

Canary Rockfish Rebuilding Analysis Addendum for November 2000 PFMC meeting

This addendum to the canary rockfish rebuilding analysis documents the expected impact of the scenario selected by the PFMC at its September 2000 meeting. In addition, The results of other assessment and rebuilding scenarios are tabulated in Tables 1 and 2.

FEATURES OF SELECTED SCENARIO:

1. Age-specific female natural mortality (scenario #1 from northern area assessment).
2. Current female spawning stock size is at 8.7% of the unfished level in scenario #1¹.
3. Forecasts are based upon 50% reduction in recruitment for 1996-1998
4. Rebuilding target (40% of unfished biomass level) is based upon expected unfished biomass calculated from the average age 1 recruitment level in 1967-1977 (Figure 1)
5. Rebuilding rates are based upon random resampling of recruits per spawner (R/S) observed in 1978-1997 (Figure 2)

BASIC RESULTS:

1. Rebuilding with no fishing occurs in 64 years in 50% of the simulations (Table 1, Figure 3)
2. Generation time is 17 years, so allowed rebuilding time frame is $64+17 = 81$ years
3. Catch in the northern area of 39 mtons per year would allow rebuilding in 81 years in 50% of the simulations (Figure 3 and Figure 4)
4. The range of possible rates of rebuilding is wide (Figure 3 and Figure 5) due to the high variability in recruitment.
5. A constant catch of 39 mtons per year represents an exploitation rate of less than 1% per year during the early years of rebuilding. A constant exploitation rate of only 0.37% would also

¹Similar overall rebuilding results are obtained from scenario #2 which has a lesser decline in biomass, but a greater decline in recruitment compared to scenario #1.

achieve rebuilding in 81 years, but would have short-term catch levels of only 16 mtons then higher catch levels as the stock rebuilds.

DISCUSSION POINTS:

1. The extremely low rate of rebuilding, and the low level of allowable catch while rebuilding, is due to the low level of R/S (Figure 2) that has been observed for canary rockfish. There are two reasonable explanations for this low recruitment:
 - STOCK - If the low level of R/S observed during the 1990s is due to an inherent inability of the canary rockfish stock to produce good recruitment at low spawner levels, then rebuilding is unlikely to be faster than calculated here, and future fishery productivity of canary rockfish could be lower than for other rockfish species.
 - CLIMATE - If the low level of R/S observed during the 1990s is due to long term, climate-related fluctuations in fish productivity, then a change to more productive ocean conditions could restore higher recruitment levels sooner and produce more rapid rebuilding. The timing and magnitude of such a current or future climate shift and its effect on recruitment of canary rockfish cannot be predicted with available information. As more information on climate effects on recruitment is obtained, better forecasts of rebuilding times should be possible.
2. A coastwide annual catch of 60 mtons is based upon the calculated 39 mtons for the northern area and an expansion to the southern area. Because of uncertainty in the north-south boundary in the assessment, there is not sufficient evidence to require a strict north-south allocation of the 60 mton coastwide catch. An updated stock assessment that carefully examines the north-south characteristics of the stock should be conducted after results of the summer 2001 survey are available.
3. Future rebuilding analyses will present the progress towards rebuilding and will update information on expected future rates of rebuilding. These analyses will incorporate updated stock assessments and should have more information on effects of climate on recruitment, so it is highly likely that some adjustment to the rebuilding plan will be necessary.

Table 1. Summary results of rebuilding calculations for assessment scenario #1. Each row of table summarizes results from 500 trials. **Allowable Years** is the median number of years to rebuild without fishing plus the mean generation time. The **%Rebuilt** is the percentage of trials that achieve rebuilding within the allowable number of years. HR represents scenarios with the 1996-1998 recruitments at their original (high) level. Other scenarios have these 3 recruitments at half of their original level.

		Scenario #1				
Years for Resampling	% Rebuilt	Years to Rebuild			Annual Catch	Allowable Years
		Min	Max	Median		
78-95	-	55	249	119	0	136
78-95	53%	63	275	132	13	
78-86	-	47	165	74	0	
87-95	-	114	999	369	0	
78-96	-	38	176	74	0	
78-97	-	37	129	64	0	81
78-97	50%	43	167	80	39	
78-95, HR	-	39	231	82	0	
87-97, HR	-	13	57	24	0	41
87-97, HR	67%	17	97	35	150	
78-97 HR	--	14	105	31	0	48
78-97 HR	51%	18	136	47	125	

Table 2. Summary results of rebuilding calculations for assessment scenario #2.

