

# NORTHERN SHRIMP IN ARNARFJÖRÐUR – RÆKJA Í ARNARFIRÐI

## *Pandalus borealis*

### COMMERCIAL FISHING

Shrimp fishing started in Arnarfjörður in the 1930's. Between 1960 and 2015, the catch in Arnarfjörður fluctuated between 100 and 850 tonnes, except in the quota years 2005/2006 and 2006/2007 (Figure 1) when no fishing was allowed due to low shrimp biomass indices. Since 1994, the catch has decreased steadily and was only 116 tonnes in the quota year 2016/2017. The fishing season is from early winter (following the annual Icelandic shrimp survey in September/October) until 30<sup>th</sup> April. Catch per unit effort (CPUE) was relatively stable between 1960 and 1985, with a sharp increase in the following decade. Since 2000, CPUE has increased steadily, mainly due to increased density of shrimp within the innermost part of the fjord.

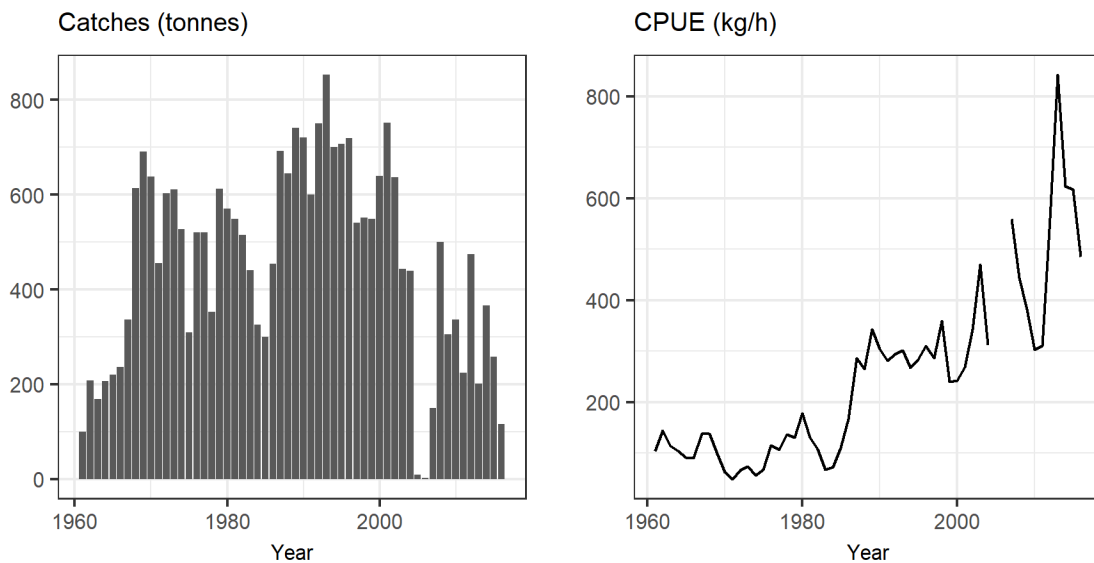


Figure 1. Total catch and catch per unit effort in Arnarfjörður.

*Mynd 1. Heildarafli og afli á sóknareiningu í Arnarfirði.*

The distribution of the fishery has varied over time (Figure 2). The main fishing area has decreased and since 2009 most of the catch has been taken from a relatively small area within the innermost part of Arnarfjörður.

