

ECOREGION North Sea
STOCK Northern shrimp (*Pandalus borealis*) in Divisions IIIa West and IVa East (Skagerrak and the Norwegian Deep)

Advice for 2015

ICES advises on the basis of MSY and precautionary considerations that catches should be no more than 10 900 t in 2015. If discard rates do not change from the average of the last three years, this implies landings of no more than 9777 t. Measures should be taken to reduce discarding of small shrimp.

Stock status

Fishing pressure				
	2011	2012	2013	
MSY (F_{MSY})	✓	✓	✓	At target
Precautionary approach (F_{lim})	✓	✓	✓	Harvested sustainably
Stock size				
	2012	2013	2014	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{lim})	✓	✓	✓	Full reproductive capacity

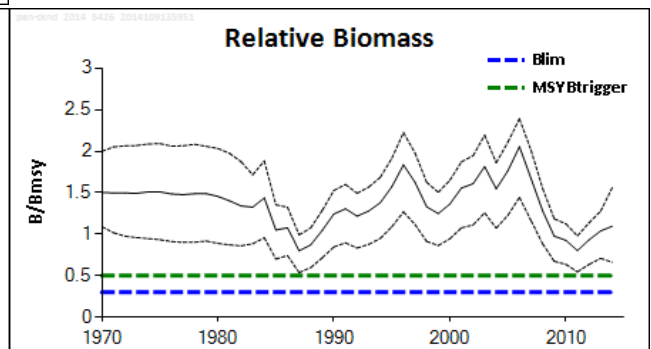
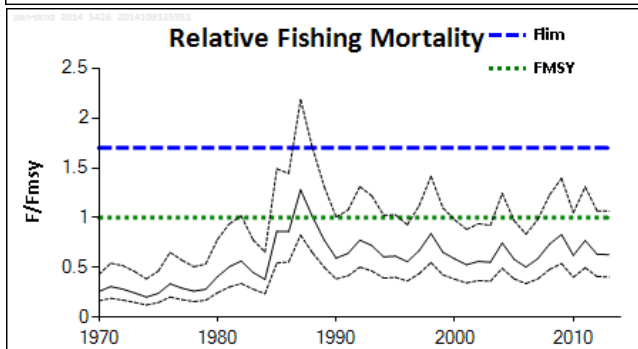
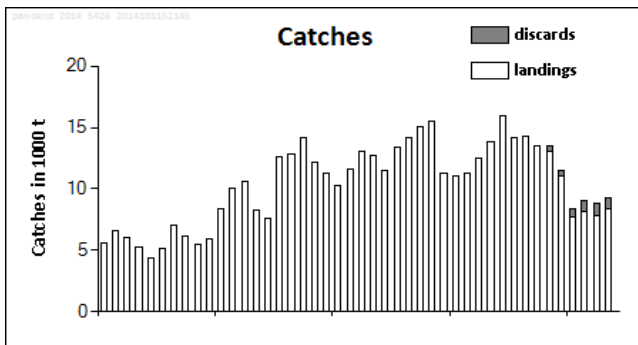
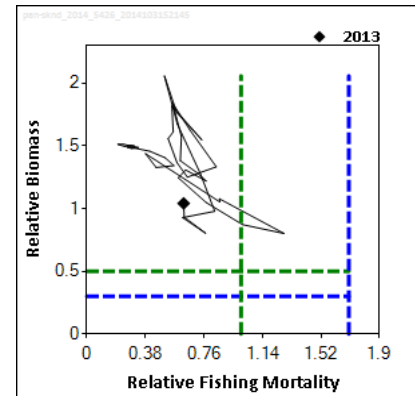


Figure 6.3.23.1 Northern shrimp in Divisions IIIa West and IVa East. Summary of the stock assessment (weights in thousand tonnes). Median of relative fishing mortality and biomass with 90% probability intervals. Top right: Relative biomass and F for the time-series used in the assessment.

Since the beginning of the 1990s stock biomass has been above MSY $B_{trigger}$ and fishing mortality below F_{MSY} .

Management plans

No specific management objectives are known to ICES.

Biology

Northern shrimp are hermaphroditic. Individuals mature as males, then at around 2 years of age they change sex and complete their lives as females. Several fish and marine mammal species prey on northern shrimp and may be important drivers of northern shrimp stock dynamics. Natural mortality for this stock is probably higher than fishing mortality.