Years for Resampling	% Rebuilt	Scenario #2 Years to Rebuild			Annual Catch	Allow -able Years
		Min	Max	Median		
78-95	-	58	797	192	0	218
78-95	34%	66	999	273	15	
78-86	-	35	180	75	0	
87-95	-	999	999	999	0	
78-96	-	37	312	98	0	
78-97	-	33	228	84	0	110
78-97	51%	51	338	108	25	
78-95, HR	-	23	675	85	0	
87-97, HR	-	10	66	20	0	46
87-97, HR	68%	12	183	36	150	
87-97, HR	51%	14	999	45	185	
78-97, HR	-	11	77	24	0	50
78-97, HR	59%	14	262	45	100	
78-97, HR	52%	14	313	48	125	

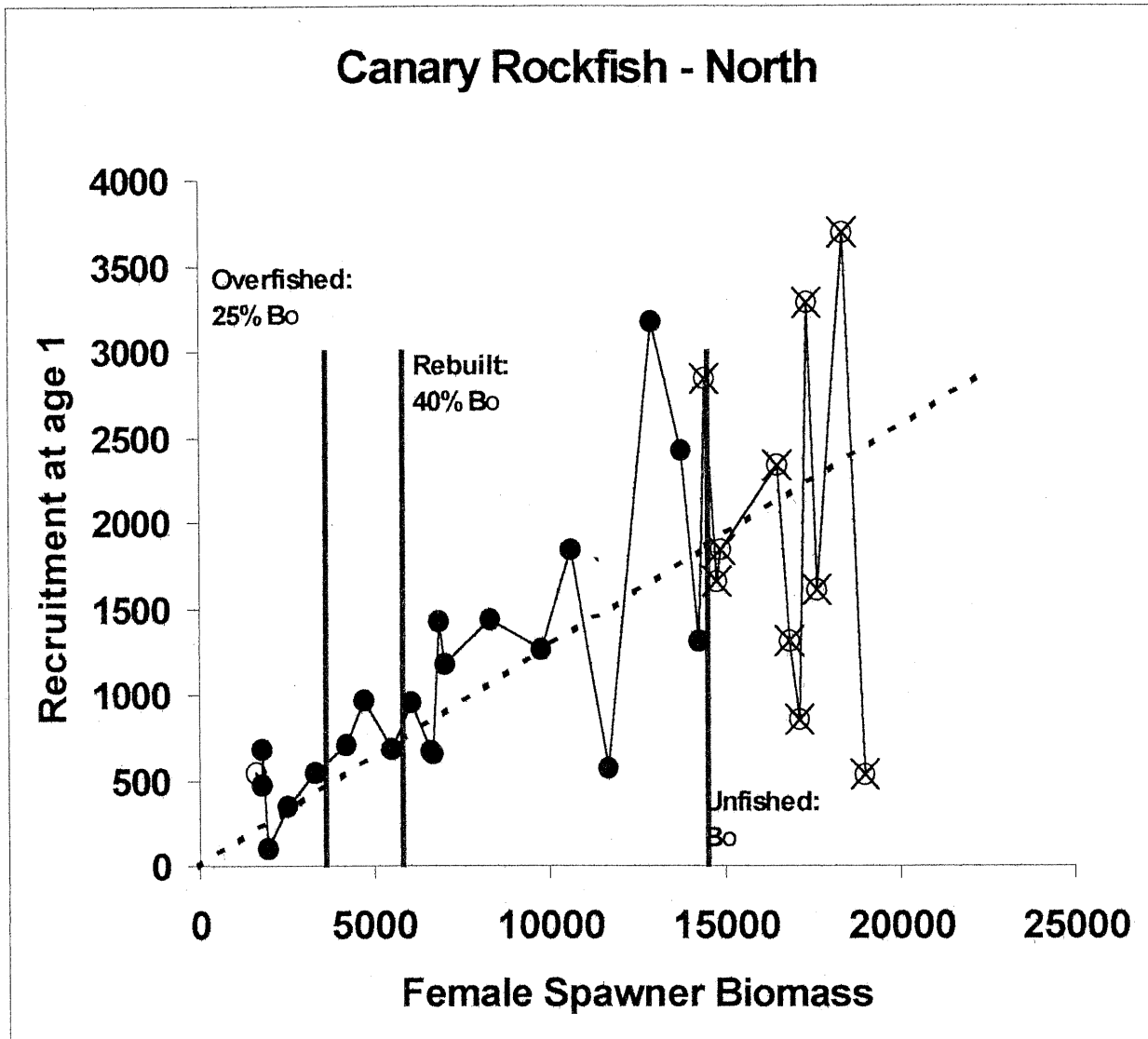


Figure 1. Time series of recruitment versus spawning biomass for canary rockfish in the northern