Iranian Journal of Fisheries Sciences 17(3) 552-563 2018
DOI: 10.22092/IJFS.2018.116505

Comparing some biological characteristics of two sturgeons species, Persian sturgeon (*Acipenser persicus* Borodin, 1897) and Russian sturgeon (*A. gueldenstaedtii* Brandt & Ratzeburg, 1833) in the Caspian Sea

Tavakoli M.[1*]; Fazli H.[2]; Moghim M.[2]; Behrooz Khoshghalb M.R.[1]

Received: October 2016 Accepted: May 2018

Abstract

The objective of this study was to compare the biological parameters such as length, weight, age, caviar production indices, caviar/weight, condition factor and sex ratio of Persian sturgeon (*Acipenser persicus* Borodin, 1897) and Russian sturgeon (*A. gueldenstaedtii* Brandt & Ratzeburg, 1833) in the Caspian Sea during 1990-2014. All these characteristics (except condition factor) of Persian sturgeon were greater than the Russian sturgeon. In the long period, annually average (±SD) fork length ranged from 129.3 (±11.87) to 140.9 (±15.99) cm for Russian sturgeon and 145.7 (±17.61) to 157.4 (±19.31) cm for the Persian sturgeon. The annually caviar harvest for the Russian sturgeon ranged from 3.86 (±1.05) to 5.02 (±1.82) kg with a caviar/weight ratio were ranged from 16.9 (±4.12) to 20.1% (±5.12), while comparatively for the Persian sturgeon was greater and ranged from 4.84 (±1.62) and 7.04 (±2.58) kg with a caviar/weight ratio of 16.2 (±3.99) to 21.1% (±5.20). The age of both species ranged between 6 to 40 years but the modal age of Russian sturgeon was less than Persian sturgeon. The male:female sex ratio of Russian and Persian sturgeons were 0.23:1 and 0.57:1, respectively. The sex ratio of Russian sturgeon was significantly different from sex ratio of Persian sturgeon (p<0.001). The condition factor of Russian and Persian sturgeons were 0.92 (±0.16) and 0.74 (±0.13), respectively. Moreover, results of the MANOVA revealed significant differences in population structure of two species (p<0.001). Therefore, different conservation and management activities need for these two valuable sturgeons in the Caspian Sea.

Keywords: *Acipenser persicus*, *Acipenser gueldenstaedtii*, Age, Length, Weight, Sex, Caspian Sea

1-International Sturgeon Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Rasht, Iran

2-Iranian Fisheries Science Research Institute, Caspian Sea Ecology Research Center, Agricultural Research, Education and Extension Organization, Sari, Iran

*Corresponding author's Email: m_tavakoli_e@yahoo.com

Introduction

Caspian Sea is the largest brackish water lake in the world and inhabits six species of sturgeons in the basin. Five of these sturgeon species are anaderomous and can find in the Iranian waters including: Persian sturgeon *Acipenser persicus* Borodin, 1897; Russian sturgeon *A. gueldenstaedtii* Brandt and Ratzeburg, 1833; stellate *A. stellatus* Pallas, 1771; ship *A. nudiventris* Lovetsky, 1828 and beluga *Huso huso* Linnaeus, 1758 (Levin, 1997). Persian sturgeon comprises the largest proportion of the total Iranian commercial catch of sturgeons over the past 25 years (Moghim *et al*., 2006). Persian sturgeon can find mainly in the southern Caspian region while Russian sturgeons are distributed throughout the Caspian Sea (Berg, 1948). The Iranian fishery for Persian and Russian sturgeon takes place in the southern basin, near the coast as well as in the rivers of the Caspian Sea. The sturgeon fishery by hook was banned in 1952 and afterward gill nets with large mesh sizes were used (Rostami, 1961). Also, sturgeons are caught as by-catch in the commercial teleost fishery using beach seines. Gill nets are operated from small boats crewed by two to three fishermen at depths less than 70 m within about 15 km of the shoreline of the Caspian Sea. The Capron gillnets commonly used are 18 m long and 2.7 m deep with a mesh size of 150 mm (Moghim and Nielson, 1999).

Several studies reported on systematic characteristics of Persian and Russian sturgeons in the Caspian Sea. Berg (1948) reported that Persian sturgeon is a subspecies of Russian sturgeon but based on biochemical characteristics of protein of caviar (Keyvanfar *et al*., 1987), morphological parameters (Holcik, 1989) and morpho-biologic parameters (Nasrichari, 1995) these species are different. Also, using RAPD (Random Amplified Polymorphic DNA) and RAD sequencing, similar differences were reported by Gharaei (2001), Ogden *et al*. (2013) and Moghim *et al*. (2013). Although, Ruban *et al*. (2011) reported that with combining the results of morphological and molecular genetic studies of the Russian sturgeon there is support to the validity of the existence of Persian sturgeon as a separate species. According to Ludwig (2008) accurate species, population and stock identification is a major prerequisite for each conservation and management activity. This study focuses on commercial catch data which were collected during the long-term dataset. The main objective of this study was to compare some biological parameters such as length, weight, age, caviar production indices, caviar/weight ratio, condition factor and sex ratios of Persian and Russian sturgeons in Iranian waters of the Caspian Sea during 1990-2014.