The fisheries

Northern shrimps are mainly caught by 35–45 mm single- and twin-trawl nets (minimum legal mesh size is 35 mm). The targeted northern shrimp fishery by Danish vessels has declined over the last 20 years, whereas the Norwegian shrimp fleet of vessels < 11 m has expanded. The Swedish fishery has shown an increase in the use of twin trawls since around 2007. Due to the increasing use of twin trawl in all fisheries (and the accompanying increase in the average size of trawls), the efficiency of the fisheries has increased.

Catch distribution Total catches (2013) = 9279 kt, where 90% are landings (100% trawl) and 10% discards.

Effects of the fisheries on the ecosystem

When sorting grids are not used, bycatch of marketable species, dominated by saithe and cod, may constitute up to 30% of the landed catch. In addition, the shrimp survey indicates that other species such as argentinines, roundnose grenadier, rabbitfish, and sharks are frequently caught in shrimp trawls in the deeper parts of Skagerrak and the Norwegian Deep. Legislation requiring sorting grids was implemented in the Skagerrak, starting on 1st of February 2013.

Quality considerations

The surplus production assessment model best describes trends in stock development and is not fully sensitive to year-to-year changes. Large and rapid changes in recruitment may therefore not be fully captured in model predictions. The stock-production model this year estimated recent F values at about 65% of F_{MSY} , whereas in 2013 recent values were estimated at about 95% of F_{MSY} . This evidence of instability in model results is taken into account in the basis for this year's advice. In the benchmark of this stock (ICES, 2013a), a length-based model was considered preferable, but the length-based model requires further development before it can be used as the basis for advice.

Making the electronic logbooks introduced in the Norwegian fishery in 2011 compulsory for all vessels, instead of only the larger ones, would improve the data available for the assessment.

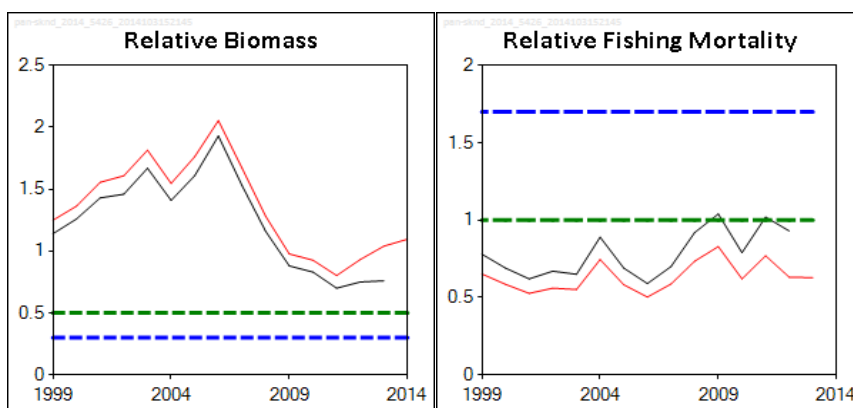


Figure 6.3.23.1 Northern shrimp in Divisions IIIa West and IVa East. Historical assessment (median results).

Scientific basis

Stock data category	1 (ICES, 2014a)
Assessment type	Bayesian fitting of a surplus-production model.
Input data	Commercial landings (until 2007), commercial catches (since 2008), two survey indices of biomass (Norwegian shrimp survey 1984–2002 and 2006–2013), and two fishery indices of biomass (Danish and Norwegian standardized l_{pue}).
Discards and bycatch	Discards are included in the assessment (Norwegian, Danish, and Swedish fleets since 2008).
Indicators	Swedish standardized l_{pue} ; recruitment index from Norwegian shrimp survey.
Other information	A length-based analytical assessment model adopted at the 2013 benchmark meeting was not fully operational for providing advice for the assessments in 2013 and 2014. A surplus production model is used instead.
Working group	Joint NAFO/ICES <i>Pandalus</i> Assessment Working Group (NIPAG).

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Reference points

	Type	Value	Technical basis
MSY approach	MSY B _{trigger}	0.5 B _{MSY} *	Relative value. B _{MSY} is directly estimated from the assessment surplus production model and changes when the assessment is updated.
	F _{MSY}	*	Relative value. F _{MSY} is directly estimated from the assessment surplus production model and changes when the assessment is updated.
Precautionary approach	B _{lim}	0.3 B _{MSY}	Relative value.
	B _{pa}	Not defined.	
	F _{lim}	1.7 F _{MSY}	Relative value (the F that drives the stock to B _{lim}).
	F _{pa}	Not defined.	

(Last changed in: 2013)

* Fishing mortality is estimated only in relation to F_{MSY} and total stock biomass is estimated only in relation to B_{MSY}.

