DRAFT

Status of the U.S. splitnose rockfish (*Sebastes diploproa*) resource in 2009.

Vladlena V. Gertseva
Northwest Fisheries Science Center
NOAA Fisheries
2032 South East OSU Drive
Newport, OR 97365

Jason M. Cope
Northwest Fisheries Science Center
NOAA Fisheries
2725 Montlake Blvd East
Seattle, WA 97365

Donald E. Pearson
Southwest Fisheries Science Center
NOAA Fisheries
110 Shaffer Road
Santa Cruz, CA 95060

May 28, 2009

Table of Contents:

EXECUTIVE SUMMARY

Stock

Splitnose rockfish (*Sebastes diploproa*) are distributed from the northern Gulf of Alaska (Prince William Sound) to central Baja California. This assessment reports the status of the splitnose rockfish resource off the continental coast of the United States from the U.S.-Canadian border in the north to the U.S.-Mexican border in the south. Within the assessment area the resource is treated as a single stock due to the lack of biological and genetic data supporting the presence of multiple stocks. Nevertheless, management decisions on a coast-wide population need to account for effort concentration, since abundance is higher in some areas such as off central California.

Catches

Splitnose rockfish have not been a target of commercial fisheries, but have been taken incidentally. Off Washington and Oregon, it was historically bycaught in the Pacific ocean perch fishery. Since the adoption of the formal rebuilding plan for Pacific ocean perch, splitnose rockfish have been caught primarily in fisheries for mixed slope rockfish or other deepwater targets. Because of their small size, splitnose rockfish have a limited market and are often discarded. Over the last twenty years, discard rates ranged between 27% and 80% of the total catch.

Splitnose rockfish are not consistently sorted to species, and landings are estimated from applying port sampling species compositions to mixed rockfish landings. Trawl landings on average comprise 90% of annual catches, with 80% of fish landed in California. Only 10% of splitnose rockfish on average are caught by non-trawl commercial fisheries. The vast majority of non-trawl landings are caught by net gear, and only a small portion is caught by hook-and-line in the sablefish fishery. This species is rarely taken in the recreational fishery.

The landed catch of splitnose rockfish was reconstructed back to 1900 from variety of published sources and databases. The fishery removals were divided among three fisheries - domestic trawl, foreign trawl and domestic non-trawl. Landings peaked in the 1960s, when foreign trawl fleets operated in U.S. waters, and reached 5313 mt in 1967. The highest catch by domestic fleets was in 1998, when 1526 mt of splitnose rockfish was landed. For the last ten years landings were relatively low and ranged between 65 and 274 mt.

Table ES-1. Recent landings (mt) of splitnose rockfish in domestic trawl (by state) and non-trawl fisheries.

Year	Trawl CA	Trawl OR	Trawl WA	Non Trawl	Total (mt)
1999	231	35	1	1	267
2000	101	23	2	6	132
2001	99	9	1	2	110
2002	57	4	1	3	65
2003	151	4	1	1	157
2004	170	11	1	0	182
2005	86	10	0	1	97
2006	269	4	0	1	274
2007	61	7	1	0	69
2008	61	3	2	0	67

