Appendix A
DESCRIPTION OF PROJECTION MODELS

2011-2012 GROUNDFISH HARVEST SPECIFICATIONS
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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This Appendix describes the projection models used for each fishery to estimate the total catch of selected non-overfished species (generally target species) and overfished species. Additionally, a description of trip limit models is provided for sablefish in the limited entry daily trip limit fisheries and open access.

A.1 Limited Entry Non-Whiting Trawl

This section was adapted from the Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2009-2010 Pacific Coast Groundfish Fishery Final Environmental Impact Statement Including Regulatory Impact Review and Initial Regulatory Flexibility Analysis (PFMC 2008).

The limited entry non-whiting trawl fishery is modeled using several different data sources that are compiled into a framework often described as the “trawl bycatch model”. The WCGOP provides discard estimates for target and rebuilding species by several different depth and latitudinal strata and these data are used to estimate discards of select species, depending on where fishing is estimated to be taking place.

In addition to discard rate estimates, staff at the WCGOP develop bycatch rates for rebuilding species that estimate the total catch of rebuilding species (landings and discard) based on a rate of rebuilding species catch to retained target species catch. These rates are used to estimate the catch of rebuilding species based on an estimated retained catch amount of target species in various locations. The location of fishing effort and catch is informed by logbook information. Logbooks record several pieces of information including the latitude, longitude, depth, month, species, and pounds of retained catch on a vessel by vessel basis. This information is used to indicate the productive potential of each vessel at various locations on a species by species basis. Logbooks do not, however, capture 100 percent of the landed catch that the limited entry trawl fleet generates. In order to develop spatial target species catch estimates that are reflective of all trawl landings, the weight of catch in logbook records are expanded up to the amount recorded on fish tickets from the three west coast states. In this exercise, the spatial distribution of catch recorded in logbooks is maintained, but the total amount is increased. Discard, bycatch rate, and logbook information is compiled into matrices stratified by bi-monthly period, 3 latitudinal strata, and 7 different depth strata.

The interface of the model selects for particular depth and latitudinal strata by imposing a distinct set of RCA boundaries within each of 3 latitudinal areas. For example, if RCA boundaries are set at 75 fm to 200 fm north of 40°10' N. latitude, the model selects records that are both deeper and shallower than the area between 75 fm and 200 fm. The model then estimates a depth preference for each active vessel based on logbook information and the established set of RCA boundaries. Logbook data indicates clear depth preferences and fishing success for individual vessels. Based on the set of RCAs imposed on the fishery, the model estimates whether a vessel will tend to fish deeper or shallower than the trawl RCA based on the preference of each vessel to fish in areas that remain open, and then selects the retained catch associated with that vessel from the depth strata where the vessel is estimated to be fishing.

In addition to RCA boundaries, the model interfaces controls for retained catch quantities by species and bi-monthly period. Historic records of vessel catch are matched up with historic catch limits. It is assumed that those vessels that have attained their trip limits in the past would catch their trip limits if those limits are increased. An increase in a trip limit therefore results in an increase in predicted catch only in cases where particular vessels have historically attained their trip limit. It is assumed that those vessels that have not attained their trip limit will not do so if the limit is raised. Inversely, as trip limits are reduced, the catch of each vessel is constrained, but only if the limit is less than their historic catch of a particular species. If a limit is reduced, some vessels may not be constrained by that limit because their historic catch levels have been relatively small.

After calculating retained catch on a vessel-by-vessel basis, and the location of that catch, the model estimates the catch of rebuilding species. This is done by aggregating the amount of target species predicted to be caught by various depth and latitudinal strata and multiplying those retained target species tonnages by the bycatch rates of rebuilding species that have been observed in the WCGOP. The result is then aggregated for each rebuilding species to derive an estimated annual catch of rebuilding species in the limited entry non-whiting trawl fishery.

Beginning in 2007, bycatch rates from the WCGOP were stratified in a more refined manner to accommodate more spatially refined management. This was done to more precisely manage the impacts of rebuilding species in the non-whiting trawl fishery. Data provided by the WCGOP included bycatch rates of rebuilding species in 8 sub-areas north of 40°10' N. latitude. This stratification allowed for analysis of more refined/focused spatial restrictions. This more refined bycatch data allows analysts to estimate an aggregate bycatch rate in areas north of 40°10' N. latitude that is based on a series of various depth restrictions in one or more of the eight subareas. For example, if an area off northern Washington is closed, analysts can re-estimate an aggregate bycatch rate for the areas remaining open and incorporate this new bycatch rate into the trawl model. The trawl model then uses this new bycatch rate to estimate the catch of rebuilding species that would be associated with a fishery that is closed off northern Washington. Bycatch rates used to project depleted species impacts in the fishery north of 40°10' N latitude and shoreward of the RCA (using selective flatfish trawls) are average annual rates from the last two years of WCGOP observations weighted equally by depth, area, and season (Table A-1). Bycatch rates used to project depleted species impacts in the fishery north of 40°10' N. latitude and seaward of the RCA are weighted average annual rates from that last four years of WCGOP observations and are modeled by depth and bi-monthly period (Table A-2).

Table A-1 Bycatch rates for rebuilding species used in projection modeling for 2010-12 trawl fisheries, expressed as a percentage of target species landings, by area, depth zone and bi-monthly period, based on data collected by the West Coast Groundfish Observer Program between May 2005 and April 2009.

Area	2-month period	< 50 fm	< 60 fm	< 75 fm	< 100 fm	> 150 fm	> 180 fm	> 200 fm	> 250 fm
Bocaccio									
S of 40°10'									
	1	0.000%	0.000%	0.973%	0.906%	0.056%	0.002%	0.003%	0.000%
	2	0.000%	0.000%	0.973%	0.906%	0.168%	0.027%	0.001%	0.001%
	3	0.920%	0.514%	0.806%	1.531%	0.026%	0.024%	0.026%	0.028%
	4	0.920%	0.514%	0.806%	1.531%	0.026%	0.024%	0.026%	0.028%
	5	0.920%	0.514%	0.806%	1.531%	0.168%	0.027%	0.001%	0.001%
	6	0.000%	0.000%	0.973%	0.906%	0.056%	0.002%	0.003%	0.000%
Canary rockfish									
N of 40°10'									
	1	0.085%	0.198%	0.216%	2.613%	0.001%	0.001%	0.001%	0.001%
	2	0.085%	0.198%	0.216%	2.613%	0.005%	0.005%	0.008%	0.004%
	3	0.100%	0.120%	0.180%	0.269%	0.003%	0.002%	0.001%	0.001%
	4	0.100%	0.120%	0.180%	0.269%	0.003%	0.002%	0.001%	0.001%
	5	0.100%	0.120%	0.180%	0.269%	0.005%	0.005%	0.008%	0.004%
	6	0.085%	0.198%	0.216%	2.613%	0.001%	0.001%	0.001%	0.001%
S of 40°10'									
	1	0.000%	0.000%	1.384%	0.696%	0.000%	0.000%	0.000%	0.000%
	2	0.000%	0.000%	1.384%	0.696%	0.012%	0.012%	0.021%	0.023%
	3	0.140%	0.116%	0.678%	0.407%	0.011%	0.010%	0.011%	0.014%
	4	0.140%	0.116%	0.678%	0.407%	0.011%	0.010%	0.011%	0.014%
	5	0.140%	0.116%	0.678%	0.407%	0.012%	0.012%	0.021%	0.023%
	6	0.000%	0.000%	1.384%	0.696%	0.000%	0.000%	0.000%	0.000%
Widow rockfish									
N of 40°10'									
	1	0.000%	0.003%	0.111%	0.110%	0.056%	0.038%	0.014%	0.007%
	2	0.000%	0.003%	0.111%	0.110%	0.008%	0.007%	0.004%	0.004%
	3	0.005%	0.006%	0.007%	0.011%	0.084%	0.007%	0.007%	0.006%
	4	0.005%	0.006%	0.007%	0.011%	0.084%	0.007%	0.007%	0.006%
	5	0.005%	0.006%	0.007%	0.011%	0.008%	0.007%	0.004%	0.004%
	6	0.000%	0.003%	0.111%	0.110%	0.056%	0.038%	0.014%	0.007%
S of 40°10'									
	1	0.000%	0.154%	0.361%	0.359%	0.038%	0.000%	0.000%	0.000%
	2	0.000%	0.154%	0.361%	0.359%	0.047%	0.000%	0.000%	0.000%
	3	0.000%	0.000%	0.072%	0.071%	0.843%	0.829%	0.843%	0.391%
	4	0.000%	0.000%	0.072%	0.071%	0.843%	0.829%	0.843%	0.391%
	5	0.000%	0.000%	0.072%	0.071%	0.047%	0.000%	0.000%	0.000%
	6	0.000%	0.154%	0.361%	0.359%	0.038%	0.000%	0.000%	0.000%
Cowcod									
S of 40°10'									
	1	0.000%	0.000%	0.000%	0.000%	0.017%	0.000%	0.000%	0.000%
	2	0.000%	0.000%	0.000%	0.000%	0.017%	0.000%	0.000%	0.000%
	3	0.002%	0.004%	0.060%	0.069%	0.000%	0.000%	0.000%	0.000%
	4	0.002%	0.004%	0.060%	0.069%	0.000%	0.000%	0.000%	0.000%
	5	0.002%	0.004%	0.060%	0.069%	0.017%	0.000%	0.000%	0.000%
	6	0.000%	0.000%	0.000%	0.000%	0.017%	0.000%	0.000%	0.000%

Table A-1. Bycatch rates for rebuilding species used in projection modeling for 2010-12 trawl fisheries (continued).

Area	2-month period	< 50 fm	< 60 fm	< 75 fm	< 100 fm	> 150 fm	> 180 fm	> 200 fm	> 250 fm
Yelloweye rockfish									
N of 40°10'									
	1	0.000%	0.000%	0.011%	0.006%	0.000%	0.000%	0.000%	0.000%
	2	0.000%	0.000%	0.011%	0.006%	0.000%	0.000%	0.000%	0.000%
	3	0.008%	0.005%	0.004%	0.005%	0.001%	0.000%	0.000%	0.000%
	4	0.008%	0.005%	0.004%	0.005%	0.001%	0.000%	0.000%	0.000%
	5	0.008%	0.005%	0.004%	0.005%	0.000%	0.000%	0.000%	0.000%
	6	0.000%	0.000%	0.011%	0.006%	0.000%	0.000%	0.000%	0.000%
S of 40°10'									
	1	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
	2	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
	3	0.000%	0.008%	0.006%	0.003%	0.000%	0.000%	0.000%	0.000%
	4	0.000%	0.008%	0.006%	0.003%	0.000%	0.000%	0.000%	0.000%
	5	0.000%	0.008%	0.006%	0.003%	0.000%	0.000%	0.000%	0.000%
	6	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
Darkblotched rockfish									
N of 38°									
	1	0.000%	0.001%	0.023%	0.044%	1.883%	1.765%	0.858%	0.497%
	2	0.000%	0.001%	0.023%	0.044%	0.753%	0.694%	0.532%	0.297%
	3	0.031%	0.026%	0.053%	0.080%	1.005%	0.907%	0.821%	0.356%
	4	0.031%	0.026%	0.053%	0.080%	1.005%	0.907%	0.821%	0.356%
	5	0.031%	0.026%	0.053%	0.080%	0.753%	0.694%	0.532%	0.297%
	6	0.000%	0.001%	0.023%	0.044%	1.883%	1.765%	0.858%	0.497%
S of 38°									
	1	0.000%	0.000%	0.000%	0.006%	0.400%	0.377%	0.340%	0.148%
	2	0.000%	0.000%	0.000%	0.006%	0.321%	0.283%	0.280%	0.174%
	3	0.002%	0.021%	0.015%	0.044%	1.299%	1.330%	1.299%	1.041%
	4	0.002%	0.021%	0.015%	0.044%	1.299%	1.330%	1.299%	1.041%
	5	0.002%	0.021%	0.015%	0.044%	0.321%	0.283%	0.280%	0.174%
	6	0.000%	0.000%	0.000%	0.006%	0.400%	0.377%	0.340%	0.148%
Pacific ocean perch									
N of 40°10'									
	1	0.000%	0.000%	0.001%	0.001%	0.670%	0.619%	0.341%	0.120%
	2	0.000%	0.000%	0.001%	0.001%	0.603%	0.469%	0.341%	0.164%
	3	0.001%	0.005%	0.010%	0.095%	0.804%	0.502%	0.357%	0.183%
	4	0.001%	0.005%	0.010%	0.095%	0.804%	0.502%	0.357%	0.183%
	5	0.001%	0.005%	0.010%	0.095%	0.603%	0.469%	0.341%	0.164%
	6	0.000%	0.000%	0.001%	0.001%	0.670%	0.619%	0.341%	0.120%
S of 40°10'									
	1	0.000%	0.000%	0.000%	0.000%	0.013%	0.014%	0.017%	0.000%
	2	0.000%	0.000%	0.000%	0.000%	0.001%	0.000%	0.000%	0.000%
	3	0.000%	0.000%	0.000%	0.012%	0.010%	0.010%	0.010%	0.000%
	4	0.000%	0.000%	0.000%	0.012%	0.010%	0.010%	0.010%	0.000%
	5	0.000%	0.000%	0.000%	0.012%	0.001%	0.000%	0.000%	0.000%
	6	0.000%	0.000%	0.000%	0.000%	0.013%	0.014%	0.017%	0.000%

Notes: Northern-area rates for depths less than 100 fm reflect the status quo closure of these depths north of 48.167° N. latitude. Northern-area rates for Periods 3 and 4 in the column '> 150 fm' do not include data shallower than 200 fm for the sub-area south of 45.767° N. latitude.

Table A-2 Discard rates used in projection modeling for the 2010-12 trawl fisheries, expressed as a percentage of total stratum catch of each species, by area, depth zone, and bi-monthly period, based on data collected by the West Coast Groundfish Observer Program between May 2005 and April 2009.

	< 50 fm		< 60 fm		< 75 fm		< 100 fm		> 150 fm			> 180 fm			> 200 fm			> 250 fm		
	Periods		Periods		Periods		Periods		Periods			Periods			Periods			Periods		
	1,2,6	3,4,5	1,2,6	3,4,5	1,2,6	3,4,5	1,2,6	3,4,5	1,6	2,5	3,4	1,6	2,5	3,4	1,6	2,5	3,4	1,6	2,5	3,4
N of 40°10'																				
Canary	99%	81%	93%	82%	48%	85%	71%	87%	100%	91%	94%	100%	100%	93%	100%	100%	91%	100%	100%	80%
Widow	0%	71%	100%	81%	81%	81%	87%	82%	61%	25%	59%	65%	28%	37%	19%	22%	35%	11%	19%	35%
Yelloweye	0%	72%	0%	72%	0%	69%	0%	67%	14%	11%	45%	14%	14%	20%	14%	14%	0%	14%	0%	0%
Darkblotched	0%	17%	100%	72%	100%	85%	100%	78%	63%	39%	47%	65%	36%	44%	45%	25%	42%	18%	11%	11%
POP	0%	0%	0%	57%	0%	51%	0%	34%	23%	36%	22%	24%	33%	14%	22%	34%	9%	11%	37%	9%
Lingcod	29%	74%	20%	77%	44%	76%	44%	76%	26%	10%	14%	19%	12%	12%	20%	14%	8%	7%	11%	1%
Sablefish	76%	67%	79%	54%	70%	44%	80%	41%	7%	7%	8%	7%	7%	8%	6%	7%	7%	6%	7%	7%
Shortspine	0%	0%	0%	31%	0%	2%	0%	6%	7%	7%	11%	7%	7%	10%	5%	7%	10%	5%	5%	7%
Longspine	0%	0%	0%	0%	0%	0%	0%	0%	21%	18%	15%	21%	18%	15%	21%	18%	15%	21%	18%	14%
Dover sole	32%	22%	24%	14%	16%	11%	16%	10%	5%	6%	8%	5%	6%	8%	5%	6%	8%	5%	8%	11%
Petrale	11%	10%	10%	8%	9%	8%	9%	8%	2%	1%	4%	2%	1%	2%	3%	1%	2%	10%	2%	5%
Arrowtooth	46%	73%	80%	77%	86%	72%	88%	66%	16%	11%	15%	16%	11%	15%	12%	10%	21%	13%	9%	20%
English	53%	28%	36%	26%	32%	27%	32%	26%	4%	4%	4%	4%	4%	4%	2%	1%	2%	3%	1%	2%
Other flatfish	44%	37%	32%	41%	38%	42%	39%	42%	17%	11%	14%	18%	10%	14%	15%	10%	14%	13%	14%	19%
Chilipepper	0%	89%	0%	70%	100%	76%	100%	77%	58%	74%	91%	51%	54%	91%	10%	54%	80%	18%	40%	0%
Slope rockfish	0%	6%	0%	3%	55%	6%	46%	16%	30%	27%	34%	29%	27%	31%	31%	27%	26%	29%	21%	19%
Shelf rockfish	0%	31%	0%	49%	10%	68%	15%	57%	64%	65%	70%	67%	71%	59%	57%	62%	54%	44%	54%	55%
S of 40°10'																				
Bocaccio	0%	100%	0%	73%	100%	85%	100%	95%	17%	53%	43%	100%	97%	43%	100%	0%	43%	0%	0%	0%
Canary	0%	19%	0%	14%	90%	44%	93%	42%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cowcod	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Widow	0%	0%	100%	0%	100%	72%	100%	80%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Yelloweye	0%	0%	0%	100%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Darkblotched	0%	100%	0%	25%	0%	22%	36%	37%	20%	1%	0%	18%	1%	0%	15%	0%	0%	0%	0%	0%
POP	0%	0%	0%	0%	0%	0%	0%	100%	100%	25%	50%	100%	25%	50%	100%	0%	50%	0%	0%	0%
Lingcod	37%	30%	67%	52%	24%	52%	22%	47%	0%	2%	32%	1%	14%	50%	0%	17%	32%	0%	0%	0%
Sablefish	0%	25%	0%	17%	0%	11%	69%	12%	4%	4%	5%	4%	3%	10%	4%	4%	5%	4%	4%	7%
Shortspine	0%	0%	0%	100%	0%	100%	0%	26%	5%	4%	3%	5%	4%	3%	4%	4%	3%	3%	4%	2%
Longspine	0%	0%	0%	72%	0%	43%	0%	6%	9%	14%	7%	9%	14%	8%	9%	14%	7%	9%	14%	7%
Dover sole	0%	72%	100%	74%	100%	75%	97%	33%	12%	16%	12%	12%	14%	11%	11%	14%	12%	15%	16%	18%
Petrale	24%	5%	10%	9%	6%	8%	5%	5%	1%	10%	8%	0%	8%	17%	0%	8%	8%	1%	19%	4%
Arrowtooth	0%	100%	0%	53%	0%	56%	100%	93%	94%	90%	51%	93%	87%	63%	93%	84%	51%	83%	80%	49%
English	71%	55%	55%	54%	52%	48%	48%	47%	8%	31%	6%	11%	34%	13%	0%	29%	6%	0%	0%	8%
Other flatfish	16%	31%	19%	35%	37%	37%	40%	39%	19%	44%	35%	17%	41%	35%	12%	35%	35%	17%	38%	46%
Chilipepper	0%	7%	98%	49%	73%	64%	85%	80%	4%	15%	26%	7%	12%	32%	0%	8%	26%	0%	0%	0%
Slope rockfish	0%	0%	0%	0%	0%	8%	0%	16%	13%	19%	5%	12%	16%	4%	8%	18%	5%	18%	25%	2%
Shelf rockfish	0%	86%	100%	66%	100%	93%	100%	87%	62%	80%	30%	91%	75%	66%	97%	48%	30%	0%	12%	17%

A.2 Limited Entry Trawl Whiting

Under No Action, the Council's Groundfish Management Team utilizes a model for assessing bycatch impacts in the Pacific whiting fishery. This model estimates the catch of depleted species based on a rate of depleted species catch per unit of Pacific whiting catch in each sector. This model is used to help inform appropriate bycatch limits for the Pacific whiting fishery given a particular Pacific whiting OY. Under Amendments 20 and 21, the whiting bycatch model is no longer necessary since allocations of overfished species (i.e., widow, darkblotched, and POP) are done through formal amendments. The model can be used to inform potential impacts to canary rockfish, which are allocated through the harvest specifications and management measures process.

