

ECOREGION **Barents Sea**
STOCK **Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea)**

Advice for 2015

ICES advises on the basis of MSY and precautionary considerations, and considering that the stock has always been exploited far below F_{MSY} , that a catch increase, with total catches not exceeding 70 000 t, would remain precautionary. All catches are assumed to be landed.

Stock status

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

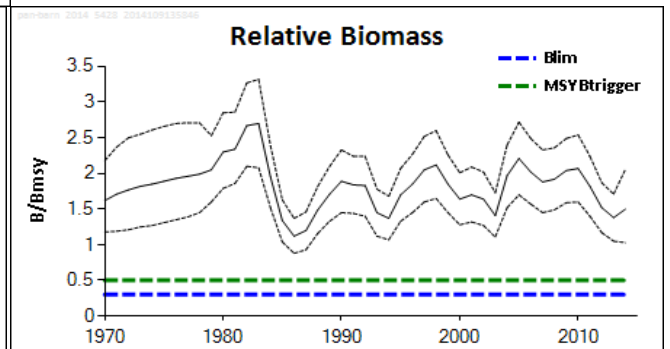
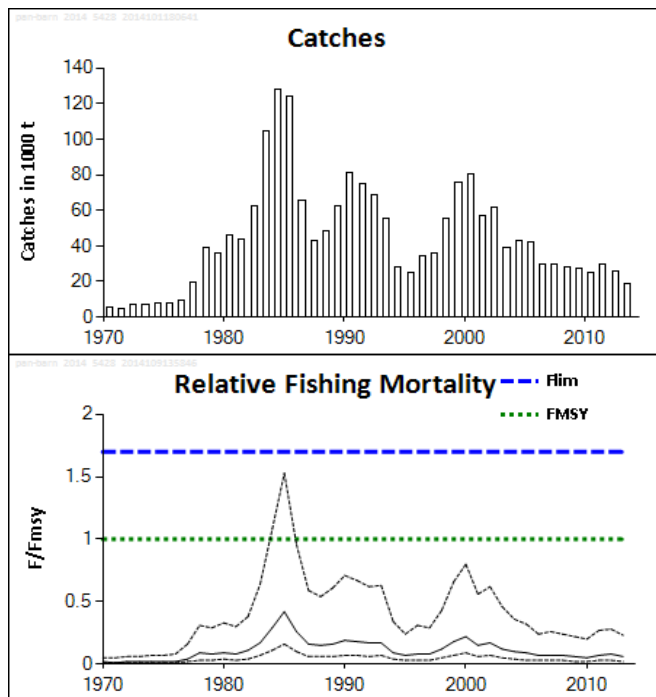
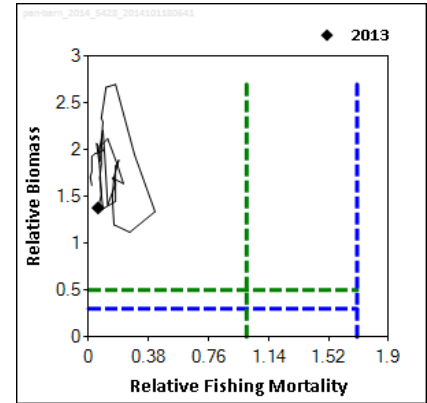


Figure 3.3.9.1 Northern shrimp in Subareas I and II (Barents Sea). Summary of stock assessment. Median estimates of the relative biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}); dashed lines are 95% probability intervals of the distribution. Top right: Fishable biomass and F over the years.

Throughout the history of the fishery, estimates of stock biomass have been far above $MSY B_{trigger}$ and fishing mortality far below F_{MSY} .

Management plans

No specific management objectives are known to ICES.

Biology

Northern shrimp are hermaphroditic. Individuals mature as males, then at 3–4 years of age they change sex and complete their lives as females. Various fish and marine mammal species prey on Northern shrimp, and predation is considered important in influencing Northern shrimp stock dynamics.

