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# RECONSTRUCTION OF FISHERIES CATCHES FOR BOSNIA-HERZEGOVINA: 1950-2010

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## ABSTRACT

The total marine catches made by Bosnian fisheries between 1950 and 2010 were estimated by using officially reported landings as baseline data, including landings reported by the former Yugoslavia that were disaggregated to each member of the former Yugoslavia. The total reconstructed catches were assigned to different fisheries sectors (i.e., artisanal, subsistence, and recreational) by catch type (i.e., reported landings, discards, or unreported catches) by taxon. The total reconstructed marine catches between 1950 and 2010 made by Bosnian fisheries were estimated at around 3,200 t, which is approximately 35 times the 92 t of official landings reported by the FAO on behalf of Bosnia-Herzegovina (including re-allocated former Yugoslavian catches). The majority of the reconstructed unreported catches were attributable to the subsistence sector. Evidently, current methods of accounting for catch in Bosnian fisheries are insufficient to properly assess marine resource use in Bosnian waters and may lead to misinformation when considering fishing and environmental policies, especially in light of Bosnia-Herzegovina's future prospects for EU membership.

## INTRODUCTION

Bosnia and Herzegovina is a country located in Southeastern Europe on the Balkan Peninsula, and is considered an upper-middle income country (http://www.worldbank.org). It is currently a candidate for membership in the European Union, but has historically experienced many changes in politics. During the late 12$^{th}$ century, Bosnia established a monarchy that lasted until 1463 when it came under Ottoman occupation. Ottoman rule marked a period of drastic social changes including in politics, the ethnic composition of the population, and religious views. In 1878, Bosnia and Herzegovina came under Austro-Hungarian rule. Following WWI, the country joined the Kingdom of Yugoslavia. Bosnia and Herzegovina was occupied by Germany during WWII, and became part of the Socialist Federative Republic of Yugoslavia after WWII until the dissolution of Yugoslavia in 1992. The breakup of Yugoslavia triggered social tensions within Bosnia and Herzegovina, which eventually led to the Bosnian war from 1992 to 1995.

Bosnia is almost entirely landlocked, except for a very narrow coastal stretch around the town of Neum. Its potential Exclusive Economic Zone is only 14 km$^2$ (http://www.seaaroundus.org; Figure 1). Despite its short coastline, Bosnia and Herzegovina still engages in fishing activities. As countries have been repeatedly shown to underreport catches (eg., Zeller *et al.*2007; Wielgus *et al.* 2010; Harper and Zeller 2011; Zeller *et al.* 2011a; Zeller *et al.* 2011b; Harper *et al.* 2012; Le Manach *et al.* 2012), this study aims to estimate the actual catch being taken from Bosnian waters from 1950 to 2010.