area according to scenario #1 and with recruitments in 1996-1998 (leftmost points on figure) reduced to 50% of initial assessment according to recommendations of STAR panel. The recruitment points with an X were used to calculate the unfished biomass level, B_0 . The dashed line shows the level of recruitment that would maintain that level of female spawning biomass. The recruits/spawner values for the solid points (see Figure 2) were resampled to calculate rebuilding rates.

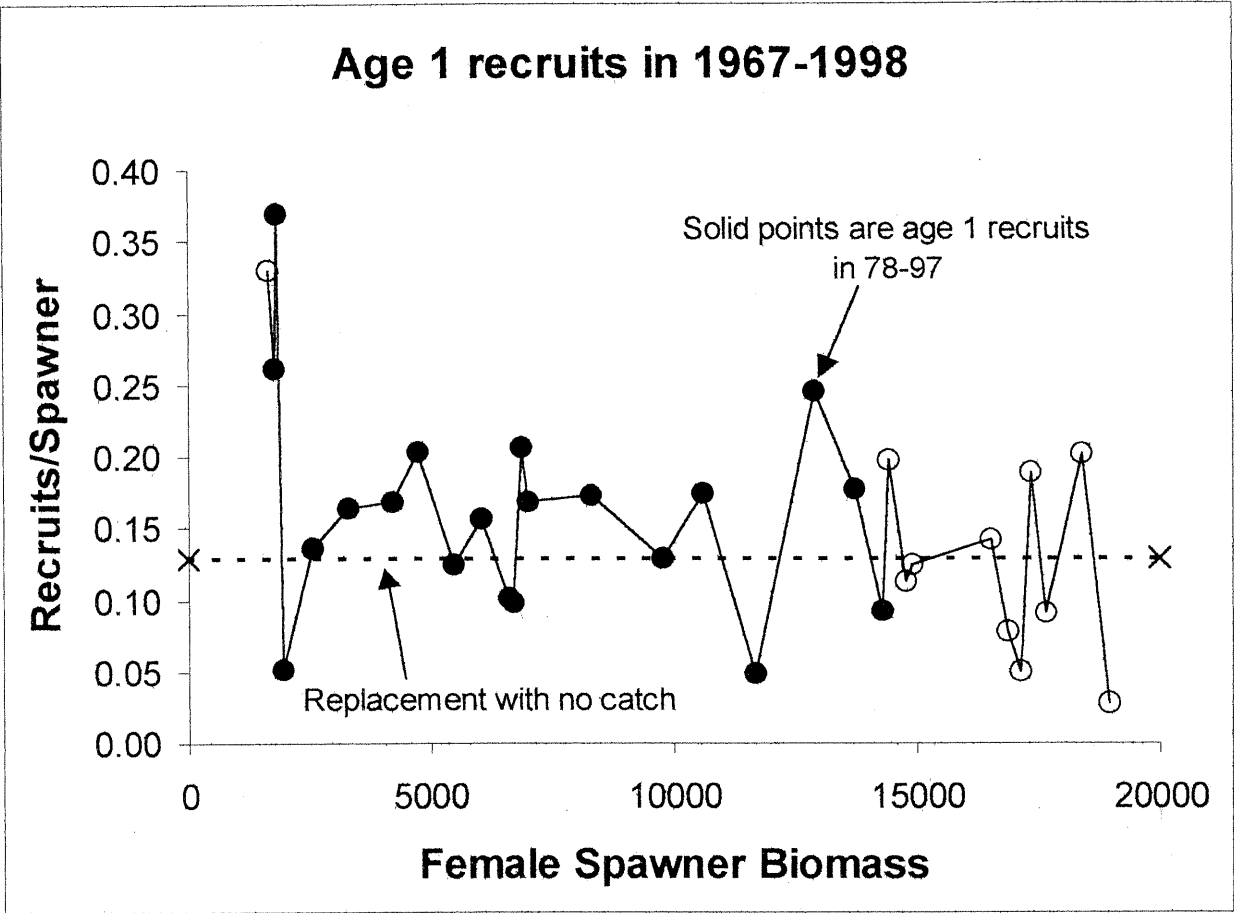


Figure 2 Level of recruitment per spawner that was used to calculate rebuilding rate.