The fisheries

Norwegian and Russian vessels exploit the stock over the entire resource area, while vessels from other nations are restricted to the Svalbard fishery zone. No overall TAC has been established for this stock, and the fishery is partly regulated by effort control, licensing, and a partial TAC (Russian zone only). Bycatch is constrained by mandatory sorting grids and by temporary closures of areas where high bycatch occurs of juvenile cod, haddock, Greenland halibut, redfish, or small shrimp (< 15 mm). The minimum mesh size is 35 mm. Catches are lower than the advice, which is considered to be the result of lack of commercial interest in the species.

Catch by fleet	Total catch (2013) = 18.7 kt, where 100% are landings (100% trawl).
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Effects of the fisheries on the ecosystem

Northern shrimp is an important forage species in the Barents Sea ecoregion and ecosystem considerations need to be taken into account in the management of this stock. This may require setting a fishing mortality target lower than F_{MSY} . Small-mesh trawls are used to catch Northern shrimp, with frequent bycatch of juvenile fish. However, overall bycatch is considered to be relatively small owing to the use of sorting grids, which is mandatory, and temporary closures of areas where high bycatch is occurring.

Quality considerations

Input data are considered to be of good quality. The model was able to produce good simulations of the observed data. The results of this assessment are consistent with those of previous years.

Scientific basis

Stock data category	1 (ICES, 2014a).
Assessment type	Bayesian fitting of a surplus-production model.
Input data	Fishery catches. Three survey indices: the Norwegian shrimp survey 1982–2004, the Russian shrimp survey 1984–2005, and the Norwegian–Russian ecosystem survey (Eco-Norw-Q3) 2004–2013; one fishery index (standardized cpue since 1980).
Discards and bycatch	Not included, considered negligible.
Indicators	Length frequencies from survey catches and recruitment index from Norwegian and Russian surveys.
Other information	Current assessment model introduced and approved by the WG in 2006.
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: 2011)

* 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 F₂₀₁₄/F_{MSY} = (catch constraint) = 0.06; median B₂₀₁₅ > MSY B_{trigger}; Catches (2014) = 21.

Catch option 2015	30	50	60	70	90	290
Stock size (B ₂₀₁₆ /B _{MSY}), median	1.65	1.62	1.61	1.59	1.56	1.38
Fishing mortality (F ₂₀₁₅ /F _{MSY}), median	0.08	0.14	0.17	0.20	0.26	1
Probability of B ₂₀₁₆ falling below B _{lim}	0.0%	0.1%	0.1%	0.2%	0.2%	1%
Probability of F ₂₀₁₅ exceeding F _{lim}	1.2%	2.6%	3.4%	4.0%	6.2%	30%

Weights in thousand tonnes.

MSY and precautionary considerations

The stock is well above MSY B_{trigger} and has always been exploited far below F_{MSY}. Catches following the ICES MSY approach (fishing mortality at F_{MSY}, which would imply catches of no more than 290 000 t in 2015) would constitute a very large extrapolation from the regions covered by past data on catches. This would bring the stock in a region not seen in the history of the fishery, and the assessment model may not be robust to forecast stock dynamics under such circumstances.

An increase in annual catch to 70 000 t would move stock exploitation in the direction of F_{MSY}. This corresponds to a three-fold increase with respect to recent exploitation (fishing mortality), while waiting for a better understanding of the stock dynamics at an exploitation level not observed since the mid-1980s. A catch of 70 000 t in 2015 is forecast to result in less than 5% probability of F₂₀₁₅ exceeding F_{lim} or of B₂₀₁₆ falling below B_{lim}. All catches are assumed to be landed.

Precautionary approach

There is a less than 5% risk of the stock falling below B_{lim} in 2016 or of the fishing mortality exceeding F_{lim} in 2015 at catch options up to 70 000 t.