Materials and methods

Data were collected in Iranian waters of the Caspian Sea from commercial fisheries in 1990-2014. During the years 1990-2004, 9 commercial landing centers out of 47 were selected by clustering analysis as sampling stations. From 2005-2014, 30 or more

commercial landings centers were monitored. Daily samples were collected randomly during each fishing season (Moghim *et al*., 2006).

During the sampling periods, the fork length was measured to the nearest 1 cm, total weight to the nearest 100 g, caviar weight to the nearest 1 g and sex of Russian and Persian sturgeons were recorded using the macroscopic method based on 6 steps maturity stage (Bagenal, 1978). Age was determined by fin ray sections (Chugunova, 1959). The condition factor (*CF*) was calculated as below (Bagenal, 1978):

$$CF = \frac{W}{L^3} \times 100$$

where W_t is the total weight (g) and L is the fork length (cm.

The t-test was used to test for differences in the mean fork length, total weight, weight of caviar and caviar/weight ratio between two species (Zar, 2010). Also, Multivariate Analysis of Variance (MANOVA) was used for fork length, total weight, weight of caviar and caviar/weight ratio to compare between the species (Slice, 2007). Chi-squared analysis was used to test for significant deviations from an expected 1:1 sex ratio by each year (Zar, 2010). Data were analyzed using SPSS (ver. 18) and PAST (ver 3.02; Hammer *et al*., 2001) softwares. Mean values were considered significantly different at $p<0.05$. Data are expressed as mean values ± SD.

Results

During 1990-2014, the average (±SD) fork length ranged from 129.3 (±11.87) to 140.9 (±15.99) cm for Russian sturgeon and ranged from 145.7 (±17.61) to 157.4 (±19.31) cm for Persian sturgeon. In this long-term period (except 2014), the average length of Persian sturgeon was significantly more than Russian sturgeon ($p<0.01$, Table 1). The average (±SD) total weight was ranged from 19.5 (±5.11) to 24.4 (±10.40) kg for Russian sturgeon and ranged from 22.4 (±8.39) to 27.3 (±8.29) kg for Persian sturgeon (Table 2). In the years 1990-2009, 2010 and 2012 the average total weight of Persian sturgeon were significantly more than Russian sturgeon ($p<0.01$, $p<0.05$ and $p<0.05$, respectively, Table 2). In the years 2011 and 2013-2014, the total weight was not significantly different between two species ($p>0.05$, Table 2).

In the years 1991-2014, the average caviar harvest of Russian sturgeon ranged between 3.86 (±1.05) and 5.02 (±1.82) kg and Persian sturgeon ranged between 4.84 (±1.62) and 7.04 (±2.58) kg. In all years (except 2013 and 2014) the average caviar harvest of Persian sturgeon was significantly more than Russian sturgeon ($p<0.01$, Table 3).

During 1991-2014, the average caviar/weight ratio were ranged from 16.9 (±4.12) to 20.1 (±5.12) % and 16.2 (±3.99) to 21.1 (±5.20) % for Russian and Persian sturgeons, respectively. In the years 1991, 1993, 1994, 1996-1998 and 2001-2002 the average caviar/weight ratio of Russian sturgeon was statistically more than the Persian sturgeon ($p<0.05$, Table 4), then in the years 2004-2006, the average caviar/weight ratio of Persian sturgeon

was statistically higher than the Russian sturgeon (p<0.01, Table 4).

During this period, the age of both species limited between 6 to 40 years, but the modal age of Russian sturgeon was smaller than Persian sturgeon (Fig. 1). Ages 14 and 15 were the largest age groups represented 21.8% and 22.0% for Russian and Persian sturgeon, respectively. Russian sturgeon age between 11-17 represented 87.6% while age 13-19 represented 87.8% of the total catch for Persian sturgeon. In all age groups (except 6 years), the average fork length of Persian was significantly more than the Russian sturgeon (p<0.05).

The long-term commercial fisheries data showed that females of Russian sturgeon were more abundant in all tested years (Fig. 3). The male:female sex ratio for sampled Russian adult was 0.23:1 (n=25182), which were significantly different from the expected 1:1 (p<0.001, Fig. 2). The male:female sex ratio of Persian sturgeon were 0.57:1 (n = 81497), and was significantly different from the expected 1:1 (p<0.001). Females were more abundant from 1990 to 2011 (p<0.001). However, the relative frequency of female declined in the years 2012-2014 and male became more predominated (p<0.001, Fig. 3). Also, the sex ratio of the whole samples of Russian sturgeon was significantly different from sex ratio of Persian sturgeon (p<0.001).

The long-term data showed that condition factor of Russian sturgeon were significantly greater than the Persian sturgeon in years 1990-2014 (p<0.05; Fig. 5). The average (±S.D.) condition factor of all samples was 0.92 (±0.16) for Russian sturgeon compared to 0.74 ±0.13 for Persian sturgeon.

Also, results of the MANOVA revealed significant differences in population structure of two the species (Wilkes Lambda = 0.899, F = 8.74, p<0.001).

Table 1: Mean (±SD) fork length (cm) of Persian sturgeon and Russian sturgeon in the Caspian Sea during the years 1990-2014 (t, Student's t-test for comparison of the means)..