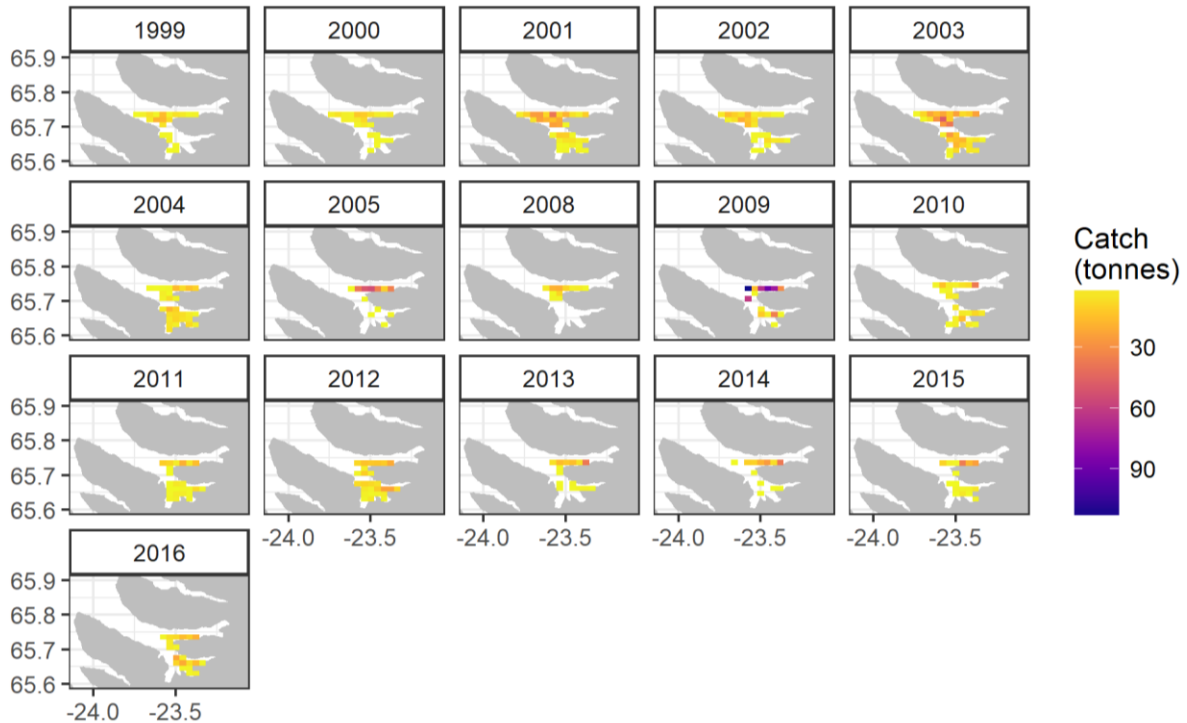


Figure 2. Distribution of shrimp catch in Arnarfjörður from 1999 to 2016.

*Mynd 2. Dreifing rækjuaflla í Arnarfirði 1999-2016.*

## ICELANDIC SHRIMP SURVEY

The annual Icelandic shrimp survey has been conducted since 1988 in Arnarfjörður. The survey was conducted between 25<sup>th</sup> to 28<sup>th</sup> of October 2017 and included 22 fixed stations at depths of 38-97 m. Due to diurnal vertical migration of shrimp, all tows are carried out during the daylight hours. All information on sampling procedure can be found in the report 'Northern shrimp research in Icelandic waters, 1988-2015' (Jónsdóttir et al. 2017).

Between 1988 and 1996, shrimp was found throughout the whole fjord. In 1997, the distributional area decreased and since 2005 shrimp has only been found within a small area at the innermost part of the fjord. These changes in distribution are thought to be due to increased abundance of cod and haddock in the outer part of the fjord.