Bycatch rates in the Pacific whiting fishery model are calculated for each year and non-tribal whiting sector. The rates are estimated as the metric tons of each depleted species per metric ton of whiting. The model uses the four years immediately prior to the existing year and combines those years through the use of a weighted average formula indicated below:

$$\text{Weighted Bycatch Rate} = 0.4*\text{BCrate}_{\text{Year-1}} + 0.3*\text{BCrate}_{\text{Year-2}} + 0.2*\text{BCrate}_{\text{Year-3}} + 0.1*\text{BCrate}_{\text{Year-4}}$$

This weighted average approach is taken because it is believed that the prior year is more reflective of potential bycatch patterns in the current year. This is believed to be the case in the Pacific whiting fishery because the relative abundance of species caught in the Pacific whiting fishery can vary substantially from year to year. This is particularly the case because Pacific whiting is a highly variable stock, and variations in Pacific whiting stock abundance should have an impact on the bycatch rate of non-target stocks as those stocks become more or less relatively abundant to Pacific whiting. The bycatch rates used for estimating depleted species catch in the 2009 fishery (except for widow rockfish) are illustrated in Table A-3.

Table A-3. Bycatch rates of depleted species used to model impacts in the 2011-2012 Pacific whiting trawl fishery.

Sector	Canary	Darkblotched	POP	Yelloweye
Mothership	0.0000222	0.0000597	0.0000450	0.0000000
CP	0.0000105	0.0000309	0.0000453	0.0000001
Shoreside	0.0000400	0.0000192	0.0001105	0.0000002

One exception to the weighted average approach described above is widow rockfish. The bycatch rate of widow rockfish has been increasing year over year in all non-tribal sectors of the Pacific whiting fishery. Due to this clear trend of increasing bycatch rates, widow rockfish bycatch rates are estimated with a linear regression analysis that uses the prior four years to estimate bycatch rates in the future. This is done on a sector by sector basis.

A.3 Non-nearshore Fixed Gear Model

The non-nearshore model projects impacts for limited entry and open access fixed gear vessels that are fishing seaward of the non-trawl RCA. Generally, these vessels target sablefish. The sablefish ACL north of 36° N. latitude is apportioned according to the formal intersector allocations shown in Figure A-1. It is assumed in the analysis that the annual sablefish allocation will be fully attained by the fixed gear fleets seaward of the RCA. WCGOP observations on discards and landed catch 2002-2008 provide the primary data input for estimating bycatch with PacFIN fish ticket data also providing information on the distribution of catch among gear types.

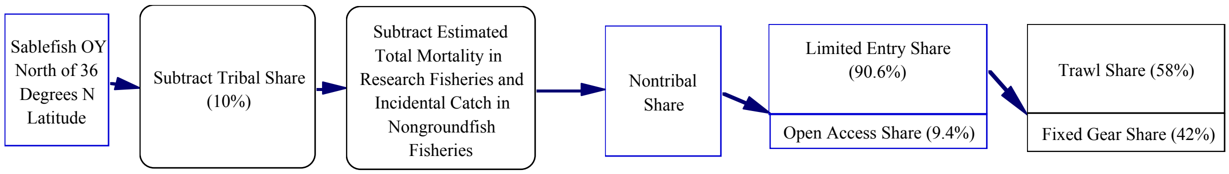


Figure A-1. The formal intersector allocations of sablefish north of 36° N. latitude.

Observations from the fixed gear sablefish fishery north and south of 40°10' N. latitude were pooled for all years of data (2002-2008), with no differential weighting applied to catch from different years. This level of data aggregation enables reporting of retained and discarded catch of groundfish species by gear type at a finer latitudinal and depth scale than has been done in previous specifications and management measure analyses. Data summarizing observed retained and discarded catch from fishing efforts north of 40°10' N. latitude were stratified by gear type (longline and pot/trap) and three alternative depth ranges that are used to evaluate different seaward boundaries of the non-trawl RCA. Although the range of depths recorded for an individual fixed gear set by observers is commonly much smaller than for observed trawl tows, it may not be possible to accurately assign the catch and discard of many sets to a specific 25 fm interval. For this exercise, the average of the beginning and ending depths of each set was used to represent the depth at which all fish on the set were caught.

The area stratification used in this model was developed first for use in the 2009-10 biennial management cycle. This stratification was arrived at through consideration of canary and yelloweye bycatch north of 40°10' N. latitude by depth and area and provides the Council with the option of employing differential seaward RCA boundaries. Four subareas were identified bounded by: Cape Mendocino at 40°10' N. latitude, the boundary of the Columbia and Eureka INPFC areas (43°10' N. latitude), Cascade Head (45.064°10' N. latitude), Point Chehalis (46.888°10' N. latitude), and the U.S.-Canada border. Several alternative boundaries were evaluated, but those listed above provided the greatest contrast between areas of high and low yelloweye bycatch. Since rockfish bycatch in the pot gear fleet is very small and there are very limited numbers of pot gear observations in some areas, results for this group are summarized with respect to depth only (without subareas). The seaward boundary of the non-trawl RCA south of 40°10' N. latitude has always been 150 fm and so no data is available shallower than that depth.

The spreadsheet model projects the distribution of sablefish catch between the areas north and south of 40°10' N. latitude and between longline and pot gear types for both the open access and limited entry sectors based on fish ticket landings for the years 2002-2008 (Table A-4). The 2002-2008 average of WCGOP observed landings are then used to project the distribution of the longline catch north of 40°10' N. latitude among the four management subareas (Table A-5). The model then applies WCGOP observed discard rates to these projected catch distributions using the appropriate area, depth, and gear stratification to produce annual estimates of discard for the rebuilding rockfish encountered by the non-nearshore fixed gear sectors. Discard rates were calculated by dividing the total observed discard weight for each species by the weight of retained sablefish and are reported in Table A-6 through Table A-9. The analysis of impact associated with alternative RCA specifications based on this methodology is discussed in Appendix C.

Table A-4. Distribution of fish ticket landings among longline (hkl) and pot gear types in the limited entry and open access non-nearshore fixed gear sectors, 2002-2008.

	LIMITED ENTRY						OPEN ACCESS				
	36° - 40°10' N lat		North of 40°10' N		TOTAL		36° - 40°10' N lat		North of 40°10' N		TOTAL
	hkl	pot	hkl	pot	(LE)		hkl	pot	hkl	pot	(OA)
2002	154	16	783	345	1,298	2002	125	82	138	16	361
2003	201	24	1,013	587	1,825	2003	126	148	246	29	549
2004	214	58	1,264	575	2,111	2004	90	156	191	10	447
2005	212	-	1,319	623	2,154	2005	111	262	419	101	893
2006	186	50	1,389	564	2,189	2006	78	247	280	182	787
2007	190	45	1,117	391	1,742	2007	31	209	185	32	458
2008	226	39	1,146	398	1,809	2008	66	206	273	24	570
Total	1,381	231	8,031	3,483	13,127	Total	627	1,310	1,733	395	4,065
% of LE total	11%	2%	61%	27%	100%	% of OA total	15%	32%	43%	10%	100%

Table A-5. Distribution of observed longline sablefish landings among the four management subareas north of 40°10' N. latitude, 2002-2008.

	Longline				
	North of 40°10' N	40°10' - Col./Eur. line 43°	Col./Eur. line 43° - Cascade Head 45.064°	Cascade Head 45.064° - Pt. Chehalis 46.888°	North of Pt. Chehalis 46.888°
Observed sablefish landings (mt)	1,962	278	510	318	856
% of total		**14%**	**26%**	**16%**	**44%**
min (02-08)		6%	17%	4%	24%
max (02-08)		24%	37%	45%	55%
mean (02-08)		12%	26%	18%	43%
stdev (02-08)		6%	8%	14%	13%

Table A-6. Rates of species discard (2002-2008 average) for rebuilding species and select non-rebuilding species, relative to retained sablefish, used to project bycatch impacts for longline gear south of 40°10' N. latitude and for pot gear types north and south of north of 40°10' N. latitude.

	36° - 40°10' N. lat.		North of 40°10' N. Lat Pot		
	Longline	Pot	100 fm	125 fm	150fm
Bycatch ratios (total catch lbs / retained sablefish lbs)					
Rebuilding species					
Bocaccio	0.0000	0.0000	0.0000	0.0000	0.0000
Canary rockfish	0.0000	0.0000	0.0000	0.0026	0.0000
Darkblotched rockfish	0.0016	0.0011	0.0006	0.0006	0.0007
Pacific ocean perch	0.0000	0.0000	0.0000	0.0002	0.0000
Widow rockfish	0.0002	0.0000	0.0000	0.0000	0.0000
Yelloweye rockfish	0.0000	0.0000	0.0000	0.0004	0.0000
Non-rebuilding species					
Sablefish	1.3639	1.4768	1.2265	1.2227	1.2060
Unspecified grenadiers	0.2656	0.0000	0.0021	0.0023	0.0025
Other slope rockfish	0.0498	0.0124	0.0102	0.0102	0.0104
Blackgill (South of 40°10' N. lat.)	0.0417	0.0108	0.0000	0.0000	0.0000
Longnose skate	0.0499	0.0000	0.0000	0.0000	0.0000
Spiny dogfish	0.0419	0.0002	0.0012	0.0011	0.0012
Shortspine thornyhead	0.0381	0.0004	0.0005	0.0005	0.0005
Lingcod	0.0041	0.0185	0.0109	0.0103	0.0094
Unspecified skate	0.0109	0.0007	0.0000	0.0000	0.0000
Mixed thornyheads	0.0113	0.0000	0.0000	0.0000	0.0000
Dover sole	0.0062	0.0009	0.0024	0.0025	0.0027
Longspine thornyhead	0.0094	0.0000	0.0000	0.0000	0.0000
Arrowtooth flounder	0.0001	0.0002	0.0050	0.0052	0.0052
Other groundfish	0.0032	0.0000	0.0000	0.0000	0.0000
Pacific hake	0.0006	0.0000	0.0000	0.0000	0.0000
Other shelf rockfish	0.0005	0.0000	0.0001	0.0001	0.0001
Splitnose rockfish	0.0004	0.0002	0.0000	0.0000	0.0000
Bank rockfish (South of 40°10' N. lat.)	0.0004	0.0000	0.0000	0.0000	0.0000
Big skate	0.0002	0.0000	0.0000	0.0000	0.0000
Petrale sole	0.0000	0.0001	0.0000	0.0000	0.0000
Chilipepper	0.0002	0.0000	0.0000	0.0000	0.0000
Yellowtail rockfish	0.0000	0.0000	0.0000	0.0000	0.0000

Table A-7. Rates of species discard (2002-2008 average) observed on fixed gear sablefish sets deeper than 100 fm for rebuilding species and select non-rebuilding species, relative to retained sablefish, used to project bycatch impacts for longline gear north of 40°10' N. latitude by management subareas.

	North of 40°10' N	40°10' - Col./Eur. line 43°	Col./Eur. line 43° - Cascade Head 45.064°	Cascade Head 45.064° - Pt. Chehalis 46.888°	North of Pt. Chehalis 46.888°
Bycatch ratios (total catch lbs / retained sablefish lbs)					
Rebuilding species					
Bocaccio	0.0001	0.0004	0.0000	0.0000	0.0002
Canary rockfish	0.0016	0.0001	0.0002	0.0022	0.0029
Darkblotched rockfish	0.0025	0.0095	0.0030	0.0010	0.0005
Pacific ocean perch	0.0003	0.0006	0.0001	0.0002	0.0003
Widow rockfish	0.0000	0.0000	0.0000	0.0001	0.0000
Yelloweye rockfish	0.0007	0.0005	0.0008	0.0003	0.0007
Non-rebuilding species					
Sablefish	1.1379	1.1577	1.2162	1.1924	1.0628
Spiny dogfish	0.1645	0.0468	0.0238	0.1137	0.3098
Other slope rockfish	0.0775	0.0902	0.0218	0.0532	0.1165
Longnose skate	0.0458	0.0278	0.0344	0.0387	0.0616
Arrowtooth flounder	0.0477	0.0018	0.0137	0.0259	0.0923
Unspecified skate	0.0201	0.0093	0.0182	0.0186	0.0256
Lingcod	0.0109	0.0058	0.0059	0.0123	0.0150
Big skate	0.0077	0.0066	0.0011	0.0010	0.0146
Shortspine thornyhead	0.0071	0.0030	0.0007	0.0033	0.0139
Other shelf rockfish	0.0055	0.0012	0.0016	0.0059	0.0093
Dover sole	0.0021	0.0008	0.0005	0.0044	0.0026
Other groundfish	0.0016	0.0027	0.0015	0.0013	0.0015
Unspecified grenadiers	0.0016	0.0021	0.0000	0.0001	0.0029
Pacific cod	0.0016	0.0000	0.0001	0.0022	0.0028
Yellowtail rockfish	0.0014	0.0000	0.0000	0.0003	0.0032

Table A-8. Rates of species discard (2002-2008 average) observed on fixed gear sablefish sets deeper than 125 fm for rebuilding species and select non-rebuilding species, relative to retained sablefish, used to project bycatch impacts for longline gear north of 40°10' N. latitude by management subareas.

	North of 40°10' N	40°10' - Col./Eur. line 43°	Col./Eur. line 43° - Cascade Head 45.064°	Cascade Head 45.064° - Pt. Chehalis 46.888°	North of Pt. Chehalis 46.888°
Bycatch ratios (total catch lbs / retained sablefish lbs)					
Rebuilding species					
Bocaccio	0.0001	0.0004	0.0000	0.0000	0.0000
Canary rockfish	0.0012	0.0000	0.0001	0.0001	0.0026
Darkblotched rockfish	0.0031	0.0100	0.0037	0.0020	0.0006
Pacific ocean perch	0.0002	0.0005	0.0001	0.0003	0.0002
Widow rockfish	0.0000	0.0000	0.0000	0.0001	0.0000
Yelloweye rockfish	0.0004	0.0004	0.0005	0.0003	0.0004
Non-rebuilding species					
Sablefish	1.1331	1.1607	1.2202	1.1792	1.0617
Spiny dogfish	0.1440	0.0497	0.0208	0.1403	0.2518
Other slope rockfish	0.0931	0.0957	0.0250	0.1018	0.1308
Longnose skate	0.0436	0.0274	0.0376	0.0350	0.0547
Arrowtooth flounder	0.0506	0.0018	0.0148	0.0388	0.0918
Unspecified skate	0.0168	0.0075	0.0170	0.0153	0.0202
Shortspine thornyhead	0.0089	0.0034	0.0008	0.0061	0.0163
Lingcod	0.0073	0.0058	0.0058	0.0031	0.0096
Big skate	0.0055	0.0049	0.0009	0.0013	0.0094
Other shelf rockfish	0.0035	0.0012	0.0013	0.0015	0.0060
Unspecified grenadiers	0.0020	0.0024	0.0000	0.0002	0.0035
Other groundfish	0.0015	0.0029	0.0015	0.0008	0.0012
Dover sole	0.0017	0.0009	0.0005	0.0014	0.0028
Yellowtail rockfish	0.0016	0.0001	0.0000	0.0003	0.0033
Pacific cod	0.0007	0.0000	0.0000	0.0009	0.0013

Table A-9. Rates of species discard (2002-2008 average) observed on fixed gear sablefish sets deeper than 150 fm for rebuilding species and select non-rebuilding species, relative to retained sablefish, used to project bycatch impacts for longline gear north of 40°10' N. latitude by management subareas.

