observed discarded and retained species were summarized within each of seven depth strata for northern and southern areas (divided at 40°10' N. Lat.). For major target species (e.g. DTS, flatfish), discard ratios were calculated within each stratum by dividing the amount of a species that was discarded by its retained weight. For bycatch species (those under rebuilding plans and hake), discard ratios were calculated by dividing the amount of a species that was discarded by the sum of the retained target species weight.

Retained weights of individual and combined target species recorded in trawl logbooks were summarized using the same area and depth stratification scheme. For a designated target species, the estimated discard within each stratum was calculated by multiplying the stratum retained weight of that species recorded in logbooks by the observed discard ratio for that species and stratum. For a designated bycatch species, the estimated discard within each stratum was calculated by multiplying the observed discard ratio for that species and stratum by the retained weight of all designated target species in that stratum, as recorded in the logbooks.

Not all landings have a corresponding entry in the logbook data base. To adjust for these missing records, ratios of fish ticket-to-logbook species poundage were used to expand the estimates of discard for logbook trips up to a coast-wide directed trawl total. For rebuilding species, the expansion ratios used the combined target-species retained weights from each data set. For the target species, the retained poundage of each individual species was used to expand that species' estimated discard. Expansion ratios were calculated for each area, state, and 2-month period. Following application of the expansion ratios, discard amounts were then aggregated coast-wide.

Several trawl Exempted Fishing Permit (EFP) programs were conducted during 2003 and all required full retention of *Sebastes* species. Since all potential discards were landed and captured within the fish ticket reporting system, application of non-EFP discard rates to all logbook tows would have overstated the true amounts of discard (and total catch) for *Sebastes* species. Because an official listing of tows conducted as part of EFPs was not available at the time these estimates were made, an interim approach for categorizing EFP tows is used. During 2003, only EFP participants had the ability to legally bottom trawl for groundfish within the trawl RCA. Utilizing this restriction, rockfish discard rates were not applied to target tonnage caught within the RCA depths off Oregon and Washington. Additionally, the principal EFP in Washington allowed large amounts of arrowtooth flounder to be landed in excess of trip limits. Accordingly, tows by Washington vessels that exceeded the 2-month allowance of arrowtooth flounder for non-EFP vessels are also categorized as EFP tows. The total target species poundage estimated for EFPs, using these criteria, was also subtracted from fish ticket landings in each state and 2-month period before expansion ratios were calculated.

An example which illustrates the derivation of the NWFSC discard estimate for sablefish the area north of 40°10' N. Lat. is presented in Table 2. Columns A and B summarize observed sablefish retention and discard, respectively, for the seven depth intervals used in the analysis. Dividing Column B amounts by those in Column A yields the ratios of discarded-to-retained catch shown in Column C. Column D summarizes retained amounts of sablefish reported in logbooks for each depth interval. Estimated discard, at the logbook level (Column E), is obtained by multiplying the retained catch (Column D) by the discard ratio (Column C). The amount of sablefish landed in the northern area, for all depths, is shown in Column F. The ratio of fish-ticket-to-logbook tonnage (Column F divided by Column D) is shown in column G. This ratio is multiplied by the Column E total to expand the logbook-level discard estimate up to the entire fleet (Column H).

### ***Major areas of difference between MRAG and NWFSC discard estimation methods***

The two approaches outlined above reflect several important methodological differences.

1. The MRAG group used 2002 discard information to estimate discard in both the 2002 and 2003 fishery. The WCGOP data through August 2003 was reviewed, posted and available in January 2004 and could have been used by MRAG for their report published in 2005. This is

important since the management measures in 2002 were very different from those used in 2003. The NWFSC analysis outlined here used 2003 data to estimate discard for the 2003 fishery.

