

7.4.5 Sardine in Divisions VIIIc and IXa

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Undefined	Undefined	Undefined	Undefined	

In the absence of defined reference points, the state of this stock cannot be evaluated with regard to these. SSB has declined since 2006 due to successive low recruitments and SSB in 2009 was below the long-term average. Fishing mortality in 2008 was 40% higher than in 2007, but is still below the historical average.

Management objectives

There are no explicit management objectives for this stock.

Reference points

Reference points have not been identified for this stock.

Single-stock exploitation boundaries

The current fishing mortality does not appear detrimental for the development of the stock, which is largely driven by the incoming recruitment. Therefore, ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that the current level of fishing mortality could be maintained as a guide for management. This corresponds to a catch of 75 thousand tonnes in 2010.

Short-term implications

Outlook for 2010

Basis: $F(2009) = \text{average } F(06-08 \text{ unscaled}) = 0.18$; $SSB(2009)^{1)} = 421$; $\text{catch}(2009) = 80$; $R(2009)$ and $R(2010) = GM(1995-2008) = 4923$ million.

Rationale	Landings (2010)	Basis	F (2010)	SSB (2010) ¹⁾	SSB (2011) ¹⁾	%SSB change ²⁾
Zero catch	0	$F=0$	0	440	478	+7.9
<i>Status quo</i>	61	$F_{sq} * 0.8$	0.14	428	424	-0.9
	68	$F_{sq} * 0.9$	0.16	427	417	-2.4
	75	$F_{sq} * 1.0$	0.18	425	411	-3.4
	82	$F_{sq} * 1.1$	0.19	424	405	-4.7
	89	$F_{sq} * 1.2$	0.21	422	399	-5.8

Weights in '000 t.

¹⁾ For spring spawning stocks, the SSB is determined at spawning time and is influenced by fisheries between 1st January and spawning.

²⁾ SSB 2011 relative to SSB 2010.

Management considerations

There are no management objectives for this stock and there is no TAC. Almost all catches are taken by Spanish and Portuguese purse-seiners in a directed human consumption fishery. The stock is managed by Portugal and Spain through minimum landing size, maximum daily catch, days fishing limitations, and closed areas.

Sardine is distributed in the Iberian region, to the north in Subareas VII and VIII and in the North Sea, and to the south on the Moroccan shelf. The information presented here assumes that sardine in Divisions VIIIc and IXa is a unit stock,

based on biological characteristics. However, some movement of fish between Divisions VIIIb and VIIIc is known to occur. The effect of this movement is uncertain but is presently considered to have little influence on the estimation of the stock in the assessed area (Divisions VIIIc and IXa).

Short-term predictions indicate a moderate decline (-14%) in SSB in 2010 from the SSB in 2008 at the assumed fishing mortality level, providing the 2008 recruitment is confirmed to be average and no strong recruitment occurs in 2009. Therefore, the catch in 2010 should be reduced. In the past, extended periods of successive low recruitments have been associated with periods of minimum stock size, most recently in the late 1990s, causing a negative impact in the Spanish fisheries.

A long-term plan would result in an improved management of this stock. Such a plan should take into account the spatial distribution of the stock. Management aiming at stability of catches may be more consistent with the objectives of stakeholders. A long-term management plan would be useful if stability of catches is desired. Such a strategy should be sufficiently flexible with respect to catch limitation to protect the stock under periods of poor recruitment, but also avoid unnecessary fluctuations in the catches when the stock biomass is higher.

Factors affecting the fisheries and the stock

The effects of regulations

Different management measures have been enacted by Spain and Portugal since 1997. In Spain, management measures include a maximum allowable catch of 7000 kg per fishing day and a 5-fishing-days week limitation in effort is regulated. In Portugal, management measures include an overall limitation in the number of fishing days (180 days per year, and a weekend ban). The effects of these fishery regulations are uncertain but may have contributed to the decline in fishing mortality observed between 1998 and 2007.