	North of 40°10' N	40°10' - Col./Eur. line 43°	Col./Eur. line 43° - Cascade Head 45.064°	Cascade Head 45.064° - Pt. Chehalis 46.888°	North of Pt. Chehalis 46.888°
Bycatch ratios (total catch lbs / retained sablefish lbs)					
Rebuilding species					
Bocaccio	0.0000	0.0001	0.0000	0.0000	0.0000
Canary rockfish	0.0013	0.0000	0.0001	0.0000	0.0027
Darkblotched rockfish	0.0040	0.0112	0.0061	0.0026	0.0006
Pacific ocean perch	0.0002	0.0005	0.0000	0.0004	0.0001
Widow rockfish	0.0000	0.0000	0.0000	0.0000	0.0000
Yelloweye rockfish	0.0002	0.0001	0.0003	0.0004	0.0002
Non-rebuilding species					
Sablefish	1.1306	1.1769	1.2340	1.1677	1.0581
Spiny dogfish	0.1456	0.0507	0.0190	0.1118	0.2465
Other slope rockfish	0.1133	0.0939	0.0374	0.1288	0.1529
Longnose skate	0.0420	0.0288	0.0363	0.0398	0.0501
Arrowtooth flounder	0.0479	0.0016	0.0128	0.0319	0.0846
Unspecified skate	0.0156	0.0058	0.0188	0.0120	0.0185
Shortspine thornyhead	0.0113	0.0041	0.0012	0.0070	0.0195
Lingcod	0.0043	0.0043	0.0034	0.0021	0.0052
Big skate	0.0033	0.0042	0.0001	0.0019	0.0047
Unspecified grenadiers	0.0029	0.0031	0.0001	0.0003	0.0046
Other shelf rockfish	0.0026	0.0010	0.0008	0.0015	0.0042
Dover sole	0.0018	0.0010	0.0005	0.0016	0.0028
Other groundfish	0.0013	0.0034	0.0014	0.0005	0.0006
Yellowtail rockfish	0.0019	0.0001	0.0000	0.0004	0.0038
Pacific cod	0.0004	0.0000	0.0000	0.0003	0.0008

A.4 Limited Entry Fixed Gear Sablefish Daily Trip Limit Model north of 36° N. latitude

Available information indicates that catches in the Limited Entry Fixed Gear Daily Trip Limit (LEFG-DTL) sablefish fishery north of 36° N. latitude have been substantially less than the allocations during the past six years (Table A-10). Even though catches and the percentage of the allocation caught have generally increased over that period, this fishery has typically under-harvested its allocation.

Table A-10. Limited Entry Fixed Gear Sablefish DTL allocation, landings, and percentage of allocation landed for 2004 – 2009 north of 36° N. latitude.

Year	Allocation (mt)	Landings (mt)	Proportion of Allocation
2004	367	79	0.22
2005	367	146	0.40
2006	356	104	0.29
2007	276	116	0.42
2008	276	150	0.54
2009	351	205	0.58

Measures to remedy this problem of under-harvesting the allocation by this fishery were initiated in November 2009, when the GMT first presented a new model to predict landings by the LEFG-DTL sablefish fishery (Agenda Item G.4.b, Supplemental GMT Report, November 2009). This model was subsequently improved and used to predict the impacts of inseason trip-limit adjustments during the June 2010 PFMC meeting (Agenda Item B.5.b, Supplemental GMT Report 2, June 2010), and to develop trip limits for the 2011-2012 seasons (Agenda Item B.7.b, Supplemental GMT Report, June 2010). This section provides detail on the development and application of this new LEFG-DTL sablefish trip limit model.

Data Sources

Landings and catch data were acquired from PacFIN using the PacFIN query "slct_ves_sabl_arid_DTL.sql". Currently, only PacFIN staff can run this query because it selects data from an internal table that cannot be accessed by general users. The output from this query contains monthly summaries by vessel for fleet (limited entry and open access) and INPFC area (Conception and Vancouver-Columbia-Eureka-Monterey areas). Data used to create this model were LEFG-DTL sablefish landings north of 36° N. latitude for years 2004-2009 (periods 1-6) and 2010 (periods 1-2). It was recently learned that this data set may include landings under research or exempted fishing permits. These potential additional landings, which if present, should be excluded from this analysis and not be attributed to LEFG-DTL fisheries. This potential inclusion of inappropriate data was not an issue for this fishery north of 36° N. latitude.

Daily-, weekly-, and bimonthly-landing limits were obtained from the Federal Pacific Coast Groundfish Regulations (50 CFR 660). There have been significant contrasts among landing limits throughout the six-year period included in this analysis; landing limits have been altered frequently and at many different levels. For example, bimonthly landing limits have been set at the following levels for this LEFG-DTL sablefish: 3600, 5000, 5500, 6000, 7000, and 9000 lbs/2 months. Landing limits within bimonthly periods were consistent across months for all years except 2005 (period 5) for which the lowest limit within that period was used.

Analysis

The present analysis was conducted using SAS software. The significance of potential explanatory variables was evaluated using the REG procedure (stepwise selection). Potential explanatory variables included in the full model were daily, weekly, and bimonthly landing limits (continuous variables, lbs). This analysis eliminated daily and weekly trip limits from the model, leaving a model containing cumulative bimonthly landing limit as the only significant explanatory variable. However, potential impacts of seasonal variation (calendar period) were not included in the REG procedure because period is a class variable (rather than continuous). Hence, the significance of including calendar period in the predictive model was tested using the GLM procedure; both calendar period and cumulative bimonthly landing limit significantly contributed to variation ($p < 0.0001$). The correlation coefficient (R^2) for this GLM model containing both bimonthly landing limit and calendar period was 0.81. The R^2 with calendar period removed (i.e., with only bimonthly landing limit) was 0.52, indicating calendar period explains much of the variation. Hence, parameters were estimated using the REG procedure by calendar period (ι) as:

Equation 1 $\ln(landings_\iota) = \ln(\alpha_\iota) + \beta_\iota(\ln(bml_\iota))$

where landings = bimonthly landed catch (mt), bml = cumulative bimonthly landing limit (lbs), and *i* = bimonthly calendar period (1 – 6). Parameter estimates for each calendar period are shown in (Table A-11). The model R^2 for each period ranged from a low of 0.45 (period 5) to a high of 0.93 (period 4).

Table A-11. Parameter estimates obtained by fitting Equation 1 to 2004-April 2010 landings data for the LEFG-DTL sablefish fishery north of 36° N. latitude. Associated correlation coefficients (R^2) are also shown.

Period (*i*)	$\ln(\alpha_\iota)$	β_ι	R^2
1	-8.35	1.35	0.46
2	-8.95	1.42	0.47
3	-24.63	3.19	0.74
4	-22.03	2.91	0.93
5	-6.74	1.12	0.45
6	-10.50	1.65	0.89

Annual-sablefish landings can be predicted for the LEFG-DTL sablefish fishery using the parameter estimates shown in Table A-11 and any level of cumulative bimonthly landing limit. Table A-12 provides an example for estimating annual landings using a constant 8,000 lb/2 month cumulative limit. Under this scenario, the model predicted a total of 321 mt of sablefish would be landed. Note that ln(landings) must be back transformed, and should be adjusted for bias. Both unadjusted and bias-adjusted landings are provided in (Table A-12). The back-transformed landings estimates were adjusted using:

Equation 2 $\text{Adjusted Landings} = \exp((\ln(landings)+(0.5 \times \sigma^2)))$,

where σ = root mean square error. Sigma (σ) values were 0.26, 0.38, 0.39, 0.19, 0.35, and 0.21 for periods 1-6, respectively.

Table A-12. Example of predicted annual landings for the LEFG-DTL sablefish fishery north of 36° N. latitude for cumulative bimonthly landing limits of 8,000 lbs/2 months using the model ln(landings)=ln(α_ι) + β_ι(ln(bml)).

Period (*i*)	Bimonthly landing limit (bml), lbs	ln(bml)	ln(α_ι)	(β_ι)	Predicted landings		
					ln(landings, mt)	Unadjusted landings (mt)	Adjusted landings (mt)
1	8,000	8.99	-8.35	1.35	3.82	45.8	47.4
2	8,000	8.99	-8.95	1.42	3.84	46.6	50.1
3	8,000	8.99	-24.63	3.19	4.00	54.6	58.1
4	8,000	8.99	-22.03	2.91	4.08	59.3	60.4
5	8,000	8.99	-6.74	1.12	3.32	27.8	29.5
6	8,000	8.99	-10.50	1.65	4.30	73.7	75.4
TOTAL							320.9

Model Performance (Predicted vs. Actual Landings)

In general, patterns were similar between actual landings and landings predicted by this new LEFG-DTL sablefish model throughout the six-year period (Figure A-2). This figure demonstrates that much of the variability in landings can be explained by cumulative bimonthly trip limits and calendar period. This model tracks catches close enough that it may be useful to help this fishery fully prosecute its allocation. However, careful inseason monitoring will be necessary to prevent this fishery from exceeding its annual allocation, especially leading up to the final period of each year where catches are typically highest (Figure A-2). Highest landings and effort (number of vessels) were consistently observed during period 6 (November and December).

This model should be updated at the end of each year to re-estimate parameters with the additional data to improve the predictive performance. Additional variables may also be included in future models to increase precision of predictions if deemed important (i.e., statistically significant). Finally, all PacFIN data requests in the future should be made for the query "slct_ves_sabl_arid_DTL_no_EFP.sql". This query excludes all landings made under research or exempted fishing permits. Although the potential of additional research or EFP landings has not affected this analysis to date, it is possible that significant research or EFP landings could occur in the future.

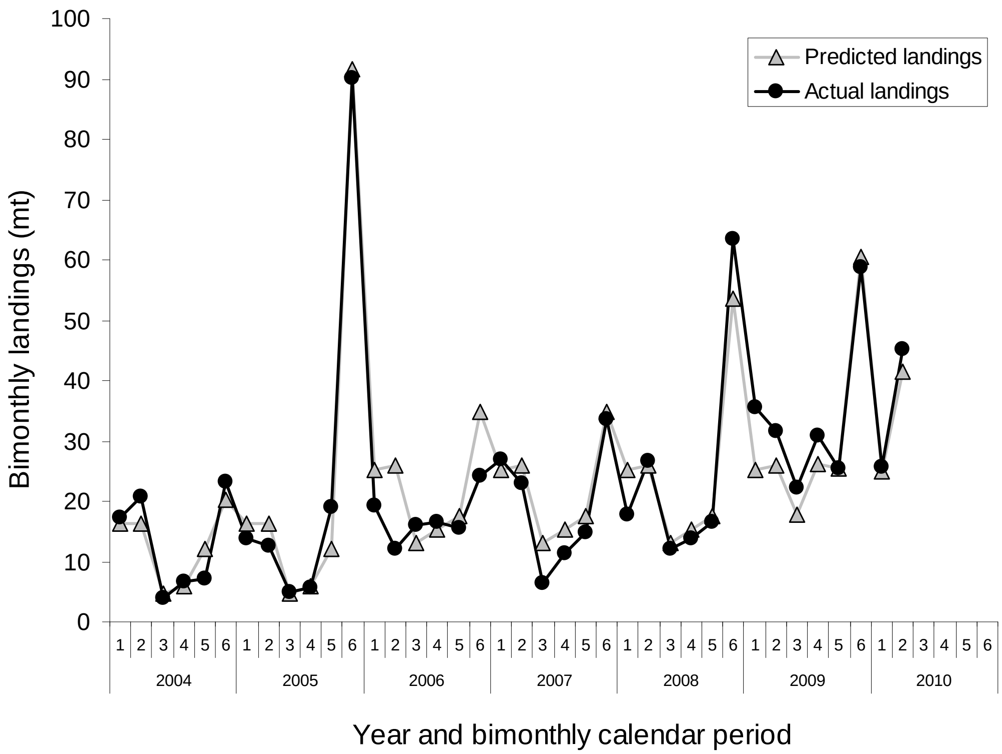


Figure A-2. Predicted and actual landings (mt) by the LEFG-DTL sablefish fishery north of 36° N. latitude for each bimonthly period from 2004 (periods 1-6) through 2010 (periods 1-2).

A.5 Open Access DTL Sablefish north and south of 36° N. latitude

The GMT prepared regional models (north and south of 36° N. latitude) to predict landings of sablefish by the open access (OA) sectors of the fishery. In each region, the effects of trip limits are examined with respect to the number of participating vessels and the average bimonthly catch per vessel. The analysis also evaluates the influence of price per pound, fuel costs, and seasonal effects on vessel participation and average catch.

Data requirements

- Open-access sablefish landings by date, vessel and region
- Historical trip limits (daily, weekly, and bimonthly) for each region
- Catch-weighted average ex-vessel price by region
- Median fuel cost by region

Bimonthly landings and ex-vessel prices were obtained from the PacFIN database (www.pacfin.org). Marine fuel prices are available from the website of the Pacific States Marine Fisheries Commission's Fisheries Economics Data Program (http://www.psmfc.org/efin/data/fuel.html). Historical trip limits are available online from the NMFS Northwest Region website (http://www.nwr.noaa.gov). Although rare, changes to historical trip limits sometimes occurred within a bimonthly period. Trip limits in the models were set equal to the largest limit within a bimonthly period.

Model Structure, Assumptions, and Results

The proposed model estimates bimonthly sablefish landings by the OA sector as the product of predictions from two linear statistical models. This approach assumes that the number of vessels entering the fishery is independent from the average bimonthly catch per vessel. Similarly, vessel participation and average bimonthly catch are assumed to be independent among regions. Standard model diagnostics and variable selection routines (residual plots, analysis of variance, and Akaike's Information Criterion) were used to reduce model dimensions and maintain reasonable predictive ability.

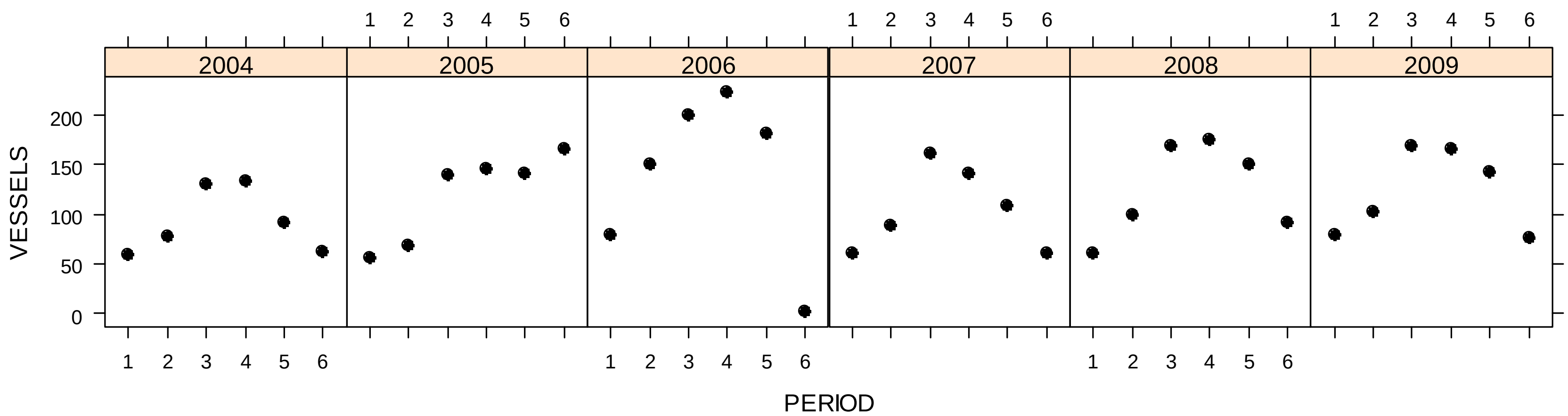
Within the northern region, bimonthly landings averaged among participating vessels are modeled as a simple linear function of the bimonthly trip limit. In this region, no other covariates were found to have a statistically significant relationship with average bimonthly landings after bimonthly trip limit was included in the model. The number of vessels participating in each bimonthly period varies seasonally in the northern region (Figure A-3, upper panel) with peak participation usually occurring near July or August (period 4). This seasonal pattern is approximately linearized (Figure A-4) in the model using a transformation of bimonthly calendar period ($-| x - 4 |$). Weekly trip limits and catch-weighted average price per pound were also found to influence vessel participation north of the Conception area (Table A-13, Figure A-5). All data in the final northern model are provided in Table A-14.

In the southern region, average bimonthly landings vary with changes to both daily and weekly trip limits, and in response to ex-vessel price per pound (Table A-13, Figure A-5). Bimonthly (and monthly) trip limits have not been implemented often enough in the Conception area to provide information about their effect on landings or vessel participation. The number of vessels participating in the southern OA sector does not have the same seasonal pattern as the northern region (Figure A-3, lower panel).

The catch-weighted price per pound for sablefish varies seasonally, but shows an overall increasing trend since 2004. Using these models, predictions for future bimonthly periods will require an estimate of price per pound. Prices from the most recent year are likely to be a reasonable first approximation for practical applications of the models, and any unforeseen changes in price leading to deviations from model predictions could be accounted for through inseason management.

In both regions, the use of average vessel catch as a response (regression of averages), rather than catch by individual vessel, results in artificially high R^2 values and underestimates variability in bimonthly catch. Analysis of vessel-specific data is recommended for future analysis. However, retrospective estimates of landings in the northern region closely match the actual landings (Figure A-6, upper panel). Landings estimates in the south are less accurate (Figure A-6, lower panel), in part due to a lack of contrast in historical trip limits (Table A-15).

Figure A-3. Number of vessels by period and year; upper panels = north of Conception area; lower panels = Conception area



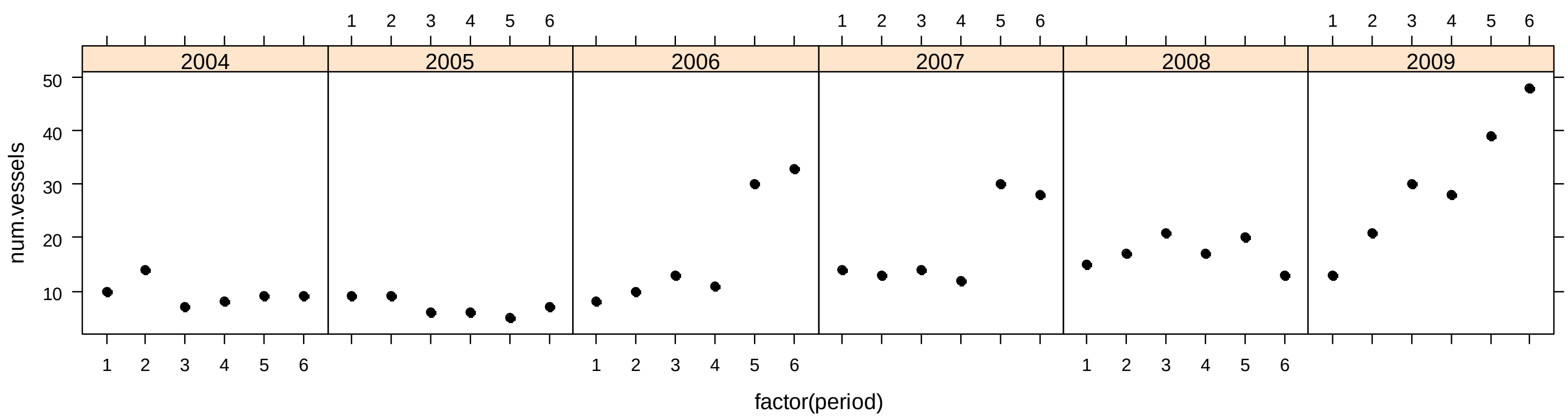


Figure A-4. Number of vessels versus transformed 2-month period (-abs(period-4)). This transformation assumes the number of participating vessels peaks in period 4, with a linear decline in surrounding periods. North of Conception area only.

