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[Research]

Stock assessment of juvenile sturgeons in the Iranian water of the Caspian Sea by bottom trawl survey

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ABSTRACT

The sturgeon stock assessment was performed to aim at estimation of absolute and relative abundance and determination of species composition at lower 10 m depths using the Si-Sara2 RV vessel in the Iranian coasts of the Caspian Sea in Guilan, Mazandaran and Golestan provinces during 6-30 September 2011-2012. In this study, 40 stations were selected on the basis of stratified random sampling design and then the stock estimation was performed using the swept area method. The study was carried out using bottom trawling with 9 m head rope. The time and speed of trawling in each station were 30 minutes and 2.5 knots respectively. The Catch per Unit of Effort (CPUE) in 2011–2012 were 7.03 and 6.96 individuals per trawling, respectively. The catch per unit of area in these years were found to be 1662 and 1644 fish in nm^2, respectively. Total abundance of sturgeon juveniles was 13,327,164 individuals in 2011. So, the species composition included *A. persicus* (87.8%) and *A. stellatus* (12.2%). Total abundance of sturgeon juveniles was found to be 14,364,882 individuals in 2012 and the species composition comprised *A. persicus* (61.4%) and *A. stellatus* (38.6%). In 2011 the biomass of sturgeons in Iranian coastal water of the Caspian Sea was 295 tons and the composition of biomass included *A. persicus* (81.5%) and *A. stellatus* (18.5%), respectively. In the cruises conducted in 2011, this amount was estimated to be 217 tons comprising A. *persicus* (54.2%) and A. *stellatus* (45.8%), respectively. The results of this study in 2011–2012 showed remarkable abundance of juvenile sturgeons in Iranian coastal waters of the Caspian Sea in late summer and early autumn. So, by conserving these valuable stocks, the number of spawners will be increased in the future.

Key words: Caspian Sea, Sturgeon, Stock assessment, Bottom trawling, CPUE.

INTRODUCTION

Sturgeons of the Caspian Sea are the most important and valuable resources. Only five out of 27 species in the world (Pikitch *et al*. 2005) including beluga *(Huso huso)*, stellate sturgeon (*Acipenser stellatus)*, ship sturgeon *(A. nudiventris)*, Persian sturgeon (*A. persicus)* and Russian sturgeon *(A. gueldenstaedtii)* inhabit in the Caspian Sea. These species migrate to the major rivers for natural spawning (Holcik 1989). Stock assessment of sturgeons and evaluation of the changes in their stocks over time could have an important role in the fisheries management as well as planning the conservation and sustainable exploitation of their resources.

The sharp decline in sturgeon stocks has led to establishing some conservation programs by the Caspian littoral states as well as some international organizations. Since 2000, sturgeon endangered species were listed in Appendix II of CITES (Pourkazemi 2008), while

restrictions were imposed on the fish's trade from 2001. According to the Caspian Sea Bio-resources Commission approvals and also the CITES Convention and the International Workshop for assessment of sturgeon stocks in Astrakhan, Russia, in order to unify methods of study on sturgeon resources, it was decided that all Caspian states should participate in the cruises for sturgeon stocks assessment and use bottom trawl surveys for this assessment. So that one of the most important factors in determining caviar export quotas was the countries participation in the cruises for the sturgeon stocks assessment.

According to this legislation adopted in a joint meeting of experts of the Iranian Fisheries Science Research Institute and KaspNIRKH Russia with the participation of FAO experts prepared project proposals on the sturgeon stock assessment. These cruises were started with the participation of all five Caspian littoral states from 2001.

Thereafter, some studies were conducted to assess the sturgeon stocks in Iranian waters of the Caspian Sea from 2003 independently.

The sturgeon stock assessment trawl surveys were also conducted from 2011 through 2012 in order to determine the species composition, relative abundance, distribution, stocks estimation and absolute abundance of different species of sturgeon in Iranian waters.

