2021 Vermilion and Sunset Rockfish Stock Assessment and STAR Panel Report Overview

Agenda Item C.6.a
Supplemental STAR Panel Presentation 1
(Vermilion and Sunset)
September 2021

Photo by Sabrina Beyer (NMFS)

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Previous Assessments

- Full assessment attempted in 2005, not adopted due to uncertainties
- Index-based data-moderate assessment attempted in 2013, but not reviewed
- Managing on OFL/ABC from DB-SRA data-poor assessment since 2011

Photo by Marine Applied Research and Exploration

2021 Assessment Spatial Structure

- Four separate assessment areas
- Cryptic species, vermilion vs. sunset rockfish south of Point Conception
- Disparate distribution of catch in OR and WA and differing regulation history

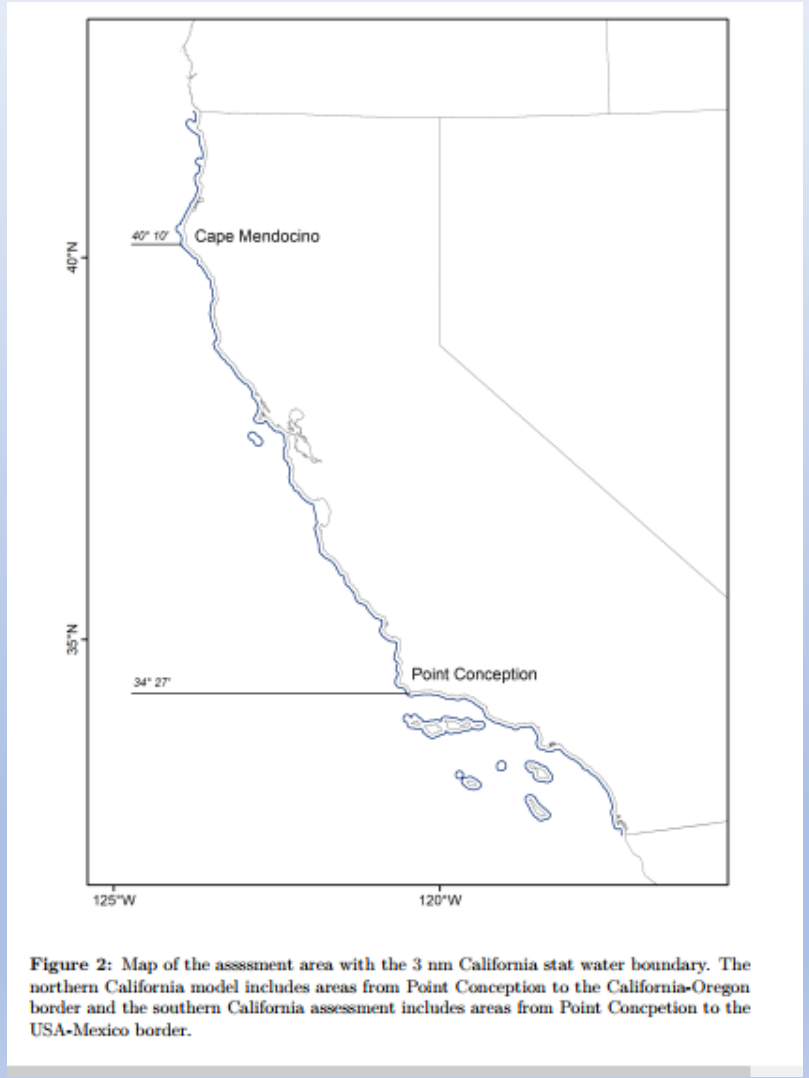


Figure 2: Map of the assssment area with the 3 nm California stat water boundary. The northern California model includes areas from Point Conception to the California-Oregon border and the southern California assessment includes areas from Point Concpetion to the USA-Mexico border.