Year	Russian Sturgeon			Persian Sturgeon			t
	N	Mean±SD	Min-Max	N	Mean±SD	Min-Max	
1990	4918	131.3±14.92	89-217	6242	152.8±17.75	98-239	69.5**
1991	5670	129.9±14.37	90-204	7929	149.0±16.45	99-222	72.1**
1992	3377	131.9±13.28	96-195	6424	148.9±15.68	92-211	56.2**
1993	1907	133.2±12.15	101-201	3420	149.3±14.54	106-230	41.3**
1994	1392	131.8±12.01	96-172	3510	149.0±13.75	99-214	43.3**
1995	1091	129.9±12.74	96-190	3174	148.0±13.27	104-220	39.2**
1996	1235	130.2±12.14	102-194	3797	148.7±12.79	105-231	45.8**
1997	1098	129.3±11.87	87-181	4302	148.8±12.86	105-212	47.7**
1998	874	129.9±12.10	92-180	3614	148.5±13.03	106-221	38.3**
1999	615	130.7±12.31	103-180	3098	147.9±13.55	99-206	31.1**
2000	533	129.7±11.88	104-189	3358	149.0±13.68	102-200	34.1**
2001	478	129.9±11.95	105-180	4923	148.5±14.13	98-204	31.9**
2002	488	131.7±12.55	98-173	4424	148.6±15.01	98-230	27.6**
2003	287	133.7±11.76	106-190	3957	151.3±13.28	103-204	24.3**
2004	317	137.4±14.18	113-199	4099	154.1±15.79	113-253	20.1**
2005	255	137.7±13.58	114-206	3711	153.7±16.99	113-220	17.8**
2006	191	139.114.31	113-187	2839	157.4±19.31	113-240	16.7**

Table 1 continued:							
2007	153	140.9±15.99	115-217	2044	155.5±18.28	113-212	10.8**
2008	84	135.2±14.58	113-180	1340	154.6±19.25	113-222	11.5**
2009	58	136.8±12.73	115-169	927	154.0±18.06	113-218	9.7**
2010	40	137.1±12.06	113-160	696	153.5±17.18	113-205	8.2**
2011	24	138.9±14.52	116-178	581	151.3±17.64	114-197	3.4**
2012	19	134.1±12.17	118-163	462	148.5±18.23	113-200	4.9**
2013	14	137.6±9.54	124-159	384	145.7±17.61	113-200	3.0**
2014	7	140.3±7.37	133-154	337	146.3±19.25	113-232	2.0
Total	25125	131.3±13.68	87-217	79592	150.4±15.63	92-253	186.3**

* $p<0.05$ and ** $p<0.01$

Table 2: Mean (±SD) body weight (kg) of Persian sturgeon and Russian sturgeon in the Caspian Sea during the years 1990-2014 (t, Student's t-test for comparison of the means).

Year	Russian Sturgeon			Persian Sturgeon			t
	N	Mean±SD	Min-Max	N	Mean±SD	Min-Max	
1990	4873	20.7±7.82	4.0-96.0	6220	26.4±9.60	4.0-112.0	34.2**
1991	5670	21.5±7.67	4.6-92.0	7928	25.8±9.21	5.0-80.0	29.9**
1992	3379	22.6±7.65	4.5-66.7	6425	25.5±9.10	5.5-71.0	17.0**
1993	1907	22.9±7.37	8.5-72.5	3420	26.4±8.58	6.0-92.8	15.9**
1994	1393	22.2±6.50	7.8-60.0	3510	26.3±7.98	5.0-70.0	18.8**
1995	1091	21.0±6.85	7.5-64.0	3174	25.4±7.66	7.0-86.0	17.9**
1996	1235	20.8±6.60	8.0-71.0	3797	25.8±7.49	6.0-87.0	22.8**
1997	1098	20.2±6.11	8.5-57.0	4302	25.7±7.22	5.5-67.0	26.0**
1998	876	20.8±6.54	4.0-61.5	3614	25.3±7.30	7.9-83.0	18.1**
1999	616	20.5±6.37	6.5-55.0	3101	25.1±7.57	6.0-72.2	15.7**
2000	533	19.7±5.88	6.0-54.0	3358	25.1±7.13	4.5-63.0	20.1**
2001	478	20.2±5.95	8.0-53.0	4928	25.4±7.44	5.8-67.0	17.4**
2002	488	21.5±6.71	5.0-50.5	4423	25.5±8.31	4.5-84.2	12.0**
2003	287	21.6±6.88	8.0-61.3	3957	26.6±7.82	7.0-78.1	11.7**
2004	356	22.0±6.83	9.0-51.0	5358	27.3±8.29	7.0-86.0	14.1**
2005	262	20.6±6.95	10.0-68.0	4257	25.4±8.58	7.0-82.0	10.8**
2006	193	21.1±7.24	7.0-65.0	2891	26.7±9.03	7.0-80.0	10.2**
2007	153	21.3±7.37	8.0-64.0	2050	26.9±9.68	5.0-88.0	8.8**
2008	85	21.2±8.24	7.0-67.0	1341	25.9±9.81	8.0-73.0	5.0**
2009	58	22.1±8.19	12.0-65.0	927	26.0±9.39	10.0-78.0	3.5**
2010	40	22.6±6.09	12.0-35.0	696	25.2±8.27	9.0-56.0	2.6*
2011	24	24.4±10.50	16.0-68.0	581	24.6±8.43	8.0-53.0	0.1
2012	19	19.5±5.11	12.0-33.0	462	22.5±8.48	8.0-57.0	2.4*
2013	14	21.0±5.25	14.0-34.0	383	22.4±8.39	8.0-52.0	0.9
2014	7	24.3±5.79	18.0-36.0	338	22.9±9.61	10.0-67.0	0.4
Total	25135	21.4±7.33	4.0-96.0	81441	25.8±8.42	4.0-112.0	81.6**