MATERIALS AND METHODS

The marine survey for sturgeon stock assessment was conducted in September 2011 and September 2012 to estimate the abundance of each species and their composition (%). The study area located in the Iranian waters of the Caspian Sea (lying below Imaginary line from Astara city (longitudinally 48° 52' and latitudinally 38° 26') to Hassan Gholi (longitudinally 53° 55' and latitudinally 37° 22') in Guilan, Mazandaran and Golestan provinces (Fig. 1). The Sisara 2 R/V with engine power of 250 hp and 9 m bottom trawl was used for sampling sturgeons at depths less than 10 m. Trawling was carried out in 40 stations selected using a stratified random sampling design (Table 1). The number of stations in each stratum was based on the area of the strata in terms of the total study area (772.7 nm^2). Trawling were carried out in the daytime, by the trawling velocity kept at 2.5 knots and lasted 30 minutes in each station. At each station, geographic location, depth, trawling duration, distance traveled along the coast were recorded. The total length of fish was measured with an accuracy of 1 cm and weight with an accuracy of 1 g.

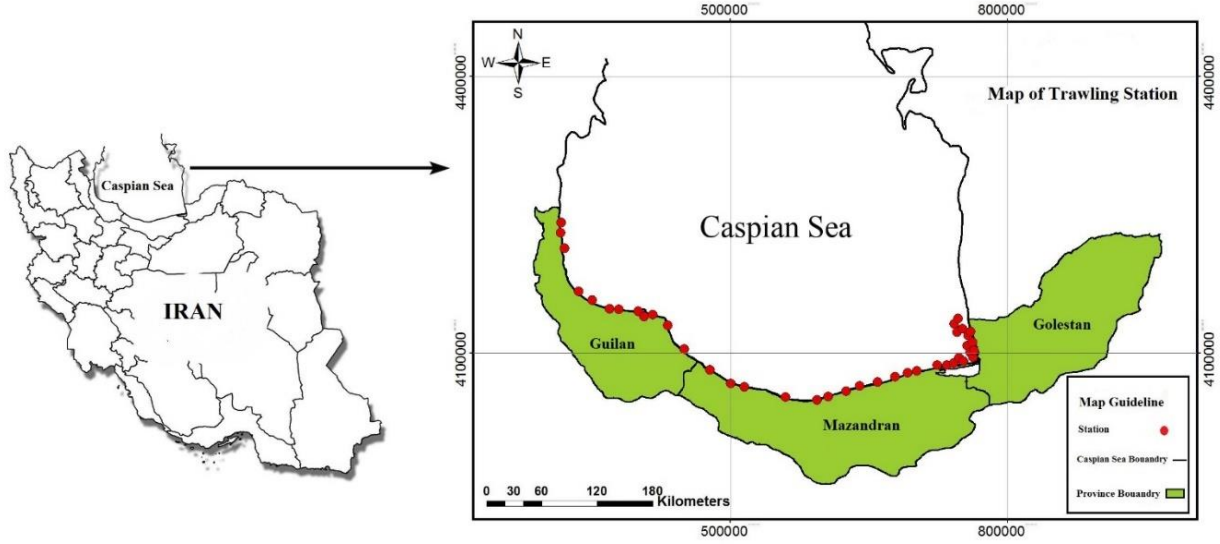

Fig. 1. Map showing trawling stations in the Iranian waters of the Caspian Sea.

Table 1. Number of trawl stations in the study area (2-10 m depth).

Province	Number of stations
Guilan (Western region)	12
Mazandaran (Middle region)	13
Golestan (Eastern region)	15
Total	40

Specimens with total lengths >86 cm were considered to be adults in the case of *A. persicus*, *A. stellatus*, *A. nudiventris* and *A. gueldenstaedtii*, while those with total lengths > 180 cm considered in the case of *H. huso* (Khodoreskaya & Krasilov 1999). Biomass of sturgeons was calculated using the swept area method (Sparre & Venema, 1998) as agreed upon the Commission on Aquatic Bio-resources of the Caspian Sea.