Additional considerations*Environmental considerations*

Cod has been documented as consuming large amounts of Northern shrimp, and the cod stock in the Barents Sea has increased considerably within the last ten years. If there are changes in predation, particularly by cod, it is likely that Northern shrimp stock dynamics will undergo large changes and the rate of change in stock size may be affected. However, as the total predation on shrimp depends on the abundance of both cod and Northern shrimp, as well as other possible prey, the effect of predation on the shrimp stock has been difficult to quantify. Continuing investigations to include cod predation explicitly in the shrimp assessment model have so far not been successful.

Temperatures in the Barents Sea have been high since 2004, largely due to increased inflow of warm water from the Norwegian Sea. An increase from 2011 to 2012 was observed in near-bottom temperatures primarily in the north and northwestern parts of the Barents Sea, but also in the southwest where temperatures at the bottom were the highest on record since 1951. Shrimps are mainly caught in areas where bottom temperatures are above 0°C. Highest densities are observed between 0 and 4°C; the upper limit of their preferred temperature range appears to lie at about 6–8°C. An eastward shift in shrimp distribution in recent years might be associated with changes in temperature.

Regulations and their effects

There is no overall TAC established for this stock, and the fishery is partly regulated by effort control, licensing, and a partial TAC (Russian zone only). Bycatch is constrained by mandatory sorting grids and by temporary closures of areas having a high bycatch of juvenile cod, haddock, Greenland halibut, redfish, or small shrimp (< 15 mm). The minimum stretched mesh size is 35 mm.

Changes in fishing technology and fishing patterns

A major restructuring of the fleet toward fewer and larger vessels has taken place since the mid-1990s. Since 1995, the average engine size of a shrimp vessel in Subareas I and II has increased from 1000 HP to more than 6000 HP in the early 2010s, and the number of vessels has markedly declined. Overall catches have decreased since 2000 (Figure 3.3.9.1).

Uncertainties in assessment and forecast

The 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. Large changes have not been observed in the recent period (2004–2014). If predation on Northern shrimp were to increase rapidly outside the range in the modelled period (1970–2012), the stock size might change more than the modelling results indicate. The mechanisms behind the unexpected lack of correlation between the stock dynamics of Northern shrimp and the biomass of cod remain under investigation.

Comparison of the basis of previous assessment and advice

The basis for the assessment has not changed from last year. The basis for the advice is MSY and precautionary considerations, taking into account that the stock has always been exploited far below F_{MSY} .

Sources

- ICES. 2012a. Report of the Joint NAFO/ICES *Pandalus* Assessment Working Group (NIPAG), 17–24 October 2012, Tromsø, Norway. ICES CM 2012/ACOM:14.
- ICES. 2012b. Report of the Arctic Fisheries Working Group, 20–26 April 2012, ICES Headquarters. ICES CM 2012/ACOM:05. 648 pp.
- 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.