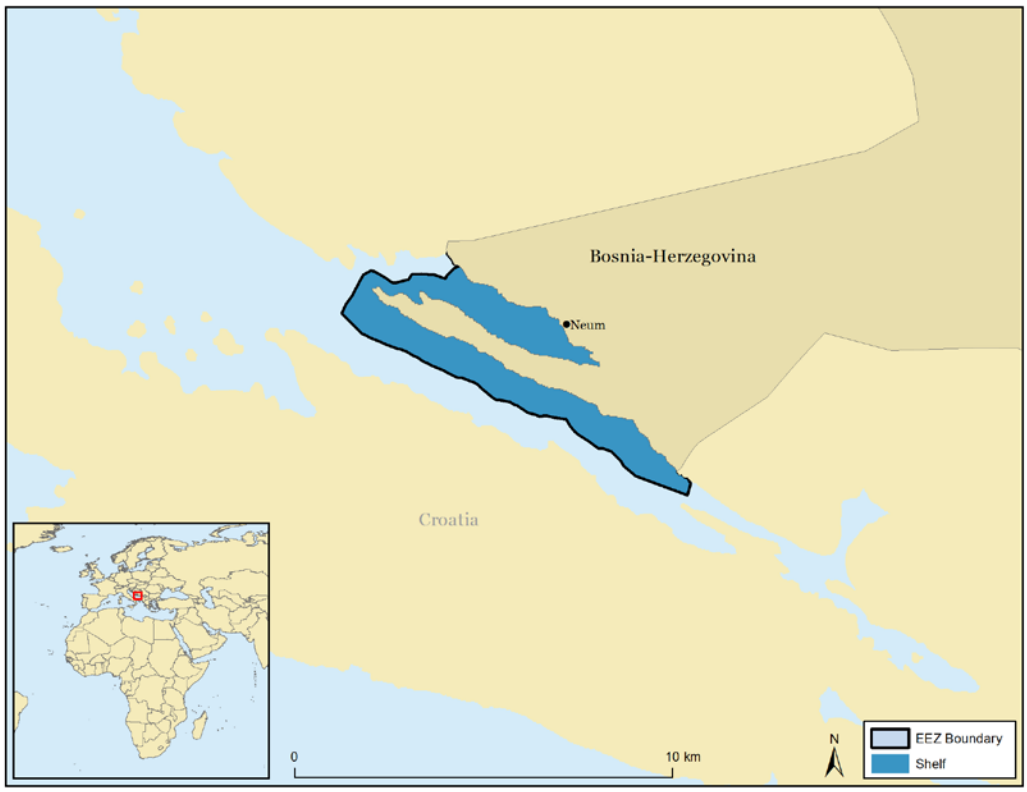


**Figure 1.** Coastal area of Bosnia-Herzegovina showing EEZ and shelf areas.

## METHODS

To reconstruct marine catches made by Bosnian fisheries between 1950 and 2010, officially reported landings data from the FAO were used as baseline data. Since landings from 1950 to 1991 were reported as catches made by the former Yugoslavia, tonnages attributable to only Bosnia were first disaggregated by Rizzo and Zeller (2007). Furthermore, between 1992 and 2010, landings reported by the FAO were all labeled as the very uninformative category 'marine fishes nei.' Therefore, to increase taxonomic resolution for these years, the species composition from 1991 was applied to the reported tonnages and assumed to have remained identical for subsequent years up to 2010.

The reported landings for Bosnia were assumed to have all been made by the artisanal (i.e., small-scale, commercial) fishing sector and that Bosnia does not have a large-scale, industrial fishing sector. Thus, the taxonomic breakdown of artisanal landings was entirely based on the species composition reported by the FAO. Since we could not find any clear and readily available information on recent Bosnian fisheries, we relied heavily on a detailed catch reconstruction conducted for neighbouring Croatia (Matić-Skoko *et al.*, in press). To estimate unreported catches for the Bosnian artisanal fisheries, the ratio between reported landings and unreported artisanal catches in Croatia between 1950 and 2010 (Matić-Skoko *et al.*, in press) was reduced by half and applied to the baseline data. We used half the Croatian rate, since Bosnia has less fishable area and fewer landings sites that could facilitate under- or misreporting. Discards for the artisanal fisheries were estimated by also using

discard rates for Croatian artisanal fisheries (Matić-Skoko *et al.*, in press). The taxonomic composition of discards in Bosnia was assumed to be identical to the discarded demersal taxa in Croatia, and was used at the family level.

Subsistence and recreational catches made in Bosnia between 1950 and 2010 were estimated by applying half the per capita catch rate of coastal populations in Croatia to the number of coastal inhabitants in Bosnia. For the purpose of this study, areas within 10 km of the coast were considered coastal. Coastal population data for Bosnia were obtained for 1990, 2000, and 2010 from CIESIN (2012), and estimated for years prior to 1990 as the 1990 percentage of coastal to total Bosnian population, while intervening years were interpolated. For 1950 to 1959, total population data were taken from PopulStat (http://www.populstat.info/). For 1960 to 2010, population data was taken from The World Bank (http://www.worldbank.org/). All subsistence and recreational catches were assigned to family level taxa based on the taxonomic composition found in Croatia.

**RESULTS/DISCUSSION**

The total reconstructed marine catches made by Bosnian fisheries were 3,230 t between 1950 and 2010, which was around 35 times the 92 t officially reported by the FAO on behalf of Bosnia (Figure 2a). Total catches increased from around 23 t·year$^{-1}$ in the 1950s to a peak of 79 t in the 1990. Following a decline during the conflict years, catches increased again to around 82 t in 2002 and have been steadily declining since to reach 73 t by 2010 (Figure 2a).

The subsistence (i.e., non-commercial) sector accounted for the largest component (72%) of total time series catches, and were all deemed unreported, while unreported recreational (19%) and reported and unreported artisanal landings (3% and 4%, respectively) catches contributed considerably less (Figure 2).

