Appendix G
ANALYSIS OF LONG-TERM BENEFITS OF ALTERNATIVE REBUILDING STRATEGIES FOR YELLOWEYE AND CANARY ROCKFISH

2011-2012 GROUNDFISH HARVEST SPECIFICATIONS
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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A.1 Introduction

In an attempt to assess the implied non-market and non-use (NMNU) values associated with the choice among alternative rebuilding schedules for overfished species, the present value (PV) of projected catch streams for yelloweye and canary rockfish was examined under the current range of rebuilding scenarios. For simplicity no attempt was made to explicitly value landings of the commercial and recreational target species that could be "leveraged" under the varying overfished species ACLs. For this analysis, the key difference between the rebuilding scenarios is the timing of when the projected catch levels occur.

The analysis compares how the choice of discount rate (i.e., the societal value associated with when a benefit is received) affects which scenario maximizes PV, and for any given discount rate how the scenario that maximizes PV compares with the PV under the fastest rebuilding alternative (i.e., zero harvest until rebuilt, or F=0). For a given discount rate, examining the ratio of PVs for any two rebuilding scenarios gives an indication of what the implied difference in NMNU values must be in order to choose the faster of the two rebuilding scenarios. Two time horizons were also examined based on the relative rebuilding times for each species: a "short-term horizon" (20 years for canary; 50 years for yelloweye), and a "long-term horizon" (50 years for canary; 90 years for yelloweye). As a general rule of thumb, the longer the time horizon or the lower the discount rate the more competitive the slower rebuilding alternatives become.

A.2 Discount Rates

Discount rates are a measure of a society's rate of time preference: the higher the discount rate, the greater the level of impatience for receiving a benefit now versus in the future. Discount rates exceeding about 10% imply a fairly high level of impatience. A discount rate of zero implies complete indifference between whether a benefit is received now or in the future. Negative discount rates imply that a benefit is actually considered more valuable received in the future than received today, as might be true of a bequest intended for future generations. A negative discount rate might therefore be used to compare the future value of benefit streams where a societal premium is placed on "intergenerational equity" (i.e., leaving something of value for future generations). Since discount rates are somewhat analgous to interest rates, and money received now has greater value than the same amount received in the future, a positive discount rate is generally used to analyze most present value situations.

Table G-1 through Table G-4 show present values of projected catch streams for selected yelloweye and canary rebuilding scenarios under the two different time horizons and discount rates ranging from -20% to +20%. The median catch streams were taken directly from the most current set of rebuilding model runs for yelloweye and canary. Under each scenario median catch is assumed to default to MSY (56.4 mt for yelloweye; 959 mt for canary) at Ttarget and each year thereafter. Each table includes two scenarios that were not explicitly designed to rebuild: "40:10 Harvest policy" and "ABC harvest rate SPR=50%". While these are not counted as "rebuilding scenarios", they are shown in order to compare PV under the rebuilding scenarios with that under the scenario that provides the "Overall Maximum" PV, rebuilding considerations aside.

In the tables, shading identifies the rebuilding scenario having the highest PV for each discount rate. The second to last column in each table shows the value of the rebuilding scenario with the highest PV, and the last column shows the value of the scenario having the highest PV overall, irrespective of rebuilding considerations.

A.3 Results

In Table G-1, the short-term (50 yr) time horizon for yelloweye:

For discount rates less than -5%, “F=0” has highest PV among rebuilding scenarios.

For all discount rates greater than -5% "SPR achieving 50% probability recovery by 16-4 Tmax" has the highest PV.

When the discount rate=0, PV of the MAX PV scenario " SPR achieving 50% probability recovery by 16-4 Tmax " is 78% greater than “F=0”.

When discount rate=+3%, PV of the MAX PV scenario " SPR achieving 50% probability recovery by 16-4 Tmax " is more than 3 times greater than “F=0”.

For discount rates greater than +20%, “F=0” has PV=0.

For discount rates greater than -20% (i.e., all discount rates shown), "ABC harvest rate SPR = 50%" has the Maximum Overall PV (i.e., non-rebuilding).

Table G-2 shows the long-term (90 yr) time horizon for yelloweye. The same patterns shown in Table G-1 generally hold, except that “F=0” now has the highest PV when the discount rate equals zero.

For all discount rates less than or equal to zero, “F=0” has highest PV among rebuilding scenarios.

For discount rates greater than zero, "SPR achieving 50% probability recovery by 16-4 Tmax" has the highest PV.

When the discount rate=0, PV of the MAX PV scenario “F=0” is 0.3% greater than the PV of the next best scenario "2010 OY = 14 mt, constant catch = 20 mt".