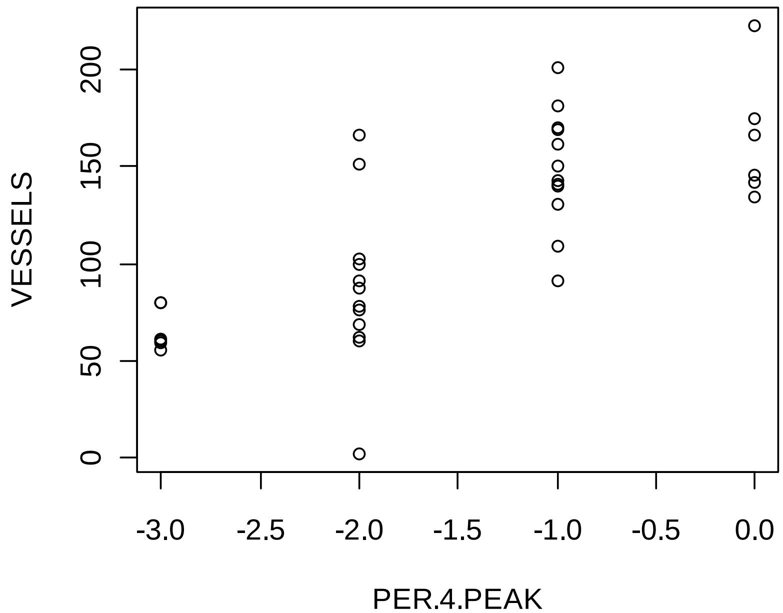


Figure A-5. Weighted average price-per-pound by period and year. Prices weighted by pounds landed. upper panels = north of Conception INPFC; lower panels = Conception area

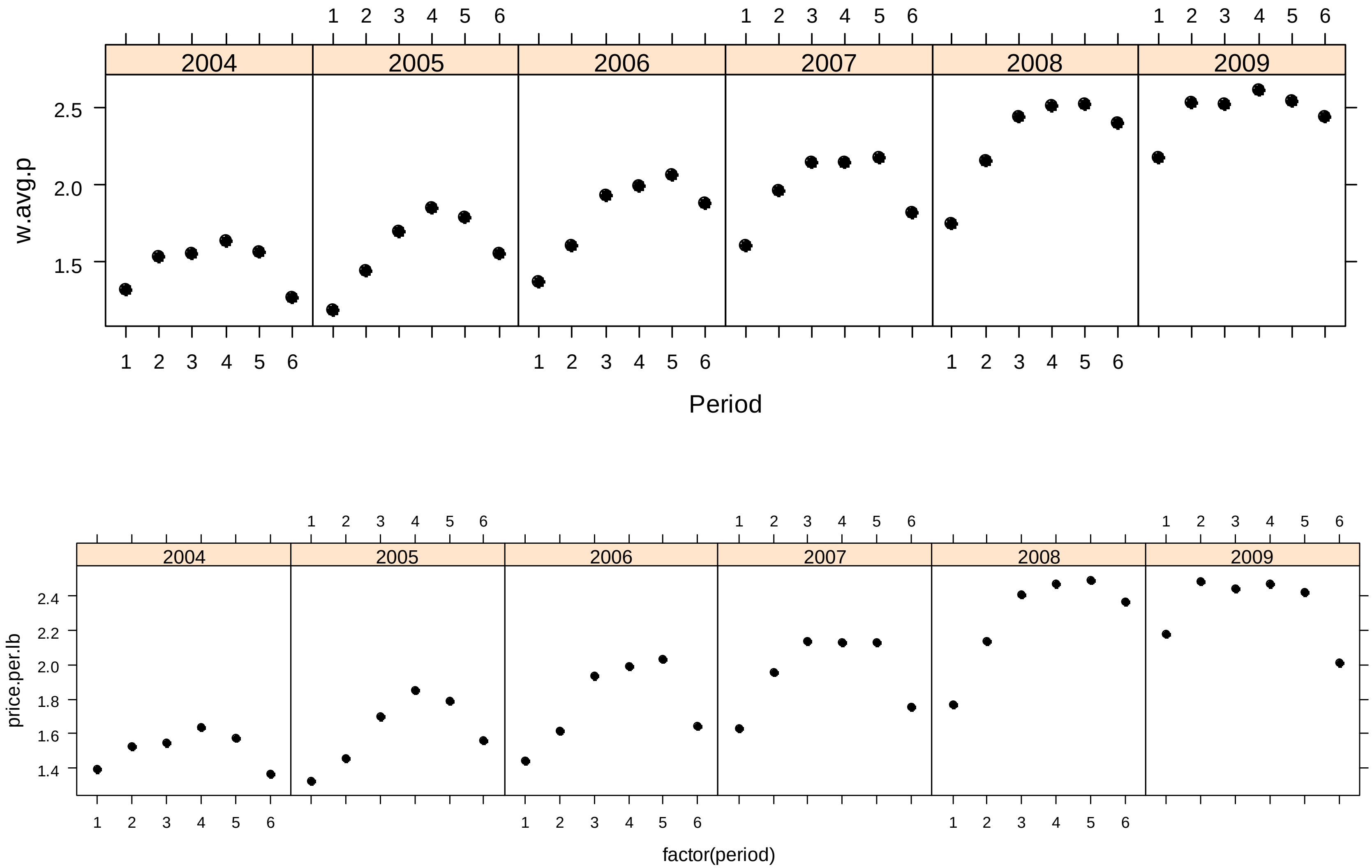
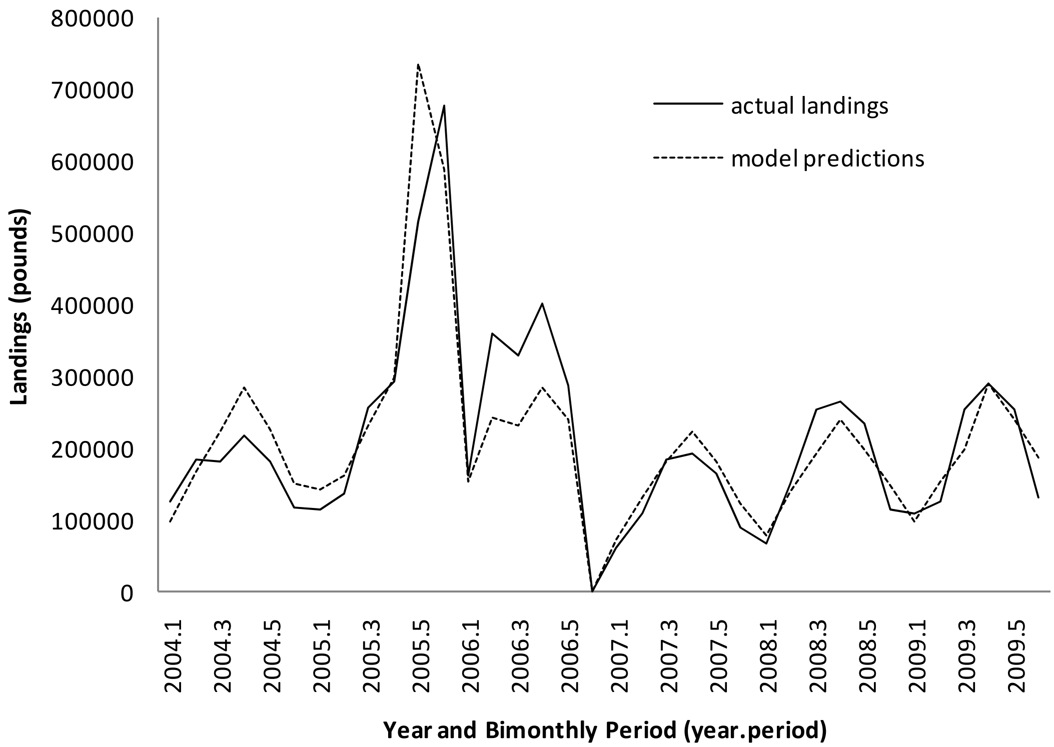


Figure A-6. Time series of actual and predicted catch [lbs]; upper panel = north of Conception area, lower panel = Conception area



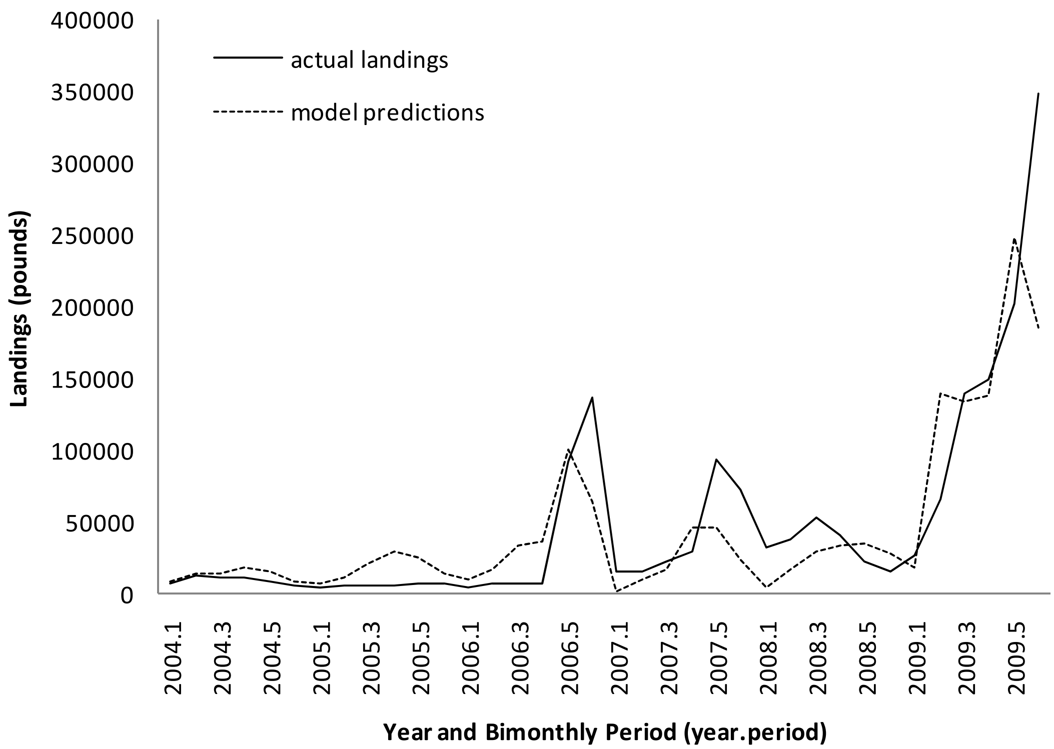


Table A-13. Regression results for sablefish open-access trip limit models

Region	Response Variable	Explanatory Variable	Coefficient	Standard Error	t-value	Pr(>|t|)
North	Average Bimonthly Landings	(Intercept)	487.585	83.667	5.83	1.44E-06
		Bimonthly Trip Limit	0.37613	0.02268	16.581	2.00E-16
North	Number of Vessels	(Intercept)	13.454	38.556	0.35	0.7294
		-|period - 4|	30.513	5.255	5.807	1.90E-06
		Weekly Trip Limit	0.101	0.021	4.78	3.76E-05
		Price per Pound	30.932	12.394	2.496	1.79E-02
South	Average Bimonthly Landings	(Intercept)	-6936.7	1388.1	-4.997	0.00002
		Daily Trip Limit	8.6759	3.6209	2.396	0.022592
		Weekly Trip Limit	1.8647	0.4278	4.359	0.000126
		Price per Pound	2052.6	398.36	5.153	1.27E-05
South	Number of Vessels	(Intercept)	-42.822	10.447	-4.099	0.000265
		Daily Trip Limit	0.070185	0.027251	2.576	0.014833
		Weekly Trip Limit	0.009473	0.003219	2.943	0.006009
		Price per Pound	12.866	2.9980	4.291	0.000153

Table A-14. Data and Predictions for OA Trip Limit Model for areas north of the Conception INPFC area. Catch is in pounds.

Year	Period	Vessels	Daily TL	Weekly TL	Bimonthly TL	Sum.Catch	Avg.Catch	Fuel Cost	Price/lb	Predicted Avg. Catch	Predicted Vessels	Predicted Landings
2004	1	59	300	900	3600	124945	2117.7	1.25	1.32	1841.6	53.6	98754.3
2004	2	78	300	900	3600	185123	2373.4	1.41	1.53	1841.6	90.6	166911.2
2004	3	131	300	900	3600	180198	1375.6	1.72	1.55	1841.6	121.8	224244.5
2004	4	134	300	900	3600	217406	1622.4	1.68	1.63	1841.6	154.8	284995.7
2004	5	91	300	900	3600	182538	2005.9	1.81	1.57	1841.6	122.4	225383.8
2004	6	62	300	900	3600	118707	1914.6	1.87	1.27	1841.6	82.6	152100.0
2005	1	56	300	1000	5000	115526	2063	1.7	1.19	2368.2	59.7	141380.9
2005	2	69	300	900	3600	136336	1975.9	2.1	1.44	1841.6	87.8	161784.2
2005	3	140	300	900	3600	256672	1833.4	2.05	1.69	1841.6	126.1	232219.8
2005	4	146	300	900	3600	291849	1999	2.13	1.85	1841.6	161.6	297528.3
2005	5	141	500	1500	9000	514841	3651.4	2.7	1.79	3872.7	189.8	734934.4
2005	6	166	500	1500	9000	677533	4081.5	2.4	1.55	3872.7	151.8	588015.9
2006	1	80	300	1000	5000	160807	2010.1	2.23	1.36	2368.2	65.0	153834.2
2006	2	151	300	1000	5000	360253	2385.8	2.32	1.6	2368.2	102.9	243676.7
2006	3	201	300	1000	3000	328243	1633	2.74	1.93	1616.0	143.6	232077.1
2006	4	223	300	1000	3000	401673	1801.2	2.7	1.99	1616.0	176.0	284384.2
2006	5	181	300	1000	3000	286996	1585.6	2.6	2.06	1616.0	147.6	238575.3
2006	6	2	0	0	0	--	--	2.38	1.88	--	--	--
2007	1	61	300	800	2400	62679	1027.5	2.43	1.6	1390.3	52.2	72554.5
2007	2	88	300	800	2400	110115	1251.3	2.48	1.96	1390.3	93.8	130458.1
2007	3	162	300	800	2400	184827	1140.9	2.56	2.14	1390.3	129.9	180620.9
2007	4	142	300	800	2400	192389	1354.9	2.63	2.14	1390.3	160.4	223042.8
2007	5	109	300	800	2400	165442	1517.8	2.67	2.17	1390.3	130.8	181911.1
2007	6	60	300	800	2400	88398	1473.3	3.16	1.81	1390.3	89.2	124007.4
2008	1	60	300	800	2400	66487	1108.1	3.04	1.75	1390.3	56.8	79005.2
2008	2	100	300	800	2400	151224	1512.2	3.42	2.15	1390.3	99.7	138629.1
2008	3	170	300	800	2400	252663	1486.3	4.04	2.44	1390.3	139.2	193522.4
2008	4	175	300	800	2400	263642	1506.5	4.27	2.51	1390.3	171.9	238954.6
2008	5	150	300	800	2400	233897	1559.3	3.7	2.52	1390.3	141.7	196962.8
2008	6	91	300	800	2400	113574	1248.1	2.54	2.4	1390.3	107.4	149380.3
2009	1	80	300	800	2400	107969	1349.6	2	2.18	1390.3	70.1	97497.4
2009	2	103	300	800	2400	126824	1231.3	1.97	2.53	1390.3	111.5	154971.0
2009	3	169	300	800	2400	253457	1499.7	2.05	2.52	1390.3	141.7	196962.8
2009	4	166	300	950	2750	290951	1752.7	2.3	2.61	1521.9	190.1	289340.1
2009	5	143	300	950	2750	253759	1774.5	2.42	2.54	1521.9	157.4	239605.9
2009	6	76	300	950	2750	131999	1736.8	2.49	2.44	1521.9	123.8	188459.5

Table A-15. Data and Predictions for OA Trip Limit Model for the Conception INPFC area. Catch is in pounds.