Fishery managers implemented a number of more restrictive measures for the 2003 limited-entry groundfish trawl fishery. The most significant change in management was the creation of the trawl Rockfish Conservation Area (RCA) in January 2003. The RCA restricted groundfish trawling to depths shallower than 75-100 fathoms and deeper than 150-200 fathoms, depending on the time of year. These restrictive measures altered the behavior of fishers, thereby changing discard rates in the fishery. The NWFSC West Coast Groundfish Observer Program Data Report and Summary Analysis released in January 2004, which summarized discard rates from September 1, 2001 through August 31, 2003, showed a substantial reduction of discard percentages between the initial year of data collection and the second year of data collection (WCGOP 2004). For instance, during the first year of analysis, 17% of coast-wide observed Dover sole catch was discarded. During the second year, the discard rate for observed Dover sole catch fell to 10% in every observed area-depth stratum.

2. The MRAG analysis combined observed discard poundage across depth strata in an unweighted manner. As a result, in situations where the distribution of observed hauls and retained poundage is significantly different from that of the overall fleet, the MRAG approach would lead to biased estimates of total discard. The NWFSC analysis herein addressed the potential for disproportionate observer coverage through applying observed depth-specific discard rates to the actual fleet fishing activity reported in logbooks for the same depth intervals.

The January 2003 Observer Program report summarized observed fishing according to five target strategy categories, which were assigned on an individual haul basis. These assignments were based on the species composition of the retained catch. This categorization was not included in subsequent observer reports for the trawl fleet, nor was it utilized in the current NWFSC analysis of discard for 2002-03. Management efforts to rebuild numerous species have effectively reduced the number of fishing strategies available to the trawl fleet and fishing depth provides a simpler method for capturing differences among the strategies that remain. The MRAG analysis was based on expanding observed discard within the five non-whiting target fishery categories, using their assignment of principal species within each target fishery.

However, as is readily apparent in Table 3, most species are retained, and can be significant contributors to, more than one target fishery. Therefore, using a small number of species to expand observations in each target fishery and restricting a species from being used to expand more than one fishery is inconsistent with the manner in which target fisheries were defined in the observer report, and is likely to introduce bias into the estimates of total discards. Furthermore, the strategy designations that were assigned at the haul level for summary in the Observer report were based on evaluation of many more species than were reported individually. The poundage of all flatfish species, including additional species such as English and rex soles, sanddabs, and starry flounder, was used in assigning a haul to the Flatfish strategy. Since all of these species were not included in the Initial Data Report's tables, they were not readily available for use by MRAG. As a result their discard expansions within the Flatfish, and other strategies, are based on the limited number of species they used to define those strategies. This shortcoming is likely to introduce an additional source of bias into the MRAG estimates. In

short, the strategies used to summarize observations in the Initial Data Report were neither designed nor intended to be used for expanding observed discard in the manner employed by MRAG.

3. The ratios used to expand the observed discard amounts of target species were very different. In the NWFSC approach herein, discarded-to-retained ratios and the expansions of observed amounts were calculated on an individual species basis. As presented in the example above, the estimated amount of total sablefish discard was estimated solely as a function of observed discarded and retained sablefish and the amount of retained sablefish recorded in logbooks and fish tickets. For bycatch species, discard ratios were calculated relative to the combined retained amounts of all target species, without consideration of target strategy.

In the MRAG analysis, the overall discard estimates for all species were based on the rate of a species' discard relative to the target species which they designated for each fishing strategy. Notwithstanding the reliance on target strategies and the related considerations identified above, this approach is conceptually similar to the NWFSC analysis of bycatch species' discard. However, the rationale behind the NWFSC's use of this approach is based on the restrictiveness of landing limits for rebuilding species, and any other factors that may have affected the propensity for fishers to land these species. For species that are targeted and routinely landed, it is not clear that estimating discard as a function of the catch of other species is the most reliable approach.

4. The MRAG report did not account for the substantial amount of EFP fishing that occurred in 2003 in the northern area. Since these EFPs required full retention of *Sebastes* species, their use of all trawl landings to expand the strategy-specific discard amounts would be expected to over-estimate *Sebastes* discard in the northern area.