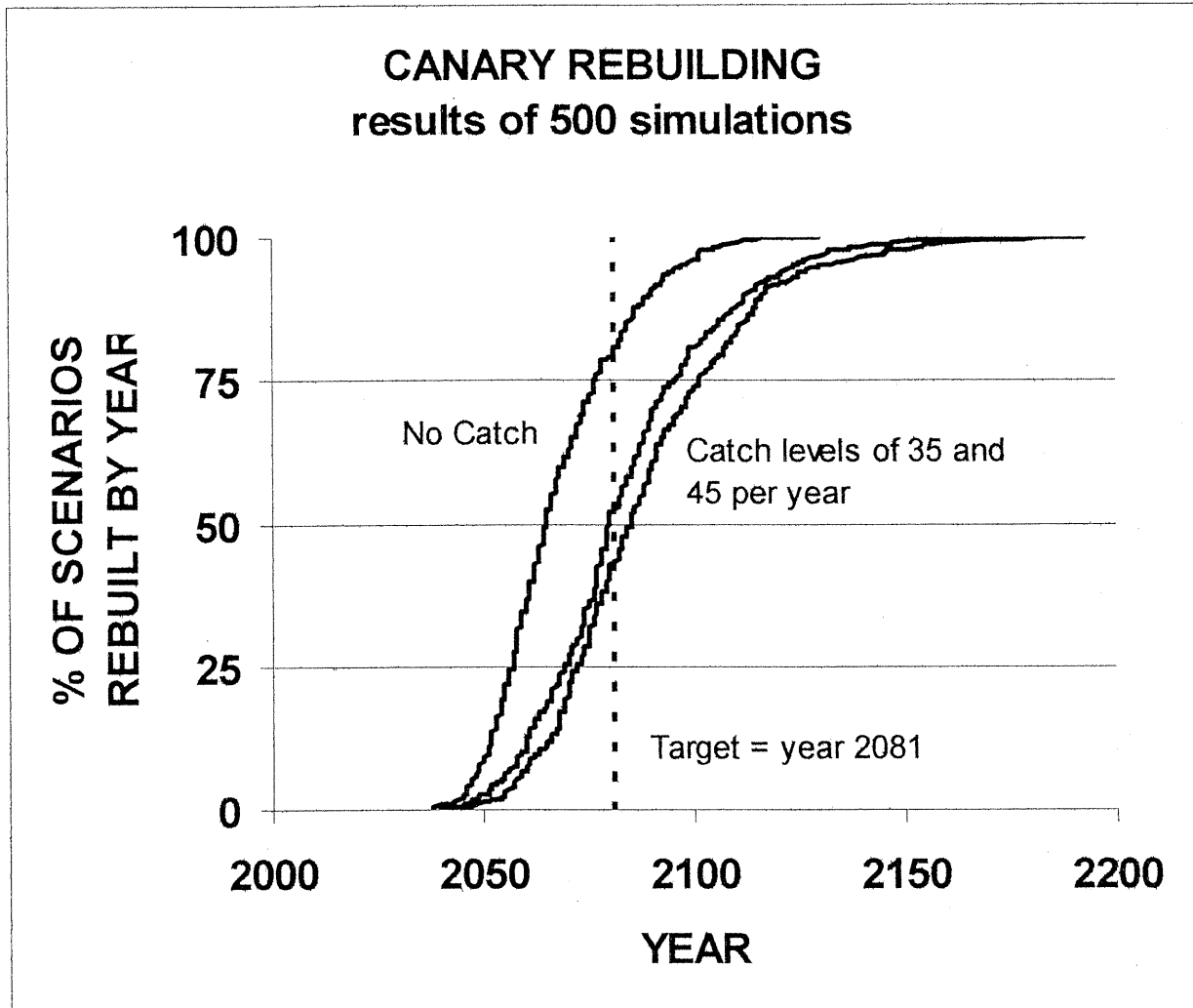


Figure 3. Percentage of 500 simulations that achieve the rebuilt biomass level in the indicated year. The “no catch” line shows that 50% of simulations achieve the rebuilt level in 64 years. At a catch of 39 mtons per year (intermediate between displayed levels of 35 and 45 mtons) the population is expected to rebuild in 50% of the simulations by the year 2081.