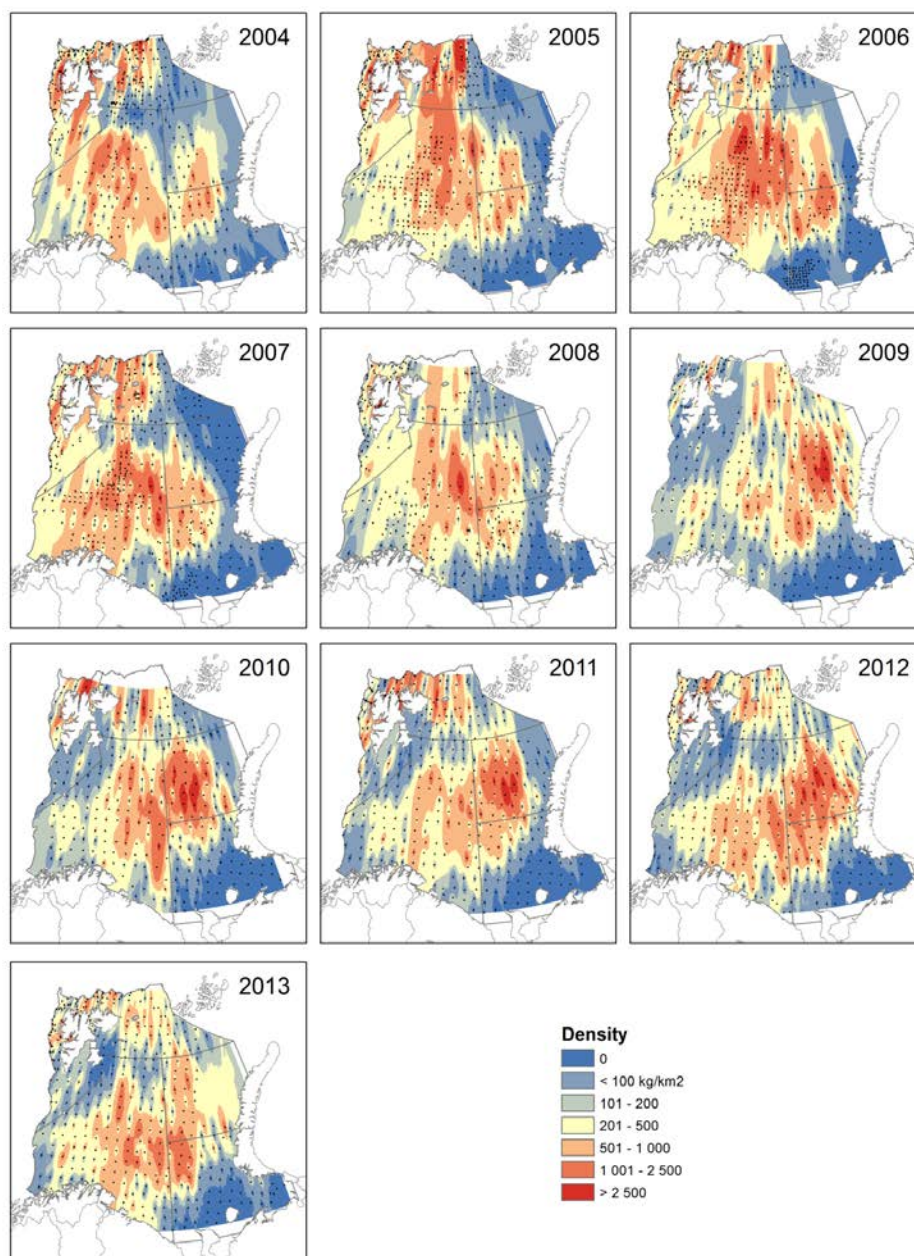


Figure 3.3.9.2 Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). Stock distribution mean survey catch rate (kg km^{-2}), 2004–2013.



Figure 3.3.9.3 Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). Recruitment index (sizes 13–16 mm CL) from Norwegian and Russian surveys.

Table 3.3.9.1 Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). Advice, management, and landings.

Year	ICES advice / Single-stock exploitation boundaries	Predicted landings corresp. to single-stock exploitation boundaries	Agreed TAC	ICES landings
2005	No increase compared to 2004	43.6	-	42.6
2006	No increase in catch above recent level	40	-	29.6
2007	Catch that will prevent exceeding F_{lim} in the long term	50	-	29.9
2008	Catch that will prevent exceeding F_{lim} in the long term	50	-	28.2
2009	Catch that will prevent exceeding F_{lim} in the long term	50	-	27.3
2010	Catch that will prevent exceeding F_{lim} in the long term	50	-	25.2
2011	Catch that will prevent exceeding F_{MSY} in the long term	60	-	29.8
2012	Catch that will prevent exceeding F_{MSY} in the long term	60	-	20.0
2013	Catch that will maintain stock at current high biomass	60	-	18.7
2014	No new advice, same as for 2013	60	-	
2015	Move exploitation towards F_{MSY}	< 70		

Weights in thousand tonnes.

Table 3.3.9.2

Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). Catch by the fishery and four indices of fishable biomass: cpue: standardized catch rate index based on fishery data, Survey 1: Norwegian research survey index (discontinued in 2004), Survey 2: Russian survey index (discontinued in 2005), and Survey 3: current Joint Russian–Norwegian survey since 2004.