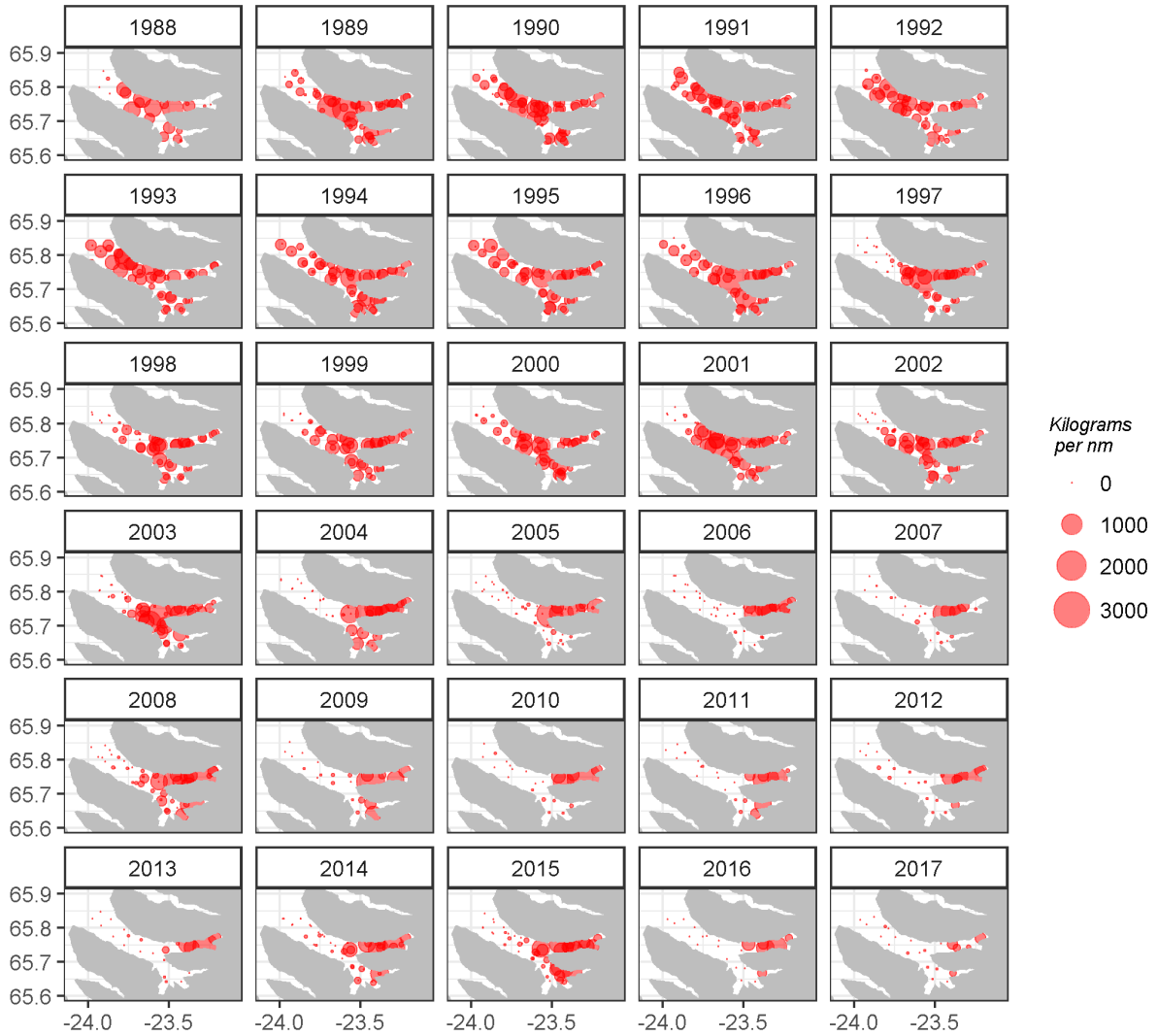


Figure 3. Distribution and abundance of shrimp in the annual shrimp survey 1988-2017.

*Mynd 3. Útbreiðsla og magn rækju í stofnmælingu 1988-2017.*

## SURVEY INDICES

Four indices are used to assess the state of the shrimp stock; total biomass, fishable biomass, female biomass and juvenile biomass. Juveniles include all individuals equal to and below 13 mm carapace length, while the fishable biomass include all individuals equal to and above 15.5 mm carapace length. Individuals between 13 and 15.5 mm carapace length are divided between the juvenile and fishable biomass indices. The female biomass includes all females and is equivalent to spawning stock biomass of various fish species.

The total stock and fishable indices were relatively stable until 2005 when they decreased sharply. Since 2006 the indices were again relatively stable but at a lower level compared with before. However, in 2016 the indices decreased, and the fishable index was slightly above the reference level where the state of the stock is considered critical. In 2017 the fishable index was at historically low levels and below the reference level (Figure 4).