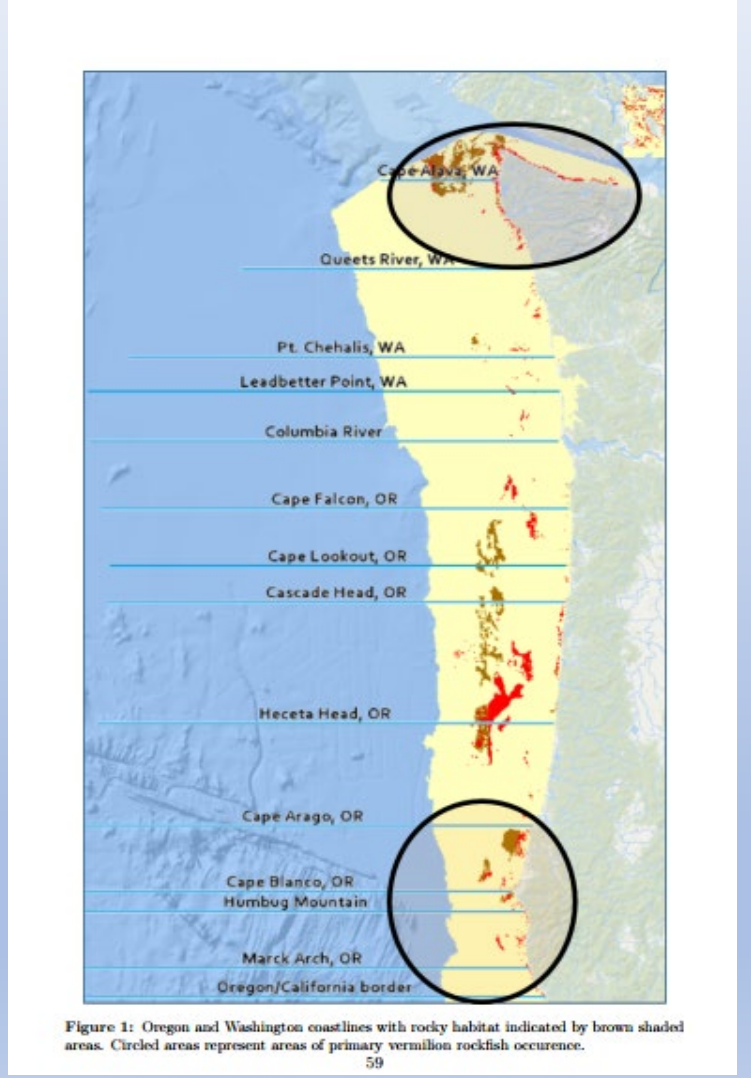


Figure 1: Oregon and Washington coastlines with rocky habitat indicated by brown shaded areas. Circled areas represent areas of primary vermilion rockfish occurence.

Data Sources

- More data in the south than north given abundance
- All Areas: Catch, length, age, conditional age at length
  - Catch is predominantly from recreational and hook and line commercial fisheries
- Washington: No index, low sample size and paucity of length and age data meeting n>10 per year
- Oregon: Fishery dependent ORBS recreational dockside Index (2001-2020)
- Northern California:
  - Fishery Dependent: MRFSS Dockside PC Index, CRFS PR dockside index, CDFW/CalPoly onboard CPFV index, DWV onboard CPFV Index
  - Fishery Independent: SWFSC Groundfish Ecology Cruise, Abrams Thesis Study, WCBTS, CCFRP
- Southern California: See sources to the right

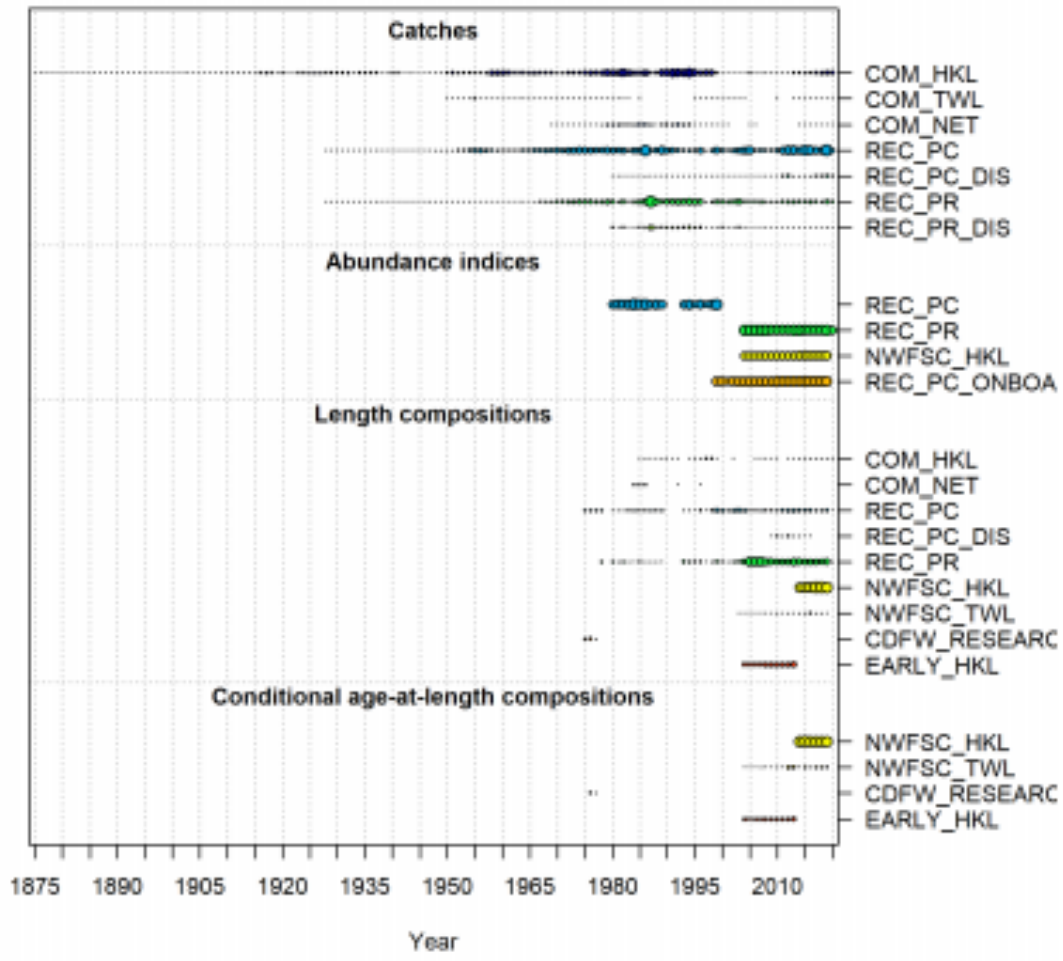


Figure 1: Summary of data sources used in the base model.

