A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), releases (numbers of fish), and total trips from MRIP-FCAL to SRFS for Gulf Gray Triggerfish (*Balistes capriscus*)

Maria McGirl and Chloe Ramsay

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Maria McGirl and Chloe Ramsay

Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 Eighth Avenue SE, St. Petersburg, Florida 33701

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Background

The Marine Recreational Information Program (MRIP) has provided vital statistics on recreational fishing effort and catch in the U.S. Gulf of Mexico since 1981. To remain useful for regional stock assessments, the time-series has undergone several calibrations to account for the effects of survey design improvements in more recent years. For example, when MRIP made the transition from the coastal household telephone survey (CHTS) to the fishing effort survey (FES) the historic estimates CHTS were calibrated into FES currency. This calibration is currently used for generating historic MRIP estimates and is termed FCAL. Stock assessments require long-term time-series of landings and discards on an annual scale that are measured consistently through time.

In response to a region-wide need for more precise and timely estimates of recreational catch, Florida's Gulf Reef Fish Survey (GRFS) was developed in May 2015 in collaboration with NOAA Fisheries alongside similar efforts in other states. The GRFS generated recreational catch estimates for the Gulf of America, excluding Monroe County. Beginning July 1, 2020, the Gulf Reef Fish Survey was expanded statewide in Florida and is now known as the State Reef Fish Survey (SRFS). The SRFS runs concurrent with the MRIP survey in Florida and produces estimates that are consistently lower. Previous stock assessments of Florida-centric species such as Gag (SEDAR 72) and Red Grouper (SEDAR 88) in the Gulf region and Mutton Snapper (SEDAR 79) and Yellowtail Snapper (SEDAR 96) in the Southeast have incorporated a long-term time series of MRIP estimates converted to SRFS currency for historic estimates of landings and discards from recreational private boats and SRFS estimates for recent years (Cross et al. 2020; Ramsay et al. 2024a-c). This data is also in consideration for other ongoing stock assessments such as South Atlantic Red Snapper (SEDAR 90; Ramsay 2025). The method that was developed to calibrate historic MRIP-FCAL estimates to SRFS currency was peer-reviewed by NOAA Office of Science and Technology (OS&T) statistical consultants and approved for use (Ramsay, NOAA OS&T et al. 2024). The method is used herein to calibrate MRIP estimates to SRFS currency for Gulf Gray Triggerfish, which will facilitate the use of SRFS estimates in this assessment.

Objectives

The objective is to develop conversion factors that may be applied to the annual MRIP-FCAL estimates for landings and releases of Gray Triggerfish in the Gulf of America, excluding Monroe County (Fig. 1). Consistent conversion factors will be applied across all years. This will produce a historic time series in the same currency as the SRFS.

Methods

This analysis used private boat mode recreational estimates of total landings (numbers and pounds of fish), releases (numbers), and effort (angler trips) derived from SRFS and MRIP from January 2016 through December 2024.

The SRFS and MRIP surveys use independent methods to estimate fishing effort (angler trips); however, catch estimates derived from each method are not completely independent. To estimate catch-per-unit-effort (CPUE), both surveys use data collected in the Access Point Angler Intercept Survey (APAIS), and SRFS uses a combination of data from the APAIS and supplemental reef fish angler intercepts. Assignments for both intercept surveys are drawn together so that sample weights are compatible (Foster, 2018).

We did not apply calibrations at a fine scale back in time (*i.e.,* by month or area fished), as neither survey was designed to generate precise estimates at this scale. Instead, we quantified the overall differences between SRFS and FCAL estimates across the years over which the two surveys overlap. This allowed for a single calibration factor to be applied to annual FCAL estimates back in time for landings and releases. Separate conversion factors are provided for landings in numbers, landings in pounds, releases in numbers, and effort in angler trips. As requested by assessment analysts for SEDAR 100, recreational estimates for Gulf Gray Triggerfish were calculated and calibrated.

All MRIP-FCAL estimates used in this calibration were generated by the NOAA Southeast Fisheries Science Center. MRIP-FCAL estimates were generated for the Gulf waters of Florida, excluding Monroe County. Variances for use in this calibration process were back calculated using the PSE and estimates values.