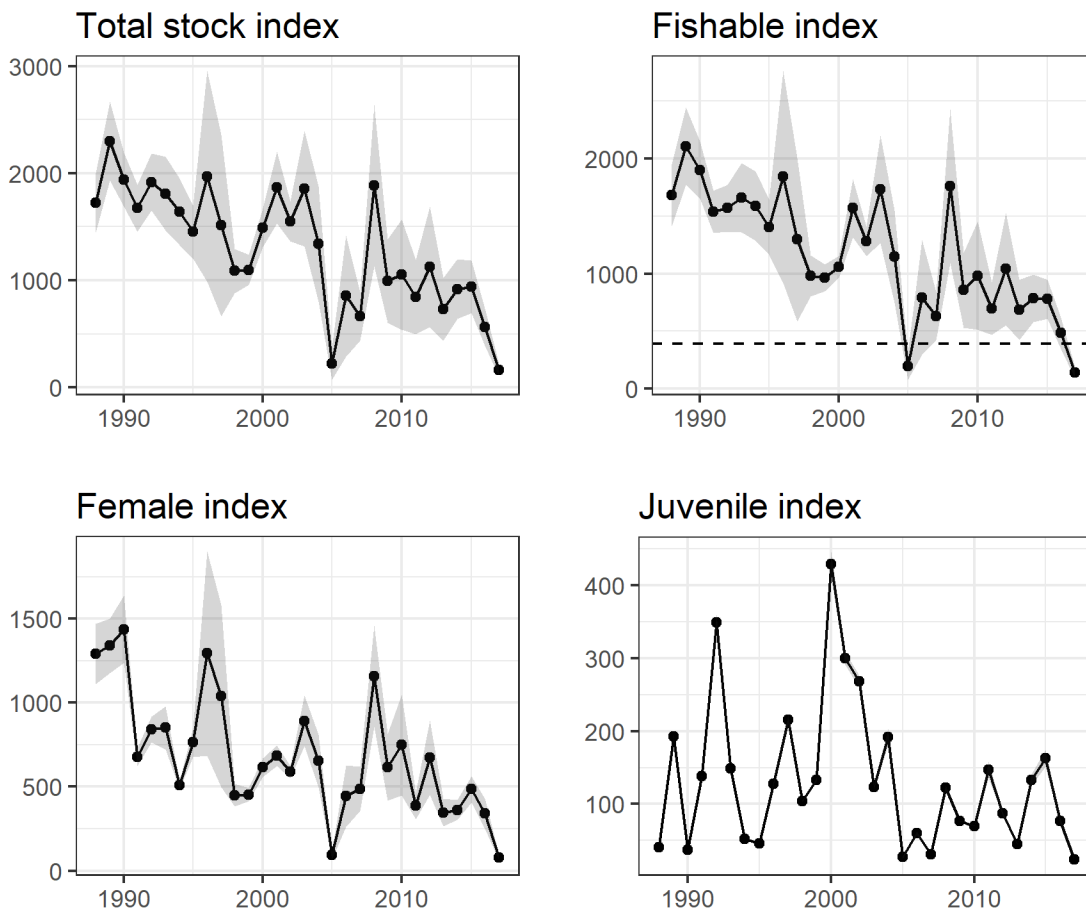


Figure 4. Stock biomass index, fishable biomass index, female biomass index, and juvenile biomass index of shrimp. The horizontal line indicates a value where the state of the stock is considered critical.

*Mynd 4. Heildarstofnsvísitala, veiðistofnsvísitala, kvendýrávísitala og vísitala ungrækju í Arnarfirði 1988-2017. Lárétt lína sýnir viðmiðunargildi fyrir ástand stofnsins.*

## LENGTH DISTRIBUTION OF SHRIMP

Since 2011, females have been smaller than average and have not reached the same maximum size as before (Figure 5). In 2017, the abundance of males was very low.