## Comparison of Results

A comparison of the coast-wide discard estimates from each of these analyses is presented in Table 4. As addressed in footnote 1, the NWFSC estimates for bocaccio, chilipepper, cowcod, and splitnose are for the area south of 40°10' N. Lat., only. These estimates were restricted to this area because individual ABCs/OYs for these species are only specified for the southern area. The amount of gross discard summed across all species for which estimates were made in both analyses is significantly higher in the MRAG analysis. In addition to being about 1.5 times higher than the NWFSC estimate in 2002 and more than 3 times higher in 2003, the MRAG estimates increase between the two years, while the NWFSC estimates drop by nearly 50%. Given that no 2003 observer data are employed in the MRAG estimates for 2003 fishery, and the Rockfish Conservation Areas were implemented for the first time in 2003, there is no basis for believing either the magnitude or the trend implied by the 2003 MRAG results. The discussion provided above, regarding the questionable use of the target fishery strategies in MRAG's expansion of observed discard, calls into question the magnitude of their estimates for both years.



In both years, sablefish and whiting are the two species where MRAG discard estimates exceed those produced by the NWFSC by the greatest amount. In the sablefish example provided above (Harrington, pers. comm.), the most striking element of the calculation is that roughly **44%** of the total sablefish discard in the northern area in each year (1,888 mt in 2002; 2,269 mt in 2003) is attributed to the Non-Groundfish strategy. Because sharks and skates were assigned by MRAG as the target species for this strategy, and only 2,200 lb were retained on observed hauls, an expansion factor of more than 1,100 was used to generate the huge amounts of discard attributed to this strategy. Since the amount retained shark/skate poundage assigned to the Non-Groundfish strategy represents less than 2% of the total retained amounts of those species that were observed, it is clear that using the ratio of total landed shark/skate poundage to the observed amount assigned to this strategy is not a reasonable method for expanding observed discard of other species in the Non-Groundfish strategy. Since the MRAG report provides only the total area discard estimates, without any of the intermediate calculations, it is not possible to easily ascertain what percentage of the total discard estimate for each species was attributed by them to the Non-Groundfish strategy.

Another important difference in the magnitude of discard estimates for sablefish and lingcod involves assumptions regarding mortality of discards. The MRAG report implies that all discards of these two species die. The columns in Table 4 summarizing the NWFSC estimates include amounts of mortality for each, based on the gross discard estimates and assumptions regarding survival of discards. Discard survival rates of 50% are used for both species, reflecting Council assumptions based on studies in the peer-reviewed literature, such as Davis and Olla (2002), Davis, et al. (2001), Olla, et al. (1997) and Olla, et al. (1998).

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Table 1.--MRAG derivation of estimated sablefish discards in the trawl fishery for the area north of 40°10' N. Lat. in 2002 and 2003.

Strategy	Depth range	From Observer Data (9/01-8/02)			Retained "target" <sup>1</sup> species (mt)	2002			2003		
		Sablefish Discard				Fleet total for "target" <sup>1</sup> species	Expansion Factor (FT / obs)	Est. Fleet Discard (mt)	Fleet total for "target" <sup>1</sup> species	Expansion Factor (FT / obs)	Est. Fleet Discard (mt)
		lb	lb	mt							
		[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]
<b>Non-Groundfish</b>	0-100 fm	3,568	3,579	1.6	1.0	1,129	1,131	1,888	1,395	1,398	2,269
	>200 fm	11									
<b>DTS</b> (Dover sole, sablefish, and thornyheads)	0-100 fm	82,142	193,841	87.9	780.6	7,051	9	794	8,800	11	991
	100-200	35,772									
	>200 fm	75,927									
<b>Shelf Rockfish</b>	0-100 fm	5,003	5,054	2.3	190.3	1,555	8	19	500	3	6
	100-200	51									
<b>Slope Rockfish</b>	0-100 fm	281	4,294	1.9	15.5	251	16	32	234	15	29
	100-200	3,442									
	>200 fm	571									
<b>Flatfish</b>	0-100 fm	437,776	476,850	216.3	490.9	3,611	7	1,591	4,094	8	1,804
	100-200	26,439									
	>200 fm	12,635									
<b>Total</b>			683,618	310				<b>4,324</b>			<b>5,100</b>

<sup>1</sup> Species designated by MRAG for use in expanding discards from observed vessels up to the fleet level:

**Non-groundfish:** sharks and skates

**DTS:** Dover sole, shortspine and longspine thornyheads, and sablefish

**Shelf rockfish:** bocaccio, chilipepper, canary, cowcod, widow, yellowtail, and yelloweye rockfishes

**Slope rockfish:** darkblotched and splitnose rockfish and Pacific ocean perch

**Flatfish:** petrale sole and arrowtooth flounder

Table 2.--Northwest Fishery Science Center derivation of estimated sablefish discards in the trawl fishery for the area north of 40°10' N. Lat. in 2002 and 2003.