Year	Period	Vessels	Daily TL	Weekly TL	Sum.Catch	Avg.Catch	Fuel Cost	Price/lb	Predicted Avg. Catch	Predicted Vessels	Predicted Landings
2004	1	10	350	1050	6703.8	670.4	1.54	1.39	917.6	9.6	8822.8
2004	2	14	350	1050	13078	934.1	1.56	1.53	1198.6	11.4	13635.5
2004	3	7	350	1050	11134.4	1590.6	1.63	1.55	1239.7	11.6	14422.1
2004	4	8	350	1050	11478	1434.8	1.6	1.64	1420.5	12.8	18136.7
2004	5	9	350	1050	8415	935.0	2.025	1.57	1284.7	11.9	15309.1
2004	6	9	350	1050	6180	686.7	1.74	1.37	868.8	9.3	8087.1
2005	1	9	350	1050	4951	550.1	1.85	1.32	777.2	8.7	6788.7
2005	2	9	350	1050	5905	656.1	2.47	1.46	1051.6	10.5	10994.6
2005	3	6	350	1050	5687	947.8	2.23	1.70	1551.6	13.6	21085.4
2005	4	6	350	1050	6354	1059.0	2.55	1.86	1866.8	15.6	29054.8
2005	5	5	350	1050	7115	1423.0	2.92	1.79	1738.3	14.8	25655.5
2005	6	7	350	1050	7172	1024.6	2.44	1.56	1265.4	11.8	14925.2
2006	1	8	350	1050	4803	600.4	2.37	1.44	1020.3	10.3	10467.4
2006	2	10	350	1050	7343	734.3	2.47	1.62	1377.2	12.5	17209.7
2006	3	13	350	1050	7940	610.8	2.95	1.94	2031.6	16.6	33720.3
2006	4	11	350	1050	7589	689.9	2.725	1.99	2145.0	17.3	37126.8
2006	5	30	500	1050	92361.8	3078.7	2.595	2.03	3532.0	28.4	100214.4
2006	6	33	500	1050	137160	4156.4	2.495	1.65	2738.9	23.4	64096.1
2007	1	14	300	700	16031	1145.1	2.54	1.63	317.2	5.8	1851.0
2007	2	13	300	700	15857	1219.8	2.59	1.96	991.3	10.1	9975.0
2007	3	14	300	700	23222	1658.7	2.64	2.14	1358.1	12.4	16787.3
2007	4	12	350	1050	29443	2453.6	2.725	2.13	2437.2	19.1	46649.4
2007	5	30	350	1050	93185	3106.2	2.7	2.13	2426.9	19.1	46295.4
2007	6	28	350	1050	73201	2614.3	3.075	1.75	1656.7	14.2	23603.5
2008	1	15	300	700	32051	2136.7	3.11	1.77	603.7	7.6	4608.1
2008	2	17	300	700	37364.8	2197.9	3.48	2.14	1367.2	12.4	16977.8
2008	3	21	300	700	52710	2510.0	4.38	2.41	1910.2	15.8	30222.2
2008	4	17	300	700	41271	2427.7	4.32	2.47	2046.6	16.7	34129.7
2008	5	20	300	700	22475	1123.8	3.745	2.49	2086.2	16.9	35310.1
2008	6	13	300	700	15382	1183.2	2.555	2.37	1828.2	15.3	27986.0
2009	1	13	300	700	27214	2093.4	2.06	2.18	1446.3	12.9	18678.0
2009	2	21	400	1500	65336	3111.2	1.95	2.49	4434.8	31.5	139496.4
2009	3	30	400	1500	139734	4657.8	2.2	2.45	4350.0	30.9	134516.6
2009	4	28	400	1500	149739	5347.8	2.475	2.47	4410.6	31.3	138062.4
2009	5	39	400	2500	201976.4	5178.9	2.4	2.42	6167.2	40.1	247297.5
2009	6	48	400	2500	347805.8	7246.0	2.615	2.01	5330	35	185766.0

A.6 Limited Entry Fixed Gear Sablefish Daily Trip Limit Model South of 36° N. Latitude

There has never been a model available for predicting sablefish landings for the limited entry fixed gear daily trip limit (LEFG-DTL) sablefish fishery south of 36° N. latitude (Conception INPFC area). In addition, there has never been a formal allocation between open access and limited entry fixed gear DTL fisheries in this area. Hence, trip limits (= landing limits) in the Conception INPFC area have been set annually with little basis. As a result, sablefish have been largely underutilized by this DTL fishery.

Landings by the LEFG-DTL sablefish fishery south of 36° N. latitude increased dramatically in 2009 relative previous years (Table A-16). Although fishing effort (number of LEFG_DTL boats fishing per year) increased from 31 to 42 from 2004 to 2009 (36% increase), landings increased 143% over the same period, suggesting something other than (or in addition to) an effort increase caused the recent spike in sablefish landings for this fishery. Landing limits were higher in 2009 than during any of the previous years (Table A-17), and is likely the primary reason for recent increase in landings by this fishery. These observed increases in effort and landings illustrate that a predictive model is not only needed to more fully utilize the sablefish allocation for this fishery, but also to reduce the chance of exceeding the allocation.

Table A-16. Limited Entry Fixed Gear DTL sablefish landings and effort for 2004 – 2009 south of 36° N. latitude. Sablefish landings and effort by research and exempted fishing permit fisheries were excluded.

Year	LEFG-DTL landings (mt)	Effort (number of boats per year)
2004	77	31
2005	73	32
2006	63	37
2007	70	37
2008	80	36
2009	187	40

Data Sources

Landings and effort data were acquired from PacFIN using the PacFIN query “slct_ves_sabl_arid_DTL_no_EFP.sql”. Currently, only PacFIN staff can run this query because it selects data from an internal table that cannot be accessed by general users. The output from this query contains monthly summaries by vessel for fleet (limited entry and open access) and INPFC area (Conception and Vancouver-Columbia-Eureka-Monterey areas). This query eliminated fixed gear landings made under research and exempted fishing permits. Data used to create this model were LEFG-DTL sablefish landings south of 36^{o} N. latitude for years 2006-2009 (Jan-Dec) and 2010 (Jan-Apr). The number of vessels fishing in the LEFG-DTL sablefish fishery was 31-32 boats per year during 2004-2005 and 37-42 boats per year during 2006-2009 (Table A-16). This relative difference in effort between the two periods (2004-2005 and 2006-2010) provided the basis to only use landings data beginning 2006; the latter years are most representative of the current fishery.

Daily-, weekly-, and monthly-landing limits were obtained from the Federal Pacific Coast Groundfish Regulations (50 CFR 660) and are summarized in Table A-17. Landing limits during 2004-2005 were constant (350 lb/day or 1 landing per week of up to 1,050 lb) and did not provide additional contrast relative to landing limits shown in Table A-17, providing further justification for using only 2006-2010 data for model development.

Table A-17. Daily, weekly, and monthly landing limits for the LEFG-DTL sablefish fishery south of 36° N. latitude.

Year	Month	Period	Daily limit (lbs)	Weekly limit (lbs)	Monthly limit (lbs)
2006	Jan - Sep	1 - 5	350	1,050	.
	Oct - Nov	5 - 6	500[a]	1,050	.
	Dec	6	300[b]	1,050	3000[b]
2007	Jan - Dec	1 - 6	350	1,050	.
2008	Jan - Dec	1 - 6	350	1,050	
2009	Jan - Feb	1	350[c]	1,050[c]	.
	Mar - Oct	2 - 5	400[d]	1,500[d]	.
	Nov - Dec	6	.	3,000[e]	.
2010	Jan -Apr	1 - 2	400	1,500	.

[a]Public Notice from September 28, 2006 changed daily trip limit from 350 lb/day to 500 lb/day effective Oct 1.
[b]Public Notice from November 29, 2006 changed daily trip limit from 500 lb/day to 300 lb/day and implemented monthly total effective Dec 1.
[c]Trip limits for Jan-Feb 2009 are the same as those from the same time period in 2008 since 2009-2010 specifications were not publish until Mar 2009.
[d]Public Notice from February 27, 2009 provided trip limits for 2009-2010 effective Mar 1.
[e]Public Notice from October 27, 2009 eliminated daily trip limit and increased weekly trip limit from 1,500 lb to 3,000 lb effective Oct 28.

Analysis

This analysis was conducted using SAS software. The significance of potential explanatory variables was evaluated using the GLMSELECT procedure (stepwise selection). Potential explanatory variables included in the full model were natural-log transformed daily and weekly landing limits (continuous variables, lbs) and 2-month calendar period (class variable; 1 = Jan and Feb, 2 = Mar and Apr, 3 = May and Jun, 4 = Jul and Aug, 5 = Sep and Oct, 6 = Nov and Dec). The response variable was natural-log transformed landings (monthly, mt). This analysis eliminated daily limits from the model, leaving a model containing weekly landing limits and calendar period as significant explanatory variables. The final GLM model showed that both calendar period ($p < 0.0003$) and weekly trip limit ($p < 0.0001$) significantly contributed to variation in landings. The correlation coefficient (R^2) for this GLM model containing both weekly landing limit and calendar period was 0.74. The R^2 with calendar period removed (i.e., with only weekly landing limit) was 0.57, indicating calendar period explains much of the variation. Parameters were subsequently estimated using the REG procedure by calendar period (ι) as:

Equation 3 $\ln(\text{landings}) = \ln(\alpha_\iota) + \beta_\iota(\ln(\text{wkl}))$, where landings = monthly landings (mt) and wkl = weekly landing limit (lbs). Parameter estimates for each bimonthly calendar period (*i*) are shown in (Table A-18). The model R^2 for each period ranged from a low of 0.56 (period 3) to a high of 0.84 (period 3).

Table A-18. Parameter estimates obtained by fitting Equation 1 with 2006-April 2010 landings (monthly landings, mt) and weekly landing limit data for the LEFG-DTL sablefish fishery south of 36° N. latitude. Associated correlation coefficients (R2) are also shown.

Month	Period (*i*)	$\ln(\alpha_\iota)$	β_ι	R^2
1	1	-14.94	2.32	0.74
2	1	-14.94	2.32	0.74
3	2	-23.91	3.64	0.84
4	2	-23.91	3.64	0.84
5	3	-13.33	2.18	0.56
6	3	-13.33	2.18	0.56
7	4	-12.92	2.13	0.80
8	4	-12.92	2.13	0.80
9	5	-15.41	2.50	0.72
10	5	-15.41	2.50	0.72
11	6	-8.19	1.45	0.75
12	6	-8.19	1.45	0.75

Annual-sablefish landings can be predicted for the LEFG-DTL sablefish fishery using the parameter estimates shown in Table A-18 and any level of weekly landing limit. Table A-19 provides an example for estimating annual harvest using a constant 2,000 lb/week limit. Under this scenario, the model predicted a total of 341 mt of sablefish would be landed. Note that ln(monthly landings) must be back transformed, and should be adjusted for bias. Both unadjusted and bias-adjusted landings are provided in (Table A-19). The back-transformed landings estimates were adjusted using:

Equation 4 Adjusted monthly landings = $\exp((\ln(\text{monthly landings})+(0.5 \times \sigma^2)))$,

where σ = root mean square error. Sigma (σ) values were 0.22, 0.31, 0.35, 0.19, 0.28, and 0.44 for bimonthly calendar periods 1-6, respectively.

Table A-19. Example of predicted annual landings for the LEFG-DTL sablefish fishery south of 36° N. latitude for weekly landing limits of 2,000 lbs/week using the model ln(monthly landings)=ln(α_i) + β_i(ln(wkl)), where *i* = bimonthly period.

Month	Period (*i*)	Weekly landing limit (wkl, lbs)	ln(wkl)	ln(α_i)	(β_i)	Predicted landings		
						ln(landings, mt)	Unadjusted landings (mt)	Adjusted landings (mt)
1	1	2,000	7.60	-14.94	2.32	2.69	14.8	15.2
2	1	2,000	7.60	-14.94	2.32	2.69	14.8	15.2
3	2	2,000	7.60	-23.91	3.64	3.76	42.8	44.9
4	2	2,000	7.60	-23.91	3.64	3.76	42.8	44.9
5	3	2,000	7.60	-13.33	2.18	3.24	25.5	27.2
6	3	2,000	7.60	-13.33	2.18	3.24	25.5	27.2
7	4	2,000	7.60	-12.92	2.13	3.27	26.3	26.8
8	4	2,000	7.60	-12.92	2.13	3.27	26.3	26.8
9	5	2,000	7.60	-15.41	2.50	3.59	36.3	37.8
10	5	2,000	7.60	-15.41	2.50	3.59	36.3	37.8
11	6	2,000	7.60	-8.19	1.45	2.83	17.0	18.7
12	6	2,000	7.60	-8.19	1.45	2.83	17.0	18.7
TOTAL								341.2

Model Performance (Predicted vs. Actual Landings)

In general, monthly patterns were similar between actual landings and landings predicted by this new LEFG-DTL sablefish model throughout the four-year period (Figure A-7). This figure demonstrates that much of the variability in landings can be explained by weekly landing limits and bimonthly-calendar period. This model tracks catches close enough that it may be useful for setting landing limits that will help this fishery fully prosecute its allocation while preventing this fishery from exceeding its allocation. However, for some months, predicted catches were much different than actual catches. This is not surprising because there has been little variation in weekly limits (Table A-17). A scatter plot of predicted versus actual landings (Figure A-8) provides an indicator of precision for this predictive model. This clearly demonstrates that although monthly predictions were typically within ± 2 mt (43 of 52 observations), some monthly predictions would have been incorrect by as much as 8 mt. Hence, careful inseason monitoring will be necessary to prevent this fishery from exceeding its annual allocation.

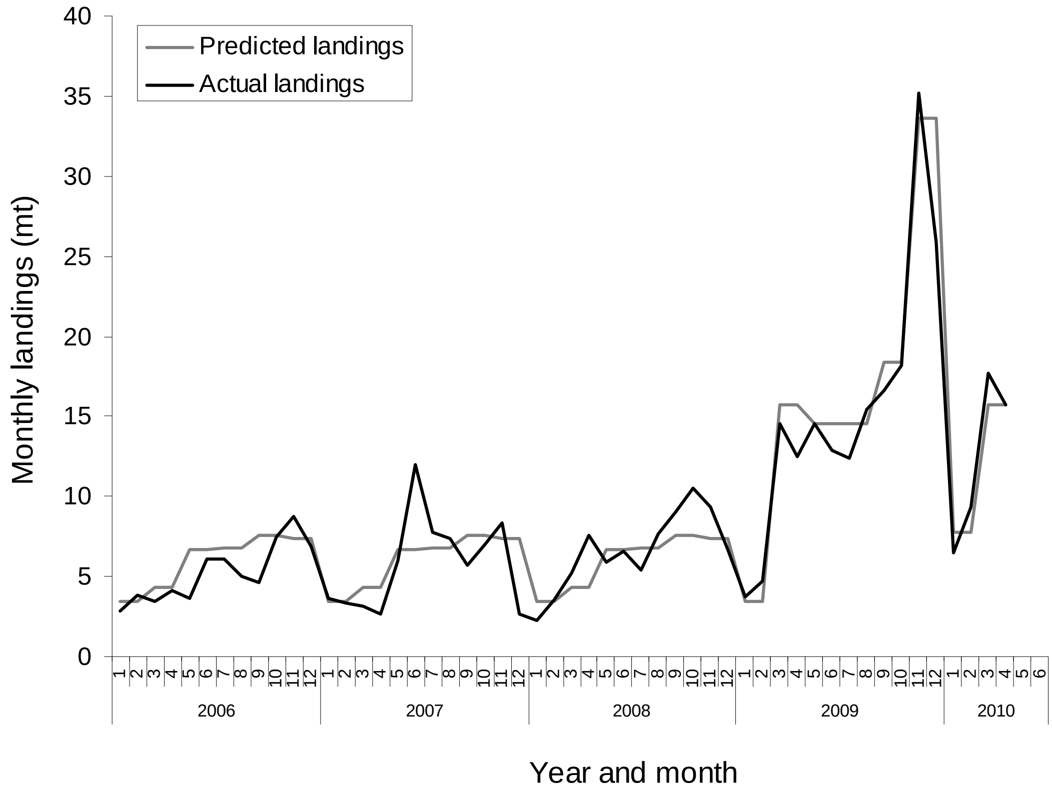


Figure A-7. Predicted and actual monthly landings (mt) by the LEFG-DTL sablefish fishery south of 36° N. latitude for each month (1 = Jan through 12 = Dec) from 2004 through April 2010.

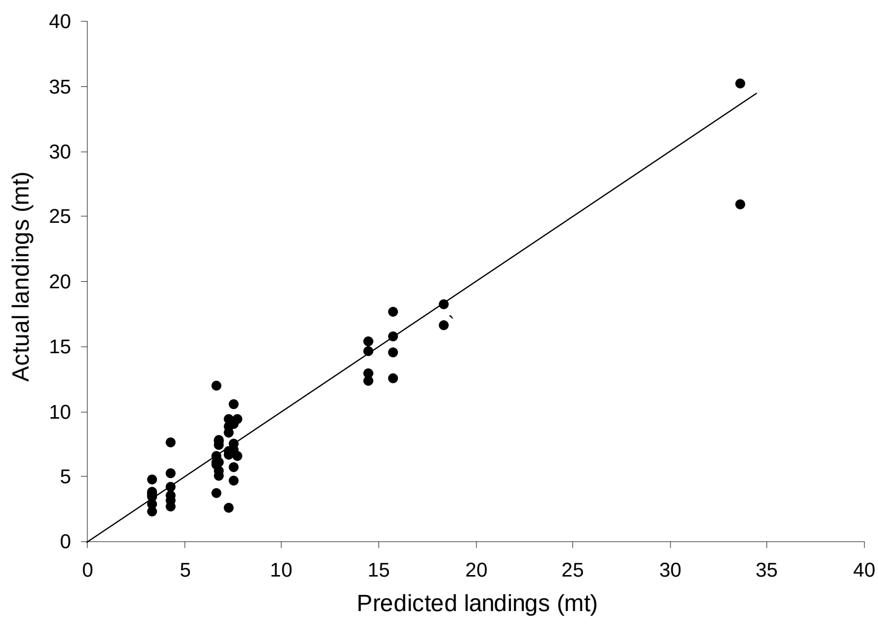


Figure A-8. Predicted versus actual landings (mt) for the LEFG-DTL sablefish fishery south of 36° N. latitude for 2004 – April 2006. A 1:1 line is included.

Options for Landing Limits

This model suggests an exponential increase in landings relative to increases in weekly trip limits, predicting an increase from 341 mt (at 2,000 lb/wk landing limits) to 611 and 1,005 mt at 2,500 and 3,000 lb/week landing limits, respectively (Figure A-9). This exponential relationship may be largely due to the lack of contrast in the independent variable; only three weekly landing limits were available for fitting this model (Table A-17). Additional data may reduce this predicted rate of increase. On the other hand, if weekly landing limits become too high, then it is possible that effort may shift from the north into the Conception area, making this exponential increase in landings plausible. For example, a 3,000 lb/week landing limit equates to potential landings of up to 24,000 lbs/2 months per vessel. The bimonthly limit planned for 2011 north of 36° N. latitude ranges from 6,500 to 7,500 lb/2 months (Agenda Item B.7.b, Supplemental GMT Report, June 2010), substantially lower than these potential scenarios in the south. Shifting of effort from north to south should be considered before increasing this weekly landing limit beyond 2,000 lb/week in the absence of monthly or bimonthly caps. Indeed, effort may shift to the south under the current preliminary preferred landing limit of 2,000 lb/week, which provides the opportunity of landing up to 16,000 lbs/2months per vessel.

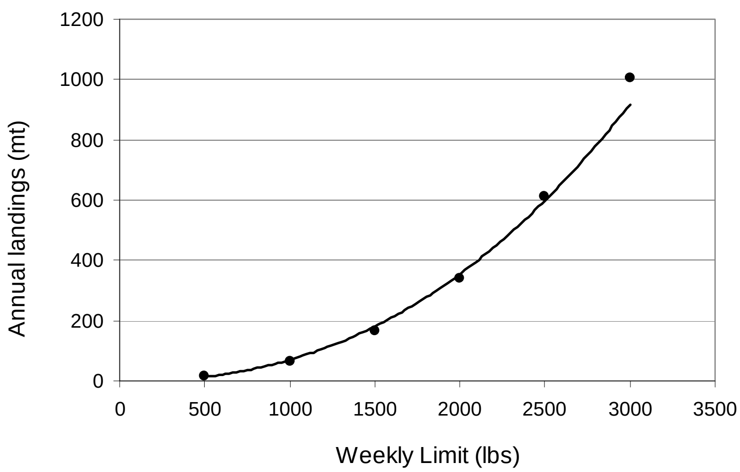


Figure A-9. Predicted annual landings (mt) relative to weekly landing limits (lbs) for the LEFG-DTL sablefish fishery south of 36° N. latitude.