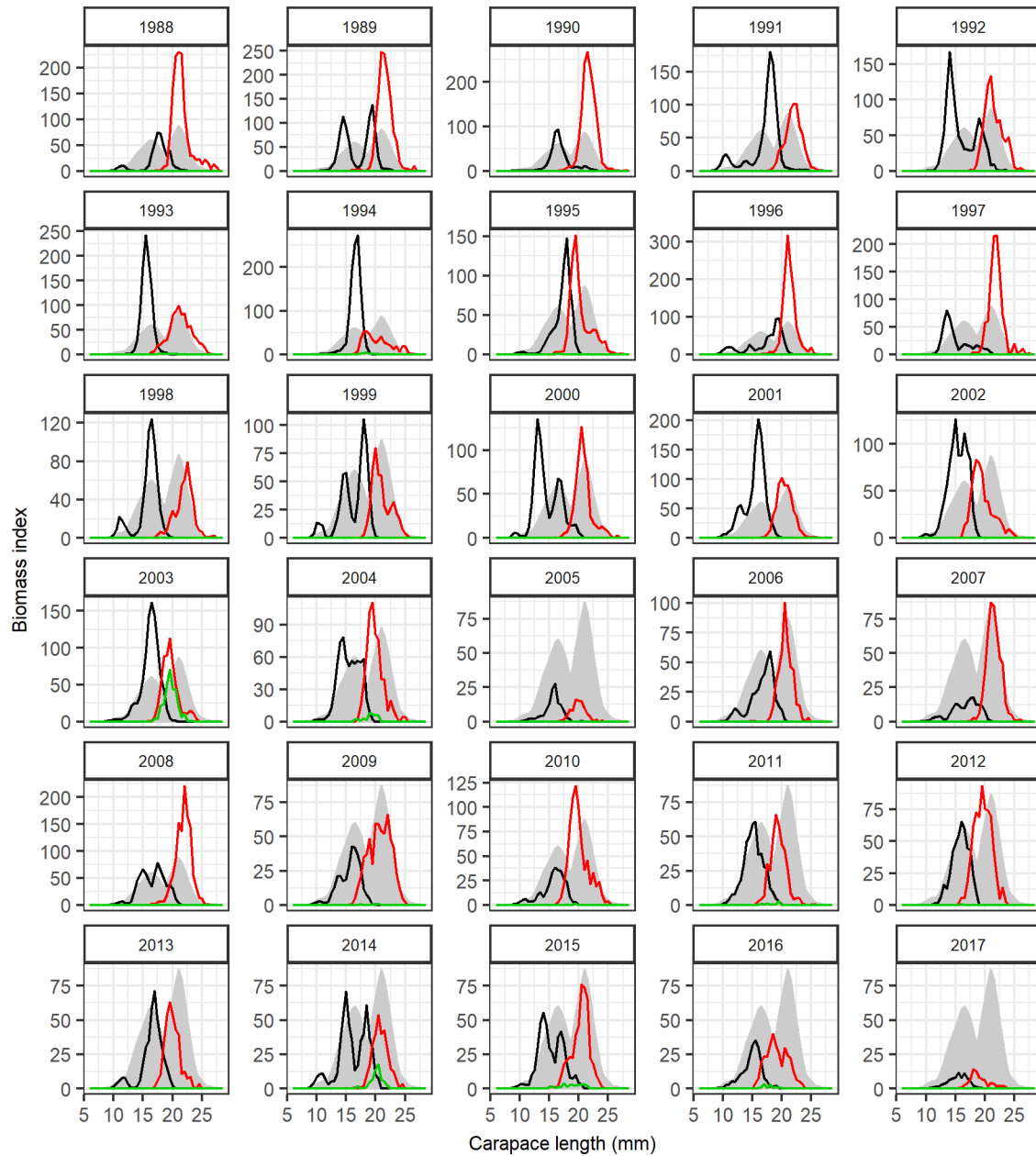


Figure 5. Length distribution of shrimp. The black line indicates males, the green immature females, and the red line mature females. The grey area is the mean length distribution of both sexes for the whole study period. Please note different scales on the y-axes.

*Mynd 5. Lengdardreifing rækju í stofnmælingu í Arnarfirði 1988-2017. Svört lína sýnir karldýr, græn lína ókynþroska kvendýr og sú rauða kynþroska kvendýr. Gráa svæðið sýnir meðallengdardreifingu beggja kynja allt rannsóknatímabilið. Athugið að skalinn á y-ás er mismunandi.*

## ABUNDANCE OF COD AND HADDOCK

In general, the cod abundance index has fluctuated throughout the study period. The cod abundance index has been decreasing since 2014. The haddock abundance index increased from 1994 to 2008 but has decreased since then (Figure 6).