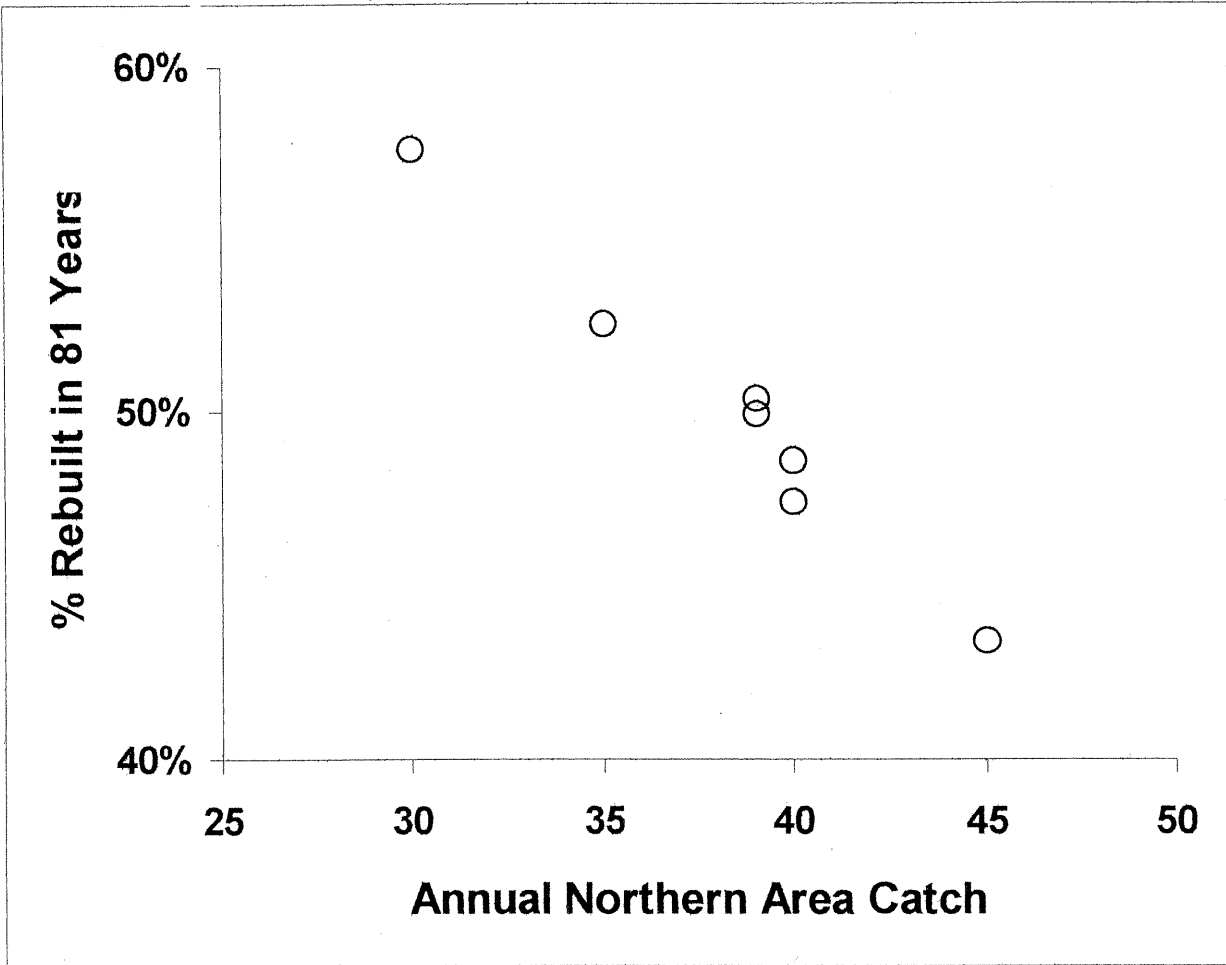


Figure 4. Relationship between annual catch level in the northern area and the probability of being rebuilt in 81 years. The multiple points shown at catch levels of 39 and 40 mtons demonstrate the level of variability in this calculation due to the use of only 500 simulations.