* $p<0.05$ and ** $p<0.01$

Table 3: Mean (±SD) caviar harvest (kg) of Persian and Russian sturgeon in the Caspian Sea during the years 1991-2014 (t, Student's t-test for comparison of the means)..

Year	Russian Sturgeon			Persian Sturgeon			t
	N	Mean±SD	Min-Max	N	Mean±SD	Min-Max	
1990	-	-	-	-	-	-	-
1991	1390	4.88±1.66	0.70-13.80	2807	5.93±1.79	1.10-17.00	18.8**
1992	840	5.02±1.82	0.62-15.40	2293	6.02±1.80	0.53-13.50	13.3**
1993	656	4.79±1.78	1.00-11.10	1313	5.44±1.83	1.50-13.80	7.6**
1994	325	4.65±1.60	1.00-13.00	1192	5.18±1.76	1.00-22.10	4.9**
1995	242	4.39±1.66	1.20-9.60	993	5.22±1.64	1.70-13.20	7.1**
1996	311	4.04±1.57	1.20-11.30	1398	4.84±1.62	0.60-13.20	7.9**
1997	286	3.91±1.49	1.30-10.50	1446	4.96±1.56	1.40-15.00	10.6**
1998	227	4.26±1.85	1.30-18.50	1373	5.03±1.53	1.50-12.00	6.8**
1999	145	4.12±1.60	1.70-11.70	1160	4.98±1.59	1.50-14.60	6.1**
2000	126	3.98±1.36	1.90-9.20	1401	5.00±1.57	1.60-13.70	7.1**

Table 3 continued;							
2001	109	4.16±1.49	1.80-10.90	1707	4.99±1.43	1.30-14.60	5.3**
2002	123	4.35±1.65	1.30-9.80	1651	5.42±1.76	1.10-17.50	6.5**
2003	59	4.31±1.22	1.80-7.40	1502	5.55±1.74	1.80-13.10	7.4**
2004	163	4.29±1.63	1.30-9.51	2764	5.92±2.01	0.90-17.45	12.2**
2005	66	4.42±1.57	2.00-8.60	1748	6.64±2.07	2.06-15.18	10.7**
2006	63	4.61±1.80	1.75-9.43	1320	7.02±2.50	1.05-14.32	10.1**
2007	65	4.58±1.37	0.80-8.09	852	7.04±2.58	1.00-15.52	12.8**
2008	35	4.31±1.87	2.08-10.27	537	6.51±2.11	1.90-13.76	6.0**
2009	19	3.86±1.05	2.10-6.77	355	5.99±1.77	1.90-11.96	8.2**
2010	19	4.60±1.28	2.21-7.14	264	6.00±1.75	2.46-12.33	3.4**
2011	10	4.35±1.35	2.56-7.14	239	5.70±1.58	2.50-11.00	2.7**
2012	9	3.90±0.65	3.20-5.00	166	5.84±1.65	2.53-12.50	7.7**
2013	4	4.26±0.48	3.80-4.75	143	5.33±1.45	3.40-11.77	1.5
2014	5	4.64±0.72	3.78-5.75	126	5.46±1.61	2.70-12.51	1.1
Total	5297	4.61±1.70	0.62-18.50	28750	5.65±1.94	0.53-22.10	65.6**

* $p<0.05$ and ** $p<0.01$

Table 4: Mean (±SD) caviar harvest/body weight (%) of Persian and Russian sturgeon in the Caspian Sea during the years 1991-2014 (t, Student's t-test for comparison of the means)..

