Projection results for Zones A, B, C and D in 2007

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SUMMARY

Model results are presented for a revised Reference Case model that is based on the revised poaching trend information given in document AB/WG/07/Aug/26. Results are also represented for the "old" Reference case and one other scenario.

Model results for the revised Reference Case estimate a pristine spawning biomass, B_0^{sp} (in tonnes), of 8120, 5790, 6680 and 10200 for Zones A, B, C and D respectively. The current (inshore+offshore) spawning biomasses of abalone in Zones A, B and D are estimated at ca. 34 %, 31 % and 18 % respectively of their pre-exploitation levels. The "nonpoached" CNP and "poached" CP areas of Zone C are estimated at ca. 8 % and 7 % respectively with the inshore region particularly depleted: the model predicts zero remaining abalone in the inshore CNP, CP and Zone D areas. Natural mortality is reasonably estimated (e.g. 0.33 yr^{-1} for age 0 and 0.14 yr^{-1} for age 15+) and in Zones C and D, the additional mortality estimated for 0-yr old abalone (due to the ecosystem-change effect) corresponds to near zero current annual survival rates. Poaching is severely impacting the resource, with Zones A and B particularly impacted in recent years. The combined Zones A-D model-predicted 2006/07 poaching estimate of 578 MT (corresponding to the assumption that, on average, 17% of all poached abalone are confiscated) is approximately eight times the legal 2007 commercial TAC for these zones.

Projections

Preliminary 20-yr projection results are given at the end of Table 2 for a single scenario that assumes future commercial catches stay constant at the current levels (with recreational catches set at zero) and that future poaching is the average of the 2006 and 2007 estimated poaching levels (assumed to remain at this level for all future years).

Further projection results are given in Tables 3 and 4 for Zones A and B respectively, and are shown graphically in Fig. 6. The scenarios assume Poaching catches (P) remain constant at the current level (computed as the average of the 2006 and 2007 levels in terms of numbers), or the 2007 level, or zero. Illustrative commercial catch scenarios show catches set at the current TAC, at zero and at higher illustrative values.

Table 1. Best fit estimates of the pre-exploitation spawning biomass B_0^{sp} (or K) for the "poached" CP and "nonpoached" CNP areas of Zone C, and for each of Zones A, B and D, the estimated natural mortality estimates M_a, the inshore-offshore migration parameters ρ (yr^{-1}), the proportions of recruitment in each subarea that occur inshore versus offshore r_I, and the poaching maximum CP_{max} (i.t.o. NUMBERS). The CP_{max} estimates are also shown in terms of biomass and the years to which these estimates apply are given in the row below. Minimum values of the negative of the log-likelihood function are also shown. The estimated selectivity parameters are shown for the commercial sector (CS), recreational sector (RS), poaching sector (PS), FIAS (FS) and the old 1980's survey (OS). Note that for the 2002 industry survey (IS), $S_a^{IS} = 1$. Note also that all $-ln$L contributions from catch-at-age data have been multiplied by 0.1 as an *ad hoc* adjustment to compensate for likely positive correlation in these data.

Model	a) NEW Ref. case					b) OLD Ref Case					c) Estimate Cmult				
No. parameters			30					30					30		
Zone	A	B	CNP	CP	D	A	B	CNP	CP	D	A	B	CNP	CP	D
Ave confiscation %	11%	46%	8%		5%	16%	40%	17%		6%	10%	48%	8%		6%
$B(0)^{sp}$	8122	5792	2312	4367	10199	9332	6049	2337	4477	12122	8902	5804	2421	4415	9294
ρ	0.000466	0.000466	0.000466	0.000233	0.000466	0.000495	0.000495	0.000495	0.000247	0.000495	0.000396	0.000396	0.000396	0.000198	0.000396
r^I	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Cpmax (no.)	1660020	7.79E+05		558791	842088	1741720	7.93E+05		544271	856666	1824720	7.35E+05		534841	774084
Cpmax (MT)	574	360		271	403	410	363		275	551	647	347		263	373
Cpmax (YEAR)	2006	2002		1995	2002	2004	2002		1995	2002	2006	2002		1995	2002
CP(2007) (MT)	304	173		0	100	672	106		1	4	332	167		0	92
Cmult (Zone A)	1.50					1.50					2.50				
Ppoach			0.81					0.64					0.89		
M_0			0.326					0.322					0.319		
M_1			0.226					0.222					0.219		
M_2			0.193					0.189					0.186		
M_3			0.176					0.172					0.169		
M_4			0.166					0.162					0.159		
M_5			0.159					0.156					0.153		
M_6			0.155					0.151					0.148		
M_7			0.151					0.147					0.144		
M_8			0.148					0.144					0.142		
M_9			0.146					0.142					0.139		
M_{10}			0.144					0.140					0.138		
M_{11}			0.143					0.139					0.136		
M_{12}			0.141					0.138					0.135		
M_{13}			0.140					0.136					0.134		
M_{14}			0.139					0.136					0.133		
M_{15}			0.139					0.135					0.132		
steepness of recruitment failure)			0.2455					0.2352					0.2446		
Mmax (Recruitment failure scale parameter|)			13.9524					10.0003					13.9524		
h	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
a(CS)			8.99941					8.99924					8.99939		
a(RS)			8.99961					8.99954					8.99964		
a(PS)			4.91306					4.99941					4.91288		
a(FS)			6.48564					6.94021					6.58158		
a(OS)			4.74436					5.12146					4.67673		
a(IS)			-					-					-		
(CS)			0.000451					0.000687					0.000386		
(RS)			0.000962					0.001032					0.001108		
(PS)			0.000169					0.000121					0.000141		
(FS)			0.001317					0.001491					0.001505		
(OS)			5.9E-05					0.000344					1.65E-12		
(IS)			-					-					-		
(CS)			826.641					516.874					839.262		
(RS)			851.967					643.465					870.094		
(PS)			306.198					1.13889					306.198		
(FS)			0.844163					0.726992					0.815899		
(OS)			0.676025					0.668038					0.650528		
(IS)			-					-					-		