To assess overall differences between SRFS and FCAL estimates the estimates ($\hat{E}$) and variances ($\hat{V}$) for each estimation method (*m: SRFS, FCAL*) were summed across years (*y*), two-month waves (*w*), and areas fished (*a*: federal or state waters) for each variable (*v*: number landed, pounds landed, number released, trips) [1, 2].

$$\hat{E}_{m,v} = \sum_{m,v} \hat{E}_{y,w,a,m,v} \quad [1]$$

$$\hat{V}(\hat{E}_{m,v}) = \sum_{m,v} \hat{V}(\hat{E}_{y,w,a,m,v}) \quad [2]$$

This resulted in 4 pairs of SRFS and FCAL sums (4 variables; Table 1). For each of the paired sums, the ratio was calculated as the total SRFS estimate divided by the total FCAL estimate (landings, releases, and trips) [3].

$$\hat{R}_v = \frac{\hat{E}_{SRFS,v}}{\hat{E}_{FCAL,v}} \text{ [3]}$$

Although SRFS and MRIP estimates are derived from survey data that are not completely independent, the strength of correlation between estimates from the two surveys is unknown. To calculate the variance of the ratio above, we assumed a 0% correlation as this is the most conservative approximation of variance if correlation between the two survey estimates is ignored (Cross et al. 2020). This correlation percentage was recommended by peer review (Stokes et al. 2020). A delta method approximation for the variance of two independent variables was used to calculate the variance of the ratio above ($\hat{V}(\hat{R}_v)$) because this method incorporates error associated with both the numerator (SRFS estimates) and denominator (FCAL estimates). The R statistical software package 'msm' and the function deltamethod (R Core Team 2023; Jackson 2011) were used to carry out these calculations.

Historic estimates were converted to SRFS currency by multiplying the annual FCAL estimate for each year and variable type (number landed, pounds landed, number released, number of trips) [4] with the corresponding ratio [3]:

$$\hat{E}_{SRFS-hind,y,v} = \hat{R}_v \hat{E}_{FCAL,y,v} \text{ [4]}$$

Variance was again approximated using the delta method and, once again, a 0% correlation was assumed.

Findings and Conclusions

For the years in which the SRFS and MRIP overlap, annual Gray Triggerfish estimates derived from SRFS and FCAL and associated variances, observed ratios of summed SRFS to FCAL estimates, and approximated variance for each ratio are provided in Table 1. Comparisons of MRIP and SRFS estimates for overlapping years (2016–2024) are presented in Figure 2. The Gray Triggerfish ratios were marginally larger for landings (number of fish = 0.48; lbs of fish = 0.50) than for releases (0.44) and effort (0.41). Median PSE values for the calibrated estimates were 36%. Calibrated estimates for Gray Triggerfish are provided (Fig. 3, Table 2).

The purpose of this report was to calibrate the historic FCAL estimates to SRFS currency for evaluation of use in the SEDAR 100 Gulf Gray Triggerfish stock assessment.