The environment

Several studies have tried to detect a relationship between selected environmental variables and sardine dynamics, in particular to explain the high variability in recruitment. Local and large-scale variables (i.e. upwelling index, NAO, etc.) that could affect recruitment through influencing the survival of eggs and larvae have been explored through modelling work. In general, environmental effects in the models tend to be weak and have sometimes given contradictory results.

A number of studies are investigating the role of sardine in the ecosystem, both as predator and prey. Sardine is an omnivorous predator able to feed on both phytoplankton and zooplankton. In addition, sardines have been found to ingest their own eggs (and probably those of other species) and this cannibalism would act as a density control mechanism.

Sardine is prey for a range of fish and marine mammal species which take advantage of its schooling behaviour and availability.

Scientific basis

Data and methods

The assessment is based on combined Spanish and Portuguese acoustic surveys in March, a DEPM (Daily Egg Production Method) survey series in March in Spanish waters and in January in Portugal and Cadiz, and catch-at-age data.

The Portuguese November acoustic survey is used to corroborate the recruitments estimates from the assessment.

Uncertainties in assessment and forecast

The main uncertainties in the assessment relate to the extent of sardine movement across the northern stock boundary, the weighting of Portuguese and Spanish acoustic surveys in the combined abundance index, and the estimation of fishery selection pattern for the older age groups. A discrepancy in the stock trends indicated by the most recent DEPM and acoustic surveys added some uncertainty to the absolute estimates of SSB and F in recent years, but not to the trends.

Comparison with previous assessment and advice

The assessment and advice are consistent with that provided last year despite some difference in the absolute SSB and F estimates for recent years. The new assessment generated a 17% higher estimate of SSB and an 22% lower estimate of

fishing mortality in 2007 compared with the values provided last year, reflecting the influence of a new SSB data point from the 2008 DEPM survey.

Sources of information

Report of the Working Group on Anchovy and Sardine, ICES Headquarters, Copenhagen 15-20 June 2009 (ICES CM 2009/ACOM:13).

Table 7.4.5.1 Sardine in Divisions VIIIc and IXa. Single-stock exploitation boundaries (advice), management, and landings.

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	Official Landings VIII & IX	ICES Landings ³
1987	No increase in F; TAC	140	-		178
1988	No increase in F; TAC	150	-	167	162
1989	No increase in F; TAC	212	-	146	141
1990	Room for increased F	227 ²	-	150	149
1991	Precautionary TAC	176	-	135	133
1992	No advice	-	-	139	130
1993	Precautionary TAC	135	-	153	142
1994	No advice	118 ¹	-	147	137
1995	No advice; apparently stable stock	-	-	137	125
1996	Lowest possible level	-	-	134	117
1997	Lowest possible level	-	-	n/a	116
1998	Significant reduction	-	-	n/a	109
1999	Reduce F to 0.2	38	-	n/a	94
2000	F below 0.2	<81	-	n/a	86
2001	F below 0.2	<88	-	n/a	102
2002	F below 0.25	<95	-	n/a	100
2003	No increase in F	100	-	n/a	98
2004	No increase in F	128	-	n/a	98
2005	No increase in F	106	-	n/a	97
2006	No increase in F	96	-	n/a	87
2007	No increase in F	114	-	n/a	96
2008	No increase in F	92	-	n/a	101
2009	No increase in F	71	-		
2010	No increase in F	75			

Weights in '000 t.

¹Estimated catch at *status quo* F.

²Catch corresponding to 20% increase in F.

³Includes only Divisions VIIIc and IXa.

n/a=not available.