Outlook for 2015

Basis: Median $F_{2014}/F_{MSY} = (\text{catch constraint}) = 0.62$; median $B_{2015} > \text{MSY } B_{\text{trigger}}$; Catches (2014) = 9.5.

Catch options 2015	6	8	10	10.9	12	14	14.8	16
Stock size (B ₂₀₁₆ /B _{MSY}), median	1.19	1.17	1.14	1.14	1.12	1.10	1.08	1.04
Fishing mortality (F ₂₀₁₅ /F _{MSY}), median	0.36	0.49	0.62	0.68	0.76	0.91	1.00	1.10
Probability of B ₂₀₁₆ falling below B _{lim}	1%	1%	1%	1%	1%	1%	1%	1%
Probability of F ₂₀₁₅ exceeding F _{lim}	1%	2%	4%	<5%	7%	12%	14%	20%

Weights in thousand tonnes.

MSY and precautionary considerations

The lack of robustness observed in this year's assessment raises concern about the reliability of an advice based on $F_{2015} = F_{MSY}$ (which would imply catches of no more than 14 800 t). Until more experience is gained concerning the retrospective revisions in this assessment, ICES advises not to increase F compared to the average F of the last three years (2011–2013). A better understanding of the retrospective performance of this assessment should be gained before advice is provided next year, aiming to be able to provide a full application of the MSY approach in next year's advice.

The average F of 2011–2013 corresponds to $F/F_{MSY} = 0.68$ (median value) in 2015, which results in catches of no more than 10 900 t. If discard rates do not change from the average of the last three years (10.3% between 2011 and 2013), this implies landings of no more than 9777 t in 2015.

Additional considerations

As many fish species prey on northern shrimp, predators (e.g. cod and saithe) have a significant effect on its stock dynamics.

Data and methods

A benchmark was finalized for this stock in 2013 (ICES, 2013a) to decide on an appropriate assessment model. The benchmark discussed a length-based model and a surplus production model, which gave generally similar results (except for the last years, when they showed more differences) and were both considered capable of forming the basis for the stock assessment. The length-based model was preferred because it made more use of the available data from the surveys and catches. It was decided that the surplus production model should be run alongside the length-based model, at least initially, to ensure that assessments from the two models are consistent and that differences are noted and the reasons for them understood. However, since the length-based model was not fully operational to provide catch advice last year or this year, only results from the surplus production model are presented this year.

Genetic analyses have shown that shrimp in Skagerrak and the Norwegian Deep form a single stock; this is in agreement with the oceanic current pattern in the area. The benchmark assessment in September 2013 concluded that the northern shrimp in the Skagerrak and Norwegian Deep area can continue to be assessed as a single stock.

Uncertainties in the estimates of discards and highgrading have been reduced following discard data collection in the European Data Collection Framework.

Regulations and their effects

The main regulatory measure is a TAC. Minimum legal mesh size is 35 mm, but an increasing number of shrimp vessels use 45 mm.

Discarding of lower-value shrimp has been documented in both the Danish and Swedish fisheries. There is no data on Norwegian discards. The estimated discards are included in the total catch, and in 2013 amounted to 10% of it.

Sorting grids should be mandatory in all areas to minimize bycatch; such legislation was implemented in the Skagerrak on 1st of February 2013. If quota allows, a fish retention tunnel (120 mm square mesh) is allowed, but in Swedish national waters it is mandatory to use trawls equipped with sorting grids with unblocked fish outlet.

Changes in fishing technology and fishing patterns

The number of Danish shrimp vessels has decreased from 138 in 1987 to only 10 in 2014. Most of the vessels leaving the fishery have been small trawlers. The efficiency of the Danish shrimp vessels has increased due to the introduction of twin-trawl technology and increasing trawl size.

In the Norwegian fleet small vessels < 11 m are the most numerous, as they need no licence to fish.

Since 2006, the number of Swedish vessels using twin trawl has increased from 5 to 23. They have 50–80% higher catch rate than vessels using single trawls.

Comparison of the basis of previous assessment and advice

The basis for the assessment has not changed from last year. Although last year it was planned to follow the benchmark recommendation and use the length-based model this year, the model is not yet fully operational to provide catch advice.

The basis for advice last year was MSY considerations (lower catch advice than the MSY approach to account for the different signals provided by the surplus-production and the length-based assessment models). The advice this year is based only on the results of the surplus-production model. The advice basis is MSY and precautionary considerations, and accounts for the retrospective revision observed in the assessment.