Model Description

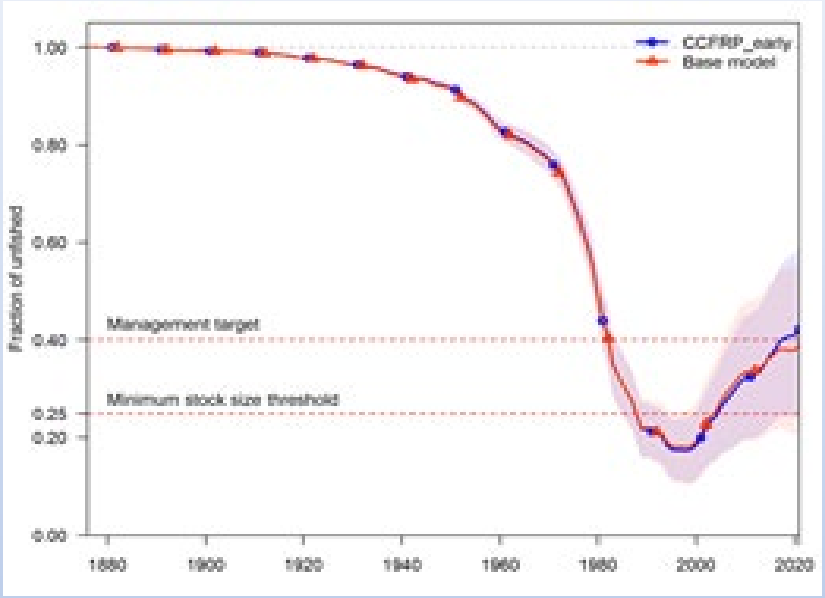
- Fully integrated length and age structured assessment conducted in Stock Synthesis
- Fixed steepness *(h)* of the stock/recruitment curve at Thorson-Dorn prior from meta-analysis of 0.72
  - Estimated 0.73 south of Point Conception
- Fixed weight at length, maturity at length, fecundity at length and recruitment variability
- Estimated sex specific growth and recruitment
- Estimated female natural mortality (*M)* with a diffuse prior based on Hamel (2015) with maximum age of 54 years assumed
  - Male *M* fixed equal

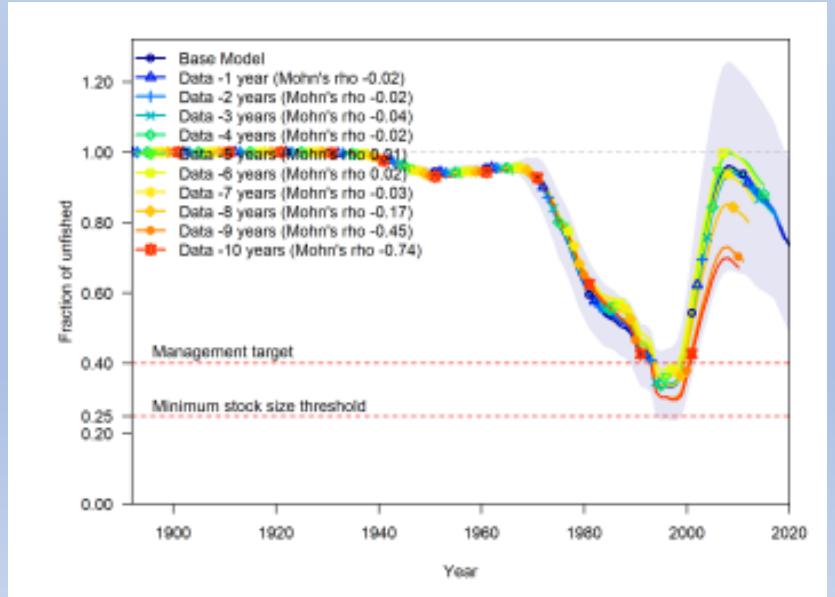
Model Parameters	Southern California	Northern California	Oregon	Washington
M_female	0.130	0.086	0.080	0.085
L_inf Female	55.378	55.184	57.184	57.106
VonBert_K_Fem	0.156	0.147	0.146	0.093
M_male	*0.130*	0.080	0.073	0.087
L_inf Male	52.000	49.940	54.193	54.240
VonBert_K_Male	0.137	0.199	0.180	0.109
LN(R0)	6.697	6.041	2.793	0.908
h	0.730	*0.720*	*0.720*	*0.720*
sigma_R	*0.500*	*0.500*	*0.600*	*0.600*
RecrDev_1998	-0.434	0.566	1.758	-0.049
RecrDev_1999	1.353	1.139	0.759	0.520
RecrDev_2000	0.678	0.476	-0.383	1.370
RecrDev_2015	0.030	-0.215	1.738	-0.177
RecrDev_2016	0.895	1.472	-0.324	-0.044
Derived Parameters				
B0	978	1145	29	3
FracUnfished (2021)	48%	43%	73%	56%
OFL_FSPR (2021)	169.3	149.0	13.0	0.9
MSY_SPRproxy	148.3	139.0	8.0	0.8

Values in standard text are estimated, those in italics are fixed.