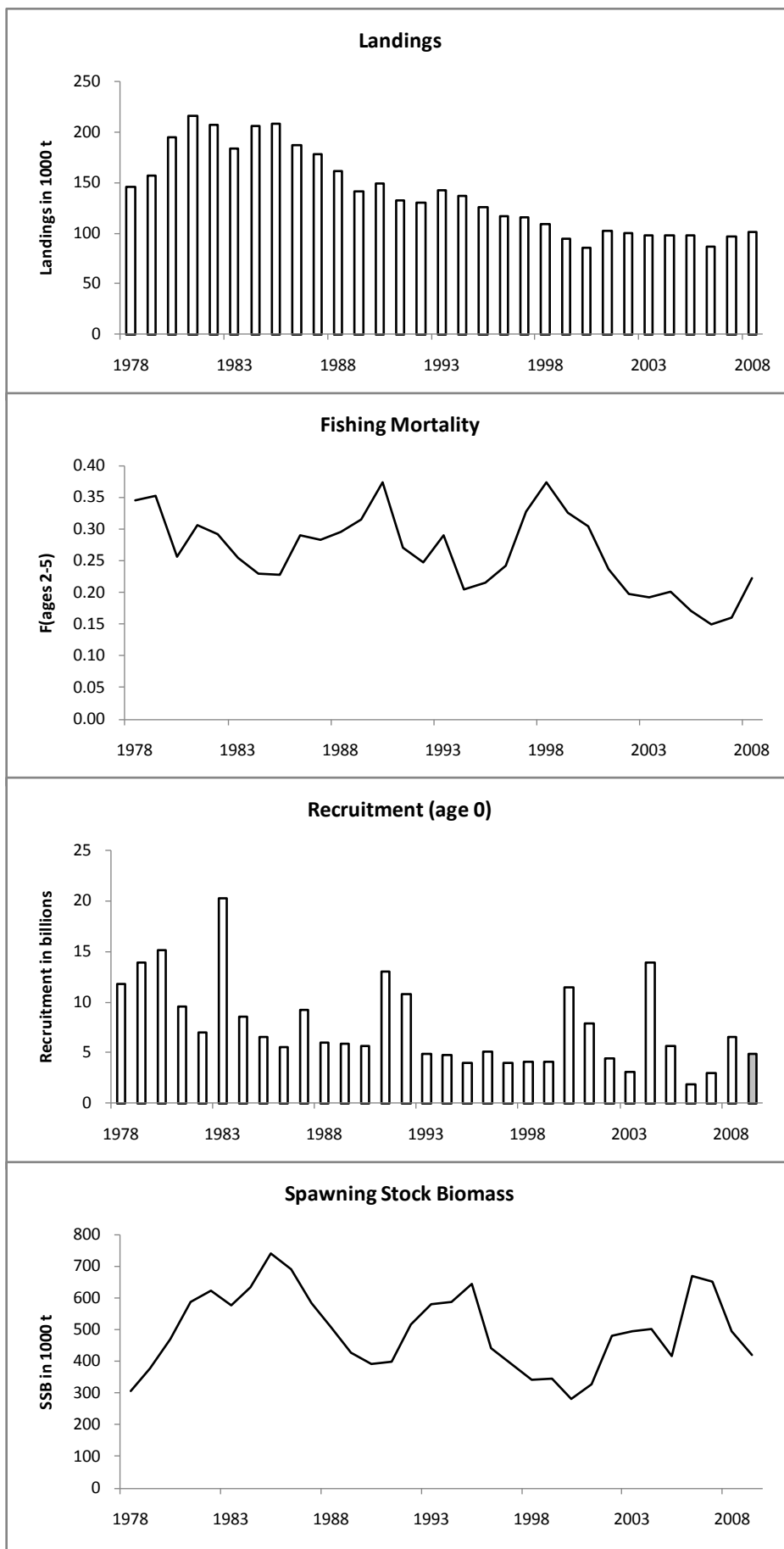


Figure 7.4.5.1 Sardine in Divisions VIIIc and IXa: Summary of stock assessment: landings, fishing mortality, recruitment, and SSB. Predicted values are shaded.