Discarding accounted for 46 t over the 1950-2010 time period, and thus contributed approximately 1% to total estimated catches (Figure 2a).

Members of the family Clupeidae constituted the majority of Bosnian catches at 1,800 t or 56% of total catch between 1950 and 2010, with 4% being contributed by *Sardina pilchardus* (Figure 2b). Catches of Engraulidae came to 320 t which is equivalent to 10% of total catch. Scombridae catches were just under 140 t (%) and Centracanthidae contributed almost 80 t (2%). With the exception of *S. pilchardus* which is caught by artisanal fishers, the majority of the above catches are made within the subsistence sector.

This study suggests that total catches made by Bosnian fisheries may be much higher than landings officially reported by the country suggest. Thus, current record keeping methods and regulations may not be sufficient to account for all extractive use of marine resources in Bosnian waters. Under-reporting may misguide decisions when creating new fishing or environmental policies. Therefore, more inclusive and comprehensive methods for tracking fishing practices are recommended, particularly given Bosnia's aspirations for EU membership. As a first step, we suggest local experts repeat the present exercise using local data and information, as suggested by Pauly (1998) and Zeller *et al.* (2007).

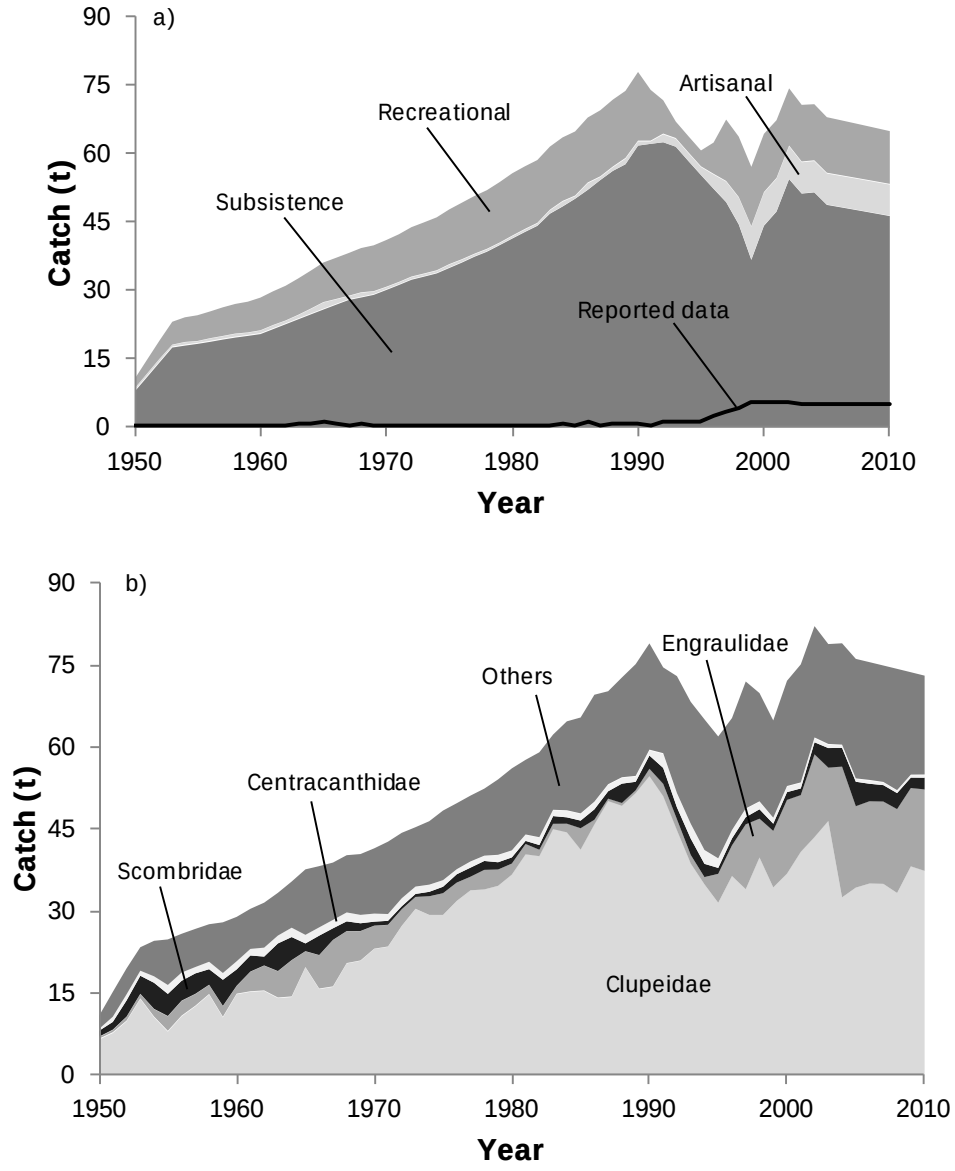