Model	a) Ref. case					b) OLD Ref Case					c) Estimate Cmult				
	A	B	CNP	CP	D	A	B	CNP	CP	D	A	B	CNP	CP	D
-*ln* L CPUE	-43.336	-50.211	-34.472	-44.597	-33.451	-42.256	-46.205	-33.460	-47.513	-31.319	-49.801	-50.586	-34.159	-44.750	-34.189
-*ln* L FIAS	9.117	-7.427	-5.726	10.536	-1.636	13.954	-4.572	-5.961	9.121	-2.620	8.881	-7.353	-5.489	10.511	-1.615
-*ln* L age CS	-16.447	-18.335	-8.477	-10.303	-11.806	-16.625	-19.627	-8.692	-10.245	-11.888	-15.517	-18.418	-8.349	-10.336	-11.890
-*ln* L age RS	-1.648	-8.052	-6.987	-0.025	-8.778	-1.587	-8.073	-7.059	-0.023	-8.664	-1.672	-8.022	-6.858	-0.015	-8.784
-*ln* L age PS	-2.784	-2.700		-2.077	-3.488	-2.794	-3.953		-1.985	-4.543	-2.706	-3.276		-2.095	-3.755
-*ln* L age FIAS	-2.680	-9.615	-4.398	-0.364	-5.378	-2.709	-9.968	-3.860	-0.174	-5.571	-2.846	-9.668	-4.127	-0.348	-5.441
-*ln* L age OS inshore	-3.343	-1.099		-1.339	-1.032	-3.217	-1.113		-1.394	-1.043	-3.441	-1.080		-1.286	-0.933
-*ln* Lage OS offsh.	-3.324	-1.455		-0.940	-2.115	-3.270	-1.424		-0.982	-2.285	-3.483	-1.545		-0.922	-2.091
-*ln* L age IS insh+offsh.		-1.012	-0.751				-0.914	-0.589				-0.973	-0.732		
-*ln* L zone subtotal	-64.444	-99.904	-109.919		-67.684	-58.505	-95.850	-112.816		-67.933	-70.584	-100.921	-108.955		-68.700
-*ln* L TOTAL			-341.951					-335.105					-349.160		
CPUE	0.124	0.096	0.156	0.065	0.179	0.129	0.112	0.162	0.056	0.194	0.098	0.095	0.158	0.065	0.174
age CS	0.082	0.074	0.114	0.096	0.097	0.081	0.068	0.113	0.096	0.097	0.086	0.073	0.115	0.095	0.096
age RS	0.114	0.057	0.060	0.196	0.060	0.116	0.057	0.059	0.197	0.061	0.113	0.057	0.061	0.199	0.060
age PS	0.122	0.141		0.147	0.103	0.121	0.121		0.149	0.085	0.123	0.131		0.147	0.098
age FIAS	0.117	0.072	0.085	0.131	0.086	0.116	0.069	0.094	0.139	0.084	0.114	0.071	0.089	0.132	0.085
OS insh.	0.038	0.061		0.050	0.068	0.041	0.061		0.047	0.067	0.037	0.062		0.052	0.074
OS offsh.	0.043	0.052		0.075	0.029	0.044	0.053		0.072	0.025	0.040	0.048		0.076	0.029
S		0.036	0.070				0.040	0.085				0.037	0.072		
q CPUE	0.000296	0.000633	0.003367	0.000996	0.000233	0.000256	0.000605	0.00313	0.000967	0.000196	0.000299	0.000659	0.003648	0.001018	0.000268
Confiscation percentage			Zone C					Zone C					Zone C		
%Co/Po$_{1995}$		0.48	0.07		0.05		0.24	0.08		0.03		0.51	0.07		0.06
%Co/Po$_{1996}$		0.22	0.08		0.03		0.09	0.07		0.02		0.24	0.08		0.04
%Co/Po$_{1997}$		0.26	0.06		0.03		0.08	0.05		0.01		0.27	0.06		0.03
%Co/Po$_{1998}$	0.19	0.32	0.08		0.04	0.10	0.18	0.05		0.02	0.17	0.34	0.08		0.04
%Co/Po$_{1999}$	0.13	0.05	0.05		0.01	0.05	0.05	0.04		0.01	0.12	0.06	0.05		0.01
%Co/Po$_{2000}$	0.09	0.28	0.13		0.05	0.11	0.27	0.17		0.04	0.08	0.29	0.13		0.05
%Co/Po$_{2001}$	0.04	0.28	0.07		0.04	0.04	0.16	0.05		0.02	0.04	0.30	0.07		0.04
%Co/Po$_{2002}$	0.11	0.56	0.07		0.05	0.17	0.38	0.15		0.04	0.10	0.59	0.07		0.05
%Co/Po$_{2003}$	0.11	0.42	0.14		0.06	0.10	0.24	0.11		0.05	0.10	0.44	0.14		0.06
%Co/Po$_{2004}$	0.08	0.39	0.05		0.03	0.17	0.23	0.16		0.03	0.07	0.41	0.05	<mark></mark>	0.04
%Co/Po$_{2005}$	0.06	0.33	0.04		0.06	0.15	0.32	0.12		0.05	0.06	0.35	0.04		0.06
%Co/Po$_{2006}$	0.17	0.59	0.11		0.06	0.22	0.83	0.32		0.12	0.16	0.63	0.11		0.07
Ave prop over last 5 yrs	**0.11**	**0.46**	**0.08**		**0.05**	**0.16**	**0.40**	**0.17**		**0.06**	0.10	0.48	0.08		0.06
Mean CS Fishing mortality	0.04	0.14	0.14	0.16	0.03	0.03	0.11	0.13	0.15	0.02	0.07	0.14	0.14	0.16	0.03
Catches	577.7	75	7.703045			782.6	75	10.43406			591.4	75	7.885526		
Ccomm(2007)	0	75	0	0	0	0	75	0	0	0	0	75	0	0	0
Cpoa(2007)	303.8	173.3	0.2	0.2	100.3	671.8	105.6	0.6	0.7	3.8	332.2	166.9	0.2	0.2	91.9
Catch total (2007) MT	303.8	248.3	0.2	0.2	100.3	671.8	180.6	0.6	0.7	3.8	332.2	241.9	0.2	0.2	91.9
	A	B	CNP	CP	D	A	B	CNP	CP	D	A	B	CNP	CP	D
Depletion comp. yr	1986/87	1982		1981	1983	1986/87	1982		1981	1983	1986/87	1982		1981	1983
Insh OBS	0.33	0.67		0.33	0.36	0.33	0.67		0.33	0.36	0.33	0.67		0.33	0.36
Insh PRED	0.81	0.56		0.46	0.75	0.83	0.58		0.47	0.78	0.72	0.52		0.44	0.70
Offsh OBS	0.20	0.54		0.24	0.50	0.20	0.54		0.24	0.50	0.20	0.54		0.24	0.50
Offsh PRED	0.66	0.34		0.29	0.62	0.70	0.36		0.29	0.67	0.53	0.32		0.28	0.56