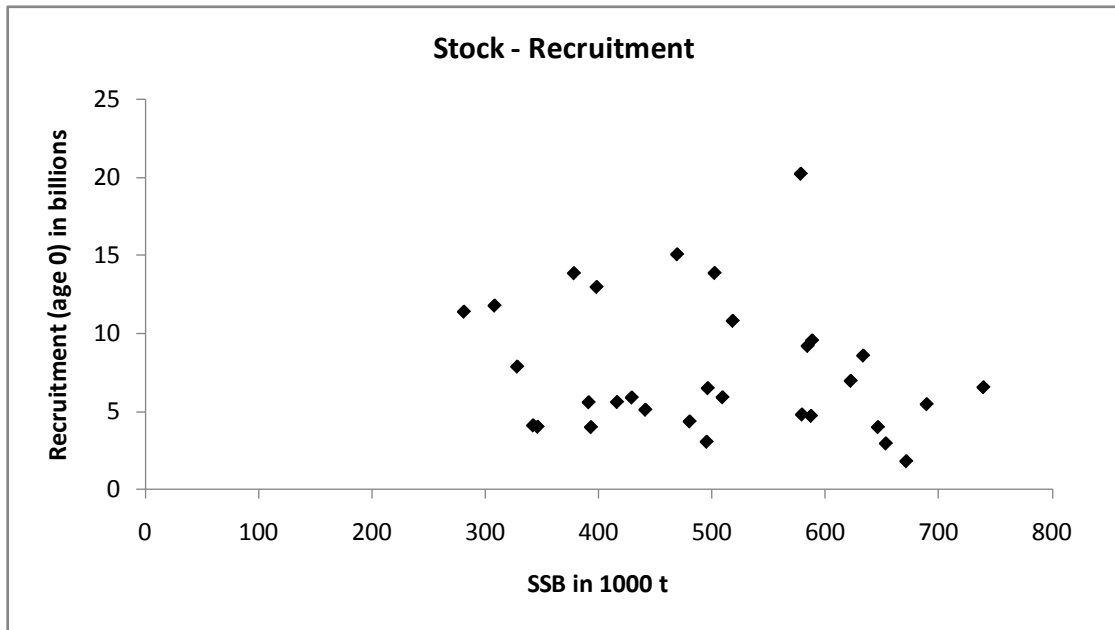


Figure 7.4.5.2 Sardine in Divisions VIIIc and IXa: Stock–recruitment relationship.

Sardine in Divisions VIIIc and IXa

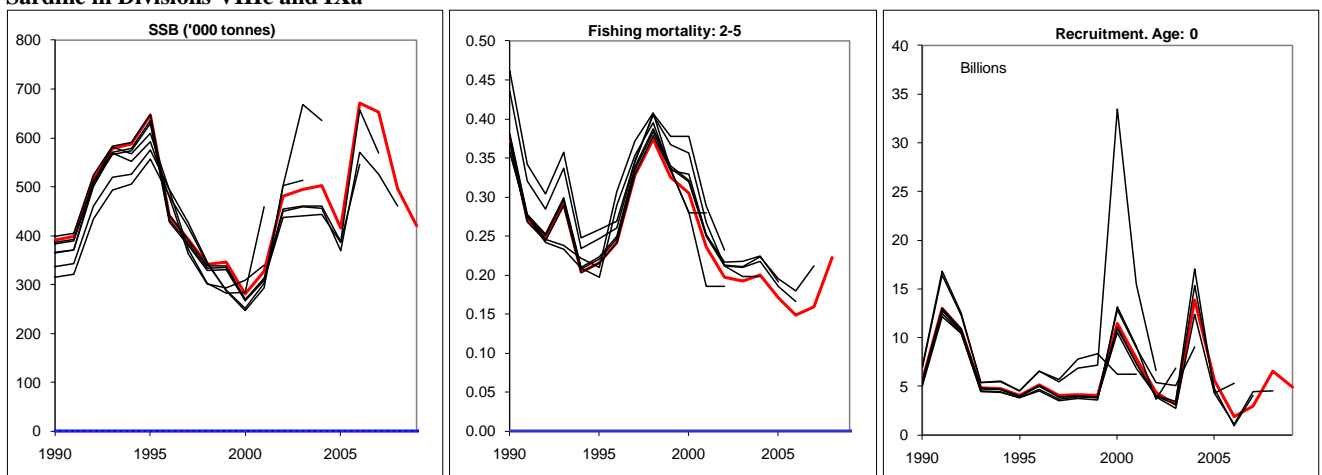


Figure 7.4.5.3 Sardine in Divisions VIIIc and IXa. Comparison of current assessment with previous assessments.