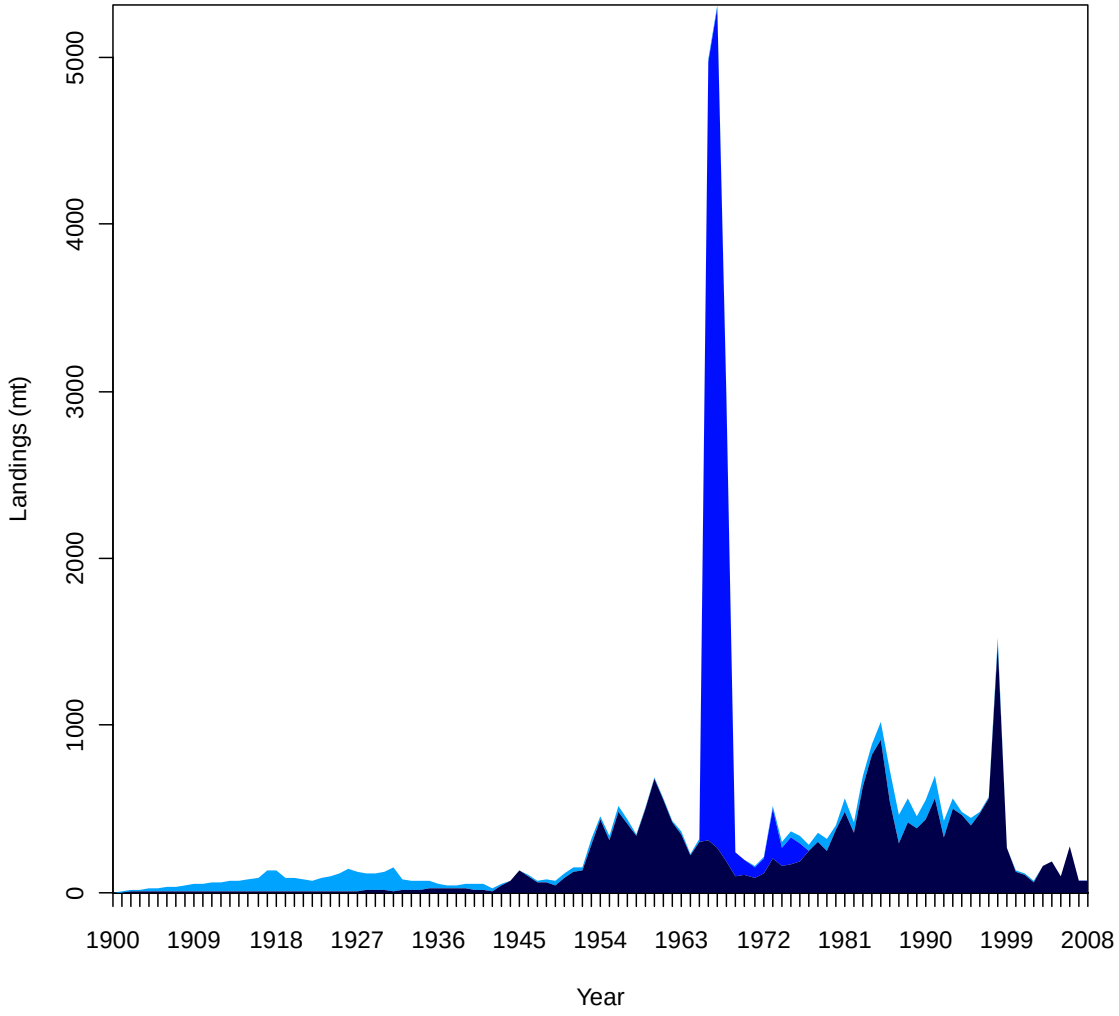

Figure ES-1. Reconstructed historical landings (mt) for splitnose rockfish by domestic trawl (dark blue), foreign trawl (mid blue) and non-trawl (light blue) fisheries.

Data and Assessment

This is the first full assessment for splitnose rockfish on the U.S. West Coast. Preliminary assessment of the splitnose rockfish status was conducted in 1994, when the available data about the species were compiled. However, since the data were sparse and no evident trends in biomass or mean size were detected, the results were inconclusive. In 1996, the status of the remaining rockfish species in the *Sebastes* complex was assessed, and species-specific Allowable Biological Catch (ABC) for splitnose rockfish was calculated.

In this assessment, the Stock Synthesis modeling program (version 3.02E) was used to conduct the analysis and estimate management quantities. The assessment is based on a two-sex model. The modeling period begins in 1900, assuming an unfished equilibrium state of the stock in 1899. The model includes three fisheries (domestic trawl, foreign trawl and domestic non-trawl)

that operate within the entire area of assessment. Fishery-dependent data used in the assessment include landings by domestic trawl (1916-2008), foreign trawl (1966-1976) and non-trawl (1916-2008) fisheries; length frequency distributions for domestic trawl (1978-2008) and non-trawl (1983-1998, 2002) fleets; domestic trawl discards and discard length frequency distributions from Pikitch's study (1987) and the West Coast Groundfish Observer Program (2002-2007). Fishery-independent data include survey abundance estimates (1983-2008) from four National Marine Fisheries Service (NMFS) surveys conducted on the continental shelf and slope, length frequency distributions (1983-2008) from three of the four NMFS surveys and age compositions (2003-2008) from one of the surveys.

Stock spawning output

The splitnose rockfish assessment model uses a non-proportional egg-to-weight relationship, and the spawning output is reported in millions of eggs. The unexploited level of spawning stock output for splitnose rockfish is estimated to be 12853 million eggs. At the beginning of 2009, the spawning stock output is estimated to be 8426 million eggs, which represents 65.55% of the unfished spawning output.

Splitnose rockfish were relatively lightly exploited until 1940s, when the trawl fishery for the rockfish first became important. With the development of the Pacific ocean perch fishery (a species with which splitnose rockfish co-occur), spawning output of splitnose rockfish began to decline. A sharp drop in the 1960s was associated with large harvests of Pacific ocean perch by foreign trawl fleets operating in the current U.S. EEZ. Another drop occurred in 1998 when the increased availability of splitnose rockfish led to high removals off California. Since 1999, the splitnose spawning output was estimated to have been increasing in response to below-average removals and above-average recruitment during the last decade.

Table ES-2. Recent trend in estimated splitnose rockfish spawning output (million eggs) and depletion level.

Year	Estimated spawning output (million eggs)	95% confidence interval	Estimated depletion
1998	4913	2681-7145	38%
1999	4602	2363-6841	36%
2000	4651	2372-6931	36%
2001	4763	2430-7096	37%
2002	4910	2508-7312	38%
2003	5125	2627-7623	40%
2004	5404	2770-8038	42%
2005	5807	2975-8639	45%
2006	6365	3273-9457	50%
2007	6972	3574-10370	54%
2008	7690	3960-11420	60%
2009	8426	4357-12495	66%