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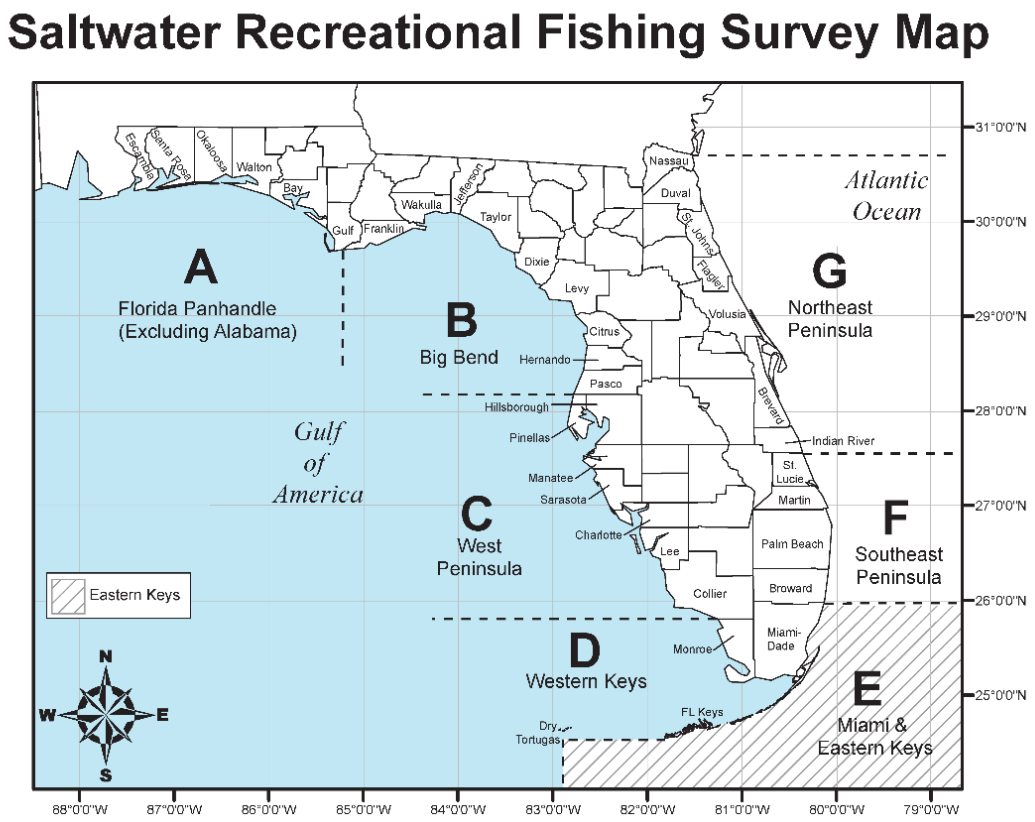

Figure 1. Regions of the state of Florida as designated by the State Reef Fish Survey (SRFS). For the purposes of this calibration, the Gulf without the Keys is defined as regions A-C.

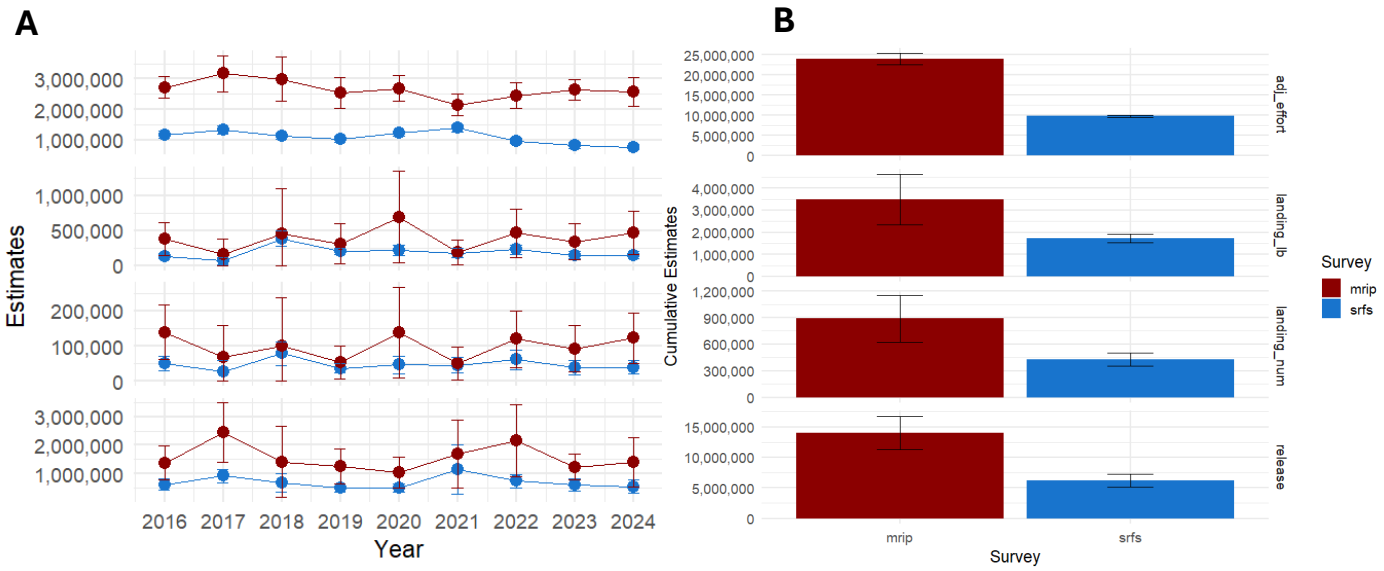

Figure 2. Estimates of landings and releases of Gray Triggerfish across years (A) or with all the years combined (B; 2016-2024). Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