Table 2. Illustrative model depletion statistics for each of Zones A, B, CNP, CP and D

Model	a) Ref. case					b) OLD Ref Case					c) Estimate Cmult				
Depletion statistics															
$B^{sp}(2007)/K$ (Insh. + Offsh)	0.34	0.31	0.08	0.07	0.18	0.39	0.38	0.09	0.07	0.18	0.31	0.30	0.07	0.07	0.16
$B^{sp}(2007)/K$ (Insh.)	0.19	0.27	0.00	0.00	0.03	0.25	0.37	0.00	0.00	0.00	0.16	0.25	0.00	0.00	0.03
$B^{sp}(2007)/K$ (Offsh.)	0.57	0.39	0.19	0.25	0.39	0.59	0.40	0.22	0.26	0.44	0.55	0.36	0.17	0.25	0.38
$B^{total}(2007)/K$	0.39	0.37	0.07	0.06	0.16	0.44	0.42	0.08	0.07	0.17	0.36	0.34	0.06	0.06	0.15
$B^{commercial}(2007)/K$	0.31	0.23	0.09	0.09	0.22	0.35	0.29	0.11	0.09	0.21	0.27	0.21	0.08	0.08	0.20
FIAS N_{2007}/N_{1951}	0.20	0.33	0.00	0.00	0.01	0.21	0.49	0.00	0.00	0.00	0.18	0.33	0.00	0.00	0.01
Projections	**A**	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**
Ccomm(2007)	0.0	75.0	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0
Cpoa(2007) (NUMBERS)	1235880	549353	88104	128004	144839	1660730	256406	49371	92555	484445	1358500	517896	85232	132117	133142
Cpoa(2007) (MT)	490	220.6	0.0	1.1	121	662	106.9	2.4	1.9	16	541	212.7	0.0	1.5	111
Catch total (2007) MT	489.6	295.6	0.0	1.1	120.9	661.9	181.9	2.4	1.9	16.3	540.8	287.7	0.0	1.5	110.9
$B^{sp}(2012)/K$	0.24	0.29	0.04	0.04	0.09	0.25	0.44	0.05	0.04	0.10	0.21	0.27	0.04	0.04	0.08
$B^{sp}(2027)/K$	0.13	0.15	0.01	0.00	0.01	0.15	0.54	0.01	0.01	0.01	0.13	0.12	0.01	0.01	0.01
$B^{sp}(2012)/Bsp(2007)$	0.71	0.92	0.56	0.55	0.50	0.64	1.15	0.57	0.56	0.53	0.67	0.91	0.57	0.57	0.51
$B^{sp}(2027)/Bsp(2007)$	0.39	0.48	0.07	0.07	0.06	0.38	1.41	0.08	0.08	0.07	0.41	0.41	0.08	0.08	0.07