Assessment and management area

This assessment is carried out for the stock in the Norwegian Deep and Skagerrak (Figure 6.3.23.2). TACs in this region are set for Division IIIa (EU and Norwegian share) and for the Norwegian zone of the North Sea south of 62°N.

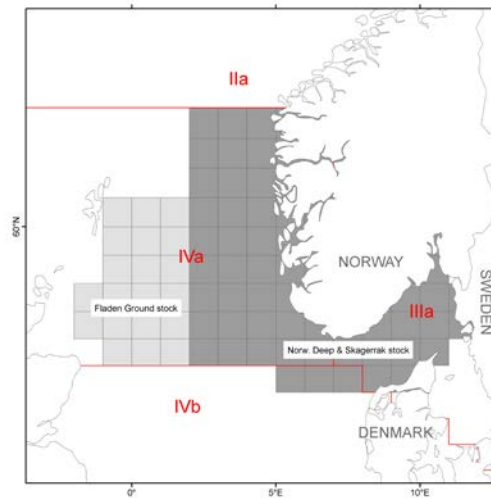


Figure 6.3.23.2 Northern shrimp in Divisions IIIa West and IVa East. Assessment areas in the North Sea and Skagerrak are shown as dark grey. The Fladen Ground stock (light grey) is described in Section 6.3.24.

Sources

- ICES. 2013a. Report of the Inter-Benchmark Protocol on *Pandalus* in Skagerrak and the Norwegian Deep (IBPPand), 12–19 September 2013, Dartmouth, NS, Canada. ICES CM 2013/ACOM:71. 9 pp.
- ICES. 2013b. Report of the Joint NAFO/ICES *Pandalus* Assessment Working Group (NIPAG), 12–19 September 2013, Halifax, Canada. ICES CM 2013/ACOM:14.
- ICES. 2014a. Advice basis. In Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.2.
- ICES. 2014b. Report of the Joint NAFO/ICES *Pandalus* Assessment Working Group (NIPAG), 10–17 September 2014, Nuuk, Greenland. ICES CM 2014/ACOM:14.



Figure 6.3.23.3 Northern shrimp in Divisions IIIa West and IVa East. Recruitment index: abundance of 1-group shrimp from the Norwegian shrimp survey (2006–2014).

Table 6.3.23.1 Northern shrimp in Divisions IIIa West and IVa East. ICES advice, management, discards, landings, and catch. In 2012 it was decided not to use discard estimates prior to 2008.

Year	ICES advice	Predicted landings corresp. to advice	Predicted catch corresp. to advice	TAC Div. IIIa	TAC Norwegian zone Div. IV ^a	Discard estimates	ICES landings	ICES catch (discards and landings)
1987	Not assessed						14.2	
1988	Catches significantly below 1985–1986 ^c						12.2	
1989	No advice			3.1 ^b			11.2	
1990	IIIa: F as F(pre-1985); IVa East: No increase in F	10.0		2.75 ^b			10.2	
1991	No increase in F; TAC	12.0		8.55			11.6	
1992	Within safe biological limits	15 ^c		10.50	4.500		13.1	
1993	Within safe biological limits	13 ^c		10.50	4.500		12.8	
1994	Within safe biological limits	19 ^c		12.60	5.400		11.5	
1995	Within safe biological limits	13 ^c		11.20	4.800		13.4	
1996	No advice	11 ^c		10.50	4.500		14.1	
1997	No advice	13 ^c		10.50	4.500		15.1	
1998	No increase in F; TAC	19 ^c		13.16	5.640		15.5	
1999	Maintain F	19 ^c		13.16	5.640		11.3	
2000	Maintain F	< 11.5 ^c		9.10	3.900		11.0	
2001	Maintain F	13.4		10.15	4.350		11.3	
2002	Long-term average landings	12.6		10.15	4.350		12.5	
2003	Maintain F	14.7		10.15	4.425		13.8	
2004	No increase in F	15.3 ^d		10.71	4.590		16.0	
2005	No increase in catch above recent level	~13 ^d		10.71	4.590		14.2	
2006	No increase in catch above recent level	~13.5 ^d		11.2	4.800		14.3	
2007	No increase in landings above recent level	~14.0 ^d		11.62	4.980		13.6	
2008	No increase in landings above recent level	~15 ^d		11.62	4.980	0.5	13.0	13.6
2009	Same advice as last year	~15 ^d		11.62	4.980	0.5	11.1	11.5
2010	No increase in landings above 2008 level	~13 ^d		9.8	4.200	0.6	7.8	8.3
2011	At least 30% decrease in landings of 2007–2009, reduce discards, mandatory sorting grids	< 8.8		8.3	3.570	0.9	8.2	9.0
2012	Reduce catches and reduce discards	-		7.1	3.035	1.1	7.8	8.8
2013	Reduce landings by 36% and reduce discards	≤ 5.8		6.65	2.850	0.9	8.4	9.3
2014	MSY considerations, reduce discards	≤ 5.426	≤ 6.0	6.65	2.850			
2015	MSY considerations, no increase in F, reduce discards	≤ 9.777	≤ 10.9					

Weights in thousand tonnes.