Year	Russian Sturgeon			Persian Sturgeon			t
	N	Mean±SD	Min-Max	N	Mean±S.D.	Min-Max	
1990	-	-	-	-	-	-	-
1991	1390	18.5±4.09	2.3-31.4	2806	18.2±3.99	2.3-33.7	2.0*
1992	840	18.8±4.32	2.3-31.6	2295	18.5±3.93	2.0-30.4	1.9
1993	656	18.3±4.48	3.6-30.0	1314	17.2±3.88	6.6-28.9	5.5**
1994	325	18.9±4.20	2.8-30.0	1192	16.9±3.61	3.4-33.3	7.5**
1995	242	17.6±3.87	6.3-30.3	993	17.4±3.94	4.7-31.5	0.8
1996	311	16.9±4.12	5.7-29.8	1398	16.2±3.99	4.6-31.6	2.9**
1997	286	17.2±4.11	6.6-30.3	1446	16.6±3.54	7.1-28.9	2.4**
1998	227	18.1±3.99	5.6-30.7	1373	17.4±3.88	6.5-30.3	2.4**
1999	145	17.3±4.11	6.3-28.3	1160	16.9±3.70	7.1-29.6	1.1
2000	126	17.1±3.75	9.1-28.9	1401	17.1±3.72	6.8-30.0	0.1
2001	109	17.9±3.44	9.4-27.8	1707	16.5±4.02	3.5-30.2	4.2**
2002	123	17.9±4.03	7.3-28.4	1651	17.4±3.98	4.1-3129	1.4*
2003	59	18.9±3.92	9.7-28.7	1502	17.9±3.76	6.4-29.2	1.9
2004	163	18.4±3.82	5.2-28.1	2746	19.2±4.61	3.3-34.0	2.5*
2005	66	19.5±4.71	10.0-31.7	1747	20.8±4.63	7.6-34.8	2.3*
2006	63	19.4±3.98	9.2-27.7	1317	21.1±5.20	6.6-33.7	3.3**
2007	65	20.1±5.12	3.2-30.7	850	20.5±5.18	2.6-34.7	0.6
2008	35	18.8±4.58	11.6-30.8	536	19.8±3.97	8.2-34.5	1.5
2009	19	17.0±3.95	8.8-23.3	354	18.7±3.94	8.7-33.9	1.8
2010	19	19.3±2.87	15.8-25.6	264	19.7±3.71	10.0-30.3	0.6
2011	10	18.6±3.07	14.6-23.8	239	18.9±3.76	9.9-29.9	0.4
2012	9	19.7±3.57	15.3-25.3	166	19.9±3.96	10.8-33.3	0.2
2013	4	20.0±4.76	15.2-24.2	142	18.2±3.65	10.4-27.8	1.1
2014	5	18.0±2.77	15.8-22.6	126	18.0±3.62	9.0-30.4	0.1
Total	5297	18.3±4.14	2.3-31.7	28725	18.1±4.34	2.0-34.8	7.6**

* $p<0.05$ and ** $p<0.01$

Figure 1: Age compositions of Russian and Persian sturgeons in Iranian waters of the Caspian Sea during the years 1990-2014.

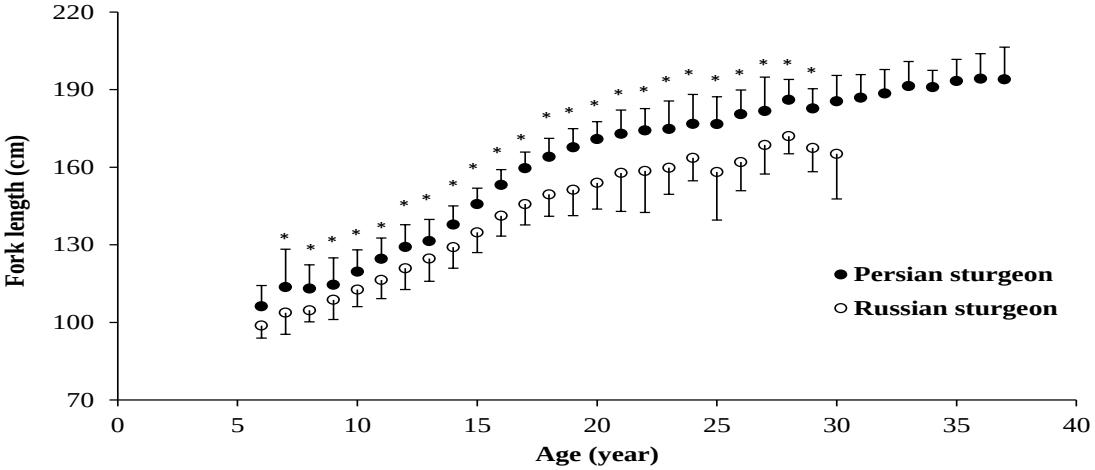

Figure 2: Average (±SD) fork length at age of Russian and Persian sturgeons in Iranian waters of the Caspian Sea. Asterisks indicates pairwise significant at age.