Relative abundance of sturgeons in terms of species was calculated on the basis of CPUE which was number of sturgeons per trawls towed for half an hour (Sparre & Venema 1998).

Formulas and equations used in sturgeon stock assessment

Calculation of swept area: $a = D*h*X_2$

where a = swept area
D = distance traversed
h = length of upper rope
X_2 = coefficient of bottom

Trawl opening (0.644 for 9 m trawl)

Catch per unit area for each trawl = $(cw/t)/(a/t) = cw/a$

where cw = catch amount per trawl
a = swept area per trawl
t = swept time (h)

Biomass per unit area = $b/a = (cw/a)/x_1$

where b = biomass per unit area
x_1 = vulnerability coefficient (0.04 for *H. huso*, 0.1 for *A. persicus* and 0.07 for *A. stellatus* for 9 m trawl)
(Cw/a) = mean catch per unit area for all trawls

Biomass for total study area $B = [(\sum cw/\sum a) *A]/ x_1$

where B = Biomass in total study area
A= total area studied (surface area of Iranian waters from 2–10 depths is calculated as 772.7m^2.

Results obtained were analyzed using Excel and SPSS.

RESULTS

The number of caught individual

In 2011, the total number of caught sturgeons was 281 individuals comprising 256 Persian sturgeons and 25 stellate sturgeons, while in 2012, the total number of caught sturgeons was 278 individuals comprising 193 Persian sturgeon and 85 stellate sturgeon. The highest number of fish was caught in Mazandaran province while the lowest number was in Golestan Province. In these cruises, only *A. persicus* and *A. stellatus* were caught (Table 2).

Species composition

In 2011, the sturgeon species composition of the trawl catch in all studied areas included Persian sturgeon (91.1%) and stellate sturgeon (8.9%),

while in 2012 were 69.4% Persian sturgeon and 30.6% stellate sturgeon (Tables 3-4, Fig. 2).

Relative abundance

The CPUE of sturgeon was 7.03 individual per 30 minutes trawling in 2011, while was 6.96 in 2012 (Table 5).

Catch per unit of Area (CPUA)

In 2011 and 2012, catch per unit of area were 1622 and 1646 individuals per nm^2,respectively including 1514 and 1141 individuals per nm^2 for Persian sturgeon and 148 and 503 individuals for stellate sturgeon in 2011 and 2012, respectively (Table 6).

Table 2. The number of sturgeons caught in different provinces.

Provinces	2011			2012		
	A. persicus	*A. stellatus*	Total	*A. persicus*	*A. stellatus*	Total
Guilan	87	5	92	61	9	70
Mazandaran	168	19	187	131	76	207
Golestan	1	1	2	1	0	1
Total Catch	256	25	281	193	85	278

Table 3. Sturgeon catch composition in different provinces (%).

Provinces	2011			2012		
	A. persicus	*A. stellatus*	Total	*A. persicus*	*A. stellatus*	Total
Guilan	94.57	5.43	100	87.14	12.86	100
Mazandaran	89.84	10.16	100	63.29	36.71	100
Golestan	50	50	100	100	0	100
Total	91.1	8.9	100	69.4	30.6	100

Table 4. Species composition of sturgeons caught in different provinces (%).

Provinces	2011		2012	
	A. persicus	*A. stellatus*	*A. persicus*	*A. stellatus*
Guilan	33.98	20	31.60	10.59
Mazandaran	65.63	76	67.88	89.41
Golestan	0.39	4	0.52	0
Total	100	100	100	100

Table 5. Catch per unit of effort (CPUE) of sturgeons caught (depths < 10 m) in Iranian coastal water of the Caspian Sea in 2011-2012(numbers of sturgeon per trawl).