¹ TACs in the Norwegian zone of Division IVa.

² EU zone only.

³ Catch at *status quo* F.

⁴ Single-stock boundaries and the exploitation of this stock should be conducted in the context of mixed fisheries, protecting stocks outside safe biological limits.

Table 6.3.23.2 Northern shrimp in Divisions IIIa West and IVa East. Official landings in Division IIIa and Subarea IV; ICES estimates of discards and catches (in tonnes); and the TAC (for Division IIIa and the Norwegian zone of Subarea IV). The ICES landings are used in the assessment.

Year	Denmark *)	Norway *)	Sweden *)	Total landings	Estimated Swedish discards	Estimated Norwegian discards	Estimated Danish discards	TAC	Estimated catch
1970	1102	1729	2742	5573					
1971	1190	2486	2906	6582					
1972	1017	2477	2524	6018					
1973	755	2333	2130	5218					
1974	530	1809	2003	4342					
1975	817	2339	2003	5159					
1976	1204	3348	2529	7081					
1977	1120	3004	2019	6143					
1978	1459	2440	1609	5508					
1979	1062	3040	1787	5889					
1980	1678	4562	2159	8399					
1981	2593	5187	2241	10021					
1982	3766	5422	1450	10638					
1983	1804	5370	1136	8310					
1984	1800	4770	1022	7592					
1985	4498	6550	1571	12619					
1986	4866	6492	1463	12821					
1987	4488	8343	1322	14153					
1988	3240	7659	1278	12177					
1989	3242	6574	1433	11249					
1990	2479	6152	1608	10239					
1991	3583	6104	1908	11595					
1992	3725	7202	2154	13081				15000	
1993	2915	7538	2300	12753				15000	
1994	2134	6814	2601	11549				18000	
1995	2460	8019	2882	13361				16000	
1996	3868	7910	2371	14149				15000	
1997	3909	8568	2597	15074				15000	
1998	3330	9704	2469	15504				18800	
1999	2072	6737	2445	11254				18800	
2000	2371	6442	2225	11038				13000	
2001	1954	7266	2108	11328				14500	
2002	2470	7703	2301	12474				14500	
2003	3270	8177	2389	13836				14575	
2004	3944	9544	2464	15952				15300	
2005	2992	8958	2257	14207				15300	
2006	3111	8669	2488	14268				16000	
2007	2422	8685	2445	13552				16600	
2008	2274	8261	2479	13014	540			16600	13554
2009	2224	6364	2483	11071	337	93	41	16600	11542
2010	1301	4672	1781	7754	386	133	60	14000	8333
2011	1601	4801	1768	8170	504	246	129	11870	9049
2012	1454	4796	1521	7771	683	288	92	10135	8834
2013	2026	5162	1191	8379	265	450	185	9500	9279

*) Swedish (all years), Norwegian (since 2000), and Danish (since 2001) landings have been corrected for loss in weight due to boiling.

Table 6.3.23.3

Northern shrimp in Divisions IIIa West and IVa East. Bycatch in the shrimp fishery in 2013. Combined data from Danish and Swedish logbooks and Norwegian landings (tonnes).

Species:	Subdivision IIIa, no grid		Subdivision IIIa, grid		Subdivision IIIa, grid+fish tunnel		Subdivision IVa East, no grid	
	% of total		% of total		% of total		% of total	
	Total (t)	catch	Total (t)	catch	Total (t)	catch	Total (t)	catch
<i>Pandalus</i>	21.8	56.5	540.9	98.3	6029.8	81.5	1170.8	81.3
Norway lobster	0.3	0.8	4.6	0.8	23.0	0.3	6.5	0.5
Anglerfish	0.6	1.6	0.1	0.0	60.7	0.8	33.1	2.3
Whiting	0.1	0.2	0.0	0.0	3.2	0.0	1.1	0.1
Haddock	1.6	4.2	0.1	0.0	48.7	0.7	9.4	0.7
Hake	0.1	0.3	0.0	0.0	10.5	0.1	7.4	0.5
Ling	0.4	1.1	0.0	0.0	50.9	0.7	25.5	1.8
Saithe	8.2	21.3	1.2	0.2	526.3	7.1	83.8	5.8
Witch flounder	0.9	2.2	0.2	0.0	71.3	1.0	0.9	0.1
Norway pout	0.0	0.1	0.2	0.0	2.8	0.0	0.0	0.0
Cod	3.9	10.0	1.3	0.2	393.7	5.3	61.7	4.3
Other market fish	0.6	1.7	1.6	0.3	180.0	2.4	39.2	2.7