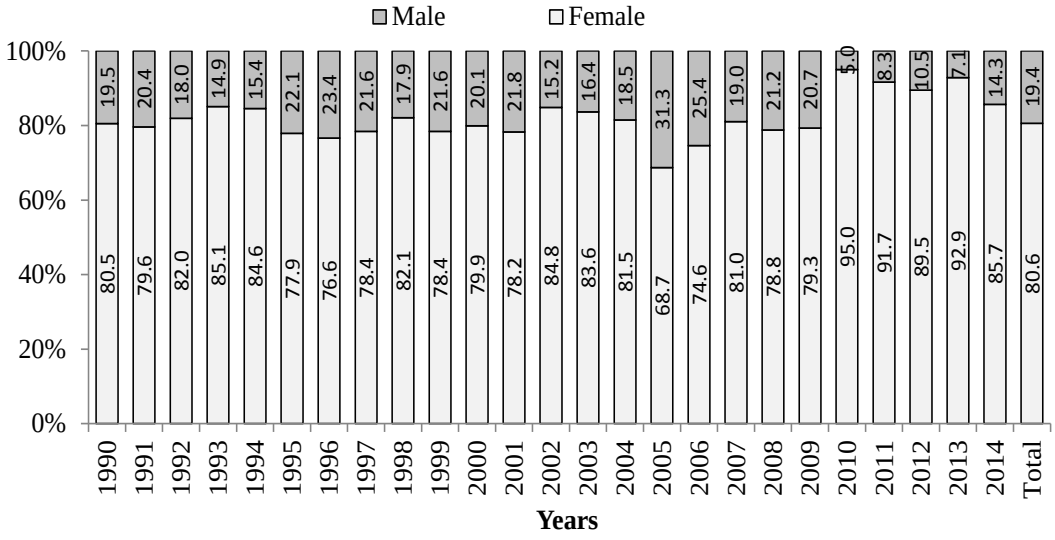

Figure 3: Sex compositions of Russian sturgeon in Iranian waters of the Caspian Sea during the years 1990-2014.

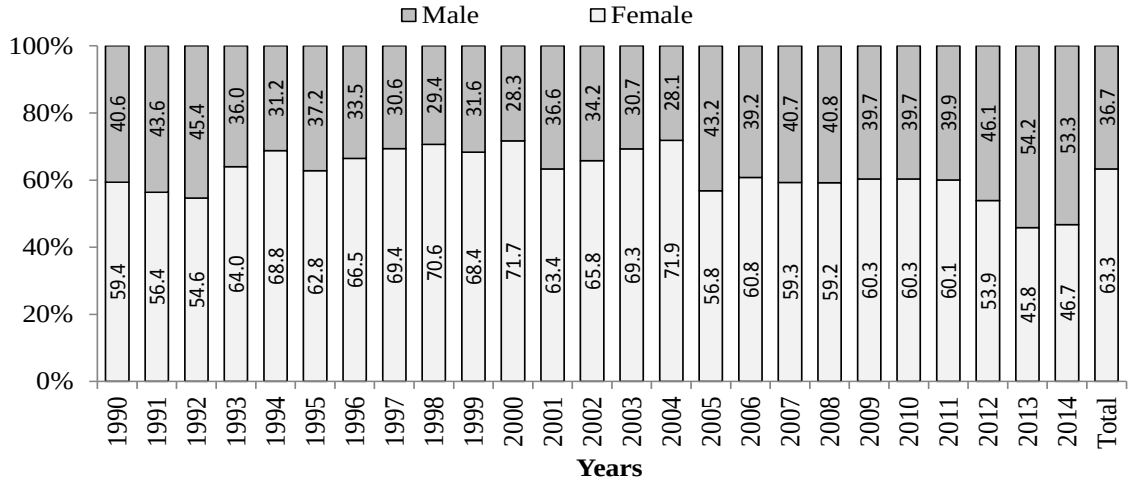

Figure 4: Sex compositions of Persian sturgeon in Iranian waters of the Caspian Sea during the years 1990-2014.

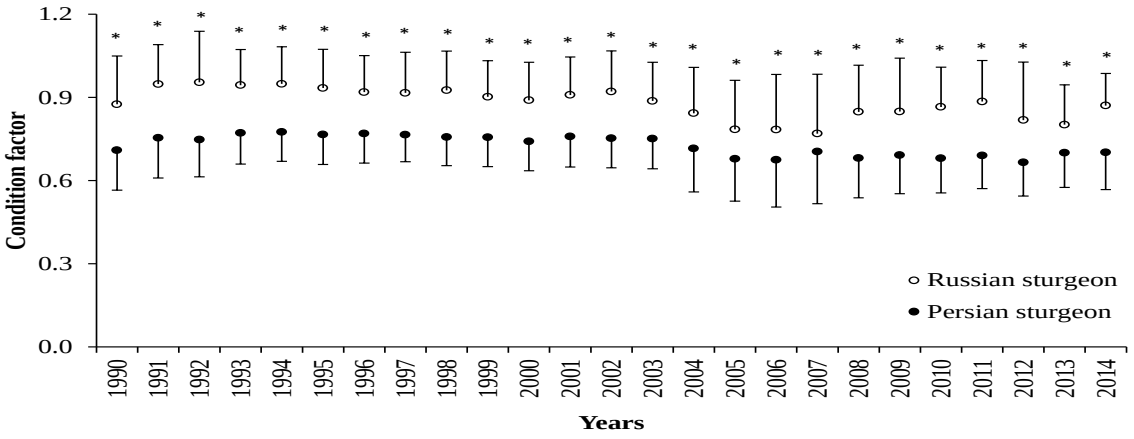

Figure 5: Average (±SD) condition factor of Russian and Persian sturgeons in Iranian waters of the Caspian Sea during the years 1990-2014. Asterisks indicates pairwise significant at year.

Discussion

The population of Persian sturgeon in the Volga and Ural Rivers was proposed to be an intra-species group of the Russian sturgeon. It was called the "summer spawning sturgeon" as it migrates for spawning in late spring (Holcik, 1989) compared to the Russian sturgeon that migrates in the winter. Comparison between morphological features of the late spring sturgeon from the Volga and Ural Rivers with those of the Kura population revealed great similarities. However, many differences were also noted between this late spring group and the winter form this sturgeon (Holcik, 1989).