Table 3. Projection results for Zone A.

	ZONE A	
a) Future poaching remains at current level: P=current = 490 t		
i) Current commercial catch		
2008 catch	**0**	**100**
$B^{sp}(2012)/K$	0.24	0.20
$B^{sp}(2027)/K$	0.13	0.03
$B^{sp}(2012)/Bsp(2007)$	0.71	0.59
$B^{sp}(2027)/Bsp(2007)$	0.39	0.09
b) Future poaching at 2007 level = 296 t		
2008 catch	**0**	
$B^{sp}(2012)/K$	0.34	
$B^{sp}(2027)/K$	0.31	
$B^{sp}(2012)/Bsp(2007)$	1.00	
$B^{sp}(2027)/Bsp(2007)$	0.90	
c) Future poaching *zero*		
2008 catch	**0**	
$B^{sp}(2012)/K$	0.50	
$B^{sp}(2027)/K$	0.85	
$B^{sp}(2012)/Bsp(2007)$	1.45	
$B^{sp}(2027)/Bsp(2007)$	2.49	

Table 4. Projection results for Zone B.

|	ZONE B		
a) Future poaching remains at current level: P=current = 220 t			
i) Current commercial catch			
2008 catch	**0**	**100**	**150**
$B^{sp}(2012)/K$	0.33	0.29	0.25
$B^{sp}(2027)/K$	0.32	0.15	0.04
$B^{sp}(2012)/Bsp(2007)$	1.06	0.92	0.78
$B^{sp}(2027)/Bsp(2007)$	1.03	0.48	0.12