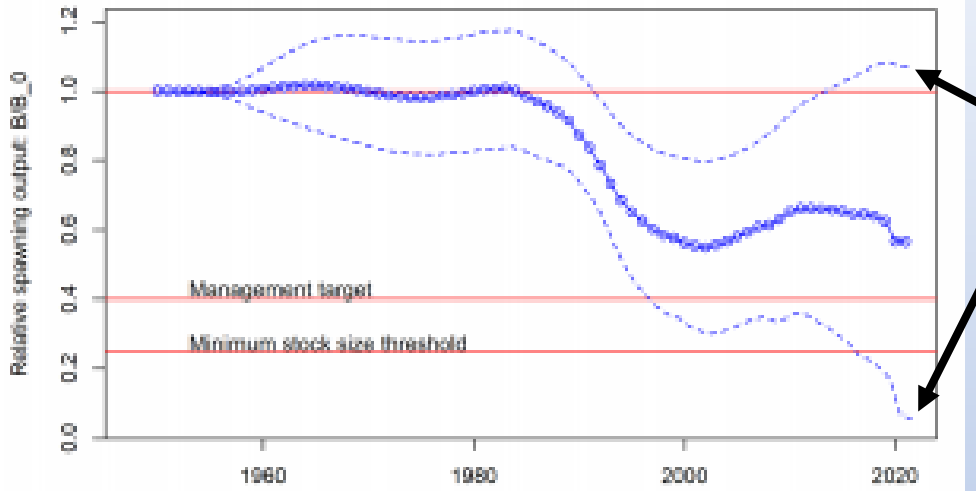
Model Evaluation

- Sensitivity analyses conducted by the STAT
  - Alternative weighting of length/age composition data
  - Data removal-leave one out
  - Alternative catch history
  - Etc. - numerous additional sensitivities
  - Natural mortality *(M)* is the major axis of uncertainty
- Requests from the STAR panel
  - Mostly related to indices of abundance
    - Time blocking for regulation changes or separate fleets accounting for changes in survey areas/protocols
    - Minor changes from the base model
- Tests for retrospective patterns
  - Sequential removal of years of data to see if depletion trends change
    - Some pattern for Oregon and Washington due to recent recruitment
    - No strong patterns in California
- Convergence tests passed
  - Reasonable parameter values
  - Acceptable fits to data
  - Jittering conducted
  - Inverted hessian