More detailed morphological investigations of *A. gueldenstaedtii* and *A. persicus* from the Volga River were conducted by Putilina, and differences were determined in 5 morphometric and 35 meristic characters, as well as in a series of biological indices, which included (Holcik, 1989). Luk'yanenko *et al.* (1973, 1974) and Karataeva *et al.* (1974) also reported that the antigenic components in the blood serum proteins of late spring sturgeon in the Volga River are almost similar with those of

A. persicus from the Kura River. While Borodin (1897) originally described this sturgeon as a separate species, Berg (1948) gave it sub-species rank using the trinomial nomenclature *A. gueldenstaedtii persicus*. However, in 1986, Artyukhin and Zarkua showed that it merits species rank and this has been accepted by taxonomists.

Keyvanfar *et al*., (1987) utilizing the iso-electrofocusing method and showed that extraction of caviar proteins was able to distinguished two species of Persian and Russian sturgeons. Based on the mtDNA analysis of the ND5 gene, Pourkazemi *et al*. (2000) found that these two species showing 2.2% sequence divergence suggesting that these two species diverged about one million years ago. Analysis using genetic distance and the UPGMA and NJ evolutionary trees confirms these findings. Further molecular-genetic investigations (Birstein and DeSalle, 1998; Birstein and Doukakis, 2001; Ludwig *et al*., 2001; Ludwig *et al*. 2002; Krieger *et al*., 2008; Ruban *et al*., 2008) based on sequence of the mitochondrial genome did not reveal in an *A. persicus*-clade separated from *A. gueldenstaedtii*. These authors found no support to consider them as separated species. Consequently, they suggested that development a system for species identification of *A. gueldenstaedtii* and *A. persicus*, and therefore it is necessary to study the polymorphism of nuclear markers.

Studies conducted by other researchers using PCR-RAPD introduced specific bands for the identification of these two species. These two species can thus be distinguished from each other base on the DNA content (Gharaei, 2001). Ogden *et al.* (2013) employed RAD sequencing to discover and characterize single nucleotide polymorphism (SNP) DNA markers for use in sturgeon conservation in four tetraploid species including Russian and Persian sturgeons and for the first time, SNPs showed wide differentiation between Russian and Persian sturgeons populations and representing an important advance in our ability to manage these cryptic species.

In conclusion, the biological information reviewed in this study shows a variety of differences between these two species. The present study shows that the average fork length, total weight, caviar weight, sex ratio, age structure and condition factor of Russia and Persian sturgeons are difference. All these characteristics (except condition factor) of Persian sturgeon were higher than the Russian sturgeon. According to the present results, two species of Persian and Russian sturgeons are separate species which is similar to that reported by several researchers. Therefore, different conservation and management activities need for these two valuable sturgeons in the Caspian Sea.

Acknowledgments

This study was supported financially and scientifically by the Iranian Fisheries Science Research Institute and the International Sturgeon Research Institute. We hereby sincerely thank all our colleagues at the Iranian Fisheries

Science Research Institute, International Sturgeon Research Institute, Caspian Sea Ecology Research Center and Iranian Fisheries Company for their cooperation during the study.

References

Artyukhin, E.N., and Zarkua, Z.G., 1986. On the question of taxonomic status of the sturgeon in the Rioni River (the Black Sea basin). *Voprosy Ikhtiologii*, 26, 61-67 (in Russian).

Bagenal, T.B., 1978. Fish production in fresh waters. Blackwell Scientific Publications, Oxford. 365 p.

Berg, L.S., 1948. Freshwater fishes of the U.S.S.R and Adjacent countries. Vol. 1I PST Jerusalem. pp. 46-81.

Birstein, V. J. and DeSalle, R., 1998. Molecular phylogeny of Acipenserinae. *Molecular Phylogenetic Evolution*, 9, 141–155.

Birstein, V.J. and Doukakis, P., 2001. Molecular identification of sturgeon species: science, bureaucracy, and the impact of environmental agreements. Monitoring migratory animals. Publ:Fed. Agency for Nature Conservation (BfN), Bonn, pp. 47–63.

Borodin, N.A., 1897. A report about a summer 1895 zoological expedition on board of the cruiser "Uralets" in the northern part of the Caspian Sea. Original title: Otchet ob ekskursii s zoologicheskoj tsel'yu letom 1895 goda na krejsere "Uralets" v severnoj chasti Kaspijskogo morya. *Vestnik rybopromyshlennosti*, 12(**1**), 1-31.

Chugunova, N.I., 1959. Procedure for study of the age and growth rate of fishes (in Russian). Sov. Nauka Press, Moscow. 164 p.

Gharaei, A., 2001. Molecular identification between two species *Acipenser persicus and A. gueldenstaedtii* by means of RAPD technique. M.Sc. Thesis, Natural Resources Engineering-Fisheries Faculty, Tehran University, Iran. 109 P.

Hammer, Ø., Harper, D.A.T. and Ryan, P.D., 2001. PAST: paleontological statistics software package for education and data analysis. *Palaeontologia Electronica* 4(**1**), 9.

Holcik, J., 1989. The freshwater fishes of Europe. Vol I/II, General Introduction to fishes: Acipenseriformes. *AULA Verlag Wiesbaden*, pp. 345-366.