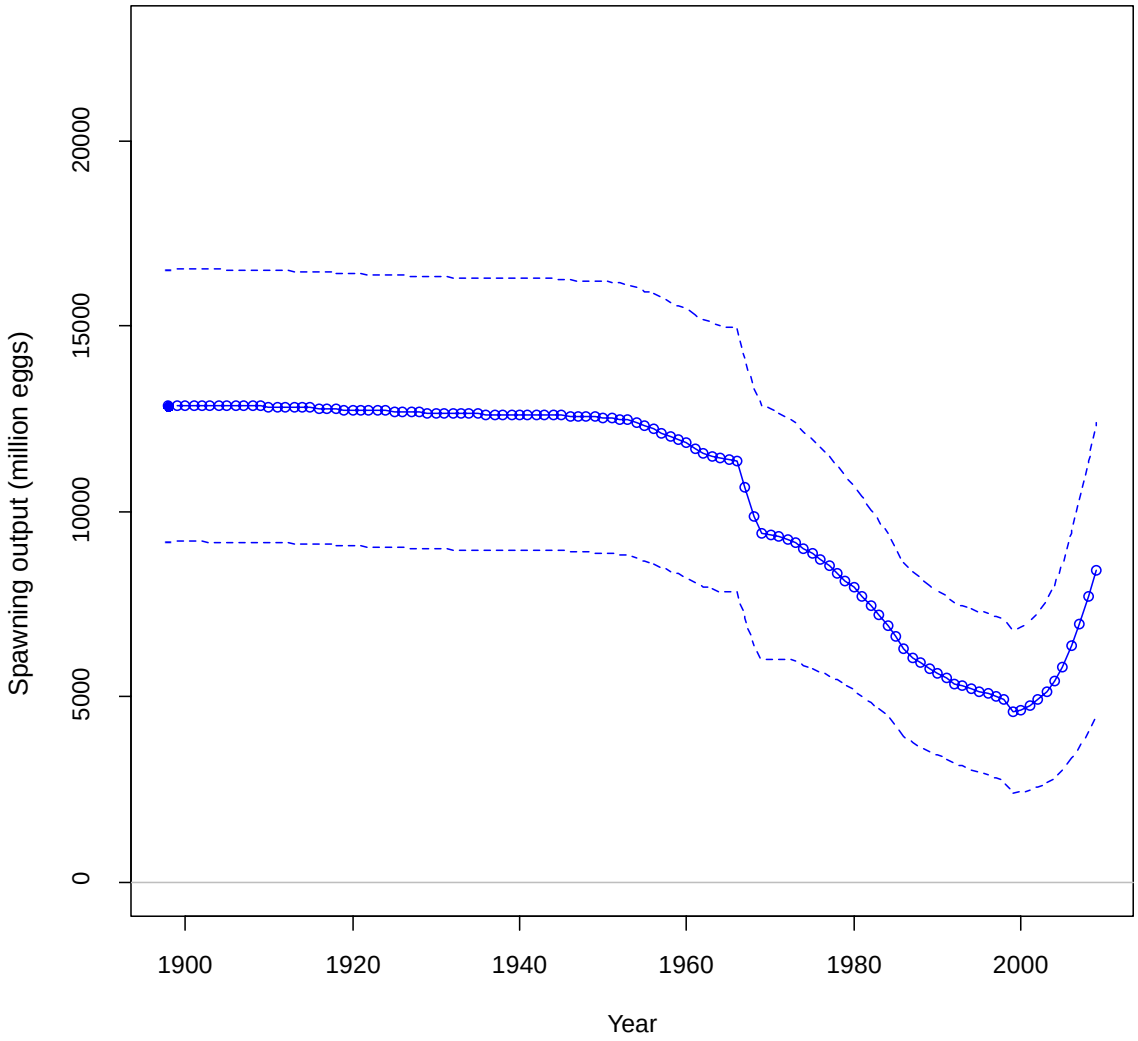

Figure ES-2. Time-series of estimated spawning output (million eggs) with 95% confidence interval.

Recruitment

In the assessment, the Beverton-Holt model was used to describe the stock-recruitment relationship. The level of virgin recruitment was estimated in order to assess the magnitude of the initial stock size. Recruitment deviations were estimated for each year between 1960 and 2006, which is the period best informed by the data based on evaluation of the variance of the recruitment deviations. Prior to 1960 and after 2006, recruits were taken deterministically from the stock-recruit curve. The standard deviation of log recruitment, used to define offset of the stock recruitment curve when recruitment deviations were estimated, was iteratively fit within the model and then fixed at the resulting level of 1. Steepness of the stock-recruitment curve was fixed at a value of 0.58, as estimated by meta-analysis for unassessed rockfish.

The model estimated above-average recruitments in the most recent years beginning 1999, which along with low catches during the last decade determine a population increase in recent and early forecast years. Uncertainty in recent recruitment was used to define alternative states of nature and develop the decision table.

Table ES-3. Recent trend in estimated recruitment for splitnose rockfish.

Year	Estimated recruitment (1000s)	95% confidence interval
1998	23415	7040-39790
1999	61334	28740-93929
2000	35490	13997-56983
2001	44964	20993-68934
2002	35911	16312-55510
2003	22393	8682-36103
2004	21045	6964-35125
2005	40017	14419-65614
2006	52323	11360-93286
2007	78227	0-186159
2008	12441	0-37683
2009	12741	0-38585