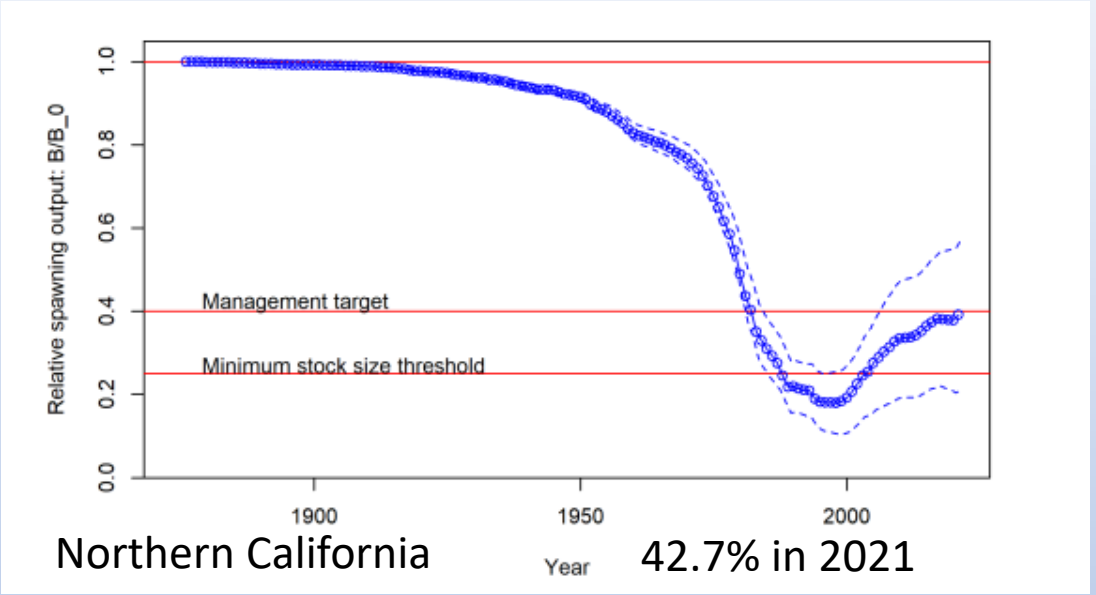


Depletion and Stock Status

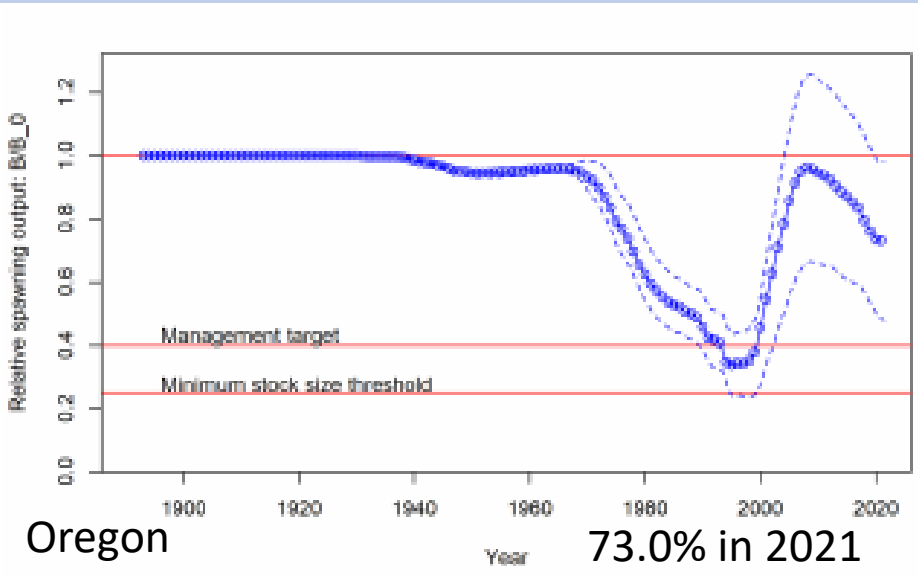


Note: wide confidence bounds

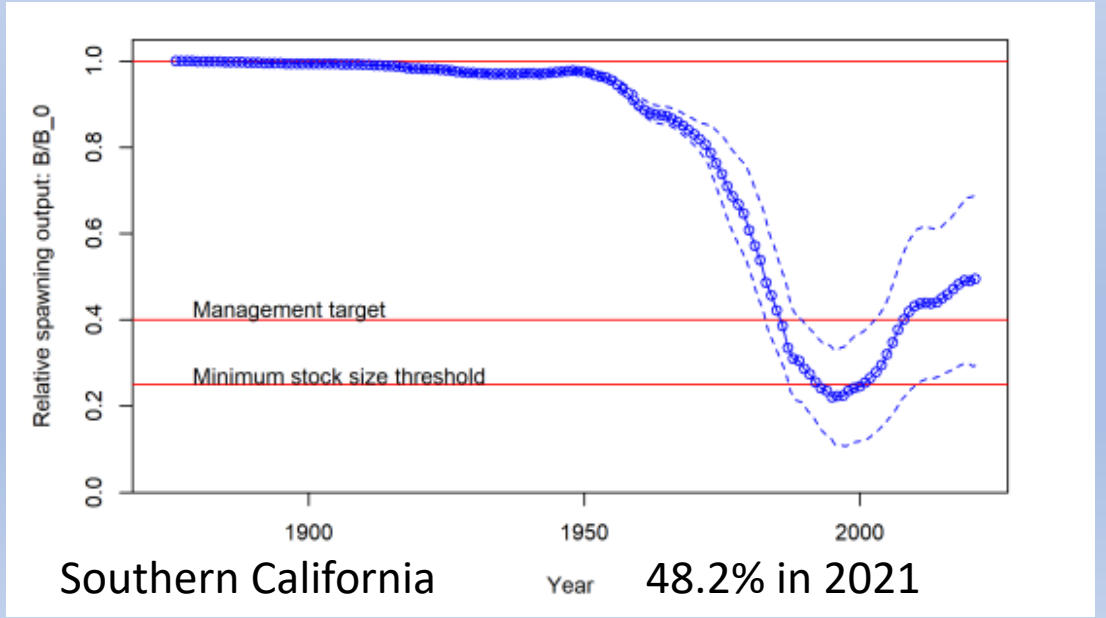
Washington 56.0% in 2021



Northern California 42.7% in 2021



Oregon 73.0% in 2021



Southern California 48.2% in 2021

Technical Merits and Deficiencies (Highlights)

Merits

- Washington:
  - Robust despite lack and paucity of length and age data
- Oregon:
  - Fishery age data for estimation of *M*/growth
- Northern California:
  - High resolution data onboard CPFV data
- Southern California:
  - Representativeness of Hook and Line Survey
  - Accounting for regulation changes through time blocking

Deficiencies

- Washington:
  - General lack of encounters providing data
- Oregon:
  - No fishery independent indices
- Northern California:
  - Lack of age data
- Southern California:
  - Inability to distinguish between species or populations

Major Research and Data Needs

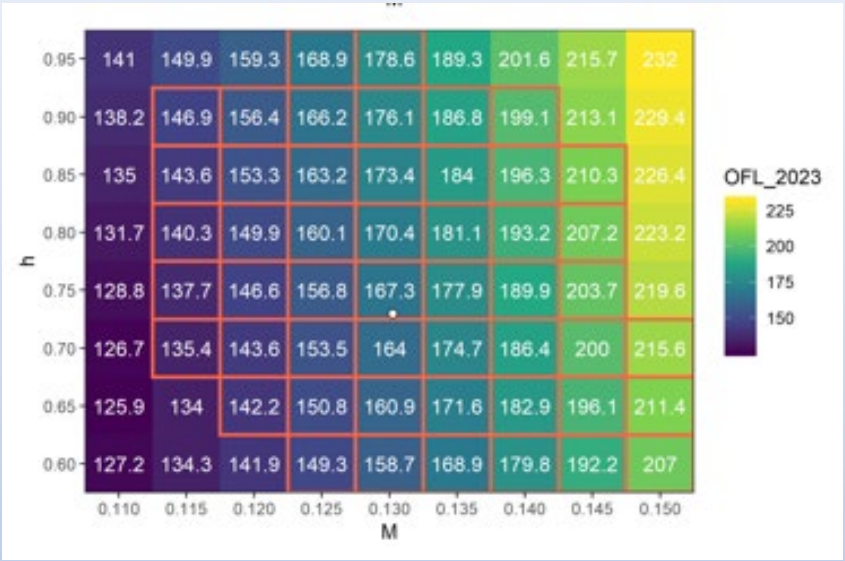
- Coastwide hook and line survey providing a fishery independent index of abundance, length and age data in open and closed areas
- Ongoing research on a Saltonstall/Kennedy grant to study vermilion rockfish population structure and the extent of the distribution of sunset rockfish
- Accounting for shifts in management affecting availability differing size classes or numbers of fish for composition and indices
- Additional age and length data from the fishery