b) Future poaching at 2007 level = 174 t			
2008 catch	**0**		
$B^{sp}(2012)/K$	0.32		
$B^{sp}(2027)/K$	0.30		
$B^{sp}(2012)/Bsp(2007)$	1.02		
$B^{sp}(2027)/Bsp(2007)$	0.94		
c) Future poaching *zero*			
2008 catch	**0**		
$B^{sp}(2012)/K$	0.49		
$B^{sp}(2027)/K$	0.85		
$B^{sp}(2012)/Bsp(2007)$	1.55		
$B^{sp}(2027)/Bsp(2007)$	2.70		
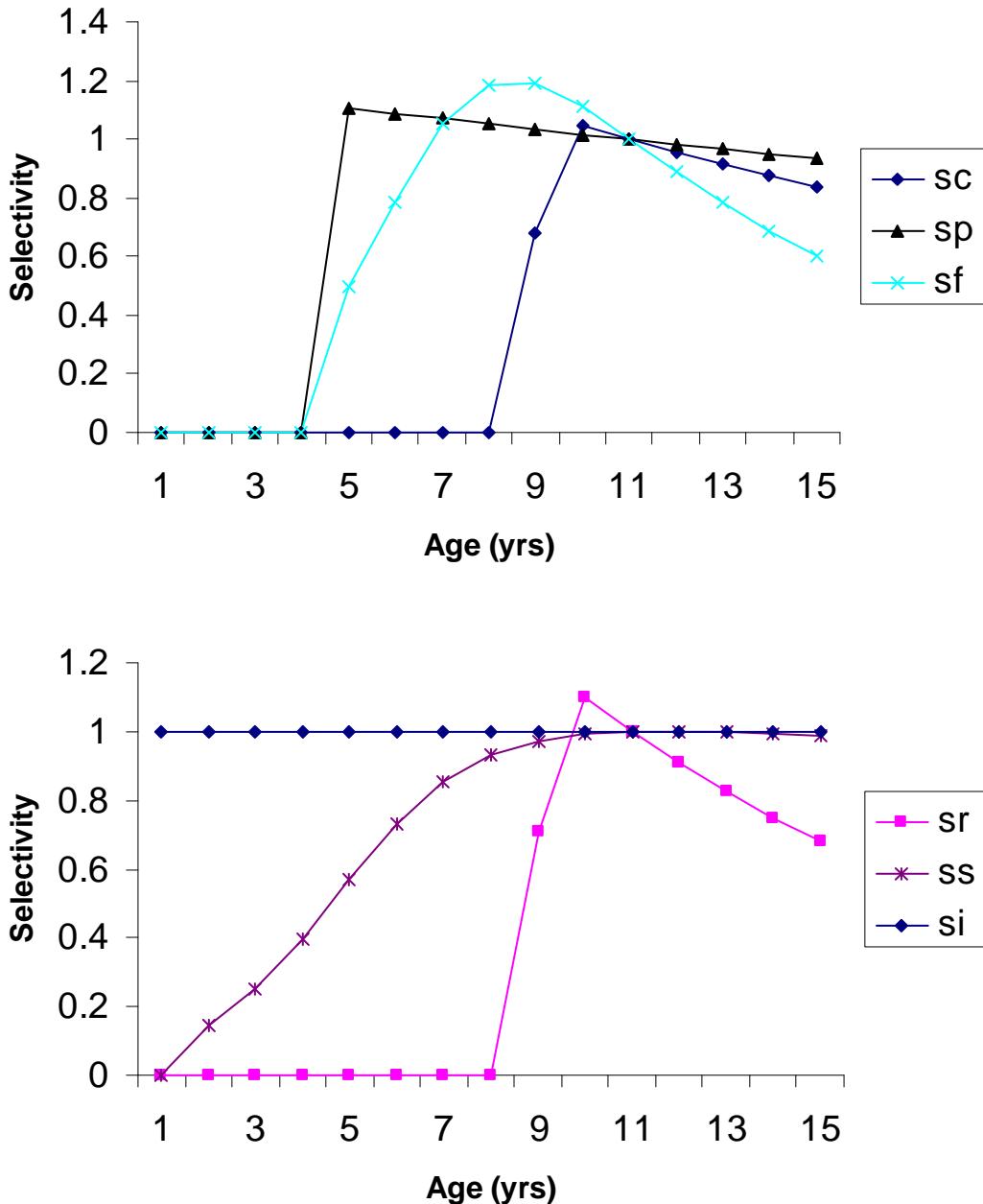
Fig. 1. Plots of the new Reference-case combined ABCD model selectivity functions estimated for the commercial (sc), recreational (sr) and poaching (sp) fishery sectors, and for FIAS (sf) and the old 1980's surveys (ss). A description of the general functional form used is given in Appendix 1 and the fitted parameter values are listed in Table 4. A uniform value is assumed for the industry/MCM survey (si) because of the extractive nature of the sampling methodology used.
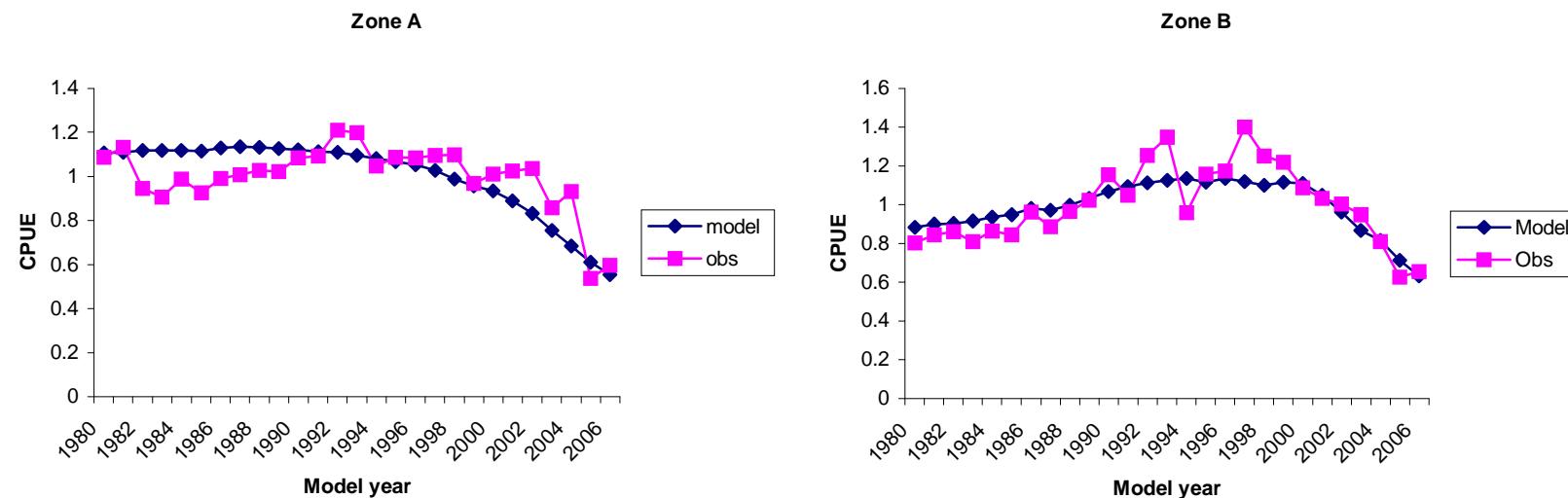