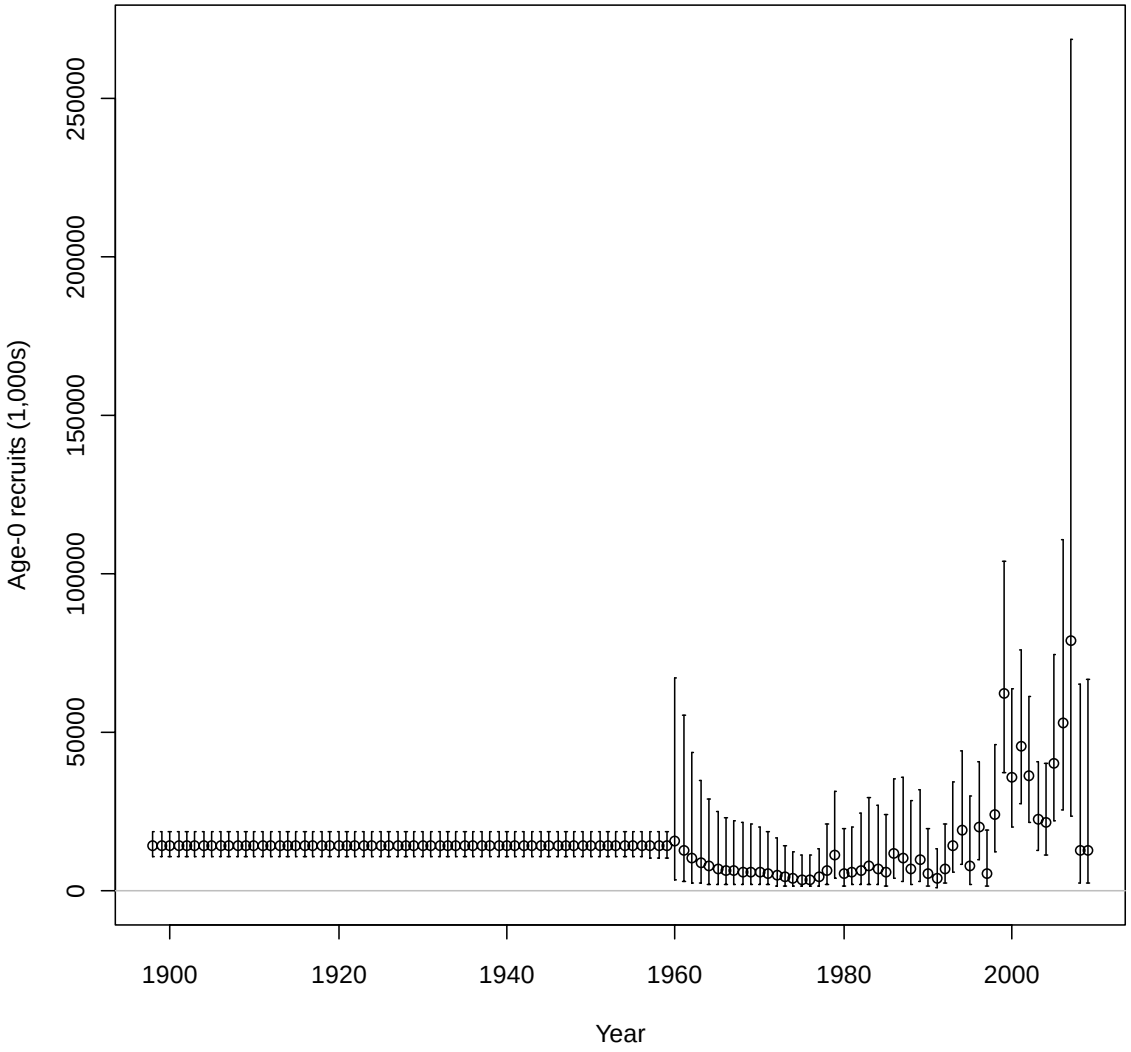

Figure ES-3. Time-series of estimated recruitment with 95% confidence interval.

Reference Points

Unfished spawning stock output for splitnose rockfish was estimated to be 12853 million eggs (95% confidence interval: 9105-16601 million eggs). The management target for splitnose rockfish is defined as 40% of the unfished spawning output ($SB_{40\%}$), which is estimated by the model to be 5141 million eggs (95% confidence interval: 3642-6641 million eggs). The stock is declared overfished if the current spawning output is estimated to be below 25% of unfished level. The MSY-proxy harvest rate for splitnose rockfish is SPR=F50%, which corresponds to an exploitation rate of 0.033. This harvest rate provides an equilibrium yield of 1236 mt at $SB_{40\%}$ (95% confidence interval: 883-1589 mt). The model estimate of maximum sustainable yield (MSY) is 1268 mt (95% confidence interval: 906-1630 mt). The estimated spawning stock output at MSY is 4121 million eggs (95% confidence interval: 2900-5342 million eggs). The exploitation rate corresponding to the estimated SPR_{MSY} of F44% is 0.039.

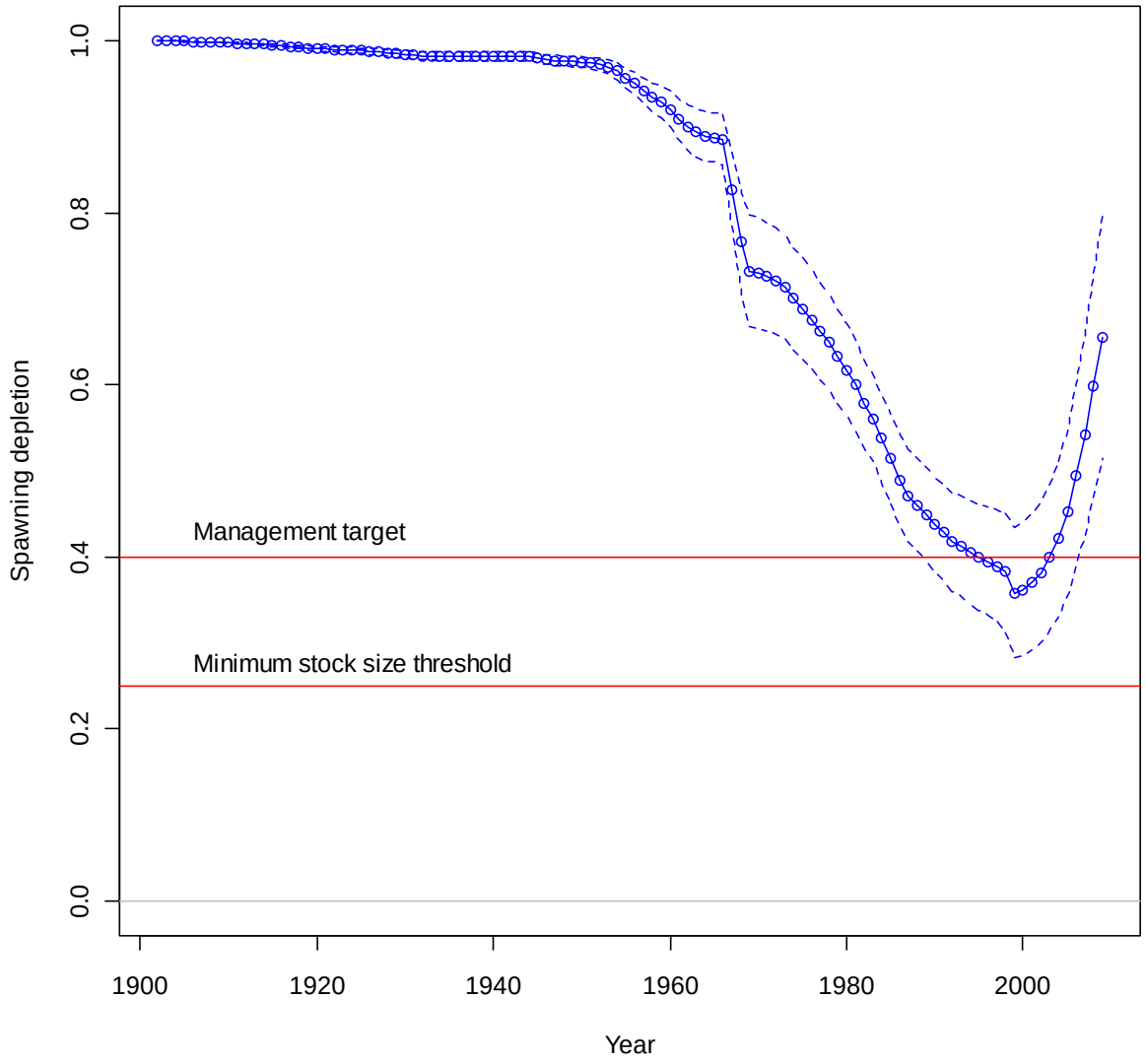

Figure ES-4.Time-series of estimated spawning depletion with 95% confidence interval