Year	Catch (ktonnes)	Cpue (index)	Survey 1 (ktonnes)	Survey 2 (ktonnes)	Survey 3 (ktonnes)
1970	5.5	-	-	-	-
1971	5.1	-	-	-	-
1972	6.8	-	-	-	-
1973	6.9	-	-	-	-
1974	8.0	-	-	-	-
1975	8.2	-	-	-	-
1976	9.8	-	-	-	-
1977	19.6	-	-	-	-
1978	38.9	-	-	-	-
1979	36.3	-	-	-	-
1980	46.3	1.000	-	-	-
1981	43.6	1.195	-	-	-
1982	62.8	1.150	327	-	-
1983	104.8	1.306	429	-	-
1984	128.1	1.382	471	661	-
1985	124.5	1.145	246	468	-
1986	65.3	0.677	166	399	-
1987	43.4	0.533	146	346	-
1988	48.7	0.573	181	233	-
1989	62.7	0.721	216	603	-
1990	81.2	0.736	262	1028	-
1991	75.3	0.778	321	1192	-
1992	68.6	0.903	239	876	-
1993	55.9	0.974	233	892	-
1994	28.3	0.800	161	404	-
1995	25.2	0.669	193	248	-
1996	34.5	0.838	276	441	-
1997	35.7	0.799	300	765	-
1998	55.8	0.969	341	576	-
1999	75.7	1.020	316	966	-
2000	80.7	0.902	247	800	-
2001	57.3	0.909	184	468	-
2002	61.5	0.896	196	980	-
2003	39.2	0.879	212	-	-
2004	42.7	0.751	151	-	261
2005	42.6	1.037	-	656	446
2006	29.6	1.133	-	-	517
2007	29.9	1.019	-	-	426
2008	28.2	1.040	-	-	317
2009	27.3	1.053	-	-	343
2010	25.2	0.986	-	-	482
2011	29.8	1.093	-	-	442
2012	25.5	0.813	-	-	487
2013	18.7	0.635	-	-	413

Table 3.3.9.3

Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). ICES catches (thousand tonnes). Others are EU countries (Portugal, Spain, Great Britain, Lithuania, Estonia), Iceland, Faroes, and Greenland.

Year	Norway	Russia	Others	Total
1970	5.508	0	0	5.508
1971	5.116	0	0.026	5.142
1972	6.772	0	0	6.772
1973	6.921	0	0	6.921
1974	8.008	0	0	8.008
1975	8.197	0	0.002	8.199
1976	9.752	0	0	9.752
1977	14.700	0	4.854	19.554
1978	20.484	18.27	0.189	38.943
1979	25.435	10.474	0.39	36.299
1980	35.061	11.219	0	46.280
1981	32.713	9.886	1.011	43.610
1982	43.451	15.552	3.835	62.838
1983	70.798	29.105	4.903	104.806
1984	76.636	43.180	8.246	128.062
1985	82.123	32.104	10.262	124.489
1986	48.569	10.216	6.538	65.323
1987	31.353	6.690	5.324	43.367
1988	32.021	12.32	4.348	48.689
1989	47.064	12.252	3.432	62.748
1990	54.182	20.295	6.687	81.164
1991	39.663	29.434	6.156	75.253
1992	39.657	20.944	8.021	68.622
1993	32.663	22.397	0.806	55.866
1994	20.162	7.108	1.063	28.333
1995	19.337	3.564	2.319	25.220
1996	25.445	5.747	3.320	34.512
1997	29.079	1.493	5.163	35.735
1998	44.792	4.895	6.103	55.790
1999	52.612	10.765	12.293	75.670
2000	55.333	19.596	5.768	80.697
2001	43.031	5.846	8.408	57.285
2002	48.799	3.790	8.899	61.488
2003	34.172	2.776	2.277	39.225
2004	35.918	2.410	4.406	42.734
2005	37.253	0.435	4.930	42.618
2006	27.352	0.004	2.271	29.627
2007	25.558	0.192	4.181	29.931
2008	20.662	0.417	7.109	28.188
2009	19.784	0.000	7.488	27.272
2010	16.779	0.000	8.419	25.198
2011	19.923	0.000	9.867	29.790
2012	15.208	0.000	10.304	25.512
2013	8.845	1.067	8.774	18.686
2014	10.000	2.000	9.000	21.000