General comments: This model should and will be improved in the future. Parameter estimates should be re-estimated annually, which will provide more data with different landing limits. This additional contrast in landing limits may provide better predictive capabilities. Also, additional parameters may be included in later models which could result in a better fit to the data and enhance the predictive capability (i.e., fishing effort).

A.7 Commercial Nearshore Fixed Gear Model

Impacts associated with the directed open access daily-trip-limit fishery targeting sablefish are modeled using the primary sablefish model described above. Nearshore commercial fisheries in waters off Oregon and California are modeled separately from offshore efforts targeting sablefish.

The nearshore commercial model incorporates fleet-wide discard estimates by depth from West Coast Groundfish Observer Program (WCGOP) data, landings data from PacFIN, and depth-specific discard mortality rates derived by the Groundfish Management Team (GMT) (refer to 2009/2010 Harvest

Specifications and Management Measures FEIS for full description of model). The WCGOP began pilot coverage of vessels targeting nearshore rockfish and associated species, such as cabezon and kelp greenling, in January 2003 for the California nearshore fishery and in May 2004 for the Oregon nearshore/rockfish fisheries. Data from these vessels from January 2003 – December 2008 were averaged for analyses. Although the number of observed trips has increased since the WCGOP began monitoring the fleet, coverage levels are still lower than for other fleets and thus greater uncertainty in estimating discard relationships exists (Table A-20).

Table A-20. Summary of WCGOP observer coverage (2003-2008)

Area/Depth	# Trips	# Sets	# Vessels
North of 42° N. lat.			
0-10 fm	397	524	76
10-20 fm	457	607	74
20-60 fm	43	48	23
42° to 40° 10' N. lat.			
0-10 fm	149	204	23
10-20 fm	187	223	20
20-60 fm	37	41	10
South of 40°10' N. lat.			
0-10 fm	310	510	76
10-20 fm	218	277	63
20-60 fm	34	56	19

In 2009-10, projected overfished species impacts were estimated based on the previous year's landings data in two areas (north and south of 40°10 N. latitude). Unlike other fisheries, nearshore overfished species impacts are not modeled based on full attainment of the target species harvest guidelines. Low target landings in a previous year (due to weather or management action) decrease the estimate of overfished species impacts and opportunity for target species for the following year, creating a use-it or lose-it fishery.

In 2009-10, any management action taken to stay within projected overfished species impacts was applied to an entire area (north or south of 40°10' N. lat) regardless of the location of impact within that area. As such, fine scale management actions (i.e., closing just part of an area) were not incorporated and areas with lower overfished species impacts were affected because they fell within the larger management area.

For 2011-12, the nearshore model structure was modified to include finer area stratifications and used modified landings data to project overfished species impacts. These modifications would facilitate management, provide greater protection to stocks while minimizing adverse impacts to communities, and provide the best estimate of fishery needs.

The nearshore model was stratified into three areas based on available WCGOP data: (1) north of 42° N. latitude; (2) between 42° and 40°10' N. latitude; and (3) south of 40°10' N. latitude. These finer area stratifications facilitated overfished species impact projections on a smaller scale, reduced adverse actions to lower bycatch areas, and allowed incorporation of state specific management measures. In 2009-10, a 20 fm depth restriction was applied to the area between 43° N. latitude and 40°10' N. latitude to reduce yelloweye impacts. Under the new model structure, these types of management actions could be accommodated on a higher scale.

Instead of using a single previous year landings data to project overfished species impacts, average landings were used as the best estimate of fishery needs. As a starting point, average landings from 2007-2009 were used for Oregon and 2006-2008 for California (California landings in 2009 were anomalously low and not likely representative of future landings). Landings data were adjusted from this starting point based on new information (i.e., higher black rockfish and cabezon ACLs) or based on increased availability in overfished species (i.e., higher nearshore allocation of yelloweye). Opportunities were maximized for this fishery where available while staying within available overfished species impacts.

Table A-21, Table A-22, and Table A-23 summarizes the ratios of observed discarded and retained catch for each of the three depth intervals (0-10 fm, 11-20 fm, and 21-50 fm) used to model impacts in nearshore commercial fisheries.

Allocation of Overfished Species (Canary and Yelloweye Rockfish) between States

Currently, WCGOP provides aggregated data for the entire area north of 40°10' N. lat and as such, the GMT was unable to attribute overfished species impacts to an individual state. Therefore, California and Oregon "co-manage" this area to ensure that the fishery stays within the allowable overfished species impacts.

The finer area stratification of the proposed nearshore model would provide an opportunity for California and Oregon to independently manage their nearshore fisheries since overfished species impacts could be estimated for each state. To facilitate modeling, it would be beneficial to provide an informal or formal split of the allowable overfished species (canary and yelloweye) between California and Oregon for the nearshore fishery.

To inform any formal or informal catch sharing agreements of canary and yelloweye rockfish between the two states, the GMT examined WCGOP Total Mortality Reports, WCGOP Data Report of the Nearshore Fixed Gear Groundfish Fishery, and individual stock assessments. Since data are not reported in the WCGOP reports on the same scale as the proposed new model, the GMT was unable to use this information to inform potential catch sharing.

Yelloweye Rockfish

Although the yelloweye stock assessment (Stewart, *et al.* 2009) did provide data to inform catch sharing, the SSC cautioned against making use of these trends as the sole basis for the spatial allocation of harvest guidelines because the trend in abundance at the coastwide level was much more robust than those at the regional level (Agenda Item E.2.c, Supplemental SSC Report, September 2009). Data provided by Stewart, *et al.* (2009) suggest a 53% - 61% allocation for Oregon and 39% - 47% allocation for California (Table A-24). This range is supported by Wallace et al (2006) which estimated that the 2005 yelloweye rockfish biomass was 581 mt (Oregon) and 484 mt (California).

In addition to any potential catch sharing informed by the stock assessment, the Council could also consider an equal sharing (50:50) between the states for 2011-12 only. The GMT could continue to work with the SSC to examine data which may be used for future catch sharing arrangements.

Canary Rockfish

Canary rockfish has typically been modeled on a coastwide basis; hence, information on distribution of biomass and catch is not available by state. Similar to yelloweye rockfish, the Council could consider an equal sharing (50:50) between the states for 2011-12 and the GMT could continue to work with the SSC to examine data to inform future catch sharing arrangements.

Table A-21 Bycatch and discard rates from the commercial nearshore projection model north of 42° N. latitude.

NORTH of 42° N. lat.	Observed discard ratio			Observed retained ratio			% of observed landings by depth			Discard mortality rate		
	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm
Rebuilding species												
Bocaccio	0.000	0.000	0.000	0.000	0.000	0.000				30%	54%	100%
Canary rockfish	0.004	0.010	0.022	0.000	0.000	0.000				32%	54%	100%
Widow rockfish	0.000	0.000	0.000	0.000	0.000	0.002				32%	54%	100%
Yelloweye rockfish	0.002	0.011	0.030	0.000	0.000	0.000				32%	56%	100%
Other species												
Black rockfish	0.032	0.025	0.020	0.684	0.516	0.351	49.4%	48.8%	1.8%	23%	42%	90%
Blue rockfish	0.018	0.029	0.036	0.028	0.030	0.057	39.7%	54.8%	5.5%	29%	49%	100%
Cabezon	0.010	0.015	0.001	0.082	0.182	0.164	24.8%	71.8%	3.5%	7%	7%	7%
Kelp greenling	0.011	0.014	0.010	0.100	0.082	0.069	47.1%	50.6%	2.3%	7%	7%	7%
Lingcod	0.100	0.118	0.189	0.101	0.163	0.286	30.1%	63.9%	6.0%	7%	7%	7%
Other minor nearshore rockfish	0.003	0.004	0.006	0.049	0.092	0.163	27.0%	66.7%	6.3%	24%	48%	100%

Table A-22. Bycatch and discard rates from the commercial nearshore projection model from 42° N. latitude to 40°10 N. latitude.

42° to 40°10' N. lat.	Observed discard ratio			Observed retained ratio			% of observed landings by depth			Discard mortality rate		
	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm
Rebuilding species												
Bocaccio	0.000	0.000	0.000	0.000	0.000	0.000				30%	54%	100%
Canary rockfish	0.004	0.018	0.035	0.000	0.000	0.000				32%	54%	100%
Widow rockfish	0.000	0.001	0.001	0.000	0.002	0.001				32%	54%	100%
Yelloweye rockfish	0.001	0.005	0.055	0.000	0.000	0.000				32%	56%	100%
Other species												
Black rockfish	0.007	0.004	0.001	0.831	0.703	0.303	46.7%	49.6%	3.7%	23%	42%	90%
Blue rockfish	0.010	0.019	0.011	0.073	0.218	0.220	18.5%	69.4%	12.1%	29%	49%	100%
Cabezon	0.010	0.008	0.010	0.031	0.020	0.043	48.2%	37.6%	14.2%	7%	7%	7%
Kelp greenling	0.011	0.008	0.004	0.007	0.009	0.001	38.9%	60.1%	1.0%	7%	7%	7%
Lingcod	0.033	0.049	0.030	0.065	0.079	0.218	30.6%	47.0%	22.4%	7%	7%	7%
Other minor nearshore rockfish	0.000	0.000	0.002	0.027	0.045	0.263	19.0%	40.3%	40.7%	24%	48%	100%

Table A-23. Bycatch and discard rates from the commercial nearshore projection model south of 40°10 N. latitude.

SOUTH of 40°10' N. lat.	Observed discard ratio			Observed retained ratio			% of observed landings by depth			Discard mortality rate		
	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm	0-10 fm	11-20 fm	21-60 fm
Rebuilding species												
Bocaccio	0.000	0.000	0.001	0.000	0.000	0.052				30%	54%	100%
Canary rockfish	0.001	0.031	0.116	0.000	0.000	0.000				32%	54%	100%
Widow rockfish	0.000	0.000	0.000	0.000	0.000	0.000				32%	54%	100%
Yelloweye rockfish	0.000	0.001	0.008	0.000	0.000	0.000				32%	56%	100%
Other species												
Black rockfish	0.005	0.013	0.010	0.020	0.047	0.060	44.9%	49.2%	5.9%	23%	42%	90%
Blue rockfish	0.013	0.046	0.231	0.023	0.038	0.073	53.6%	39.3%	7.2%	29%	49%	100%
Cabezon	0.123	0.034	0.052	0.267	0.023	0.081	95.1%	3.7%	1.2%	7%	7%	7%
Deeper nearshore rockfish	0.009	0.024	0.048	0.082	0.384	0.619	29.1%	61.6%	9.4%	23%	48%	100%
Kelp greenling	0.034	0.011	0.084	0.020	0.003	0.000	93.0%	7.0%	0.0%	7%	7%	7%
Lingcod	0.086	0.151	0.160	0.098	0.147	0.171	56.8%	38.9%	4.3%	7%	7%	7%
Shallow nearshore rockfish	0.025	0.008	0.055	0.099	0.028	0.053	86.7%	11.3%	2.0%	25%	49%	100%

Table A-24. State-specific contributions of spawning output, commercial and recreational catch, and biomass for yelloweye rockfish. The Oregon:California contribution (percentage) is shown in the right-hand column.

Source	Description	State		Percent Contribution
		OR	CA	(OR:CA)
Stewart et al. (2009	Yelloweye Spawning Output (million eggs)	93	75	55:45
	Total Commercial Catch (mt) 2000 – 2008	22.1	17.5	56:46
	Total Commercial Catch (mt) 1990 – 1998	1,048	667	61:39
	Total Recreational Catch (mt) 2000 – 2008	38.6	34.0	53:47
	Total Recreational Catch (mt) 1990 – 1998	174	147	54:46
Wallace et al. (2006)	Yelloweye Rockfish biomass (mt) of Age 3+	581	484	55:45

A.8 Evaluation of Uncertainty in the Non-Nearshore and Nearshore Models

Two overfished species (OFS)-impact models (non-nearshore and nearshore models) may have misapplied landings of two species: sablefish shoreward of the RCA and lingcod seaward of the RCA. Although these potential misapplications and the extent of the potential implications are uncertain, it is important to illuminate these sources of error by both models.

Sablefish shoreward of the fixed gear RCA

The non-nearshore model estimates OFS impacts by sablefish tier fisheries and sablefish daily trip limit (open access and limited entry) fisheries. These impacts are based on estimates of annual sablefish landings (full utilization is assumed) and associated bycatch rates by depth strata. In the past, bycatch rates have only been requested for depths > 100 fm (i.e., seaward of the RCA), because it was assumed that this fishery operates only in deeper waters. However, it is possible that sablefish catches may also occur shoreward of the RCA in some areas north of 36^o N. latitude. If sablefish catches do occur shoreward of the RCA, then those landings receive the non-nearshore (i.e., >100 fm) bycatch rates and not the shoreward of the RCA bycatch rates.

The nearshore model does not estimate OFS impacts by sablefish landings, even if sablefish are caught shoreward of the RCA. This model estimates OFS impacts based on bycatch rates of OFS relative to landings of "nearshore species", and the nearshore model does not include sablefish as one of the "nearshore species" encountered.

The impacts of these sablefish catches shoreward of the RCA may not be accounted for by any model. The magnitude of sablefish catches shoreward of the RCA by fixed gear fisheries will be examined and impacts will be attributed to one of the impact models as soon as possible.

Lingcod seaward of the fixed gear RCA:

It is known that some “nearshore” vessels target lingcod on the seaward side of the RCA. It is uncertain how the impacts of these sets are assessed, or whether they are modeled at all. It is possible that these seaward-sets are erroneously included in the nearshore model. Under this scenario, unrealistically high bycatch rates calculated for depths < 30 fm may be applied to these sets that were actually made at much deeper depths (i.e., > 100 fm). The result would be an overestimation of yelloweye rockfish impacts by the nearshore fishery. On the other hand, these catches may not be included in any model, which would result in an underestimation of overfished species impacts. The magnitude of these targeted-lingcod catches seaward of the fixed gear RCA will be examined and impacts will be attributed to one of the impact models as soon as possible.

Uncertainty Explorations

The current formulation of the both the non-nearshore and nearshore model assumes several inputs are known without error. These include total landing estimates, allocation of landing by depth strata, bycatch ratios, and discard mortality. Treating these quantities as known decreases the amount of uncertainty admitted in the model and ultimately influences the realization of model outputs (i.e. projected catches). Improvements to these models would address characterizing the uncertainty in each of the input quantities. One suggested approach to incorporate uncertainty in these inputs is Monte Carlo sampling of probability distributions. This approach assigns a probability distribution to each input, draws a sample for each input, and calculates the final projected catch based on those draws. This is performed many times, resulting in a distribution of projected catches. The projected catch distribution could then be evaluated against catch targets and limits. This approach will require defining the uncertainty distribution of each input. Given the large number of inputs that potential need this treatment, it is advisable to prioritize which inputs are considered most essentially in characterizing uncertainty. Such prioritization could be achieved via identifying which inputs have measurable uncertainty and which cause the greatest sensitivity in projected catches. This exploration is anticipated for the 2013-2014 harvest specifications and management measure process.

A.9 Washington Recreational Model

The Washington Ocean Sampling Program (OSP) generates catch and effort estimates for the recreational boat-based groundfish fishery, which are provided to Pacific States Marine Fisheries Commission (PSMFC) and incorporated directly into RecFIN. The OSP provides catch in total numbers of fish, and also collects biological information on average fish size, which is provided to RecFIN to enable conversion of numbers of fish to total weight of catch. Boat egress from the Washington coast is essentially limited to four major ports, which enables a sampling approach to strategically address fishing effort from these ports. Effort estimates are generated from exit-entrance counts of boats leaving coastal ports while catch per effort is generated from angler intercepts at the conclusion of their fishing trip. The goal of the program is to provide information to RecFIN on a monthly basis with a one-month delay to allow for inseason estimates. For example, estimates for the month of May would be provided at the end of June. Some specifics of the program are:

Exit/entrance count - boats are counted either leaving the port (4:30 AM - end of the day) or entering the port (approximately 8:00 AM through end of the day) to give a total count of sport boats for the day.

Interview - boats are encountered systematically as they return to port; anglers are interviewed for target species, number of anglers, area fished, released catch data and depth of fishing (non-fishing trips are recorded as such and included in the effort expansion). The OSP collects information on released catch but does not collect information on the condition of the released fish. Therefore, released catches must be post-stratified as live or dead based upon an assumed discard mortality rated. Onboard observers are deployed on charter vessels throughout the salmon season primarily to observe hatchery salmon mark rates but also to collect rockfish discard information on these trips.

Examination of catch - catch is counted and speciated by the sampler. Salmon are electronically checked for coded wire tags and biodata is collected from other species.

Sampling Rates - vary by port and boat type. Generally, at boat counts less than 30, the goal is 100% coverage. The sampling rate goal decreases as boat counts increase (e.g., at an exit count of 100, sample rate goal is 30%; over 300, sample rate goal is 20%). Overall sampling rates average approximately 50% coastwide through March-October season.

Sampling Schedules - due to differences in effort patterns, weekdays/weekend days are stratified. Usually, both weekend days and a random 3 of 5 weekdays are sampled.

Personnel - OSP sampling staff include two permanent biologists coordinating data collection, approximately twenty-two port samplers, three on-board observers and one data keypuncher.

Volume of data - Between 20,000 and 30,000 boat interviews completed per season coastwide.