**Figure 2.** Total reconstructed catches for Bosnia-Herzegovina for 1950-2010 a) by fishing sectors plus discards, with data officially reported or allocated to Bosnia by Rizzo and Zeller (2007) overlaid as line graph; and b) by major taxa, with 'others' representing 36 taxa with lesser contributions.

**ACKNOWLEDGEMENTS**

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**Appendix Table A1.** FAO landings[a] vs. total reconstructed catch (in tonnes), and catch by sector, for Bosnia-Herzegovina, 1950-2010.

| Year | FAO landings[a] | Total reconstructed catch | Artisanal | Subsistence | Recreational |
|---|---|---|---|---|---|
| 1950 | 0.27 | 10.3 | 0.4 | 7.9 | 2.1 |
| 1951 | 0.33 | 14.6 | 0.5 | 11.1 | 3.1 |
| 1952 | 0.36 | 18.8 | 0.5 | 14.3 | 4.0 |
| 1953 | 0.24 | 22.9 | 0.3 | 17.5 | 5.0 |
| 1954 | 0.36 | 23.9 | 0.5 | 18.0 | 5.4 |
| 1955 | 0.24 | 24.3 | 0.3 | 18.3 | 5.7 |
| 1956 | 0.36 | 25.1 | 0.5 | 18.8 | 5.9 |
| 1957 | 0.36 | 26.0 | 0.5 | 19.3 | 6.3 |
| 1958 | 0.42 | 26.8 | 0.6 | 19.7 | 6.5 |
| 1959 | 0.33 | 27.3 | 0.5 | 20.1 | 6.8 |
| 1960 | 0.39 | 28.2 | 0.5 | 20.5 | 7.2 |
| 1961 | 0.45 | 29.6 | 0.6 | 21.6 | 7.4 |
| 1962 | 0.39 | 30.8 | 0.5 | 22.6 | 7.6 |
| 1963 | 0.51 | 32.4 | 0.7 | 23.7 | 8.0 |
| 1964 | 0.72 | 34.1 | 1.0 | 24.8 | 8.3 |
| 1965 | 0.99 | 35.9 | 1.4 | 25.9 | 8.7 |
| 1966 | 0.72 | 36.9 | 1.0 | 26.9 | 9.0 |
| 1967 | 0.48 | 38.0 | 0.7 | 27.9 | 9.4 |
| 1968 | 0.63 | 39.1 | 0.9 | 28.5 | 9.7 |
| 1969 | 0.39 | 39.7 | 0.5 | 29.1 | 10.1 |
| 1970 | 0.32 | 40.8 | 0.4 | 30.1 | 10.3 |
| 1971 | 0.29 | 42.1 | 0.4 | 31.2 | 10.5 |
| 1972 | 0.32 | 43.7 | 0.4 | 32.4 | 10.8 |
| 1973 | 0.31 | 44.7 | 0.4 | 33.1 | 11.2 |
| 1974 | 0.31 | 45.8 | 0.4 | 33.8 | 11.6 |