	2002 data for sablefish							
	Observer program data			Logbook retained mt	Logbook-level discard mt	Landed (fish ticket) mt	fish ticket / logbook mt	Expanded discard mt
	retained lb	discard lb	discards / retained					
	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]
< 50 fm	4,800	29,809	6.21	15	94			
50-75 fm	25,867	189,377	7.32	56	410			
75-100 fm	21,841	85,011	3.89	78	303			
100-150 fm	16,527	24,830	1.50	48	73			
150-200 fm	10,360	29,908	2.89	47	134			
200-300 fm	99,285	102,359	1.03	216	223			
> 300 fm	174,281	63,579	0.36	393	143			
<b>All depths</b>	<b>352,961</b>	<b>524,873</b>	<b>1.49</b>	<b>853</b>	<b>1,380</b>	<b>1,025</b>	<b>1.20</b>	<b>1,576</b>

	2003 data for sablefish							
	Observer program data			Logbook retained mt	Logbook-level discard mt	Landed (fish ticket) mt	fish ticket / logbook mt	Expanded discard mt
	retained lb	discard lb	discards / retained					
	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]
< 50 fm	2,542	411	0.16	43	7			
50-75 fm	2,117	13,441	6.35	89	568			
75-100 fm	10,084	3,907	0.39	29	11			
100-150 fm	9	69	7.40	32	237			
150-200 fm	20,540	21,104	1.03	93	95			
200-300 fm	186,524	75,567	0.41	710	288			
> 300 fm	174,438	40,353	0.23	531	123			
<b>All depths</b>	<b>396,254</b>	<b>154,851</b>	<b>0.39</b>	<b>1,528</b>	<b>1,329</b>	<b>1,770</b>	<b>1.16</b>	<b>1,499</b>

Table 3.--Summary of amounts (lb) of retained and discarded trawl catch of selected species observed from September 2001 through August 2002, by area and assigned target strategy.