Table 6.3.23.4

Northern shrimp in Divisions IIIa West and IVa East. Summary of the assessment. Biomass is relative to B_{MSY} and fishing mortality relative to F_{MSY} . High and low values are the 95% probability intervals of the distribution.

Year	Relative Biomass	Relative High	Relative Low	Landings tonnes	Discards tonnes	Relative Median F	Relative High	Relative Low
1970	1.504	1.999	1.091	5573		0.258	0.429	0.164
1971	1.498	2.053	1.018	6582		0.307	0.542	0.189
1972	1.497	2.065	0.976	6018		0.282	0.518	0.172
1973	1.494	2.070	0.960	5218		0.244	0.460	0.149
1974	1.510	2.088	0.947	4342		0.202	0.384	0.123
1975	1.510	2.092	0.934	5159		0.239	0.463	0.146
1976	1.485	2.062	0.912	7081		0.335	0.651	0.202
1977	1.477	2.066	0.903	6143		0.291	0.572	0.176
1978	1.488	2.084	0.903	5508		0.261	0.507	0.157
1979	1.488	2.059	0.918	5889		0.280	0.534	0.169
1980	1.456	2.034	0.890	8399		0.407	0.782	0.245
1981	1.403	1.975	0.872	10021		0.508	0.938	0.304
1982	1.341	1.874	0.860	10638		0.564	1.018	0.338
1983	1.326	1.716	0.885	8310		0.449	0.777	0.282
1984	1.437	1.884	0.958	7592		0.380	0.655	0.236
1985	1.051	1.355	0.700	12619		0.863	1.490	0.544
1986	1.077	1.326	0.743	12821		0.860	1.444	0.555
1987	0.800	0.992	0.538	14153		1.280	2.185	0.824
1988	0.871	1.076	0.597	12177		1.010	1.703	0.649
1989	1.047	1.288	0.716	11249		0.774	1.310	0.501
1990	1.244	1.528	0.847	10239		0.593	1.005	0.385
1991	1.306	1.600	0.897	11595		0.641	1.077	0.415
1992	1.218	1.494	0.834	13081		0.774	1.311	0.503
1993	1.279	1.568	0.878	12753		0.720	1.220	0.465
1994	1.380	1.686	0.950	11549		0.606	1.024	0.393
1995	1.573	1.916	1.090	13361		0.613	1.028	0.400
1996	1.837	2.225	1.269	14149		0.557	0.929	0.363
1997	1.625	1.979	1.117	15074		0.669	1.121	0.438
1998	1.331	1.626	0.914	15504		0.840	1.415	0.549
1999	1.249	1.506	0.864	11254		0.652	1.098	0.425
2000	1.364	1.650	0.945	11038		0.585	0.977	0.382
2001	1.556	1.873	1.077	11328		0.527	0.882	0.344
2002	1.609	1.946	1.112	12474		0.560	0.939	0.367
2003	1.816	2.194	1.257	13836		0.552	0.922	0.361
2004	1.547	1.862	1.073	15952		0.745	1.244	0.491
2005	1.764	2.109	1.228	14207		0.582	0.971	0.385
2006	2.055	2.392	1.443	14268		0.503	0.834	0.338
2007	1.671	2.012	1.164	13552		0.587	0.981	0.385
2008	1.282	1.552	0.885	13014	540	0.735	1.230	0.480
2009	0.977	1.186	0.673	11071	471	0.830	1.395	0.539
2010	0.927	1.126	0.637	7754	579	0.621	1.050	0.401
2011	0.803	0.980	0.547	8170	879	0.770	1.309	0.497
2012	0.932	1.137	0.636	7771	1063	0.631	1.066	0.408
2013	1.040	1.278	0.709	8379	900	0.628	1.066	0.402
2014	1.096	1.561	0.663					