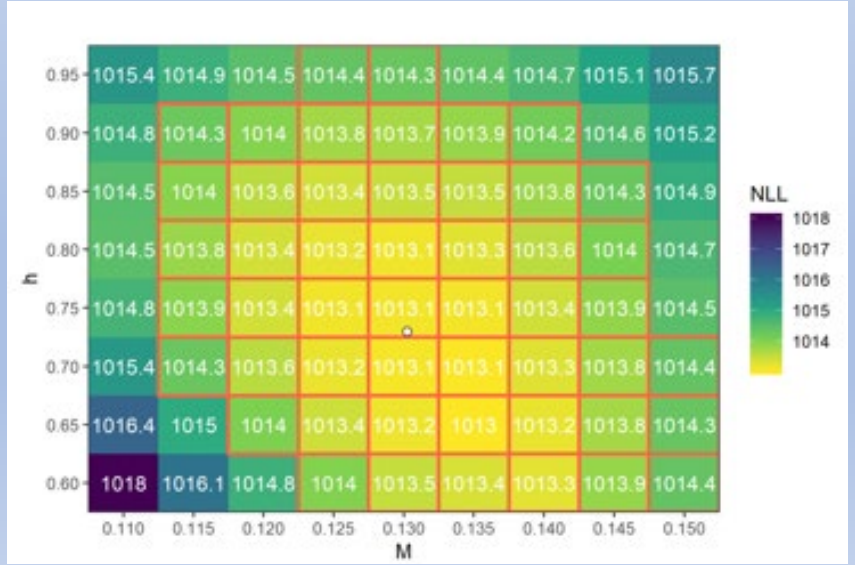
Endorsement, Category, Next Assessment

- SSC endorsed all assessments as BSIA for use in management
- Category Recommendations
  - Washington: Category 2 due to wide confidence bounds, default sigma = 1.0
  - Oregon: Category 1 since primarily vermilion rockfish, default sigma = 0.5
  - Northern California: Category 1 since primarily vermilion rockfish, default sigma = 0.5
  - Southern California: Category 2 due to sunset rockfish, default sigma = 1.0
- SSC recommended the next assessment be a full assessment given ongoing research and this being the first assessment

Decision Tables

- Primary axis of uncertainty is natural mortality (*M*)
- Southern California bivariate matrix with *M* and *h,* since *h* was estimated
- Values associated with 12.5 and 87.5 quantile values likelihood bracket uncertainty
- Catch series 2021/2022 projected by GMT, remainder full attainment, under
  - 1. P* 0.45
  - 2. P* 0.40
  - 3. Long-term MSY (SPR 50%) with and without buffer





Washington (Low state of nature declines to below MSST)

	Year	Catch	Female M = 0.067; Male =0.069		Female M = 0.084; Male =0.086		Female M = 0.099; Male =0.100	
			Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished
	2021	2.69	0.68	0.31	1.55	0.56	3.62	0.81
	2022	3.26	0.50	0.23	1.38	0.50	3.44	0.77
	2023	0.62	0.28	0.13	1.16	0.42	3.21	0.72
	2024	0.61	0.26	0.12	1.15	0.42	3.20	0.72
	2025	0.61	0.25	0.11	1.15	0.42	3.19	0.72
P*=0.45	2026	0.61	0.24	0.11	1.15	0.42	3.18	0.72
sigma=1.0	2027	0.61	0.24	0.11	1.16	0.42	3.18	0.72
	2028	0.62	0.24	0.11	1.17	0.43	3.19	0.72
	2029	0.62	0.24	0.11	1.18	0.43	3.20	0.72
	2030	0.62	0.24	0.11	1.20	0.44	3.21	0.72
	2031	0.63	0.24	0.11	1.21	0.44	3.23	0.73
	2032	0.63	0.24	0.11	1.23	0.45	3.24	0.73
	2021	2.69	0.68	0.31	1.55	0.56	3.62	0.81
	2022	3.26	0.50	0.23	1.38	0.50	3.44	0.77
	2023	0.54	0.28	0.13	1.16	0.42	3.21	0.72
	2024	0.53	0.27	0.12	1.16	0.42	3.20	0.72
	2025	0.53	0.26	0.12	1.16	0.42	3.20	0.72
P*=0.4	2026	0.53	0.26	0.12	1.17	0.43	3.20	0.72
sigma=1.0	2027	0.53	0.26	0.12	1.18	0.43	3.21	0.72
	2028	0.53	0.27	0.12	1.20	0.44	3.22	0.72
	2029	0.53	0.27	0.12	1.22	0.44	3.24	0.73
	2030	0.53	0.28	0.13	1.24	0.45	3.26	0.73
	2031	0.52	0.29	0.13	1.26	0.46	3.28	0.74
	2032	0.52	0.30	0.13	1.28	0.47	3.30	0.74
	2021	2.69	0.68	0.31	1.55	0.56	3.62	0.81
	2022	3.26	0.50	0.22	1.38	0.50	3.44	0.77
	2023	0.77	0.28	0.13	1.15	0.42	3.21	0.72
	2024	0.77	0.25	0.11	1.14	0.41	3.18	0.72
FMSY proxy	2025	0.77	0.23	0.10	1.12	0.41	3.16	0.71
SPR=0.5	2026	0.77	0.21	0.09	1.11	0.40	3.15	0.71
	2027	0.77	0.19	0.09	1.11	0.40	3.14	0.71
	2028	0.77	0.18	0.08	1.11	0.40	3.13	0.70
	2029	0.77	0.17	0.08	1.11	0.40	3.13	0.70
	2030	0.77	0.16	0.07	1.11	0.40	3.13	0.70
	2031	0.77	0.15	0.07	1.12	0.41	3.14	0.71
	2032	0.77	0.14	0.06	1.12	0.41	3.15	0.71

Oregon (Low state of nature more robust)