Data Expansion

Algorithm for expanding sampled days:

$$\frac{\text{Exit Count}}{\text{Total boats sampled}} * P_s \text{ sampled} = P_t$$

where P_s = any parameter (anglers, fish retained, fish released) within a stratum,
and P_t = total of any parameter with stratum for the sample day

Algorithm for expanding for non-sampled days:

$$\text{Total Weekday Catch} = \frac{\Sigma(P_t) \text{ on sampled weekdays}}{\text{number weekdays sampled}} * \text{no. of weekdays in stratum}$$

$$\text{Total Weekend Catch} = \frac{\Sigma(P_t) \text{ on sampled weekend days}}{\text{number weekend days sampled}} * \text{no. weekend days in stratum}$$

Total weekend catch + total weekday catch = total catch in stratum

Notes on Data Expansion:
Salmon and halibut catches are stratified by week; all other species are stratified by month. All expansions are stratified by boat type (charter or private), port, area and target species trip type (e.g., salmon, halibut, groundfish, and albacore)

Pre-Season Catch Projections

Projected impacts for Washington's recreational fishery are essentially based upon the previous season's harvest estimated by the Ocean Sampling Program (OSP) and incorporated in RecFIN. This is especially true if recreational regulations remain consistent.

In 2005 the Washington Department of Fish and Wildlife implemented a depth restriction of 30 fathoms for a portion of the Washington coast. Since 2002, the OSP program began collecting fishing depths as well as discard information. This information is keypunched and analyzed on an annual basis with respect to depth of catch for species of concern. Beginning in 2006, and carrying through 2007 and 2008, we modified our pre-season catch projections, based on the use of depth restrictions, by sub-area and fishery. This depth analysis was used to determine the pre-season catch projections of catch and mortality of discarded fish for 2009-2010 relative to these depths as follows:

Canary Rockfish

- Apply 100% mortality rate to canary rockfish caught on all recreational fishing trips targeting Pacific halibut, when there is no depth restriction in place
- Apply 66% mortality rate to canary rockfish on recreational fishing trips targeting species other than Pacific halibut, when there is no depth restriction in place (based upon average depth distribution of catch from intercept surveys).
- When a 20-fm depth restriction is in place, apply a 50% mortality rate to canary rockfish caught on all recreational fishing trips (based on research by Albin and Karpov 1995).

Yelloweye Rockfish

- Apply 100% mortality rate to yelloweye rockfish caught on all recreational fishing trips, when there is no depth restriction in place
- When a 20-fathom depth restriction is in place, apply a 50% mortality rate to yelloweye rockfish caught on all recreational fishing trips (based on research by Albin and Karpov 1995).
- When a 20-fathom depth restriction is in place, apply an encounter rate reduction of 25% (based on 2005 OSP catch-by-depth data) as yelloweye tend to inhabit deeper depths.

Washington's management measures maintain the use of depth closures in waters deeper than 20 or 30 fathoms and therefore historical catch estimates will be representative of projected mortalities. To address the transition from the method of estimating discard mortalities (described above) for canary and yelloweye rockfish to the use of coastwide discard mortality rates for all species the average of the 2008 and 2009 final estimates were used to produce projected impacts for 2011-2012. Catch by depth data from 2004 was also analyzed to determine the mortality rate by depth prior to the implementation of depth restrictions.

Inseason Catch Projections for 2011-2012

Inseason catch projections are based upon the most recent OSP estimates (with a one-month time lag) with subsequent months extrapolated from the pre-season catch projections. Starting in 2009, depth dependant mortalities were applied uniformly to all discarded fish coast wide through RecFIN. The implementation of depth based discard mortalities replaced the mortality estimates for canary and yelloweye that Washington used from 2006-2008. It should be noted that the precision of recreational groundfish catch estimates based upon previous seasons will continue to be influenced by factors such as the length and success of salmon and halibut seasons, weather and unforeseen factors.

A.10 Oregon Recreational Model

Data Source for Base Model

Modeling of expected 2011-12 Oregon recreational fishery impacts of selected groundfish species was based on recent year estimates of landings and discards. For the ocean boat fishery, the data source was the Oregon Department of Fish and Wildlife Ocean Recreational Boat Survey (ORBS). For the shore and estuary fishery, the data source was the Marine Recreational Fisheries Statistics Survey (MRFSS) and the Shore and Estuary Boat Survey (SEBS). Analyzed species included black, blue, brown, canary, china, copper, grass, quillback, and yelloweye rockfishes; as well as kelp and rock greenling, cabezon and lingcod. Base level landings and discards for the ocean boat fishery (in numbers of fish) were based on normalized 2007, 2008 and 2009 landings and discards because these data reflect fishery years with regulations most similar to those expected in 2011-12 (i.e., bag limits, offshore closures, behavioral activities to avoid depleted species, etc.). Base level landings and discards for the shore and estuary fishery (in weight), largely not affected by management of depleted species, reflect the most recent 5-year average, 1998-2002. Annual weights of greenling and cabezon were adjusted to reflect changes in minimum length.

Normalizing 2007, 2008, and 2009 Ocean Boat Catch and Angler Trip Data

A base year period of 2007-09 was chosen for modeling catch and angler effort. Equal weighting was given to each year as it is not possible to forecast the opportunity for other targeted fisheries (i.e., salmon, halibut, tuna, etc.) in 2011-12. The fisheries in 2007-09 vary in both angler opportunity and success for other target species such as salmon, tuna and halibut. All three base years include groundfish fishery restrictions (e.g., offshore closures and restrictions on groundfish retention in the directed Pacific halibut fishery).

To facilitate providing maximum flexibility in modeling 2011-12 fishery options, landings in 2007, 2008 and 2009 were normalized to a 10-fish marine bag limit and a year round season with no offshore closures (essentially the basic regulations from 2000 through 2003). Starting in 2004 the sport fishery was managed with offshore closures to reduce impacts on depleted species (i.e., lingcod, canary rockfish, and yelloweye rockfish); the marine fish bag limit of 10 was carried over from 2003. In response to an early closure in 2004 due to attainment of the black rockfish harvest guideline, the marine bag limit in 2005 started at 8 fish on January 1 and was reduced to 5 fish on July 16. During 2006-08 the marine fish bag limit imposed under state regulations was 6 fish to provide for a year round nearshore fishery and not exceed the black rockfish harvest guideline. During 2009, the marine bag limit imposed under state regulations was increased to 7 fish to allow for more access to the increased black rockfish harvest guideline. The marine fish bag limit includes rockfish, greenling, cabezon and other species excluding lingcod, flatfish, Pacific halibut, salmon, trout, steelhead, perch, sturgeon, striped bass, offshore pelagic species, and bait fish (herring, smelt anchovies and sardines).

Normalizing to a 10-fish marine bag limit was accomplished in the previous model (2009-2010) and carried forward for 2011-12, through comparing the average catch per angler trip (CPUE) under 8, 6 and 5 fish regulations in 2005-07 with comparable periods in 2003-04 under a 10 fish marine bag limit. The average CPUE change from 10 to 8 fish was a 13.5 percent reduction, which compared to a 34.3 and 37.8 percent reduction when reducing the bag limit from 10 to 6 and 5 fish, respectfully. The same exercise was also applied to discards per angler as the number discarded for many species for which retention was allowed generally increased as the retention bag limit was reduced. The average duration of groundfish trips did not change, but anglers sorted through more fish. The number of yelloweye rockfish and canary rockfish encountered, both species for which all retention was prohibited in the model base years, was not adjusted due to the reduced marine bag limit as the average duration of groundfish angler trips were nearly the same regardless of the marine bag limit. These adjustments were not made for lingcod, which has a separate bag limit.

Landings and discards were normalized to an all-depth season. In 2007-09, from April through September the groundfish fishery was closed seaward of the 40-fm line. The expected increase in encounter rates for offshore residing species (i.e., yelloweye rockfish and canary rockfish) in normalizing to an all-depth scenario was based on data from 2001 and 2003-07 at-sea observations on Oregon charter vessels (over 500 trips were observed). The observer study was not conducted in 2002. The following increased encounter rate (numbers of fish) were applied to appropriate months (those that were closed seaward of 40-fm) when normalizing to an all-depth fishery: canary rockfish = 1.20 and yelloweye rockfish = 1.47.

The expected weight of landed fish was based on the 2007-09 average by species and month for the ocean boat fishery. The expected average weight of discarded fish in the ocean boat fishery was based on combined at-sea observations in 2003-2009 with attention paid to matching samples with depth closure regulations (releases were not measured on 2001 at-sea trips). Observations indicate that yelloweye rockfish and canary rockfish caught inside of the 40-fm line were considerably smaller compared to the average size of those caught offshore as it appears more juveniles of these species reside nearshore. An exception in the method to estimate the size of discards was made for nearshore rockfish species, other than black rockfish and blue rockfish, due to small sample sizes (most are retained), where a 50 percent reduction in average landed weight was assumed for discards. The fifty percent reduction in average weight was based on the observed average size of discarded black rockfish and blue rockfish which were on the order of a 50 percent reduction from average landed weight. A 50 percent reduction was also used for greenling species since they are also rarely released.

Angler effort in shore and estuary areas was assumed to be similar to the base period of 1998-2002. Groundfish angler trips in the shore and estuary fishery are not available, only total angler trips of all trips types combined, thus all projections of angler trips by trip type exclude shore and estuary.

Model Inputs

Bag limits, offshore closures, season structure, and halibut quotas were the basic input factors applied to the standardized model.

Bag limits were modeled to range from 6 to 10 marine fish and sub-bag limits of 1, 2, and 7 for cabezon. Fish species included in the marine bag limit were defined earlier in this report. The expected reduction in CPUE from reducing the marine bag limit from 10 fish was based on the same comparison between a 10 and 8, 6 or 5 bag limit discussed earlier in this report. In estimating expected reductions in CPUE for marine bag limits a linear relationship was developed using the observations between 10, 8, 6 and 5 fish bag limits (Figure A-10). The number of released fish of species for which retention is not prohibited was estimated to increase as the bag limit was reduced (Figure A-11). As assumed in normalizing the model no effect on CPUE was expected for the non-retention species yelloweye rockfish and canary rockfish for changes in the marine fish bag limit (refer to earlier discussion in this report).

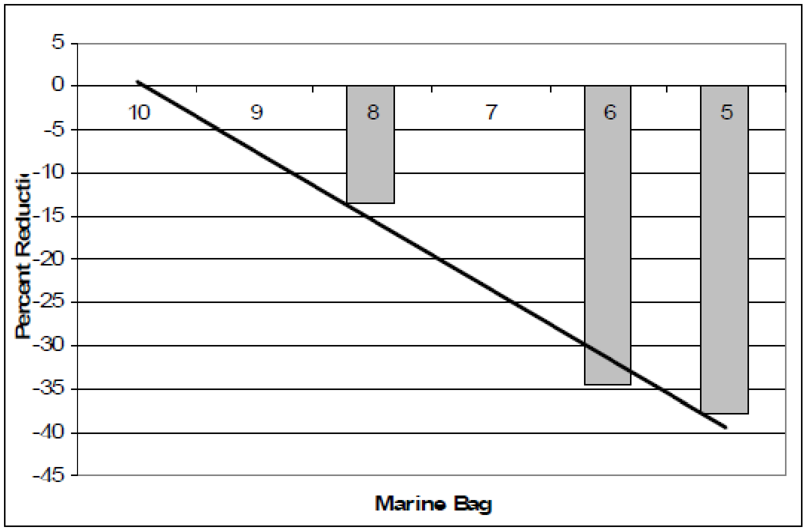


Figure A-10. Percent reduction of catch per angler under decreasing marine bag limits for nearshore groundfish.

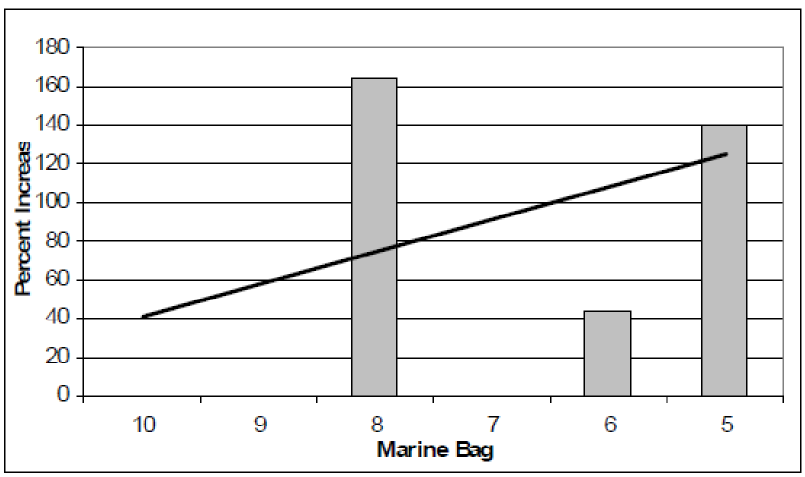


Figure A-11 Percent increase of release per angler with decreasing marine bag limits for nearshore groundfish.

Expected encounter rate reductions for yelloweye rockfish and canary rockfish normally encountered in offshore waters were developed for offshore closures outside of 40, 30, 25, and 20 fm (Table A-25). They were based on the at-sea observations mentioned earlier in the report. Modeling assumptions included a shift in offshore effort (7 percent of total groundfish directed effort) to open areas nearshore during offshore closure periods affecting the catch rates of fish encountered.

Table A-25. Percent total encounter reductions in yelloweye rockfish and canary rockfish due to depth closures.

2001, 2003-2007 Distribution of encounters by depth bin (fm) from at-sea observations (fishery open all depths)						
Species	**<20 fm**	**21-25 fm**	**26-30 fm**	**31-40 fm**	**> 40 fm**	**(n)**
Canary rockfish	59%	15%	5%	7%	16%	518
Yelloweye rockfish	32%	24%	7%	5%	31%	74

Percent reduction in total encounters from open all depths to the following depth closures				
Species	**Closed > 20 fm**	**Closed > 25 fm**	**Closed > 30 fm**	**Closed > 40 fm**
Canary rockfish	43%	28%	23%	16%
Yelloweye rockfish	67%	43%	36%	31%

Monthly groundfish directed angler effort was assumed to remain equal to the 2007-09 normalized average unless the fishery season was reduced to less than a May through September season (the five core months). If the season duration was less than May 1 through September 30 the assumption would be that a third of the normal effort during the closed season would be shifted into the open period (the same assumption used in the 2007-08 and 2009-10 EIS). Thus, for the May 1 through September 30 option it was assumed that the angler effort from the closed period (January 1 through April 30 and October 1 through December 31) would not transfer to the open period as the five core months would be open.

Angler effort in the directed Pacific halibut fishery was assumed to decrease slightly in 2011-12 due to the anticipated continued reduction in halibut allocation. The halibut allocation in 2011-12 was assumed to be equal to the 2010 allocation, which is fifteen percent lower than the allocation in 2009. The decision on the 2011 halibut catch allocation will occur after the 2011-12 groundfish regulations will be set. Estimates were made for the effect of allowing groundfish retention during the all-depth Pacific halibut openings and were made external to the impact model. Adjustment factors to encounter rates of yelloweye and canary rockfish during all-depth halibut openings were determined to be 150% and 230% of status quo encounter rates.

Model Description

The model design was similar to that used in setting the 2009-10 regulations. The model is housed as an Excel spreadsheet. The model has both landed and discarded fish sections. Each section has similar components although the discarded section also has components to apply both differential mortality rates and average size changes due to various potential offshore closures (i.e., seaward of 20, 25, 30 or 40 fm). Groundfish impacts on yelloweye rockfish and canary rockfish in the Pacific halibut fishery were modeled as a separate fishery. Cabezon landings under the sub-bag limit options were addressed separately from the remaining marine species.

The model normalized to a 12 month all-depth fishery was used to address impacts from all ocean boat fishery sources, excluding the targeted Pacific halibut fishery. It includes the following components for each species by month: (1) catch; (2) bag limit affects; (3) offshore fishery effects on encounter rates and average size; (4) a 7 percent effort shift to the nearshore fishery due to offshore closures; (5) average size and (6) mortality rates for discarded fish. For landed and discarded fish the methodology to address the affects of various marine bag limits, and offshore closure effects on (a) encounter rates and (b) effort shifts nearshore, were discussed earlier in the report under the Normalization section. Average weight was based on the 2007-09 average landed weight and at-sea observations since 2001 for discarded fish as discussed earlier in this report also under the Normalization section. Discarded fish mortality rates by rockfish species and depth were developed from at-sea observer data for catch distribution using mortality rates by species and depth adopted by the PFMC (Table A-26). Discard mortality rates of 7 percent were applied to lingcod, cabezon and greenling as they do not suffer from barotrauma.

Expected impacts on yelloweye rockfish and canary rockfish in the Pacific halibut fishery were addressed separately. The encounter rate per halibut pound landed in 2007, 2008 and 2009, using the 2002-2003 average weight of fish caught outside of 30-fm, was applied to the 2010 Oregon central coast all-depth halibut sport allocation. The estimated impacts were averaged between the three years to address expected impacts on both species. This assumes similar Pacific halibut allocations in 2011-12. A second set of encounter rates and impacts were estimated for the option of groundfish retention during the all-depth Pacific halibut openings.

Landings and discard impacts for shore and estuary caught species were modeled on a season total basis using the 1998-2002 average metric tons. This fishery will be managed for a year round season as it does not impact yelloweye rockfish and canary rockfish. The metric tons were adjusted for length limits applied to cabezon and greenling since that period (refer to the 2004-05 EIS). Sub-legal cabezon and greenling that were landed in the 1998-2002 period were now considered discards. A mortality rate of 7 percent was applied to all species discarded in the shore and estuary fishery to represent hooking mortality as the waters are not deep enough to cause mortality from barotrauma.

Table A-26. Discard mortality rate calculations for select rockfish species based on sport observer data from 2001 and 2003-07. Mortality rates are predicted for all-depth fisheries and various depth closure scenarios.

2001, 2003-2007 count of released fish by depth bin (fm)							
Species	**≤ 10 fm**	**11-20 fm**	**21-25 fm**	**26-30 fm**	**31-40 fm**	**> 40 fm**	**Total**
Black	506	522	29	2	0	0	1,059
Blue	308	846	87	7	0	0	1,248
Brown	0	1	0	0	0	0	1
China	1	7	3	0	0	0	11
Copper	0	12	1	1	0	0	14
Quillback	0	3	1	0	0	0	4
Canary	15	295	78	26	21	83	518
Yelloweye	1	24	18	5	4	23	75

Distribution of released fish by depth bin (fm) when open all depths							
Species	**≤ 10 fm**	**11-20 fm**	**21-25 fm**	**26-30 fm**	**31-40 fm**	**> 40 fm**	**Total**
Black	48%	49%	3%	0%	0%	0%	1,059
Blue	25%	68%	7%	1%	0%	0%	1,248
Brown	0%	100%	0%	0%	0%	0%	1
China	9%	64%	27%	0%	0%	0%	11
Copper	0%	86%	7%	7%	0%	0%	14
Quillback	0%	75%	25%	0%	0%	0%	4
Canary	3%	57%	15%	5%	4%	16%	518
Yelloweye	1%	32%	24%	7%	5%	31%	74

Table A-26. Discard mortality rate calculations for select rockfish species based on sport observer data from 2001 and 2003-07. Mortality rates are predicted for all-depth fisheries and various depth closure scenarios (continued).