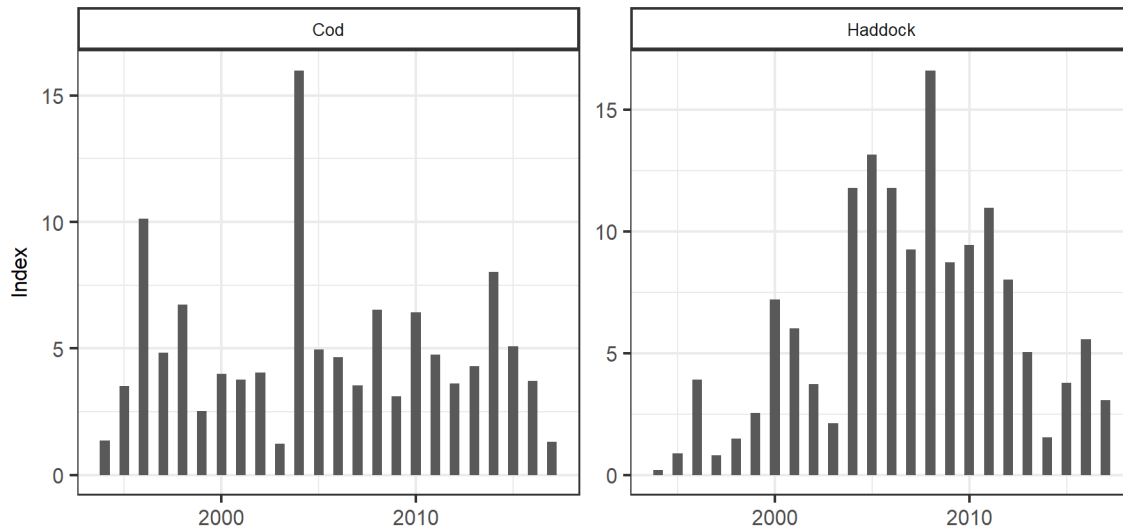


Figure 6. Abundance indices of cod and haddock 1994-2017.

*Mynd 6. Vísitala þorsks og ýsu í stofnmælingu rækju í Arnarfirði 1994-2017.*

## ADVICE

The Icelandic shrimp survey is used as a biomass indicator. The target  $F_{\text{proxy}}$  (catch/survey biomass index) of 0.346 is considered precautionary based on 80% of the mean  $F_{\text{proxy}}$  in 1988-2004.

The state of the stock is considered critical if the total biomass index is below 390 (equivalent to a relative state of 0.2; the biomass index divided with the mean of the three highest indices). The biomass index value of 390 can be considered a proxy for  $B_{\text{lim}}$  or an  $I_{\text{lim}}$ . If the total biomass index is below 390, zero catch is advised. If the total biomass index is above  $I_{\text{lim}}$ , the advice is based on multiplying the most recent biomass index value with the target  $F_{\text{proxy}}$ .

In October 2017, the fishable biomass index was below 390. Hence, MFRI advises zero catch in the quota year 2017/2018 in Arnarfjörður.

**Table 1.** Fishable biomass index (BI), state of the stock (relative to the mean of the three highest indices), advice, catch (tonnes in fishing year) and  $F_{\text{proxy}}$

*Tafla 1. Veidistofnsvísitala, ástand stofns (vísitala miðað við meðaltal þriggja hæstu vísitölu gilda), ráðgjöf, afli og vísitala veiðihlutfalls ( $F_{\text{proxy}}$ )*

Year	BI Fishable	Relative state	Rec. TAC	Catch	$F_{\text{proxy}}$
1988	1683	0.86			
1989	2107	1.08			
1990	1902	0.97	700	720	0.38
1991	1536	0.79	600	605	0.39
1992	1569	0.80	750	751	0.48
1993	1660	0.85	850	853	0.51
1994	1588	0.81	700	699	0.44
1995	1406	0.72	700	708	0.50
1996	1843	0.94	700	720	0.39
1997	1296	0.66	550	546	0.42
1998	982	0.50	550	551	0.56
1999	965	0.49	550	548	0.57
2000	1060	0.54	650	639	0.60
2001	1569	0.80	750	752	0.48
2002	1281	0.66	650	637	0.50
2003	1733	0.89	750	748	0.43
2004	1149	0.59	450	440	0.38
2005	195	0.10	0	9	-
2006	793	0.41	0	3	-
2007	632	0.32	150	158	0.25
2008	1762	0.90	500	508	0.29
2009	857	0.44	300	314	0.37
2010	984	0.50	400	337	0.34
2011	697	0.36	200	224	0.32
2012	1040	0.53	450	475	0.46
2013	687	0.35	200	2001	0.29
2014	786	0.40	350	366	0.47
2015	779	0.40	250	258	0.33
2016	484	0.25	167	124	0.26
2017	140	0.07	0		