Table 7.4.5.2 Sardine in Divisions VIIIc and IXa: Iberian sardine landings (tonnes) by Subarea and total.

Year	Sub-area						All sub-areas	Div. IXa	Portugal	Spain (excl.Cadiz)	Spain (incl.Cadiz)
	VIIIc	IXa North	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz					
1940	66816		42132	33275	23724		165947	99131	99131	66816	66816
1941	27801		26599	34423	9391		98214	70413	70413	27801	27801
1942	47208		40969	31957	8739		128873	81665	81665	47208	47208
1943	46348		85692	31362	15871		179273	132925	132925	46348	46348
1944	76147		88643	31135	8450		204375	128228	128228	76147	76147
1945	67998		64313	37289	7426		177026	109028	109028	67998	67998
1946	32280		68787	26430	12237		139734	107454	107454	32280	32280
1947	43459	21855	55407	25003	15667		161391	117932	96077	65314	65314
1948	10945	17320	50288	17060	10674		106287	95342	78022	28265	28265
1949	11519	19504	37868	12077	8952		89920	78401	58897	31023	31023
1950	13201	27121	47388	17025	17963		122698	109497	82376	40322	40322
1951	12713	27959	43906	15056	19269		118903	106190	78231	40672	40672
1952	7765	30485	40938	22687	25331		127206	119441	88956	38250	38250
1953	4969	27569	68145	16969	12051		129703	124734	97165	32538	32538
1954	8836	28816	62467	25736	24084		149939	141103	112287	37652	37652
1955	6851	30804	55618	15191	21150		129614	122763	91959	37655	37655
1956	12074	29614	58128	24069	14475		138360	126286	96672	41688	41688
1957	15624	37170	75896	20231	15010		163931	148307	111137	52794	52794
1958	29743	41143	92790	33937	12554		210167	180424	139281	70886	70886
1959	42005	36055	87845	23754	11680		201339	159334	123279	78060	78060
1960	38244	60713	83331	24384	24062		230734	192490	131777	98957	98957
1961	51212	59570	96105	22872	16528		246287	195075	135505	110782	110782
1962	28891	46381	77701	29643	23528		206144	177253	130872	75272	75272
1963	33796	51979	86859	17595	12397		202626	168830	116851	85775	85775
1964	36390	40897	108065	27636	22035		235023	198633	157736	77287	77287
1965	31732	47036	82354	35003	18797		214922	183190	136154	78768	78768
1966	32196	44154	66929	34153	20855		198287	166091	121937	76350	76350
1967	23480	45595	64210	31576	16635		181496	158016	112421	69075	69075
1968	24690	51828	46215	16671	14993		154397	129707	77879	76518	76518
1969	38254	40732	37782	13852	9350		139970	101716	60984	78986	78986
1970	28934	32306	37608	12989	14257		126094	97160	64854	61240	61240
1971	41691	48637	36728	16917	16534		160507	118816	70179	90328	90328
1972	33800	45275	34889	18007	19200		151171	117371	72096	79075	79075
1973	44768	18523	46984	27688	19570		157533	112765	94242	63291	63291
1974	34536	13894	36339	18717	14244		117730	83194	69300	48430	48430
1975	50260	12236	54819	19295	16714		153324	103064	90828	62496	62496
1976	51901	10140	43435	16548	12538		134562	82661	72521	62041	62041
1977	36149	9782	37064	17496	20745		121236	85087	75305	45931	45931
1978	43522	12915	34246	25974	23333	5619	145609	102087	83553	56437	62056
1979	18271	43876	39651	27532	24111	3800	157241	138970	91294	62147	65947
1980	35787	49593	59290	29433	17579	3120	194802	159015	106302	85380	88500
1981	35550	65330	61150	37054	15048	2384	216517	180967	113253	100880	103264
1982	31756	71889	45865	38082	16912	2442	206946	175190	100859	103645	106087
1983	32374	62843	33163	31163	21607	2688	183837	151463	85932	95217	97905
1984	27970	79606	42798	35032	17280	3319	206005	178035	95110	107576	110895
1985	25907	66491	61755	31535	18418	4333	208439	182532	111709	92398	96731
1986	39195	37960	57360	31737	14354	6757	187363	148168	103451	77155	83912
1987	36377	42234	44806	27795	17613	8870	177696	141319	90214	78611	87481
1988	40944	24005	52779	27420	13393	2990	161531	120587	93591	64949	67939
1989	29856	16179	52585	26783	11723	3835	140961	111105	91091	46035	49870
1990	27500	19253	52212	24723	19238	6503	149429	121929	96173	46753	53256
1991	20735	14383	44379	26150	22106	4834	132587	111852	92635	35118	39952
1992	26160	16579	41681	29968	11666	4196	130250	104090	83315	42739	46935
1993	24486	23905	47284	29995	13160	3664	142495	118009	90440	48391	52055
1994	22181	16151	49136	30390	14942	3782	136582	114401	94468	38332	42114
1995	19538	13928	41444	27270	19104	3996	125280	105742	87818	33466	37462
1996	14423	11251	34761	31117	19880	5304	116736	102313	85758	25674	30978
1997	15587	12291	34156	25863	21137	6780	115814	100227	81156	27878	34658
1998	16177	3263	32584	29564	20743	6594	108924	92747	82890	19440	26034
1999	11862	2563	31574	21747	18499	7846	94091	82229	71820	14425	22271
2000	11697	2866	23311	23701	19129	5081	85786	74089	66141	14563	19644
2001	16798	8398	32726	25619	13350	5066	101957	85159	71695	25196	30262
2002	15885	4562	33585	22969	10982	11689	99673	83787	67536	20448	32136
2003	16436	6383	33293	24635	8600	8484	97831	81395	66528	22819	31303
2004	18306	8573	29488	24370	8107	9176	98020	79714	61965	26879	36055
2005	19800	11663	25696	24619	7175	8391	97345	77545	57490	31464	39855
2006	15377	10856	30152	19061	5798	5779	87023	71646	55011	26233	32012
2007	13380	12402	41090	19142	4266	6188	96469	83088	64499	25782	31970
2008	13636	9409	45210	20858	4928	7423	101464	87828	70997	23045	30468