| 1975 | 0.43 | 47.6 | 0.6 | 35.0 | 12.0 |
| 1976 | 0.35 | 49.0 | 0.5 | 36.1 | 12.4 |
| 1977 | 0.30 | 50.5 | 0.4 | 37.4 | 12.7 |
| 1978 | 0.29 | 51.8 | 0.4 | 38.5 | 12.9 |
| 1979 | 0.24 | 53.6 | 0.3 | 40.0 | 13.3 |
| 1980 | 0.30 | 55.5 | 0.4 | 41.4 | 13.7 |
| 1981 | 0.32 | 57.0 | 0.4 | 42.8 | 13.8 |
| 1982 | 0.31 | 58.4 | 0.4 | 44.2 | 13.8 |
| 1983 | 0.48 | 61.4 | 0.7 | 46.9 | 13.9 |
| 1984 | 0.73 | 63.4 | 1.0 | 48.4 | 14.0 |
| 1985 | 0.36 | 64.7 | 0.5 | 50.1 | 14.1 |
| 1986 | 1.03 | 67.8 | 1.4 | 52.1 | 14.3 |
| 1987 | 0.45 | 69.4 | 0.6 | 54.2 | 14.5 |
| 1988 | 0.55 | 71.7 | 0.8 | 56.3 | 14.7 |
| 1989 | 0.87 | 73.6 | 1.2 | 57.7 | 14.7 |
| 1990 | 0.65 | 77.8 | 0.9 | 61.8 | 15.1 |
| 1991 | 0.37 | 73.8 | 0.5 | 62.2 | 11.1 |
| 1992 | 1.25 | 71.6 | 1.7 | 62.5 | 7.3 |
| 1993 | 1.25 | 66.9 | 1.7 | 61.6 | 3.6 |
| 1994 | 1.25 | 63.7 | 1.7 | 58.4 | 3.5 |
| 1995 | 1.25 | 60.5 | 1.7 | 55.3 | 3.5 |
| 1996 | 2.25 | 62.3 | 3.1 | 52.3 | 6.9 |
| 1997 | 3.25 | 67.3 | 4.4 | 49.4 | 13.5 |
| 1998 | 4.25 | 63.6 | 5.8 | 44.5 | 13.2 |
| 1999 | 5.25 | 56.9 | 7.2 | 36.7 | 13.0 |
| 2000 | 5.25 | 64.2 | 7.2 | 44.2 | 12.8 |
| 2001 | 5.25 | 67.2 | 7.2 | 47.3 | 12.7 |
| 2002 | 5.25 | 74.2 | 7.2 | 54.4 | 12.6 |
| 2003 | 5.00 | 70.5 | 6.8 | 51.3 | 12.4 |
| 2004 | 5.00 | 70.7 | 6.8 | 51.5 | 12.3 |
| 2005 | 5.00 | 67.8 | 6.8 | 48.8 | 12.2 |
| 2006 | 5.00 | 67.2 | 6.8 | 48.3 | 12.1 |
| 2007 | 5.00 | 66.6 | 6.8 | 47.8 | 12.0 |
| 2008 | 5.00 | 66.0 | 6.8 | 47.3 | 11.8 |
| 2009 | 5.00 | 65.4 | 6.8 | 46.9 | 11.7 |
| 2010 | 5.00 | 64.8 | 6.8 | 46.4 | 11.6 |