Exploitation Status

The assessment shows that the stock of splitnose rockfish in the U.S. West Coast is currently at 66% of its unexploited level and, therefore, not overfished. Historically, the abundance of splitnose rockfish was estimated to have dropped below the $SB_{40\%}$ management target in 1995, after experiencing sharp reductions from the large catches by foreign fishery in mid-1960s and increasing domestic catches in 1980s. However, the spawning stock has been increasing since the early 2000s, and stayed above the $SB_{40\%}$ management target since 2003. The assessment identifies two historical periods in which exploitation rates exceeded the current F_{MSY} proxy harvest rate: during the foreign fishery peak in the mid 1960s, and in 1998.

Table ES-4. Recent trends in estimated spawning potential ratio (SPR) and exploitation rate for splitnose rockfish.

Year	SPR (%)	Exploitation rate
1998	28.25%	0.0910
1999	70.77%	0.0077
2000	83.66%	0.0033
2001	86.02%	0.0027
2002	91.56%	0.0015
2003	81.58%	0.0043
2004	79.74%	0.0053
2005	88.68%	0.0027
2006	74.14%	0.0090
2007	92.69%	0.0019
2008	93.45%	0.0018

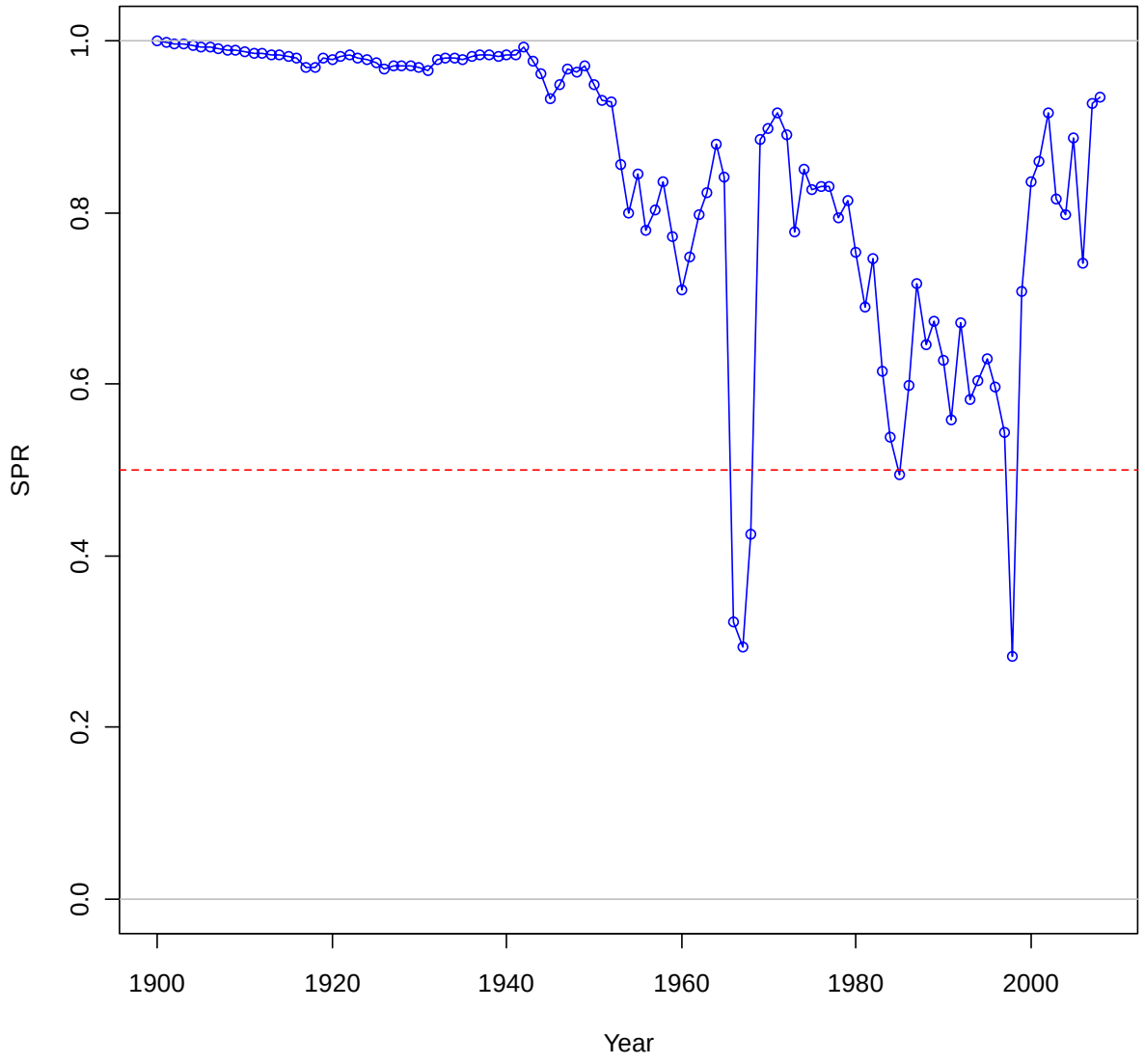

Figure ES-5. Time-series of estimated spawning potential ratio (SPR) with SPR target of 0.5. Values below target reflect harvest that exceeded current overfishing proxy.