	Year	Catch	Female M = 0.071; Male =0.065		Female M = 0.079; Male =0.073		Female M = 0.085; Male =0.079	
			Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished
	2021	12.96	17.70	0.62	21.37	0.73	24.46	0.79
	2022	12.96	17.76	0.62	21.53	0.73	24.68	0.80
	2023	12.60	17.89	0.63	21.79	0.74	25.01	0.81
	2024	12.45	17.93	0.63	21.92	0.76	25.20	0.82
	2025	12.19	17.81	0.63	21.85	0.74	25.16	0.82
P*=0.45	2026	11.89	17.56	0.62	21.63	0.74	24.93	0.81
sigma=0.5	2027	11.56	17.23	0.60	21.29	0.72	24.58	0.80
	2028	11.24	16.95	0.59	20.90	0.71	24.16	0.78
	2029	10.93	16.46	0.58	20.48	0.70	23.70	0.77
	2030	10.63	16.06	0.56	20.04	0.68	23.23	0.75
	2031	10.36	15.67	0.55	19.62	0.67	22.76	0.74
	2032	10.10	15.29	0.54	19.21	0.65	22.31	0.72
	2021	12.96	17.70	0.62	21.37	0.73	24.46	0.79
	2022	12.96	17.76	0.62	21.53	0.73	24.68	0.80
	2023	11.77	17.89	0.63	21.79	0.74	25.01	0.81
	2024	11.60	18.00	0.63	21.99	0.76	25.27	0.82
	2025	11.34	17.95	0.63	21.99	0.76	25.30	0.82
P*=0.4	2026	11.04	17.78	0.62	21.84	0.74	25.14	0.82
sigma=0.5	2027	10.72	17.53	0.62	21.58	0.73	24.87	0.81
	2028	10.41	17.22	0.60	21.25	0.72	24.51	0.79
	2029	10.10	16.89	0.59	20.89	0.71	24.11	0.78
	2030	9.82	16.56	0.58	20.52	0.70	23.70	0.77
	2031	9.55	16.23	0.57	20.15	0.69	23.29	0.76
	2032	9.29	15.91	0.56	19.80	0.67	22.89	0.74
	2021	12.96	17.70	0.62	21.37	0.73	24.46	0.79
	2022	12.96	17.76	0.62	21.53	0.73	24.68	0.80
	2023	7.95	17.89	0.63	21.79	0.74	25.01	0.81
	2024	7.95	18.32	0.64	22.30	0.76	25.58	0.83
FMSY proxy	2025	7.95	18.59	0.65	22.62	0.77	25.92	0.84
SPR=0.5	2026	7.95	18.72	0.66	22.75	0.77	26.05	0.84
	2027	7.95	18.73	0.66	22.75	0.77	26.03	0.84
	2028	7.95	18.66	0.66	22.65	0.77	25.89	0.84
	2029	7.95	18.53	0.65	22.47	0.76	25.67	0.83
	2030	7.95	18.36	0.64	22.25	0.76	25.39	0.82
	2031	7.95	18.16	0.64	21.99	0.75	25.09	0.81
	2032	7.95	17.94	0.63	21.71	0.74	24.76	0.80

Northern California

	Year	Buffer	Catch (mt)	Low Productivity: Female M = 0.0769, Male M = 0.0723, NLL = 1031.34		Base Model: Female M = 0.0856, Male M = 0.0805, NLL = 1032		High Productivity: Female M = 0.0956, Male M = 0.0899, NLL = 1031.34	
				Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished
$p^* = 0.45, \sigma = 1$	2021	1.000	227	437	0.362	489	0.427	554	0.506
	2022	1.000	227	435	0.361	491	0.429	558	0.510
	2023	0.874	135	438	0.363	497	0.434	568	0.519
	2024	0.865	136	453	0.376	516	0.451	591	0.540
	2025	0.857	137	467	0.387	533	0.466	612	0.559
	2026	0.849	136	477	0.396	547	0.478	629	0.575
	2027	0.841	134	485	0.402	558	0.487	642	0.587
	2028	0.833	132	491	0.407	566	0.494	652	0.595
	2029	0.826	130	496	0.411	572	0.500	658	0.602
	2030	0.818	128	499	0.414	577	0.504	663	0.606
	2031	0.810	127	502	0.416	580	0.507	666	0.608
	2032	0.803	125	505	0.418	583	0.509	667	0.610
$p^* = 0.40, \sigma = 1$	2021	1.000	227	437	0.362	489	0.427	554	0.506
	2022	1.000	227	435	0.361	491	0.429	558	0.510
	2023	0.762	118	438	0.363	497	0.434	568	0.519
	2024	0.747	118	456	0.378	519	0.453	593	0.542
	2025	0.733	118	472	0.392	539	0.470	616	0.563
	2026	0.719	117	487	0.404	556	0.485	636	0.581
	2027	0.706	115	499	0.414	570	0.498	652	0.595
	2028	0.693	113	509	0.422	581	0.508	664	0.607
	2029	0.680	111	518	0.429	591	0.516	674	0.615
	2030	0.667	108	525	0.436	599	0.523	681	0.622
	2031	0.654	106	533	0.442	606	0.529	686	0.627
	2032	0.642	105	539	0.447	612	0.534	691	0.631
Long-term Equil. Yield (MSY proxy, $SPR_{50\%}$), no buffer	2021	1.000	227	437	0.362	489	0.427	554	0.506
	2022	1.000	227	435	0.361	491	0.429	558	0.510
	2023	1.000	139	438	0.363	497	0.434	568	0.519
	2024	1.000	139	453	0.376	516	0.451	590	0.539
	2025	1.000	139	467	0.387	533	0.465	610	0.558
	2026	1.000	139	477	0.396	546	0.477	627	0.573
	2027	1.000	139	485	0.402	557	0.486	639	0.584
	2028	1.000	139	491	0.407	564	0.493	647	0.591
	2029	1.000	139	495	0.410	569	0.497	652	0.596
	2030	1.000	139	497	0.412	572	0.499	654	0.598
	2031	1.000	139	98	0.413	573	0.500	655	0.598
	2032	1.000	139	499	0.414	573	0.501	654	0.597
Long-term Equil. Yield (MSY proxy, $SPR_{50\%}$), with buffer	2021	1.000	227	437	0.362	489	0.427	554	0.506
	2022	1.000	227	435	0.361	491	0.429	558	0.510
	2023	0.874	122	438	0.363	497	0.434	568	0.519
	2024	0.865	120	456	0.378	518	0.453	593	0.542
	2025	0.857	119	472	0.392	538	0.470	616	0.563
	2026	0.849	118	486	0.403	555	0.485	635	0.580
	2027	0.841	117	498	0.413	569	0.497	651	0.595
	2028	0.833	116	508	0.421	580	0.507	663	0.606
	2029	0.826	116	516	0.428	589	0.515	672	0.614
	2030	0.818	115	522	0.433	596	0.521	678	0.620
	2031	0.810	114	528	0.438	602	0.526	682	0.624
	2032	0.803	113	533	0.442	606	0.529	685	0.626