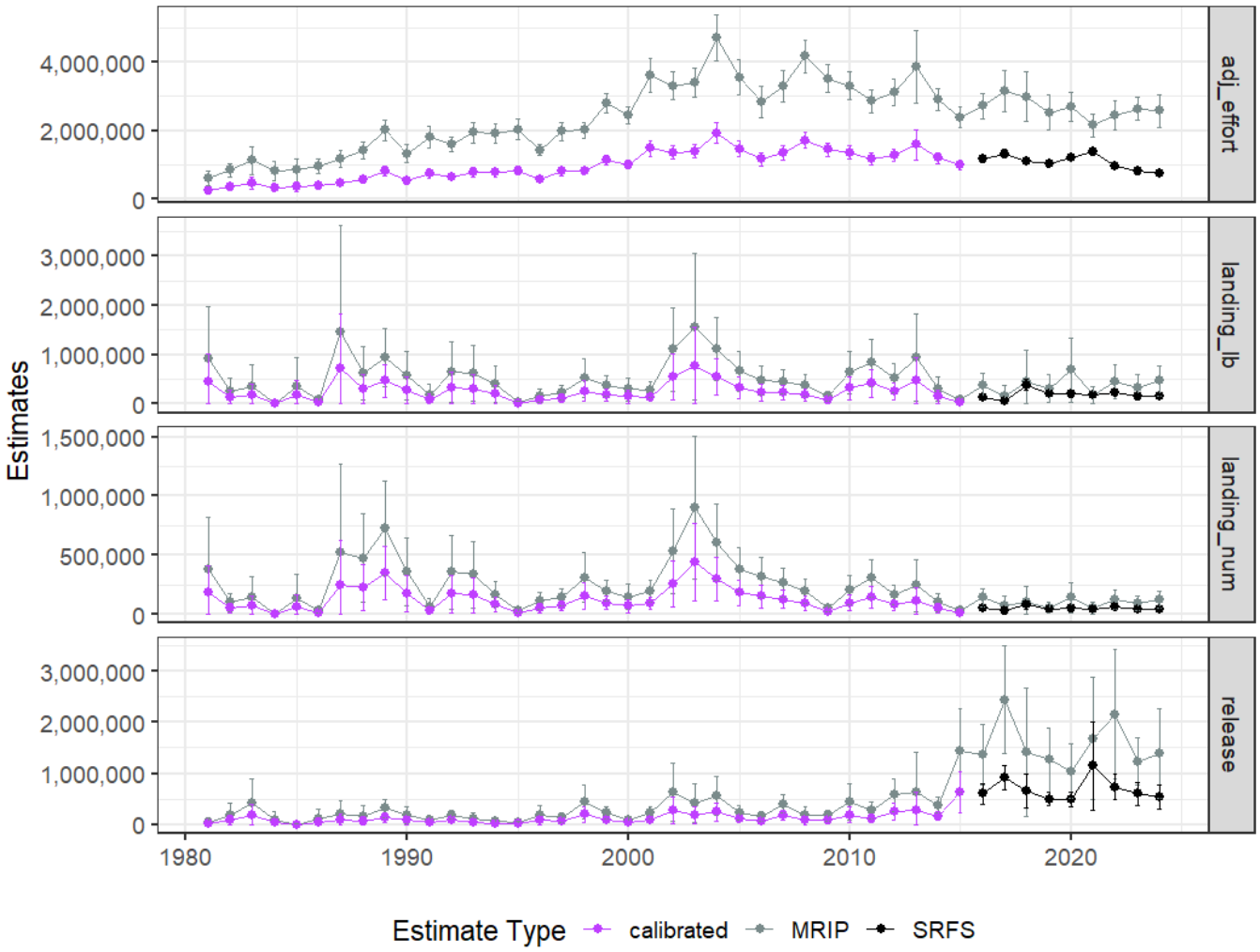

Figure 3. Gray Triggerfish estimates of effort (angler trips), landings (lbs of fish), landings (number of fish), and releases (number of fish) in the Gulf waters off of FL. Estimates shown are original SRFS estimates excluding Monroe County (2016-2024, SRFS), original MRIP-FCAL time-series (MRIP), and MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Error bars are 95% confidence limits.