When discount rate=+3%, PV of the MAX PV scenario " SPR achieving 50% probability recovery by 16-4 Tmax " is 72% greater than PV of “F=0”.

For discount rates greater than +20%, “F=0” has PV=0.

For all discount rates greater than -3%, “ABC harvest rate SPR = 50%” has the Maximum Overall PV (i.e., non-rebuilding).

Table G-3 provides the following insights regarding the short-term (20 yr) time horizon for canary:

For discount rates less than -9%, “F=0” has the highest PV among rebuilding scenarios.

For discount rates greater than -9% "SPR achieving 50% probability recovery by 2046" has the highest PV.

When discount rate=0, PV of the MAX PV scenario "SPR achieving 50% probability recovery by 2046" is 51% greater than “F=0”.

When discount rate=+3%, PV of MAX PV scenario "SPR achieving 50% probability recovery by 2046" is 82% greater than “F=0”.

For discount rates greater than -20%, "ABC harvest rate SPR=50%" has the Maximum Overall PV (rebuilds by Ttarget = 2180).

Table G-4 shows the long-term (50 yr) time horizon for canary. The same patterns shown in Table G-3 generally hold, except that “SPR that achieves 50% probability recovery by 2031” now has the highest PV when the discount rate equals zero.

For discount rates less than 0%, “F=0” has highest PV among rebuilding scenarios.

For discount rate=0, "SPR achieves 50% probability recovery by 2031" has the highest PV.

When discount rate=0, PV of the MAX PV scenario "SPR achieves 50% probability recovery by 2031" is 0.14% greater than “F=0”.

For discount rate greater than 0, "SPR achieves 50% probability recovery by 2046" has the highest PV.

When discount rate=+3%, PV of the MAX PV scenario “SPR achieves 50% probability recovery by 2046" is 8.8% greater than “F=0”.

For discount rates greater than or equal to 0, "ABC harvest rate SPR=50%" has the Maximum Overall PV (rebuilds by Ttarget = 2180).

A.4 Discussion of Results

Negative discount rates favor deferring harvest into the future; so for negative discount rates the F=0 scenario generally has higher PV than any scenario where the current harvest level is greater than zero. Negative discount rates imply a societal preference favoring future generations over current ones. However interpreting negative discount rates is problematic, as utilization of the resource by current stakeholders, communities and consumers is extremely undervalued.

Positive discount rates convey the concept of "impatience", i.e., a preference for obtaining something now rather than in the future, exemplified by, for example, the charging of interest for borrowed funds. Generally the higher the uncertainty of repayment (i.e., the greater the risk) the higher the interest rate that is charged.

A zero discount rate implies a neutral bias in terms of intergenerational equity, so the value of benefits received in the future is considered on par with benefits received today. A zero discount rate may be used to compare streams of benefits where current use and intergenerational equity concerns are more or less equally valued.

Under the shorter-term time horizons and zero discount rate, the present value of the highest PV rebuilding scenario for canary is at least 51% higher than the PV of the F=0 scenario. For yelloweye the corresponding ratio is 78%. These results imply that in order for F=0 to have higher present value to society than the highest PV rebuilding scenario, the total of all NMNU values (e.g., ecosystem services, option, existence, and bequest values) associated with allowing canary to rebuild completely before it can be harvested must be at least 51% of the market value of all the fishing opportunities that would be accommodated by the level of canary harvest allowed under the rebuilding scenario with highest PV. For yelloweye, total NMNU values must be at least 78% of the market value of the fishery that would be accommodated under the rebuilding scenario with highest PV.

With a fairly modest discount rate of +3%, the rebuilding scenario with the highest PV is 82% greater than F=0 for canary, and more than three times greater than F=0 for yelloweye. When the two non-rebuilding scenarios are included, the gap in PV between the F>0 and F=0 scenarios widens.

The rebuilding scenarios for yelloweye and canary represented by the 2011-12 groundfish management alternatives do not maximize PV. However under the shorter-term (50 year) time horizon for yelloweye and zero discount rate, the PV of the FPA rebuilding scenario is 67% greater than F=0. Under the longer-term (90 year) time horizon for yelloweye, PV under the FPA is less than under F=0 unless the discount rate is positive. When the discount rate equals +3% the PV under the FPA is 64% greater than PV under F=0.

For canary under the short-term (20 year) time horizon, the F=0 rebuilding scenario has higher PV than under the alternatives unless the discount rate is positive. The preferred alternative has lower PV than F=0 for discount rates below +5%. Under the longer-term (50 year) time horizon, PV under the FPA for canary is less than PV for F=0 unless the discount rate is positive. When the discount rate equals +3% the PV under the FPA is only 1% greater than PV for F=0.