Species		Non-Groundfish			DTS			Shelf rockfish			Slope rockfish			Flatfish			All Targets		
		North	South	Coast	North	South	Coast	North	South	Coast	North	South	Coast	North	South	Coast	North	South	Coast
Whiting	Retained	0	326	326	153	0	153	0	40	40	0	0	0	1,526	83	1,610	1,679	449	2,129
	Discarded	3,692	484	4,176	141,883	31,078	172,961	75,769	33,103	108,872	13,358	9,763	23,121	436,717	13,668	450,385	671,419	88,096	759,515
Arrowtooth flounder	Retained	0	0	0	70,584	350	70,934	1,218	0	1,218	2,055	3	2,058	583,772	0	583,772	657,629	353	657,982
	Discarded	498	0	498	189,203	632	189,835	49,228	186	49,414	5,094	10	5,104	325,108	920	326,028	569,132	1,748	570,880
Petrale sole	Retained	0	100	100	39,338	692	40,030	4,520	3,357	7,878	1,259	3,390	4,649	498,373	49,973	548,346	543,490	57,512	601,003
	Discarded	671	0	671	10,065	19	10,083	2,309	95	2,405	142	62	204	54,217	1,428	55,645	67,404	1,604	69,009
Dover sole	Retained	0	100	100	1,006,946	508,913	1,515,859	2,088	622	2,710	3,619	557	4,176	119,647	731	120,378	1,132,300	510,923	1,643,223
	Discarded	222	820	1,041	120,431	94,587	215,018	5,504	3,292	8,796	2,922	4,650	7,572	121,002	2,611	123,613	250,080	105,960	356,040
Longspine thornyheads	Retained	0	2	2	278,704	188,149	466,853	0	0	0	0	5	5	0	0	0	278,704	188,156	466,860
	Discarded	0	230	230	53,383	36,454	89,838	0	1	1	2	7	9	515	0	515	53,901	36,692	90,593
Shortspine thornyheads	Retained	0	25	25	77,837	54,208	132,045	30	306	336	413	97	510	4,566	1	4,567	82,845	54,637	137,482
	Discarded	0	108	108	30,376	16,771	47,147	102	22	124	1,162	803	1,964	7,757	379	8,137	39,398	18,082	57,480
Thornyheads	Retained	0	0	0	35,814	8,589	44,404	0	0	0	0	17	17	2,058	0	2,058	37,872	8,606	46,478
	Discarded	0	0	0	46,265	19,304	65,569	0	68	68	131	283	414	945	9	955	47,341	19,664	67,005
Sablefish	Retained	0	595	595	321,591	97,295	418,886	926	5,225	6,151	1,860	902	2,763	29,761	1,606	31,367	354,138	105,623	459,761
	Discarded	3,579	67	3,647	193,841	70,428	264,269	5,054	34,306	39,360	4,295	7,088	11,383	476,849	16,882	493,731	683,618	128,772	812,390
Bocaccio	Retained	0	0	0	99	371	470	158	1,824	1,981	10	19	29	1,881	728	2,609	2,148	2,941	5,089
	Discarded	87	18	104	381	165	546	139	6,471	6,611	73	1,220	1,293	907	5,212	6,119	1,588	13,085	14,673
Chilipepper	Retained	0	29	29	215	841	1,056	150	44,627	44,777	56	24	79	7	6,377	6,384	428	51,898	52,326
	Discarded	0	0	0	266	256	522	369	25,823	26,192	899	1,689	2,588	2,533	14,576	17,110	4,067	42,345	46,412
Canary rockfish	Retained	0	0	0	1,704	75	1,779	3,746	164	3,910	16	0	16	6,973	234	7,207	12,440	472	12,912
	Discarded	352	0	352	1,240	24	1,264	3,073	1	3,074	137	3	140	5,219	129	5,348	10,021	157	10,178
Cowcod	Retained	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	4	0	4
	Discarded	0	0	0	0	42	42	0	466	466	0	32	32	7	242	249	7	782	789
Widow rockfish	Retained	0	0	0	92	0	92	195,607	207	195,814	33	0	33	303	52	355	196,035	259	196,293
	Discarded	0	3	3	26	12	38	132	28	160	63	73	135	324	60	384	544	176	721
Yellowtail rockfish	Retained	0	0	0	2,619	0	2,619	219,942	0	219,942	0	0	0	18,501	46	18,547	241,062	46	241,108
	Discarded	650	0	650	1,605	0	1,605	36,479	0	36,479	274	0	274	6,768	3	6,771	45,777	3	45,780
Yelloweye rockfish	Retained	0	0	0	70	0	70	22	1	23	7	0	7	118	17	135	217	18	235
	Discarded	0	0	0	16	0	16	5	1	6	7	14	22	146	32	178	174	48	222
DarkBlotched rockfish	Retained	0	0	0	2,625	454	3,079	255	19	274	3,751	205	3,956	645	51	696	7,275	730	8,005
	Discarded	12	0	12	6,100	101	6,200	361	76	437	4,662	167	4,829	16,047	203	16,250	27,181	546	27,728
POP	Retained	0	0	0	9,920	10	9,930	171	0	171	30,094	0	30,094	10,782	0	10,782	50,967	10	50,977
	Discarded	6	0	6	2,006	2	2,008	76	0	76	2,929	34	2,964	1,681	0	1,681	6,698	37	6,735
Splitnose rockfish	Retained	0	278	278	320	1,482	1,801	2	112	114	310	29,974	30,284	90	1,065	1,155	721	32,911	33,633
	Discarded	1	407	408	10,657	3,780	14,437	206	1,052	1,258	8,908	8,831	17,740	8,031	1,044	9,075	27,803	15,114	42,917
Black rockfish	Retained	0	0	0	0	0	0	46	0	46	0	0	0	214	0	214	260	0	260
	Discarded	0	0	0	0	0	0	0	0	0	0	0	0	759	0	759	759	0	759
Lingcod	Retained	0	652	652	6,135	90	6,225	2,039	2,115	4,154	194	55	249	13,678	2,283	15,961	22,046	5,195	27,241
	Discarded	511	105	616	14,326	326	14,652	4,141	2,396	6,537	1,054	5,456	6,510	62,375	7,709	70,084	82,407	15,991	98,399
Pacific Halibut	Retained	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Discarded	13	0	13	7,597	0	7,597	542	0	542	97	0	97	18,219	39	18,258	26,469	39	26,508
Salmon	Retained	0	59	59	0	0	0	0	0	0	0	0	0	4	33	37	4	92	96
	Discarded	124	15,100	15,224	836	8	844	288	44	332	88	12	101	7,933	215	8,148	9,270	15,378	24,648
Shark, Skate	Retained	2,200	6,223	8,423	47,315	4,251	51,566	3,470	3,337	6,807	1,785	250	2,035	281,697	17,130	298,827	336,467	31,190	367,658
	Discarded	1,953	15,140	17,093	197,511	56,120	253,630	15,146	29,949	45,094	11,767	9,099	20,866	463,585	105,089	568,673	689,961	215,395	905,357