Table 3.3.9.4

Northern shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea). 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	High	Low	Total catch	Relative fishing mortality	High	Low
				tonnes			
1970	1.620	2.180	1.180	5508	0.02	0.05	0.01
1971	1.710	2.370	1.190	5142	0.01	0.05	0.01
1972	1.770	2.500	1.210	6772	0.02	0.06	0.01
1973	1.820	2.550	1.250	6921	0.02	0.06	0.01
1974	1.850	2.610	1.270	8008	0.02	0.07	0.01
1975	1.890	2.660	1.310	8199	0.02	0.07	0.01
1976	1.930	2.700	1.350	9752	0.02	0.08	0.01
1977	1.960	2.710	1.390	19554	0.04	0.16	0.02
1978	1.990	2.710	1.450	38943	0.09	0.31	0.03
1979	2.050	2.530	1.600	36299	0.08	0.29	0.03
1980	2.300	2.850	1.790	46280	0.09	0.33	0.04
1981	2.340	2.860	1.860	43610	0.08	0.3	0.03
1982	2.670	3.270	2.100	62838	0.11	0.38	0.04
1983	2.700	3.320	2.080	104806	0.17	0.64	0.07
1984	1.950	2.390	1.520	128062	0.29	1.08	0.11
1985	1.340	1.630	1.040	124489	0.42	1.53	0.16
1986	1.120	1.370	0.880	65323	0.26	0.96	0.1
1987	1.200	1.460	0.930	43367	0.16	0.59	0.06
1988	1.490	1.820	1.160	48689	0.15	0.54	0.06
1989	1.710	2.100	1.330	62748	0.16	0.61	0.06
1990	1.890	2.330	1.450	81164	0.19	0.71	0.07
1991	1.840	2.240	1.440	75253	0.18	0.67	0.07
1992	1.830	2.240	1.400	68622	0.17	0.62	0.06
1993	1.450	1.780	1.120	55866	0.17	0.63	0.07
1994	1.370	1.680	1.070	28333	0.09	0.34	0.04
1995	1.700	2.070	1.330	25220	0.07	0.24	0.03
1996	1.850	2.270	1.450	34512	0.08	0.31	0.03
1997	2.050	2.520	1.600	35735	0.08	0.29	0.03
1998	2.120	2.600	1.650	55790	0.12	0.43	0.05
1999	1.850	2.260	1.450	75670	0.18	0.66	0.07
2000	1.640	2.010	1.280	80697	0.22	0.8	0.09
2001	1.700	2.090	1.320	57285	0.15	0.56	0.06
2002	1.640	2.020	1.270	61488	0.17	0.62	0.07
2003	1.410	1.730	1.110	39225	0.12	0.46	0.05
2004	1.970	2.400	1.520	42734	0.1	0.36	0.04
2005	2.210	2.720	1.700	42618	0.09	0.32	0.03
2006	2.020	2.490	1.570	29627	0.07	0.24	0.03
2007	1.880	2.330	1.450	29931	0.07	0.26	0.03
2008	1.920	2.360	1.490	28188	0.07	0.24	0.03
2009	2.040	2.490	1.590	27272	0.06	0.22	0.02
2010	2.070	2.540	1.600	25198	0.05	0.2	0.02
2011	1.820	2.240	1.400	29790	0.07	0.27	0.03
2012	1.520	1.870	1.170	25512	0.08	0.28	0.03
2013	1.380	1.710	1.050	18686	0.06	0.23	0.02
2014	1.500	2.060	1.030				
Average	1.824	2.303	1.387	44312	0.112	0.412	0.044