A.5 Implications for Management

Among the range of rebuilding scenarios examined neither F=0 nor the FPA maximizes PV for either yelloweye or canary. Under the short-term time horizon for canary, F=0 shows higher PV than the FPA for discount rates up to +5%. Under the longer-term time horizon, the FPA generally shows higher PV than F=0 for discount rates greater than zero. For yelloweye, the FPA always has higher PV than F=0 for discount rates greater than zero; and the gap is always much greater than the difference between FPA and F=0 for canary.

These results imply that while it seems unlikely that total NMNU values for yelloweye could balance the use values achievable under the rebuilding scenarios that allow some harvest of yelloweye, it may be relatively more likely that NMNU values could balance use values for canary since the differences between PVs under the use and non-use rebuilding scenarios are much narrower for canary than for yelloweye. However in a mixed-stock fishery, management is interlinked, so measures designed to rebuild certain stocks more quickly will negate efforts to allow more liberal harvest of other stocks, and vice versa. The choice of FPA for canary reflects the pervasiveness of canary bycatch affecting virtually every west coast groundfish fishery. This aggregation of affected stakeholder interests creates a relatively high preference for near-term benefits over potential longer-term benefits arising from zero harvest policies.

Table G-1. Present value (PV) of Yelloweye median catch assuming constant price and 50 yr time horizon: 2011-2060

		F=0	SPR that achieves 50% prob. recovery by 2056	SPR that achieves 50% prob. recovery by 2065	SPR from 2010 OY of 17 mt	SPR achs 50% prob. recovery by 2007 TTARGET	SPR = 71.9%	SPR achs 50% prob. recovery by 16-4 Tmax	40:10 Harvest policy	ABC harvest rate SPR = 50%	MAX Rebuilding PV	MAX Overall PV
Alternative:				Alt 1	Alt 2	No Action, Alt 3	FPA					
Ttarget:		2047	2056	2065	2077	2084	2087	2096	NA	NA		
2011 ACL:		0	8	13	17	20	20	22	34	48		
Discount Rates	-20%	18,889,329	14,851,099	7,650,717	9,687,940	10,582,583	10,892,182	11,528,460	16,249,354	17,193,875	18,889,329	18,889,329
	-10%	84,399	59,569	40,391	51,395	56,282	57,980	61,484	87,623	94,498	84,399	94,498
	-5%	7,511	5,528	4,734	6,064	6,663	6,872	7,307	10,561	11,700	7,511	11,700
	-3%	2,993	2,371	2,275	2,926	3,222	3,325	3,541	5,160	5,815	3,541	5,815
	+0%	790	780	891	1,155	1,277	1,320	1,410	2,083	2,423	1,410	2,423
	+3%	220	322	428	560	621	643	689	1,033	1,243	689	1,243
	+5%	96	204	292	383	427	442	475	716	880	475	880
	+10%	13	94	147	195	218	227	244	373	477	244	477
	+20%	0	43	70	93	105	109	118	181	240	118	240

Table G-2. Present value (PV) of Yelloweye median catch assuming constant price and 90 yr time horizon: 2011-2100

		F=0	SPR that achieves 50% prob. recovery by 2056	SPR that achieves 50% prob. recovery by 2065	SPR from 2010 OY of 17 mt	SPR achs 50% prob. recovery by 2007 TTARGET	SPR = 71.9%	SPR achs 50% prob. recovery by 16-4 Tmax	40:10 Harvest policy	ABC harvest rate SPR = 50%	MAX Rebuilding PV	MAX Overall PV
Alternative:				Alt 1	Alt 2	No Action, Alt 3	FPA					
Ttarget:		2047	2056	2065	2077	2084	2087	2096	NA	NA		
2011 ACL:		0	8	13	17	20	20	22	34	48		
Discount Rates	-20%	148,644,122,020	148,640,083,790	148,616,085,127	148,328,620,080	147,370,441,985	146,322,598,827	134,147,158,074	134,950,572,964	130,562,338,166	148,644,122,020	148,644,122,020
	-10%	7,378,741	7,353,910	7,300,872	7,126,531	6,911,519	6,772,412	6,034,786	6,659,697	6,500,988	7,378,741	7,378,741
	-5%	106,924	104,941	102,176	96,909	92,952	90,939	82,998	99,321	98,974	106,924	106,924
	-3%	23,526	22,904	22,148	20,962	20,251	19,918	18,683	23,402	23,835	23,526	23,835
	+0%	3,046	3,036	3,014	2,993	3,007	3,012	2,998	4,071	4,402	3,046	4,402
	+3%	517	620	697	782	832	851	890	1,292	1,503	890	1,503
	+5%	181	289	366	443	484	499	531	790	954	531	954
	+10%	18	99	151	198	221	230	247	377	481	247	481
	+20%	0	43	70	93	105	109	118	181	240	118	240