Predicted distribution of released fish when closed outside of 40 fm						
Species	**≤ 10 fm**	**11-20 fm**	**21-25 fm**	**26-30 fm**	**31-40 fm**	**Total**
Black	48%	49%	3%	0%	0%	1059
Blue	25%	68%	7%	1%	0%	1248
Brown	0%	100%	0%	0%	0%	1
China	9%	64%	27%	0%	0%	11
Copper	0%	86%	7%	7%	0%	14
Quillback	0%	75%	25%	0%	0%	4
Canary	3%	68%	18%	6%	5%	435
Yelloweye	1%	46%	35%	10%	7%	51

Predicted distribution of released fish when closed outside of 30 fm

Species	**≤ 10 fm**	**11-20 fm**	**21-25 fm**	**26-30 fm**	**Total**
Black	48%	49%	3%	0%	1,059
Blue	25%	68%	7%	1%	1,248
Brown	0%	100%	0%	0%	1
China	9%	64%	27%	0%	11
Copper	0%	86%	7%	7%	14
Quillback	0%	75%	25%	0%	4
Canary	4%	71%	19%	6%	414
Yelloweye	2%	50%	37%	11%	47

Predicted distribution of released fish when closed outside of 25 fm

Species	**≤ 10 fm**	**11-20 fm**	**21-25 fm**	**Total**
Black	48%	49%	3%	1,057
Blue	25%	68%	7%	1,241
Brown	0%	100%	0%	1
China	9%	64%	27%	11
Copper	0%	86%	7%	13
Quillback	0%	75%	25%	4
Canary	4%	76%	20%	388
Yelloweye	2%	56%	42%	42

Predicted distribution of released fish when closed outside of 20 fm

Species	≤ 10 fm	11-20 fm	Total
Black	48%	49%	1,028
Blue	25%	68%	1,154
Brown	0%	100%	1
China	9%	64%	8
Copper	0%	86%	12
Quillback	0%	75%	3
Canary	4%	76%	310
Yelloweye	2%	56%	24

Table A-26. **Discard mortality rate calculations for select rockfish species based on sport observer data from 2001 and 2003-07. Mortality rates are predicted for all-depth fisheries and various depth closure scenarios. (continued)**

Mortality Rate

Species	≤ 10 fm	11-20 fm	21-25 fm	26-30 fm	31-40 fm	> 40 fm
Black	11%	20%	29%	29%	63%	63%
Blue	18%	30%	43%	43%	100%	100%
Brown	12%	22%	33%	33%	100%	100%
China	13%	24%	37%	37%	100%	100%
Copper	19%	33%	48%	48%	100%	100%
Quillback	21%	35%	52%	52%	100%	100%
Canary	21%	37%	53%	43%	100%	100%
Yelloweye	22%	39%	56%	56%	100%	100%

Total Mortality rate for discarded fish by proposed depth closure

Species	≤ 10 fm	≤ 20 fm	≤ 25 fm	≤ 30 fm	≤ 40 fm	All Depth
Black	11%	16%	16%	16%	16%	16%
Blue	18%	27%	28%	28%	28%	28%
Brown	12%	22%	22%	22%	22%	22%
China	13%	23%	27%	27%	27%	27%
Copper	19%	33%	34%	35%	35%	35%
Quillback	21%	35%	39%	39%	39%	39%
Canary	21%	36%	40%	40%	43%	52%
Yelloweye	22%	38%	46%	47%	51%	66%

A.11 California Recreational Model

The CDFG revised their impact projection model ("RecFISH") that was reviewed by the GMT at their January 2010 meeting and revisions were discussed in a conference call in May of 2010. The GMT recommends this updated model for use in projecting impacts of groundfish species in 2011-2012 California recreational fisheries. This model is described below and is used in impact analyses in this EIS.

Recreational fisheries management for multi-species assemblages in California presents many challenges. In recent years, declining stocks of several rockfish species have dictated recreational groundfish management seasons and depths in California. Increasingly complex restrictions have been necessary to keep total catch of depleted species within the reduced limits that are necessary to rebuild the stocks while providing fishing opportunity.

Prior to 2000, the recreational daily bag limit for rockfish was 15 fish per angler with no closed months or depths. Beginning in 2000, the daily bag limit was reduced to 10 fish. Regulations have changed each year since 2000, making analyses of the effects of particular regulations difficult. In addition, regulations have become more region-specific, adding to the difficulty of modeling projected catches.

Methodology Used to Project Recreational Catches for 2011–12

The recreational catch model incorporates a number of parameters and assumptions, all of which are either risk-neutral or risk-adverse. The basic analytical approach is the same as that used for 2009–10. The 2005-2009 data from the California Recreational Fishery Survey (CRFS) program serves as a baseline. The model output predicts expected catch under any combination of season and depth fishing restrictions for each of the regions

Key differences between 2009-10 and 2011-12 RecFISH model changes
- Includes 2008 & 2009 CRFS catch estimates
- Discard mortalities for 2009 used new GMT methodology
- Revised proportion of catch by depth for management areas north of Point Arena
- Revised proportion of catch by time for management areas north of Point Arena

CDFG/California Recreational Groundfish (RecFISH) Model Assumptions

The following assumptions are made in the application of the RecFISH model in projecting fishing impacts in the California recreational fishery.

- Effort Shift Inshore: The model includes a 27.6 percent increase in expected landings when fishing is restricted to less than 30 fm and a 39.3 percent increase in expected landings when fishing is restricted to less than 20 fm. The increase, or effort shift, is to account for increased effort in a smaller fishing area.
- Discard Mortality: The GMT developed depth-dependent mortality rates for discarded rockfish of the genus Sebastes in 10-fm increments, the derivation of which is described in section 4.1.5.6. The species specific depth-dependent mortality rates agreed upon by the GMT and approved by the PFMC in 2008 are applied to the discarded fish (B2 & B3) in the CRFS base data from 2005-09 used in the RecFISH model. When projecting the 2011-12 season catch, discard catch estimates are multiplied by the proportion of catch in a given 10-fm depth increment times the depth-dependent mortality rate for the corresponding depth for each species.

Inputs and Key Parameters for the Model

Weighting of Base Years: Base year data 2005-2009 were given nearly equal weighting by applying a 0.99 decay function. The previous biennial cycle made use of a 0.67 decay function to weight 2005 more heavily than 2004. With the exclusion of the 2004 data in the current model due to issues with the comparability of trip types between years, there are five years of data available for the model and these are weighted equally to represent the base catch in the model.

Base Year Catch: Initially, CRFS catch estimates in weight of fish were summed for caught and retained (CRFS “A” catch), filleted/caught otherwise unavailable (“B1” catch), and for species of concern, a proportion of CRFS reported discarded fish derived using depth-based mortality estimates. Base year catch estimates are assumed to be for an unrestricted fishing year with no months closed and no depths closed. Therefore, for each year, a back calculation method was used to obtain an estimate for what the catch would have been if all months and all depths had been open. This back calculation uses month and depth catch proportions derived from historical catch estimates from seasons unregulated by month and depth.

Historical Catch By Month: Estimates of historical percent catch by two-month period were calculated for each region based on Marine Recreational Fisheries Statistics Survey (MRFSS) data (weight of A+B1) from 1993-99, which was a time period when seasons and depths were unconstrained. Proxies were considered on a species by species basis for regions where there was a lack of catch data for that area. Monthly estimates of percent catch then were divided equally (50:50) for each pair of months.

Historical Catch by Depth: Estimates of percent catch by depth were calculated for each region based on MRFSS depth sample data (numbers caught A+B1 for CPFV and A+B1+B2 for PR) from 1999-2000, which was a time period when depths were unconstrained. Proxies were considered on a species by species basis for regions where there was a lack of catch data for that area.

Description of the Catch Projection Model for the California Recreational Fishery (RecFISH)

To improve the accuracy of catch estimates for yelloweye rockfish, two methods were employed when modeling the effect of depth restrictions on the catch of this species:

- For expanding baseline input catch data from regulated seasons to all depths, unregulated depth distribution of catch data from other areas can be used to supplement the existing historical data; these data must be from unregulated years to be able to expand to all depths. In the Northern Management Area, data from 1999-2003 were used (years unregulated by depth in the North), recent unregulated Oregon catch by depth (1999-2003), and 1999-2000 data from the North-Central area that is north of Point Arena (for bathymetric and fishing effort similarities to the North). For the North-Central area, additional data from dockside party charter catch by depth data from 1999-2000 were used.
- More recent catch data from CRFS were used to produce region–specific proportions of catch by depth with a higher sample size than historical data to provide improved projections that represent the current depth distribution of catch. Although this data is from regulated years, recent years have seen a consistent regulatory scheme by depth that would allow for use in apportioning catch by depth within the open depth strata. For example, for the Northern Management Area, the years 2004-2007 saw a consistent 0-30 fm depth restriction in place. The catch by depth for those years was used to project the depth distribution within the upper 30 fm for upcoming years (assuming catch will be restricted to within this zone), providing a more current framework than using the historical 1999-2000 data. Similarly, this applies to 2006-2009 catch by depth data for the North-Central Management Areas (same 0-30 fm depth restrictions). These depth distributions are applied as a post-model run adjustment, reapportioning the projections with the new depth distributions.

Determining the Proportion of Angler Reported Unavailable Dead Catch for Yelloweye and Canary Rockfish that was Composed of Discarded Dead Fish:

The California Recreational Fisheries Survey program (CRFS) uses several different catch types in generating catch estimates: sampler examined catch (“A”), angler-reported dead fish (“B1”), and angler reported discarded live catch (“B2”). The B1 category includes disposition such as retained (filleted fish, fish given away, used for bait or otherwise unavailable) and fish discarded dead. Unfortunately, since CRFS began in 2004, no disposition of the B1 catch has been recorded for the majority of private and rental trips which are sampled in the PR1 mode. Therefore, it is not possible to separate the discarded dead fish from the retained unavailable fish in the B1 catch type without use of a proxy for the proportion of fish discarded dead. Attempts have been made to use sparse available data and apply these to the B1 catch data, but little data exists for depleted non-retention species, such as yelloweye and canary rockfish.

To estimate the proportion of B1 catch of yelloweye and canary rockfish that is discarded dead, a "compliance factor" (CF) was determined from recent (2005-2009) CRFS data. The CF is calculated by dividing the B2 catch by the total catch (A+B1+B2); this represents the proportion of fish reported discarded live by anglers (reported live only) while complying with regulations. It is conservative, as a portion of the B1 catch (the discarded dead) in the denominator should be in the numerator. The CF is used as a proxy for the proportion of B1 that is discarded dead, and so it is multiplied by the B1 catch to estimate the total fish discarded dead. This amount is added to the known B2 catch to arrive at total discards. This value is then multiplied by discard mortality factors by depth to obtain the discard mortality. Total mortality is then the retained catch (A+B1, less the proportion of B1 designated discarded dead) + discard mortality. Because the CFs are conservative, the proportions of B1 that are considered otherwise unavailable dead (filleted, used for bait, given away) will be biased high, thereby leading to an estimate of total mortality that is biased high. CFs were determined for each management area for both yelloweye and canary rockfish and applied to the B1 (aggregate unavailable dead catch) catch for these species to provide a conservative proxy estimate of fish discarded dead to which depth dependent mortality rates would be applied in estimating total mortality.

Methodology Used to Calculate Annual Unrestricted Catch

- Pull (A+B1+B2+B3) Catch for each year from the RecFIN CRFS data web site: http://www.psmfc.org/recfin/forms/est2004.html. Specify species, and select the parameters: month and district under Define Table Layout.
- Pull historical catch by depth (1999-2000, most recent years unregulated by depth) from the RecFIN boatdepth3 CDFG private access website. Add PC and PR fish caught together for each separate region and species, maintaining combined depth totals for each depth strata. Calculate average percentage of total fish caught within each 10 fm depth stratum (= "Depth Profile") by dividing 10 fm depth strata totals by combined total sum of all strata for the region. Assign proxies as needed for data-poor areas, using adjacent regions, similar species, etc.
- Pull historical catch through time (1993-1999, the most recent years unregulated by monthly closure) from RecFIN website: http://www.psmfc.org/recfin/forms/est.html. Calculate average wave percents over combined years 1993-1999 by dividing individual wave totals by sum of all waves for each region. Assign proxies as needed for data-poor areas using the other region (North or South) as the proxy.
- For each management region and species, calculate total regulated catch based on months each set of regulations was in effect. For example, if fishing was only open from 0-60 fm for March-December, sum total catch for those months only. Each management region should now have catch data for all species grouped by the different sets of management regulations (MR sets) in effect for the year so that the identical calculations can easily be performed on identically restricted species.
- Expanding to All Depths. For each MR set: If there was no depth restriction, use the unmodified total regulated catch as the expected catch for all depths for that period of the year. If a depth restriction was in place, use total regulated catch to expand out each species in each MR set to all depths: from the Depth Profile, divide total regulated catch by sum of proportion of catch represented by the depths where fishing was open. This is the total expected catch for all depths. For example, if fishing for a MR set was open < 20

fm, divide the total catch by the percentage of the catch < 20 fm using the appropriate Depth Profile (historical unregulated catch data) for each species and region.

- Effort Shift. If the depth restriction is confined to a 20 or 30 fm band, we assume increased effort occurred for these months. To remove this effect, apply an Effort Shift factor to remove the increased fishing (and increased catch) for the constrained depth zone. For example, if a 0-20 fm restriction was in effect, divide the total expected catch for all depths by 1.393 to get final total expected catch for those months. Similarly, use a factor of 1.276 if fishing was restricted within a 30 fm range. No Effort Shift is applied for depth restrictions > 30 fm.
- Accounting for Closed Months. After expanding to all depths and removing Effort Shift (if needed), sum all the final expected catch values across all the MR sets for the year for each management region and species. Divide this sum b by the percent catch for the year that these regulated months represent (from the wave percents for the year). In other words, divide the calculated catch for all open months by the percentage of the catch for the year these months historically represent. This results in the expected annual unregulated catch, expanded out from the regulated catch, for each region and species.
- Input expected annual unregulated catch for each region-species into the Catch by Year Table in the RecFISH Model database. The weighting of the different years' data to be used by the model in projecting catch can be selected at the model-user interface.

Changes to the RecFISH Model for 2011-2012

The CRFS estimates from 2008 and 2009 were added to the estimates from 2005-2007 used in the previous iteration of the model. A fixed 42% discard mortality rate was applied to the B2 and B3 discarded rockfish catch for the input data for 2008. The proportion of catch by depth applied to the depth dependent mortality rates to derive Management Area Specific discard mortality rates were updated and applied to the 2009 input data. In addition, the proportion of catch by time and proportion of catch by depth in the historical catch were revised as described below, to better reflect the seasonality of effort North of Point Arena and the proportion of catch by depth North of 40 deg 10 min N. Latitude respectively.

1. Elimination of the Division between the Monterey and Morro Bay South-Central Management Areas. These areas are combined to reflect the consolidation of these two management areas into a single South-Central Management Area in 2011 and 2012. The CRFS district 3 shares the boundaries for this Management Area, extending from Pt. Conception to Pigeon Pt, allowing the same geographic scale of projections and inseason catch estimates for this region. A further analysis of this management measure is provided under Appendix B.
2. Revision to the Historical Catch by Month in North of Point Arena. The proportion of catch by wave was refined to a finer spatial resolution. Historically the fishery South of Point Conception, the area between Point Conception and Point Arena and the area between Point Arena and the CA/OR border have different proportions of catch by time due to weather, but previously only the differences North and South of Point Conception were accounted for in the model. In the area North of Point Conception, a far greater proportion of the total catch is derived from areas South of Point Arena biasing the proportion of catch by time. Oregon catch by time data were used as a proxy for North of Point Arena since catch data are available from Oregon during the unregulated fishing season, and the North Coast is similar to Oregon in terms of weather, opportunity and effort.

Historical Oregon data (1993–1999) replaced historic California data (1993–1999) for the North and North-Central North of Point Arena Management Areas for the following species: bocaccio, cabezon, canary rockfish, black rockfish, blue rockfish, brown rockfish, copper rockfish, quillback rockfish, greenling genus, kelp greenling, rock greenling, lingcod, China rockfish, grass rockfish, widow rockfish, and yelloweye rockfish. Oregon RecFIN catch data were extracted by wave for the years 1993–1999 because this is a time when Oregon had open seasons and no depth restrictions similar to California. "Catch" is defined as sampler-examined dead and angler-reported dead fish (A+B1). Estimated total catch in metric tons were compiled in MS Excel by species and wave. Catch-by-wave was converted into catch-by-month by dividing wave data in half. Areas between Point Arena and Point Conception (the North-Central South of Point Arena and the South-Central Management Areas) and Southern California, were not affected by this revision.

3. Revision to the Historical Catch by Depth in the Northern Management Area.
The proportion of catch by depth for the Northern Management Area (40°10' N. latitude to the OR/CA border) was previously calculated using data from 1999 and 2000. The RecFISH model now includes data from 2001 and 2002 as well, since depth restrictions did not go into effect until 2003. This increased the sample size and improved the accuracy of the projections. The additional data reduced the reliance on proxy data for the Northern Management Area.

Historical California data (2001–2002) from RecFIN was added the existing data for the Northern North Management Areas for all species within the RecFISH model. The "Boat Depth 3" RecFIN website was used to query the catch by depth data. The data were downloaded into MS Access and aggregated into 60ft (10 fm) depth bins to match the layout found within the RecFISH model. The RecFIN survey data used consist of angler-retained fish (A+B1) as well as angler discarded fish (B2). Proxies were used for some species where data was limited or non-existent. Similar proxy processes were used in the model before but the number of proxies was greatly reduced, resulting in a more robust RecFISH model. Recreational Groundfish Management Areas between Cape Mendocino and the California/ Mexico border were not affected by this revision.

The names of the Management Areas will be changed in 2011 to make them shorter and the south-central management areas will be combined to form a single management area, reducing the number of management areas from six to five, reducing regulatory complexity.

A.12 References

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