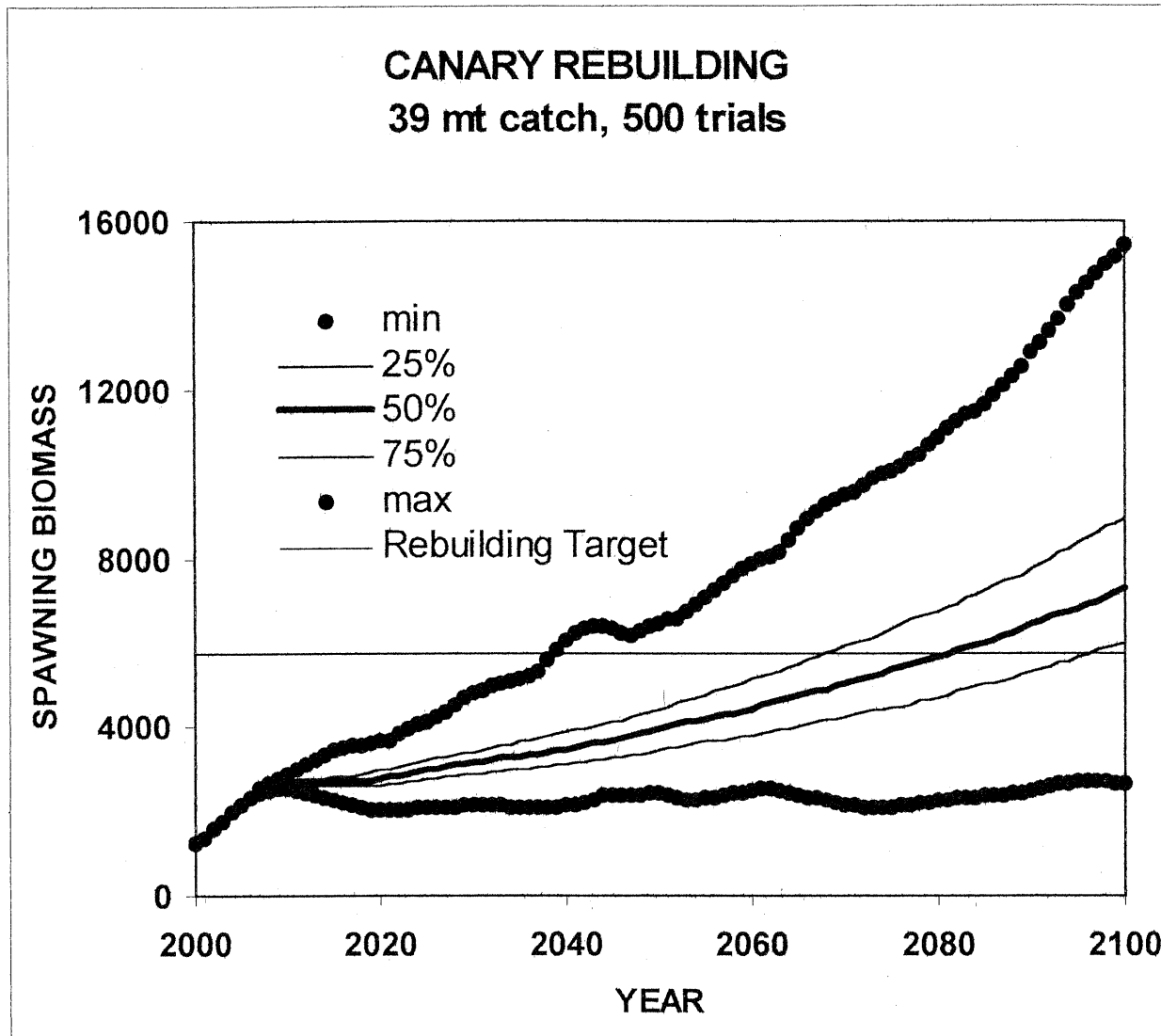


Figure 5. Trajectory of spawning biomass expected with an annual catch of 39 mtons and recruitment levels selected by resampling recruits per spawner from 1978-1997. The initial steeper recovery is due to the stronger recruitment in 1996-1998. The maximum rate of rebuilding occurs when similarly large recruitments occur frequently in the future. The minimum rate shows that if larger recruitments occur very infrequently, then the stock will maintain itself, but little or no rebuilding will occur. The 50% line (median) shows that 50% of the simulations will show rebuilding in 81 years at a catch of 39 mtons per year.