[a] FAO landings are reported by Bosnia for 1992-2010. Reported catch for 1950-1991 has been disaggregated from the Former Yugoslavia FAO data.

**Appendix Table A2.** Reconstructed total catch (in tonnes) by major taxonomic groups for Bosnia-Herzegovina, 1950 to 2010. 'Others' represents 36 additional minor taxa.

| Year | Clupeidae | Engraulidae | Scombridae | Centracanthidae | Others |
|---|---|---|---|---|---|
| 1950 | 6.5 | 0.3 | 1.1 | 0.5 | 2.4 |
| 1951 | 7.7 | 0.4 | 1.4 | 1.1 | 4.5 |
| 1952 | 9.8 | 0.7 | 3.0 | 1.2 | 4.7 |
| 1953 | 13.9 | 0.8 | 3.3 | 1.0 | 4.3 |
| 1954 | 10.6 | 1.3 | 4.8 | 1.3 | 6.5 |
| 1955 | 8.0 | 2.6 | 4.1 | 1.7 | 8.3 |
| 1956 | 10.7 | 2.7 | 3.7 | 1.6 | 7.1 |
| 1957 | 12.6 | 2.1 | 3.8 | 1.2 | 7.0 |
| 1958 | 14.7 | 1.6 | 2.9 | 1.4 | 6.9 |
| 1959 | 10.5 | 1.9 | 4.8 | 1.3 | 9.3 |
| 1960 | 14.8 | 1.4 | 3.0 | 1.6 | 8.1 |
| 1961 | 15.2 | 3.6 | 3.0 | 1.2 | 7.3 |
| 1962 | 15.4 | 4.5 | 1.6 | 1.7 | 8.2 |
| 1963 | 14.1 | 4.8 | 5.1 | 1.5 | 7.8 |
| 1964 | 14.3 | 6.6 | 4.2 | 1.7 | 8.4 |
| 1965 | 19.6 | 2.9 | 1.4 | 1.6 | 12.0 |
| 1966 | 15.7 | 6.1 | 3.6 | 1.5 | 11.2 |
| 1967 | 16.1 | 8.5 | 2.1 | 1.5 | 10.5 |
| 1968 | 20.4 | 5.8 | 1.8 | 1.6 | 10.5 |
| 1969 | 20.8 | 5.4 | 1.4 | 1.5 | 11.1 |
| 1970 | 23.0 | 4.2 | 0.7 | 1.5 | 11.9 |
| 1971 | 23.4 | 4.0 | 0.7 | 1.3 | 13.2 |
| 1972 | 27.2 | 3.0 | 0.6 | 1.4 | 12.0 |
| 1973 | 30.3 | 2.2 | 0.5 | 1.3 | 10.9 |
| 1974 | 29.2 | 3.4 | 0.8 | 1.3 | 11.6 |
| 1975 | 29.2 | 4.0 | 1.2 | 1.2 | 12.7 |
| 1976 | 31.8 | 3.4 | 1.5 | 0.9 | 12.1 |
| 1977 | 33.7 | 2.5 | 1.7 | 1.1 | 12.0 |
| 1978 | 33.9 | 3.6 | 1.6 | 0.9 | 12.3 |
| 1979 | 34.5 | 3.0 | 1.3 | 1.3 | 13.8 |
| 1980 | 36.6 | 2.0 | 1.1 | 1.2 | 15.0 |
| 1981 | 40.3 | 1.9 | 0.6 | 1.1 | 13.7 |
| 1982 | 40.0 | 1.2 | 0.9 | 1.4 | 15.5 |
| 1983 | 44.9 | 1.0 | 1.4 | 1.1 | 13.8 |
| 1984 | 44.3 | 1.6 | 1.2 | 1.2 | 16.3 |
| 1985 | 41.2 | 3.9 | 1.4 | 1.2 | 17.5 |
| 1986 | 45.8 | 0.9 | 1.9 | 1.3 | 19.6 |
| 1987 | 50.1 | 0.5 | 1.4 | 1.2 | 17.0 |
| 1988 | 49.2 | 0.6 | 3.6 | 1.0 | 18.2 |
| 1989 | 51.6 | 0.6 | 1.6 | 0.9 | 20.4 |
| 1990 | 54.7 | 1.4 | 2.4 | 0.9 | 19.4 |
| 1991 | 51.0 | 2.3 | 2.9 | 2.5 | 15.7 |
| 1992 | 44.7 | 2.0 | 2.2 | 2.5 | 21.4 |
| 1993 | 38.6 | 1.6 | 3.0 | 2.6 | 22.3 |
| 1994 | 34.8 | 1.3 | 2.4 | 2.5 | 23.9 |
| 1995 | 31.4 | 5.3 | 1.1 | 1.7 | 22.3 |
| 1996 | 36.3 | 5.6 | 1.3 | 1.4 | 20.5 |
| 1997 | 33.9 | 11.9 | 1.3 | 1.5 | 23.2 |
| 1998 | 39.7 | 7.1 | 1.7 | 1.3 | 19.8 |
| 1999 | 34.2 | 10.4 | 1.3 | 1.0 | 17.8 |
| 2000 | 36.8 | 13.6 | 1.4 | 1.0 | 19.2 |
| 2001 | 40.8 | 10.5 | 1.2 | 1.0 | 21.6 |
| 2002 | 43.5 | 15.2 | 2.2 | 0.7 | 20.4 |
| 2003 | 46.4 | 9.8 | 3.6 | 0.6 | 18.3 |
| 2004 | 32.4 | 24.0 | 3.4 | 0.4 | 18.5 |
| 2005 | 34.2 | 15.0 | 4.5 | 0.5 | 21.9 |
| 2006 | 35.0 | 15.1 | 3.2 | 0.6 | 21.5 |
| 2007 | 34.9 | 15.1 | 3.0 | 0.4 | 21.3 |
| 2008 | 33.2 | 15.4 | 2.9 | 0.4 | 22.2 |
| 2009 | 38.1 | 14.4 | 1.9 | 0.4 | 18.7 |
| 2010 | 37.3 | 15.0 | 2.2 | 0.4 | 18.1 |