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

Table 7.4.5.3

Sardine in Divisions VIIIc and IXa. Summary of stock assessment.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 2-5
1978	11805000	308000	145609	0.3459
1979	13874000	378000	157241	0.3526
1980	15081000	469000	194802	0.2556
1981	9578000	588000	216517	0.3070
1982	6994000	622000	206946	0.2926
1983	20233000	578000	183837	0.2554
1984	8610000	633000	206005	0.2305
1985	6584000	739000	208439	0.2272
1986	5500000	689000	187363	0.2898
1987	9223000	584000	177696	0.2830
1988	5942000	509000	161531	0.2947
1989	5927000	429000	140961	0.3150
1990	5622000	391000	149429	0.3736
1991	12995000	398000	132587	0.2710
1992	10831000	518000	130250	0.2466
1993	4841000	579000	142495	0.2910
1994	4753000	587000	136582	0.2039
1995	4034000	646000	125280	0.2161
1996	5147000	441000	116736	0.2421
1997	4032000	393000	115814	0.3282
1998	4145000	342000	108924	0.3736
1999	4057000	346000	94091	0.3252
2000	11414000	281000	85786	0.3045
2001	7903000	328000	101957	0.2360
2002	4399000	480000	99673	0.1968
2003	3098000	495000	97831	0.1928
2004	13888000	502000	98020	0.2005
2005	5639000	416000	97345	0.1706
2006	1856000	671000	87023	0.1490
2007	2992000	653000	96469	0.1596
2008	6525000	496000	101464	0.2221
2009	4923000*	421000		
Average	7576406	497188	138861	0.2630

* GM(1995–2008)