Table 1. Annual and summed SRFS Gulf and MRIP estimates (sum) and variances (var) and ratios of MRIP to SRFS estimates are shown for Florida's Gulf Gray Triggerfish. Estimates for effort (number of trips) are for the whole suite of species covered by the original GRFS survey.

Estimate Type	Year	SRFS Sum	SRFS Variance	MRIP Sum	MRIP Variance	Ratio
Adjusted Effort (angler trips)	2016	1,173,293	3,519,120,867	2,719,820	34,229,122,315	0.4105
	2017	1,328,974	3,817,218,310	3,166,300	92,867,915,871	
	2018	1,116,802	2,436,258,545	2,991,914	137,866,363,632	
	2019	1,027,168	2,430,004,795	2,533,501	66,439,094,273	
	2020	1,223,317	1,856,821,928	2,693,137	45,203,695,136	
	2021	1,388,630	3,612,693,035	2,150,342	31,072,503,286	
	2022	970,472	2,208,058,573	2,449,734	45,952,245,492	
	2023	825,711	2,308,049,897	2,637,123	30,680,824,152	
	2024	763,504	1,991,455,694	2,574,042	55,747,978,805	
	Total	9,817,871	24,179,681,643	23,915,914	540,059,742,962	
Landings (lbs)	2016	133,030	346,619,944	387,422	14,475,662,961	0.4968
	2017	69,109	667,595,507	166,257	12,049,769,339	
	2018	382,592	3,095,097,339	461,624	104,062,194,739	
	2019	207,129	613,407,525	310,866	21,145,084,984	
	2020	218,688	1,450,748,001	692,300	111,387,340,774	
	2021	182,974	922,730,689	188,624	8,192,958,695	
	2022	230,093	1,217,680,416	463,043	30,678,820,698	
	2023	152,154	792,406,852	342,425	17,011,264,076	
	2024	152,469	625,242,025	465,899	24,173,551,657	
	Total	1,728,237	9,731,528,297	3,478,460	343,176,647,922	
Landings (no. fish)	2016	50,337	109,565,378	139,695	1,529,961,460	0.4829
	2017	28,278	268,880,429	68,954	2,071,103,854	
	2018	79,018	277,298,540	101,569	4,911,606,191	
	2019	37,651	46,611,511	53,099	570,954,217	
	2020	47,439	157,514,085	139,354	4,289,802,758	
	2021	46,257	122,769,910	51,577	587,635,056	
	2022	61,609	215,677,839	120,632	1,682,227,786	
	2023	39,117	114,383,776	92,493	1,108,732,171	
	2024	40,168	87,576,334	122,889	1,359,161,492	
	Total	429,874	1,400,277,802	890,264	18,111,184,985	
Releases (no. fish)	2016	605,606	10,279,856,765	1,374,425	91,429,734,766	0.4425
	2017	925,140	14,242,272,597	2,440,186	288,198,082,463	
	2018	667,720	28,575,557,900	1,418,363	407,379,895,912	
	2019	496,635	4,680,436,907	1,262,876	99,678,535,059	
	2020	489,520	5,057,657,930	1,044,281	73,719,331,315	
	2021	1,146,374	191,834,390,816	1,685,644	368,244,882,233	
	2022	735,365	15,596,393,336	2,156,038	418,364,912,897	
	2023	600,659	13,733,931,306	1,231,209	54,723,106,318	
	2024	533,212	14,497,504,660	1,397,320	199,936,207,637	
	Total	6,200,232	298,498,002,217	14,010,341	2,001,674,688,600	

Table 2. Historic FCAL (MRIP-FCAL) estimates, and estimates converted to SRFS currency (Calibrated: FCAL to SRFS) for Florida Gulf Gray Triggerfish.