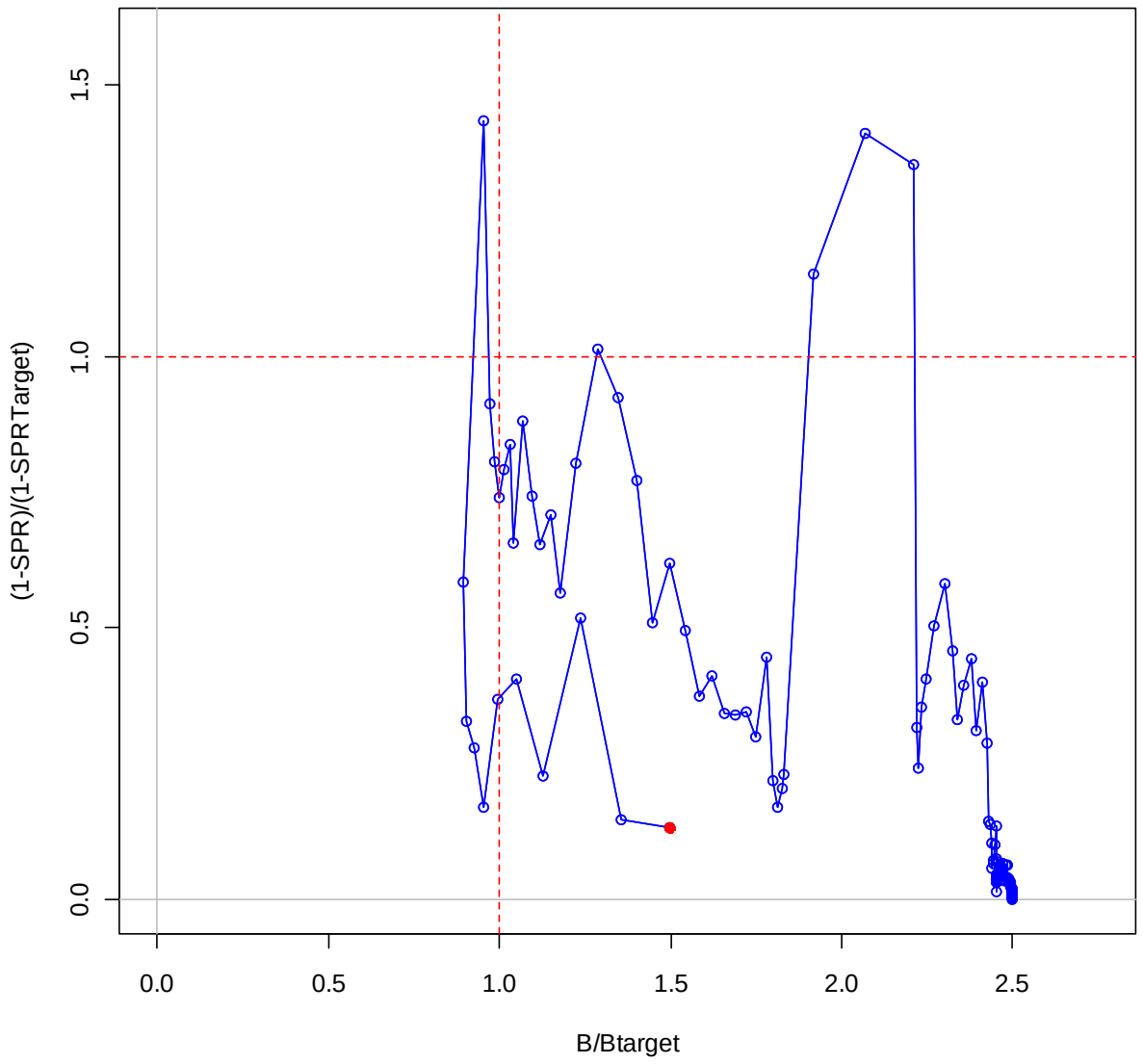

Figure ES-6. Estimated spawning potential ratio relative to its target of 0.5 versus estimated spawning output relative to its target of $SB_{40\%}$. Red dot indicates the point that corresponds to 2009.

Management
Splitnose rockfish were historically managed within the *Sebastes* complex. In 1994, the *Sebastes* complex was divided into southern (Conception, Monterey and Eureka INPFC areas) and northern (Columbia and US Vancouver INPFC areas) management areas, and harvest guidelines were established for the complex in each area. In 1999, after unusually high splitnose rockfish catches in 1998 that were mostly landed in California, splitnose rockfish for the first time were individually separated from the *Sebastes* complex in the southern area. Individual Allowable Biological Catch (ABC) and Optimum Yield (OY) for splitnose rockfish in that area have been specified along with splitnose-specific trip limits.

In 1999, the general *Sebastes* complex was divided into near-shore, shelf, and slope assemblages, and the dividing line between the northern and southern management units was shifted southward to 40°10' N. latitude, near Cape Mendocino. In the northern area, splitnose has been managed under trip limits for minor slope rockfish since 1999. For 2000, harvest specifications for splitnose rockfish were set for the Conception and Monterey INPFC areas only, and 48 metric tons for the Eureka area were added to the northern minor rockfish ABC. Also, a precautionary adjustment of the OY (reduced from the ABC by 25%) was specified to account for a less rigorous assessment. In 2000, the ABC and OY for splitnose rockfish south of 40°10' N. latitude were reduced based on the revised F_{MSY} harvest rate policy. For the last 10 years, the coast-wide landings and total catch of splitnose rockfish were relatively low, and the limits established for the area south of 40°10' N. latitude have not been exceeded.

Table ES-5. Management guidelines, recent trends in landings and estimated total catch for splitnose rockfish.

	South of 40°10' N latitude		North of 40°10' N latitude		Coaswide	
Year	**ABC**	**Total Catch OY**	**ABC**	**Total Catch OY**	**Landings**	**Total catch**
1998	NA	NA	NA	NA	1526	2780
1999	868	868	NA	NA	267	500
2000	820	615	NA	NA	132	245
2001	615	461	NA	NA	110	211
2002	615	461	NA	NA	65	125
2003	615	461	NA	NA	158	320
2004	615	461	NA	NA	182	383
2005	615	461	NA	NA	97	210
2006	615	461	NA	NA	274	610
2007	615	461	NA	NA	68	154
2008	615	461	NA	NA	66	149

Uncertainty
Uncertainty in the model was explored though asymptotic variance estimates and sensitivity analyses. Asymptotic confidence intervals were estimated within the model and reported throughout the assessment for key model parameters and management quantities. Sensitivity analysis allowed evaluation of the responsiveness of model outputs to changes in model assumptions. A variety of sensitivity runs were performed in regards to omission and inclusion of data sources, increase and decrease in reconstructed historical catches, timing of recruitment deviations, assumptions regarding selectivity parameters (asymptotic versus dome-shaped), female fecundity (proportional versus non-proportional female egg-weight relationship), and

others. The uncertainty regarding natural mortality and stock-recruitment curve steepness was explored through likelihood profile analysis.