Table G-3. Present value (PV) of Canary median catch assuming constant price and 20 yr time horizon: 2011-2030

		F=0	SPR from 2010 OY = 44	SPR from 2010 OY of 85 mt	SPR = 88.7%	SPR from 2010 OY of 105 mt	SPR that achieves 50% prob. recovery by 2031	SPR that achieves 50% prob. recovery by 2007 TMAX	achieves 50% prob. recovery by 2046	40:10 Harvest policy	ABC harvest rate SPR = 50%	MAX Rebuilding PV	MAX Overall PV
Alternative:			Alt 1	Alt 2	No Action, Alt 3, FPA								
Ttarget:		2024	2025	2026	2027	2027	2031	2041	2046	2111	2180		
2011 ACL:		0	49	94	102	116	253	381	415	493	614		
Discount Rates	-20%	328,679	314,754	298,961	272,555	276,166	167,171	227,718	241,687	288,637	306,302	328,679	328,679
	-10%	41,152	39,276	37,450	33,612	34,487	26,567	36,629	39,006	46,350	50,446	41,152	50,446
	-5%	16,140	15,573	15,096	13,545	14,037	12,646	17,582	18,765	22,227	24,608	18,765	24,608
	-3%	11,288	10,984	10,765	9,678	10,078	9,712	13,552	14,479	17,128	19,102	14,479	19,102
	+0%	6,713	6,657	6,668	6,030	6,329	6,764	9,494	10,159	11,994	13,527	10,159	13,527
	+3%	4,069	4,150	4,280	3,906	4,136	4,901	6,918	7,414	8,739	9,965	7,414	9,965
	+5%	2,943	3,078	3,251	2,990	3,187	4,036	5,719	6,135	7,224	8,295	6,135	8,295
	+10%	1,352	1,548	1,761	1,661	1,799	2,650	3,790	4,075	4,789	5,588	4,075	5,588
	+20%	323	515	706	705	785	1,427	2,069	2,234	2,620	3,130	2,234	3,130

Table G-4. Present value (PV) of Canary median catch assuming constant price and 50 yr time horizon: 2011-2060

		F=0	SPR from 2010 OY = 44	2007 SPR from 2010 OY of 105 mt	SPR from 2010 OY of 85 mt	SPR = 88.7%	SPR that achieves 50% prob. recovery by 2031	SPR that achieves 50% prob. recovery by 2007 TMAX	SPR that achieves 50% prob. recovery by 2046	40:10 Harvest policy	ABC harvest rate SPR = 50%	MAX Rebuilding PV	MAX Overall PV
Alternative:			Alt 1	Alt 2	No Action, Alt 3, FPA								
Ttarget:		2024	2025	2026	2026	2027	2031	2041	2046	2111	2180		
2011 ACL:		0	49	69	94	102	253	381	415	493	614		
Discount Rates	-20%	335,874,086	335,860,161	335,839,358	335,844,368	335,817,962	335,712,578	334,532,166	332,368,185	295,792,035	286,784,343	335,874,086	335,874,086
	-10%	1,823,044	1,821,167	1,818,001	1,819,341	1,815,503	1,808,459	1,764,740	1,726,421	1,591,321	1,553,127	1,823,044	1,823,044
	-5%	211,906	211,339	210,081	210,862	209,312	208,412	200,151	194,902	189,392	187,784	211,906	211,906
	-3%	99,095	98,792	97,929	98,572	97,486	97,519	93,631	91,420	91,545	91,880	99,095	99,095
	+0%	35,483	35,427	34,947	35,438	34,800	35,534	34,706	34,283	36,081	37,159	35,534	37,159
	+3%	14,476	14,557	14,304	14,688	14,313	15,308	15,638	15,752	17,345	18,437	15,752	18,437
	+5%	8,499	8,634	8,478	8,807	8,546	9,592	10,232	10,458	11,782	12,793	10,458	12,793
	+10%	2,696	2,891	2,870	3,105	3,005	3,994	4,804	5,057	5,872	6,662	5,057	6,662
	+20%	448	640	693	831	830	1,552	2,154	2,318	2,718	3,228	2,318	3,228