Fig. 2. Comparisons between the standardised CPUE and model-predicted CPUE values (for the new Reference-case combined ABCD model) for each of Zones A and B.
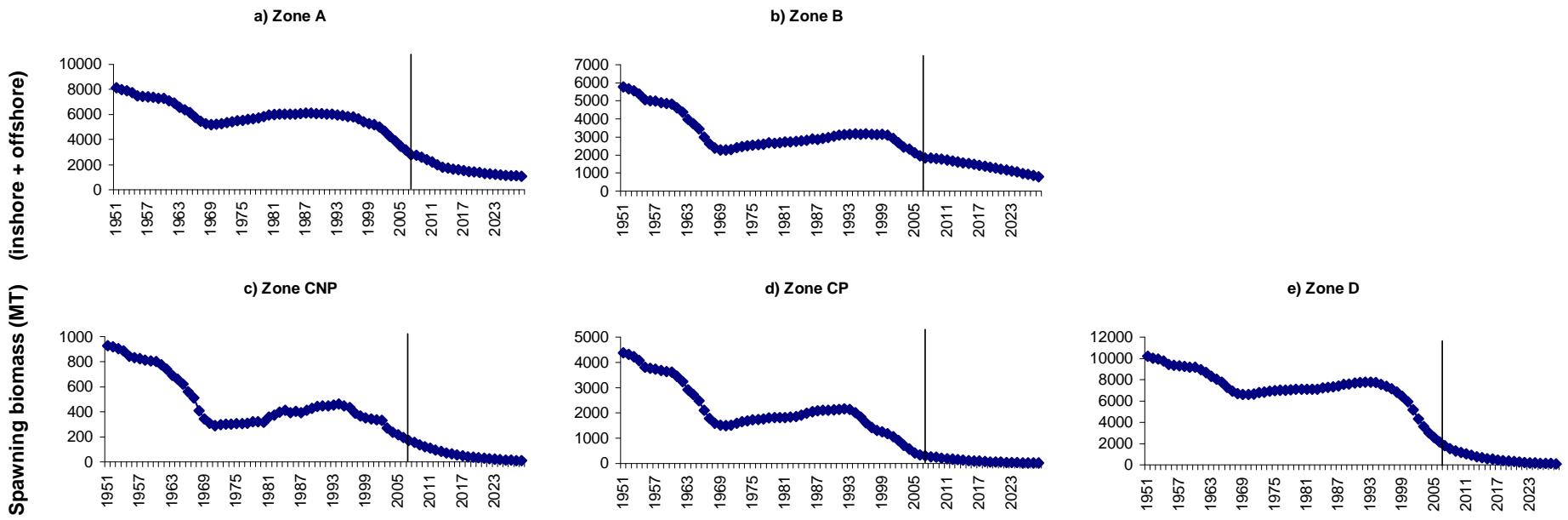
Fig. 3. Reference-case combined ABCD model total (inshore + offshore) spawning biomass trajectories shown for Zones A to D. Note that the 20-yr projections shown (indicated by vertical bar) represent scenarios under which future poaching levels are assumed to remain at the current estimated level (average of 2005 and 2006) and future commercial catches remain constant at the current level (Zone A: 0 t; Zone B: 75 t).
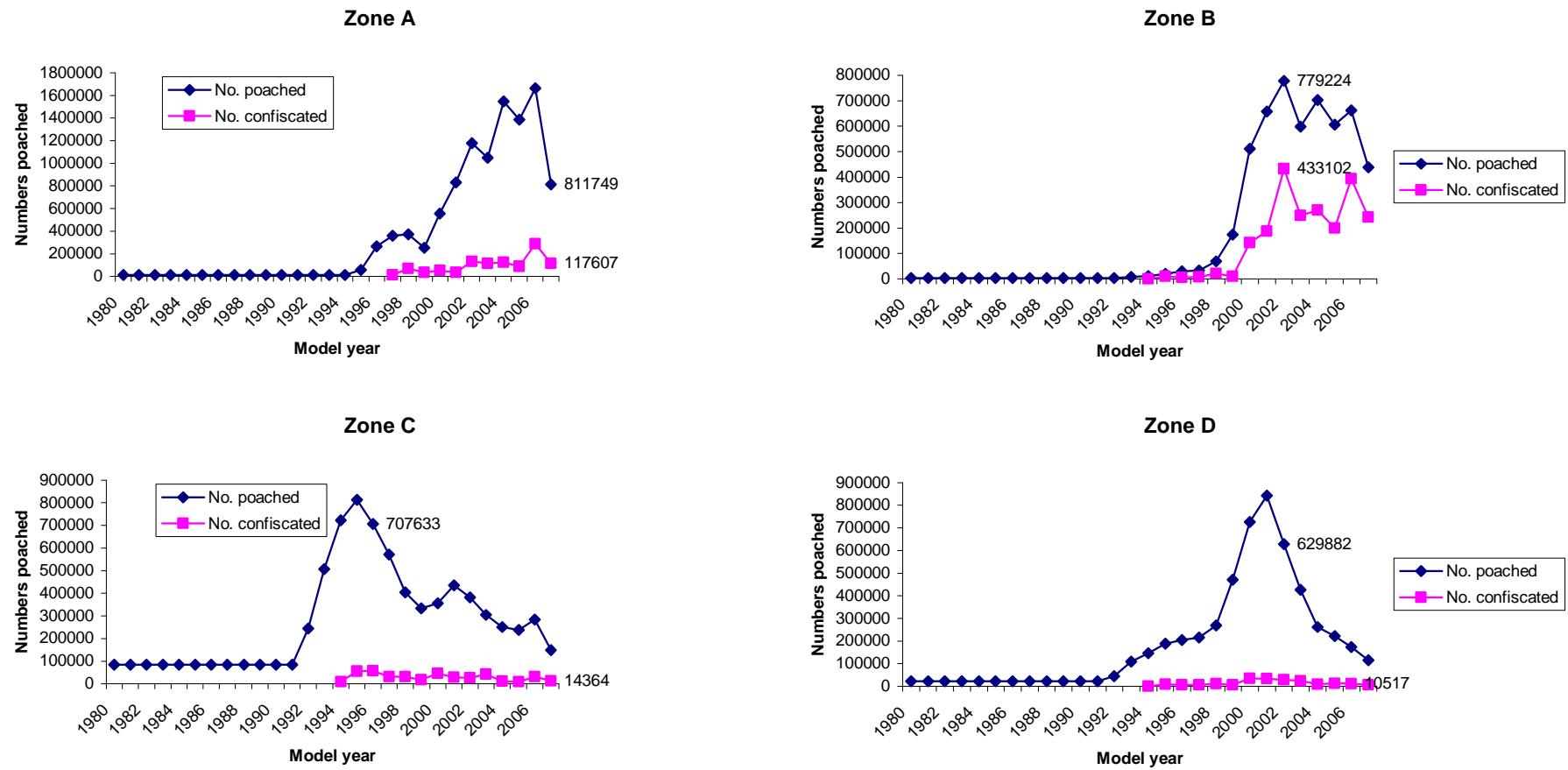
Fig . 4. Comparison of model-predicted numbers of abalone poached per Zone with "observed" numbers confiscated (after allocating confiscated abalone from the Unknown category to each of Zones A-D). The numerical value (units are numbers) corresponding to selected points on the graph is given.