Karataeva, B.B., Luk'yanenko, V.I. and Terentev, A.A., 1974. Dinamika khodasezonnykh ras russkogo osetra v del'te Volga po dannym immunokhimicheskogo issledovaniya. In: Tezisyotchetnol sessii TSNIORKH, posvyashchennol 10-letiyu institua. Lzd. Volga, Astrakhan'. pp. 92-94. (In Russian).

Keyvanfar, A., Rochu, D., Marneux, M., Herance, N. and Fine, J.M., 1987. Différenciation par focalisation isoélectrique des protéines de caviar de quatre espèces et d'une sous-espèce d'esturgeon anadrome de la mer Caspienne. *Comptes Rendus de l'Académie des Sciences,* 304(**3**), 191–193.

Krieger, J., Hett, A.K., Fuerst, P.A., Artyukhin, E.A. and Ludwig, A., 2008. The molecular phylogeny of

the order Acipenseriformes revisited. *Journal of Applied Ichthyology*, 24, 36–45.

Levin, A.V., 1997. The distribution and migration of sturgeon in the Caspian Sea. In: Birstein, V.J., Bauer, A. Kaiser-Pohlmann, A. (eds.) Sturgeon Stocks and Caviar Trade Workshop. IUCN, Gland, Switzerland and Cambridge, UK., pp. 13-19.

Ludwig, A., Belfiore, N.M., Pitra, C., Svirsky, V.G. and Jenneckens, I., 2001. Genome duplication events and functional reduction of ploidy levels in sturgeon (*Acipenser, Huso and Scaphirhynchus*). *Genetics*, 158, 1203–1215.

Ludwig, A., Debus, L. and Jenneckens, I., 2002. A molecular approach for trading control of black caviar. *International Review of Hydrobiology*, . 87, 661–674.

Ludwig, A., 2008. Identification of Acipenseriformes species in trade. *Journal of Applied Ichthyology*, 24(s 1), 2-19.

Luk'yanenko, V.I., Karataeva, B.B. and Terentev, A.A., 1973. Immuno-geneticheskaya spetsifichnost' sezonnykh rasrusskogo osetra. Doklady Akad. Nauk SSSR 213, 458-461 (In Russian).

Luk'yanenko, V.I., Umerov, I.G. and Karataeva, B.B., 1974. Yuzhnokaspiiskii osetr samostoyatel'nyl vid roda *Acipenser*.Izvestiya Akad. Nauk SSSR, *Science Biology*, 5, 736-739 (In Russian).

Moghim, M. and Nielson, J.D., 1999. Imminent collapse of the Caspian Sea stellate sturgeon (*Acipenser stellatus*): Evidence from the Iranian fishery. *Ambio*, 4(**28**), 372-373.

Moghim, M., Kor, D., Tavakolieshkalak, M. and Khoshghalb, M.B., 2006. Stock status of Persian sturgeon along the Iranian coast of the Caspian Sea. *Journal of applied Ichthyology*, 22 (Supplementary 1), 99-107.

Moghim, M., Pourkazemi, M., Tan, S.G. Siraj, S.S., Panandam J.M., Kor, D., Taghavi, M.J., 2013. Development of disomic single-locus DNA microsatellite markers for Persian sturgeon (*Acipenser persicus*) of the Caspian Sea. *Iranian Journal of Fisheries Sciences*, 12(2), 389-397.

Nasrichari, A., 1995. The study of comparison between Morphobiologic parameters of *A. gueldenstaedtii* and *A. persicus* from Southern Coast of Caspian Sea, Thesis report 131 P.

Ogden, R., Gharbi, K., Mugue, N., Martinsohn, J., Senn, H., Davey, J.W., Pourkazemi, M., Mcewing, R., Eland, C., Vidotto, M., Sergeev, A. and Congiu, L., 2013. Sturgeon conservation genomics: SNP discovery and validation using RAD sequencing. *Molecular Ecology*, 22, 3112-3123. DOI: 10.1111/mec.12234.

Pourkazemi, M., Skibinski, D.O.F. and Beardmore, A., 2000. A Preliminary study on phylogenetic relationships between five sturgeon species in the Iranian coastline of the Caspian Sea. *Iranian Journal of Fisheries Science*, 2(**1**), 1-12.

Rostami, I., 1961. Biologie et exploitation des sturgeons (Acipenserides) Caspians Narledus (meuse) France. 210 P. (In French).

Ruban, G.I., Kholodova, M.V., Kalmykov, V.A. and Sorokin, P.A., 2008. Morphological and molecular-genetic study of the Persian sturgeon *Acipenser persicus* Borodin (Acipenseridae) taxonomic status. *Journal of Ichthyology*, 48, 891–903.

Ruban, G.I., Kholodova, M.V., Kalmykov, V.A. and Sorokin, P.A., 2011. A review of the taxonomic status of the Persian sturgeon (*Acipenser persicus* Borodin). *Journal of Applied Ichthyology*, 27, 470-476.

Slice, D.E., 2007. Geometric morphometrics. *Annual Review of Anthropology*, 36, 261–281.

Zar, J.H., 2010. Biostatistical analysis. 4th edition. Prentice Hall, Upper Saddle River, New Jersey, 946 P.