Table 4.--Comparison of discard for selected species in the non-whiting groundfish trawl fishery during the 2002 and 2003 fisheries, as estimated by MRAG (2005) and NWFSC (2004).

	2002				2003			
	MRAG			NWFSC Coast- wide	MRAG			NWFSC Coast- wide
	North of 40°10'	South of 40°10'	Coast- wide		North of 40°10'	South of 40°10'	Coast- wide	
Whiting	4,351	344	4,695	1,841	4,887	231	5,118	1,255
Arrowtooth flounder	2,340	7	2,347	4,128	2,604	6	2,611	587
Petrale sole	585	7	592	185	685	7	692	105
Dover sole	1,056	413	1,469	1,210	1,241	379	1,620	1,102
Longspine thornyhead	221	144	365	380	275	132	407	321
Shortspine thornyhead	159	71	229	355	193	67	259	432
Unspecified thornyheads	194	77	271		241	71	312	
Sablefish	4,321	509	4,831	1,814	5,098	374	5,471	1,615
mortality				907				808
Bocaccio <sup>1</sup>	52	53	104	27	61	31	92	2
Chilipepper <sup>1</sup>	17	172	189	141	17	79	97	2
Canary	221	1	221	36	254	1	254	14
Cowcod <sup>1</sup>	0	3	3	3	0	2	2	0
Widow	2	1	3	39	2	1	3	5
Yellowtail	508	0	508	396	490	0	490	4
Yelloweye	1	0	1	1	1	0	1	0
Darkblotched	118	2	120	94	130	2	132	39
POP	37	0	37	36	39	0	39	14
Splitnose <sup>1</sup>	136	52	188	21	145	65	210	7
Lingcod	555	63	619	269	642	65	706	139
mortality				135				70
<b>Sum of gross discard</b>	<b>14,871</b>	<b>1,920</b>	<b>16,791</b>	<b>10,975</b>	<b>17,003</b>	<b>1,513</b>	<b>18,515</b>	<b>5,644</b>
<b>Sum of discard mortality</b>				<b>9,933</b>				<b>4,767</b>
Black rockfish	3	0	3		3	0	3	
Pacific halibut	102	0	102		117	0	118	
Salmon	97	1	98		114	1	115	
Shark/skates	3,528	846	4,374		4,100	727	4,828	
<b>Total</b>	<b>18,600</b>	<b>2,768</b>	<b>21,368</b>		<b>21,337</b>	<b>2,242</b>	<b>23,579</b>	

<sup>1</sup> NWFSC estimates are for the area south of 40°10', only, since this corresponds to the area for which individual ABCs and OYs are set for these species

MRAG estimates obtained from: Table 90: Discards in the Pacific coast groundfish trawl fishery, 2002-2003. *Wasted Resources: Bycatch and discards in U. S. Fisheries*, Harrington, et al., 2005.