	MRIP-FCAL		SRFS-FCAL Calibration		MRIP-FCAL		SRFS-FCAL Calibration		MRIP-FCAL		SRFS-FCAL Calibration	
Year	Landings (no. fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no. fish)	PSE	Releases (no. fish)	PSE
1981	384,836	58	185,823	61	918,324	59	456,260	62	53,499	72	23,676	73
1982	100,055	39	48,313	43	262,167	52	130,255	55	188,176	66	83,277	67
1983	145,266	62	70,143	64	359,435	62	178,582	65	411,198	60	181,974	62
1984	-	N/A	-	N/A	-	N/A	-	N/A	88,194	100	39,030	101
1985	130,803	83	63,160	85	355,211	83	176,483	85	2,854	100	1,263	101
1986	33,783	37	16,313	41	75,832	41	37,676	45	111,813	92	49,482	93
1987	518,811	74	250,514	76	1,462,596	75	726,676	77	205,682	68	91,024	69
1988	475,073	40	229,395	44	626,371	45	311,206	48	149,312	75	66,077	76
1989	728,091	28	351,567	33	946,288	32	470,154	37	318,382	29	140,899	32
1990	358,903	41	173,301	45	580,940	43	288,634	47	179,575	46	79,470	48
1991	66,455	50	32,089	53	193,130	55	95,955	57	78,389	76	34,691	77
1992	354,429	45	171,140	48	647,361	48	321,635	51	192,236	24	85,074	28
1993	336,290	43	162,382	46	622,441	46	309,253	50	120,954	49	53,528	51
1994	168,642	33	81,431	37	394,257	48	195,883	51	63,275	36	28,002	38
1995	30,288	32	14,625	36	42,425	34	21,078	38	34,433	32	15,238	35
1996	112,864	33	54,498	37	165,588	41	82,271	45	181,849	53	80,477	55
1997	143,375	26	69,230	31	238,085	33	118,290	37	131,039	38	57,991	40
1998	310,926	34	150,134	38	530,799	38	263,722	42	444,076	39	196,524	41
1999	197,722	23	95,472	29	369,806	28	183,734	34	225,288	27	99,701	30
2000	145,996	38	70,496	42	300,819	40	149,459	43	77,895	52	34,472	54
2001	193,744	25	93,552	31	293,153	28	145,650	33	227,374	25	100,624	28
2002	533,979	34	257,838	38	1,109,057	39	551,024	43	628,591	46	278,181	48
2003	904,732	34	436,861	38	1,571,157	49	780,613	52	414,915	47	183,619	49
2004	609,681	27	294,392	32	1,109,615	29	551,301	34	552,512	35	244,512	38
2005	379,424	25	183,210	31	664,604	31	330,202	36	233,595	30	103,377	33
2006	313,524	28	151,389	33	485,744	31	241,337	36	162,887	29	72,085	32

Table 2 Cont.

Year	MRIP-FCAL Landings (no. fish)	PSE	SRFS-FCAL Calibration Landings (no. fish)	PSE	MRIP-FCAL Landings (pounds)	PSE	SRFS-FCAL Calibration Landings (pounds)	PSE	MRIP-FCAL Releases (no. fish)	PSE	SRFS-FCAL Calibration Releases (no. fish)	PSE
2007	265,236	24	128,072	30	455,532	28	226,326	33	400,482	23	177,232	27
2008	191,485	27	92,461	32	376,407	29	187,014	34	178,532	51	79,009	53
2009	55,161	29	26,635	34	157,565	34	78,285	39	178,311	29	78,911	32
2010	203,523	31	98,273	36	646,368	34	321,141	38	440,193	41	194,806	43
2011	304,440	27	147,003	32	841,656	29	418,168	34	280,869	31	124,298	34
2012	165,011	26	79,678	31	525,233	30	260,957	35	578,107	28	255,839	31
2013	243,353	46	117,506	49	944,055	48	469,044	51	625,010	64	276,596	65
2014	102,236	38	49,366	42	316,082	40	157,042	44	381,644	20	168,895	24
2015	32,491	68	15,688	70	73,441	69	36,488	71	1,449,434	29	641,443	32