Zone A

Zone B

Zone C

Zone D
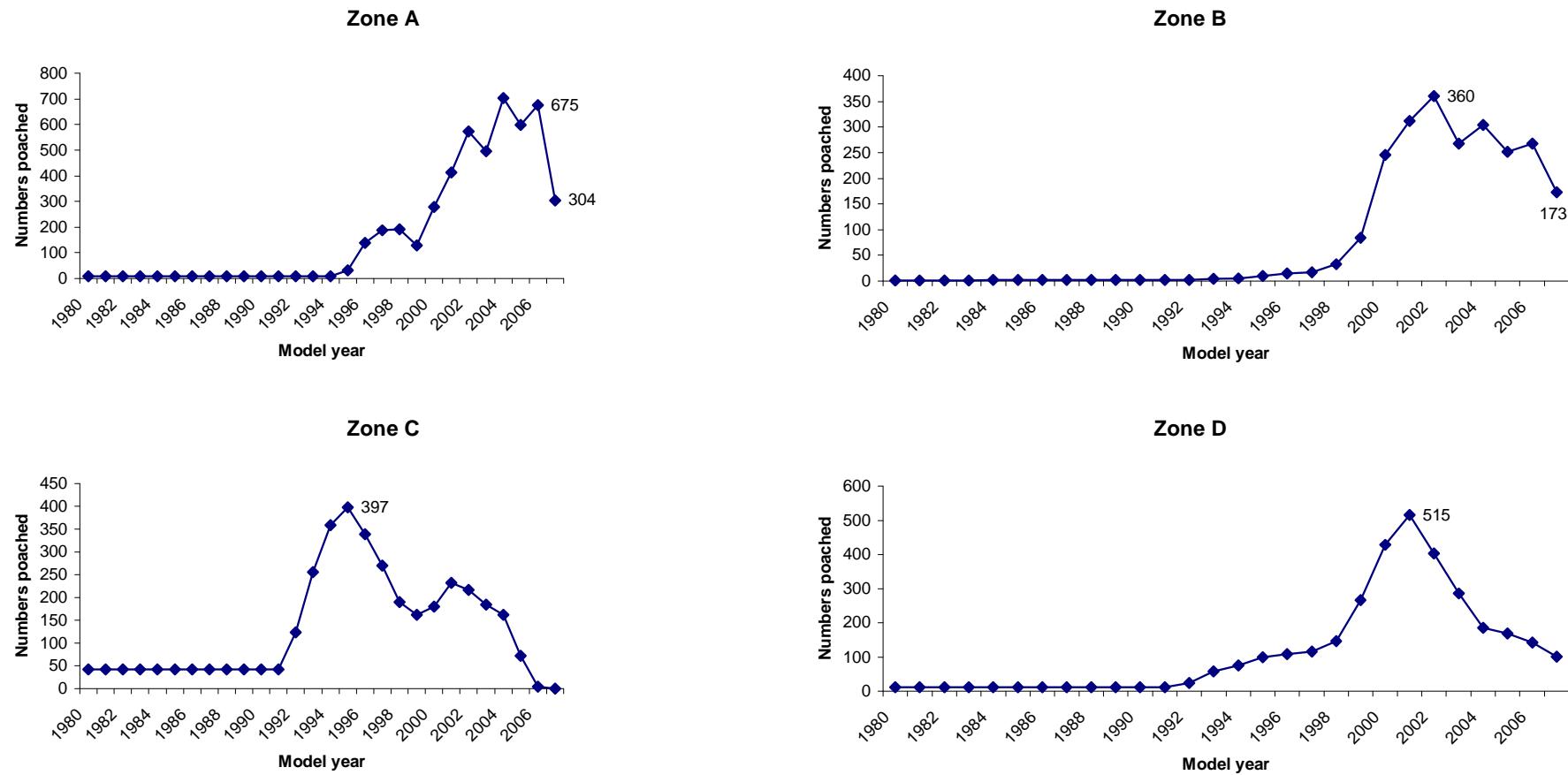
Fig . 5. Model-predicted **biomass** of abalone poached per Zone using revised poaching estimates.
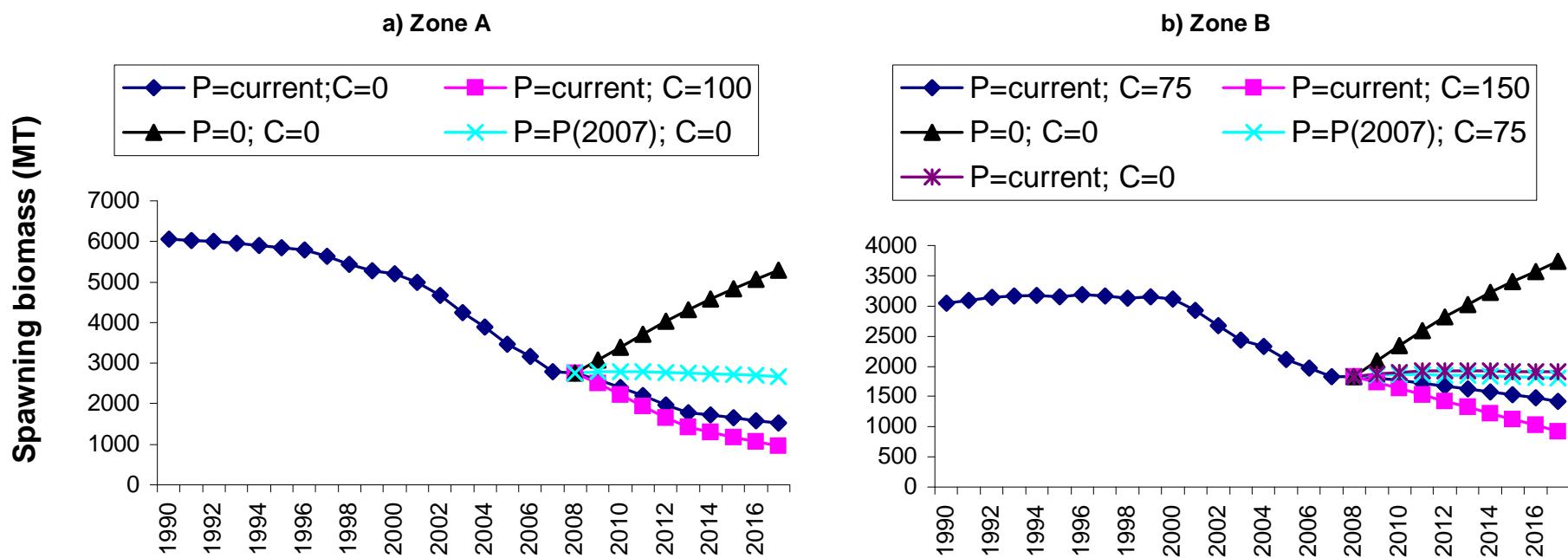
Fig. 6. Spawning biomass projections for Zones A and B under a range of future scenarios. Scenarios assume Poaching catches (P) remain constant at the current level (computed as the average of the 2006 and 2007 levels in terms of numbers), or the 2007 level, or zero. Illustrative commercial catch scenarios show catches set at the current TAC, at zero and at higher illustrative values.