Decision table
Three states of nature were defined based on the alternative assumptions regarding recent recruitments for years between 2000 and 2006. The middle scenario uses the recent recruitment deviations estimated by the base model. The “low” and “high” recruitment scenarios were generated by fixing recruitment deviations between 2000 and 2006 at the limits of the 95% confidence interval (at the low limit for the low scenario; at the high limit for the high scenario) of the expected deviations for each year. Recruitment deviations between 1960 and 1999 were fixed at the base model expectations in both scenarios.

Research and data needs
In this assessment, several critical assumptions were made based on limited supporting data and research. There are several research and data needs which, if satisfied could improve the assessment. These research and data needs include:

1) Genetic studies of splitnose rockfish stock structure in the Northeast Pacific ocean;
2) Comprehensive historical reconstruction of splitnose rockfish catches in Oregon and Washington;
3) Age-determination and age-validation studies to develop a consistent set of aging criteria for the species that could help reduce the differences among agers;
4) Histological studies of splitnose rockfish maturity to reliably estimate and reduce uncertainty in female maturity parameters;
5) Studies of the spatial dynamics of splitnose rockfish to better understand their distribution and explain increased availability of the species off California in 1998;
6) Further exploration of climate-growth relationships for splitnose rockfish and incorporation of this relationship into the stock assessment model.

It is also very important to continue to monitor discard in order to improve the accuracy of total catch estimates.

Table ES-6. Decision table of 12-year projections for alternative states of nature defined based on the alternative scenarios for recent recruitment deviations (2000-2006), with low and high scenarios corresponding to the high and low limits of the 95% confidence interval around the base model recruitment deviations for the same period.

			Low recent recruitments		**Base Case**		**High recent recruitments**	
Forecast	Year	Total removals (mt)	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion	Spawning output (million eggs)	Depletion
	2009	2,780	7,432	62%	8,426	66%	8,177	66%
	2010	2,780	7,601	64%	8,825	69%	8,785	71%
	2011	2,780	7,754	65%	9,261	72%	9,503	76%
	2012	2,780	7,906	66%	9,750	76%	10,342	83%
1998 removals	2013	2,780	8,062	67%	10,275	80%	11,256	91%
	2014	2,780	8,190	68%	10,765	84%	12,124	98%
	2015	2,780	8,263	69%	11,154	87%	12,845	103%
	2016	2,780	8,268	69%	11,416	89%	13,376	108%
	2017	2,780	8,208	69%	11,552	90%	13,719	110%
	2018	2,780	8,094	68%	11,581	90%	13,898	112%
	2019	2,780	7,936	66%	11,520	90%	13,941	112%
	2020	2,780	7,745	65%	11,391	89%	13,875	112%
	2009	291	7,432	62%	8,426	66%	8,177	66%
	2010	291	7,935	66%	9,153	71%	9,107	73%
	2011	291	8,436	71%	9,929	77%	10,159	82%
	2012	291	8,943	75%	10,768	84%	11,344	91%
Average removals	2013	291	9,461	79%	11,653	91%	12,615	101%
of the last 10 years	2014	291	9,956	83%	12,509	97%	13,848	111%
	2015	291	10,396	87%	13,268	103%	14,940	120%
	2016	291	10,766	90%	13,897	108%	15,842	127%
	2017	291	11,065	93%	14,395	112%	16,551	133%
	2018	291	11,300	94%	14,775	115%	17,086	137%
	2019	291	11,480	96%	15,054	117%	17,472	141%
	2020	291	11,615	97%	15,250	119%	17,734	143%
	2009	145	7,432	62%	8,426	66%	8,177	66%
	2010	145	7,955	67%	9,172	71%	9,126	73%
	2011	145	8,475	71%	9,968	78%	10,198	82%
	2012	145	9,004	75%	10,827	84%	11,403	92%
50%	2013	145	9,543	80%	11,733	91%	12,694	102%
of average removals	2014	145	10,060	84%	12,611	98%	13,949	112%
of the last 10 years	2015	145	10,522	88%	13,392	104%	15,063	121%
	2016	145	10,913	91%	14,043	109%	15,986	129%
	2017	145	11,233	94%	14,562	113%	16,717	134%
	2018	145	11,488	96%	14,963	116%	17,273	139%
	2019	145	11,688	98%	15,262	119%	17,679	142%
	2020	145	11,842	99%	15,476	120%	17,961	144%

Table ES-7. Summary of recent trends in estimated splitnose rockfish exploitation and stock level from the assessment model.