Southern California

	Year	Buffer	Catch (mt)	Low Productivity: M = 0.1125, h = 0.675, NLL = 1015.23		Base Model: M = 0.1302, h = 0.730, NLL = 1013.02		High Productivity: M = 0.1475, h = 0.875, NLL = 1014.72	
				Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished	Spawning Output	Fraction Unfished
$p^* = 0.45, \sigma = 1$	2021	1.000	210	406	0.355	471	0.482	581	0.642
	2022	1.000	210	407	0.357	474	0.485	585	0.646
	2023	0.874	139	408	0.358	477	0.488	589	0.651
	2024	0.865	137	411	0.360	482	0.493	595	0.658
	2025	0.857	136	413	0.361	485	0.496	599	0.662
	2026	0.849	135	413	0.362	487	0.498	601	0.664
	2027	0.841	134	413	0.362	488	0.499	601	0.664
	2028	0.833	133	413	0.362	489	0.500	600	0.663
	2029	0.826	132	414	0.362	490	0.501	599	0.661
	2030	0.818	131	415	0.363	491	0.502	597	0.659
	2031	0.810	130	417	0.365	491	0.503	594	0.657
	2032	0.803	129	419	0.367	493	0.504	592	0.654
$p^* = 0.40, \sigma = 1$	2021	1.000	210	406	0.355	471	0.482	581	0.642
	2022	1.000	210	407	0.357	474	0.485	585	0.646
	2023	0.762	121	408	0.358	477	0.488	589	0.651
	2024	0.747	119	413	0.362	484	0.495	598	0.660
	2025	0.733	118	418	0.366	490	0.501	604	0.667
	2026	0.719	116	421	0.368	495	0.506	608	0.672
	2027	0.706	115	424	0.371	499	0.510	611	0.675
	2028	0.693	114	427	0.374	503	0.514	613	0.677
	2029	0.680	112	432	0.378	506	0.518	614	0.678
	2030	0.667	111	437	0.382	510	0.522	615	0.679
	2031	0.654	109	442	0.387	515	0.526	616	0.680
	2032	0.642	108	448	0.392	519	0.531	617	0.681
Long-term Equil. Yield (MSY proxy, $SPR_{50\%}$), no buffer	2021	1.000	210	406	0.355	471	0.482	581	0.642
	2022	1.000	210	407	0.357	474	0.485	585	0.646
	2023	1.000	148	408	0.358	477	0.488	589	0.651
	2024	1.000	148	413	0.362	484	0.495	598	0.660
	2025	1.000	148	416	0.364	488	0.499	603	0.665
	2026	1.000	148	415	0.364	490	0.501	604	0.667
	2027	1.000	148	413	0.362	489	0.500	602	0.665
	2028	1.000	148	409	0.358	486	0.497	598	0.660
	2029	1.000	148	405	0.354	482	0.493	592	0.654
	2030	1.000	148	399	0.350	477	0.488	584	0.646
	2031	1.000	148	393	0.345	471	0.482	576	0.637
	2032	1.000	148	388	0.339	466	0.476	568	0.628
Long-term Equil. Yield (MSY proxy, $SPR_{50\%}$), with buffer	2021	1.000	210	406	0.355	471	0.482	581	0.642
	2022	1.000	210	407	0.357	474	0.485	585	0.646
	2023	0.874	130	408	0.358	477	0.488	589	0.651
	2024	0.865	128	415	0.364	486	0.497	599	0.662
	2025	0.857	127	420	0.368	493	0.504	607	0.670
	2026	0.849	126	423	0.370	497	0.508	611	0.675
	2027	0.841	125	424	0.372	500	0.511	612	0.676
	2028	0.833	124	425	0.372	501	0.512	611	0.675
	2029	0.826	123	425	0.372	501	0.512	609	0.673
	2030	0.818	122	424	0.371	500	0.511	606	0.669
	2031	0.810	121	424	0.371	499	0.510	602	0.665
	2032	0.803	120	423	0.371	498	0.509	598	0.660