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Landings (mt)	132	110	65	158	182	97	274	68	66
Estimated Discards (mt)	113	101	60	162	201	113	336	86	83
Estimated Total Catch (mt)	245	211	125	320	383	210	610	154	149
ABC (mt) south of 40°10' N lat	820	615	615	615	615	615	615	615	615
OY * (if different from ABC) (mt) south of 40°10' N lat	615	461	461	461	461	461	461	461	461
ABC (mt) north of 40°10' N lat									
OY * (if different from ABC) (mt) north of 40°10' N lat									
SPR	83.66%	86.02%	91.56%	81.58%	79.74%	88.68%	74.14%	92.69%	93.45%
Exploitation Rate (total catch/summary biomass)	0.0033	0.0027	0.0015	0.0043	0.0053	0.0027	0.0090	0.0019	0.0018
Summary Age 4+ Biomass (B) (mt)	75191	76985	81215	73570	72152	79014	67815	82064	82640
Spawning Stock Output (*SB*) (million eggs)	4651	4763	4910	5125	5404	5807	6365	6972	7690
Uncertainty in Spawning Stock Output estimate	2372-6931	2430-7096	2508-7312	2627-7623	2770-8038	2975-8639	3273-9457	3574-10370	3960-11420
Recruitment at age 0	35490	44964	35911	22393	21045	40017	52323	78227	12441
Uncertainty in Recruitment estimate	13997-56983	20993-68934	16312-55510	8682-36103	6964-35125	14419-65614	11360-93286	0-186159	0-37683
Depletion (SB/SB0)	36.19%	37.06%	38.20%	39.87%	42.04%	45.18%	49.52%	54.24%	59.83%
Uncertainty in Depletion estimate									46.68%-72.98%

Table ES-8. Summary of splitnose rockfish reference points from the assessment model.

	Point estimate	95% confidence interval
Unfished Spawning Stock Output (SB_0) (million eggs)	12853	9105-16601
Unfished Summary Age 4+ Biomass (B_0) (mt)	87588	NA
Unfished Recruitment (R_0) at age 0	13953	9874-18031
Reference points based on $SB_{40\%}$		
MSY Proxy Spawning Stock Output ($SB_{40\%}$) (million eggs)	5141	3642-6641
SPR resulting in $SB_{40\%}$ ($SPR_{SB40\%}$)	50.86%	50.86%-50.86%
Exploitation rate resulting in $SB_{40\%}$	3.18%	NA
Yield with $SPR_{SB40\%}$ at $SB_{40\%}$ (mt)	1236	883-1589
Reference points based on SPR proxy for MSY		
Spawning Stock Output at SPR (SB_{SPR}) (million eggs)	5006	3546-6466
$SPR_{MSY\text{-}proxy}$	50%	
Exploitation rate corresponding to SPR	3.28%	NA
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)	1244	888-1599
Reference points based on estimated MSY values		
Spawning Stock Output at MSY (SB_{MSY}) (million eggs)	4121	2900-5342
SPR_{MSY}	44.36%	43.90%-44.83%
Exploitation Rate corresponding to SPR_{MSY}	3.98%	NA
MSY (mt)	1268	906-1630

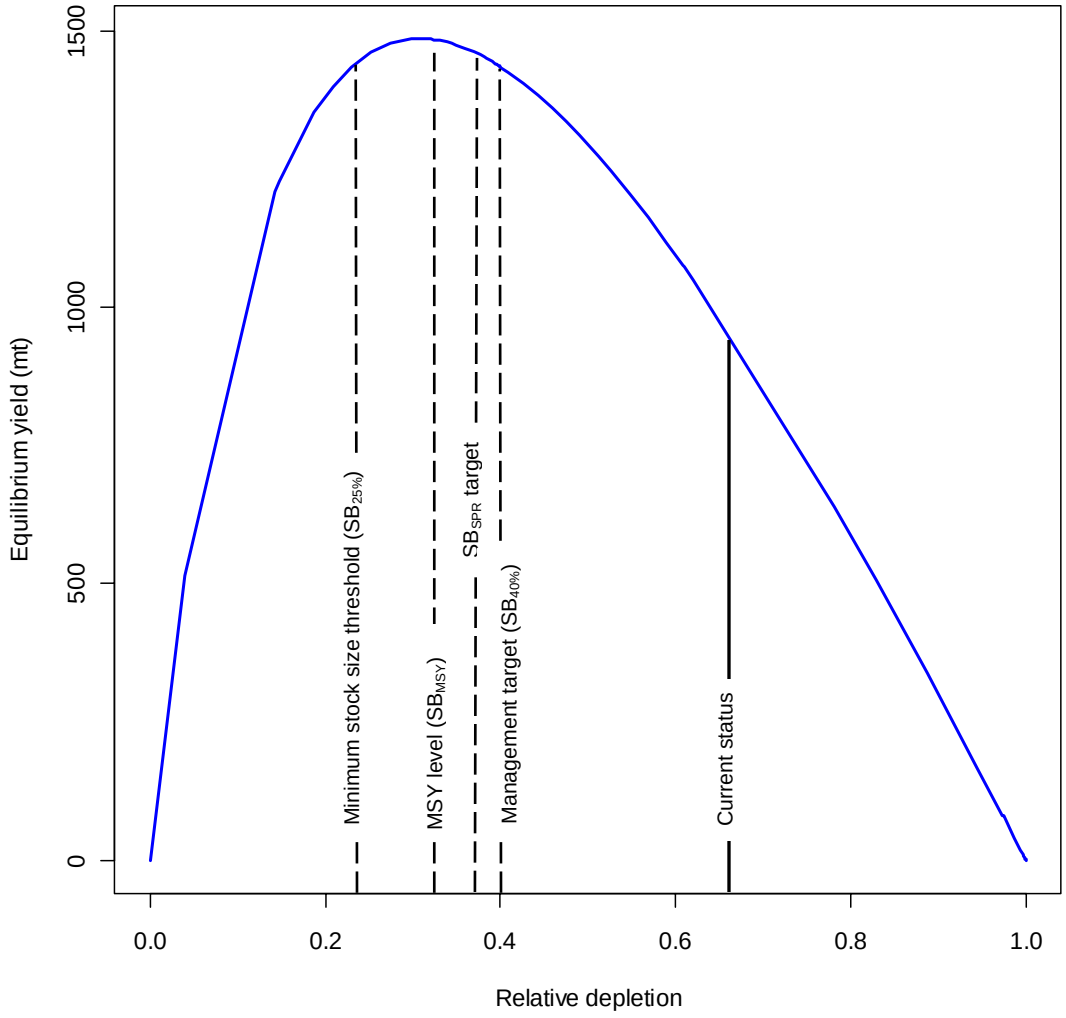

Figure ES-7. Equilibrium yield curve for splitnose rockfish from the assessment model (based on Table ES-8).