Year	Provinces	Number of trawl	*A. persicus*	*A. stellatus*	Total
2011	Guilan	12	7.25	0.42	7.67
	Mazandaran	13	12.92	1.46	14.38
	Golestan	15	0.07	0.07	0.14
	Iranian waters	40	6.40	0.63	7.03
2012	Guilan	12	5.08	0.75	5.83
	Mazandaran	13	10.08	5.85	15.93
	Golestan	15	0.07	0	0.07
	Iranian waters	40	4.83	2.13	6.96

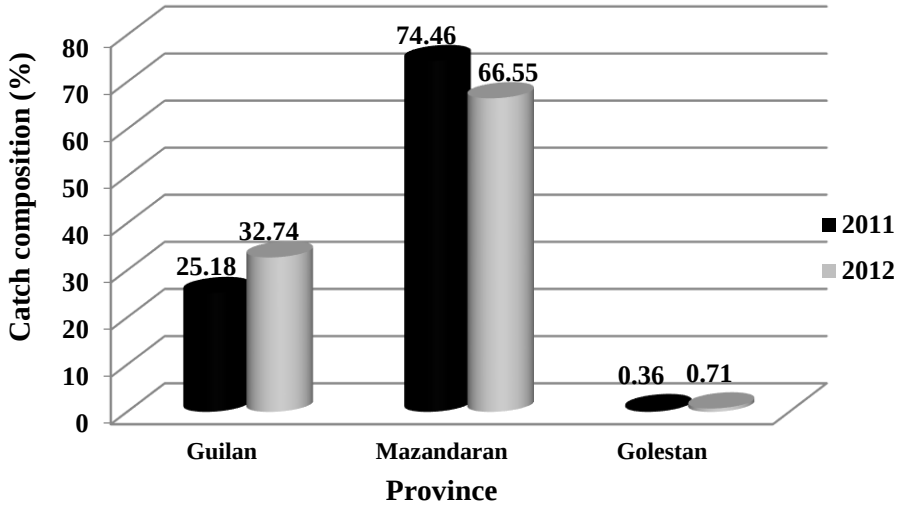

Fig. 2. The sturgeon catch composition in different provinces.

Table 6. Catch per unit of area (CPUA) of sturgeon species in 2011-2012 (numbers in nm$^{2)}$.

year	Province	Number of trawl	*A. persicus*	*A. stellatus*	Total
2011	Guilan	12	1715	98	1813
	Mazandaran	13	3056	346	3402
	Golestan	15	16	16	32
	Iranian waters	40	1514	148	1662
2012	Guilan	12	1202	177	1379
	Mazandaran	13	2383	1383	3766
	Golestan	15	16	0	16
	Iranian waters	40	1141	503	1644

Length and weight measurements

The mean total length of Persian sturgeon caught in 2011 and 2012, were 17.7 ± 3.2 ($\bar{X}$ ± SD) and 16.3 ± 3.6cm, while the mean weight were 20.5 ± 13.8 and 16.7 ± 11.7g, respectively. These values for stellate sturgeon were 26.0 ± 5.7cm, 21.9 ± 2.3cm, 33.6 ± 20.9g and 22.4 ± 5.3 g, respectively (Table 7).

Total abundance and biomass

Total abundance of sturgeons in 2011 was calculated 13,327,164 individuals, of those, 87.8% belonged to the Persian sturgeon, while 12.2% to the stellate sturgeon. In 2012, the total abundance was calculated to be 14,364,882 individuals, of those 61.4% belonging to the Persian sturgeon, while 38.6% to stellate sturgeon.

The total biomass of sturgeons in 2011 was calculated 295 tons, of those, 81.5% and 18.5% belonged to Persian sturgeon and stellate sturgeon, respectively. In 2012, the estimated total biomass was 271 tons of which, 54.2% and 45.8% belonging to the Persian sturgeon and stellate sturgeon, respectively (Table 8).

Table 7. The mean, minimum and maximum total length and weight of sturgeons caught in 2011-2012.

Year	Index	Length (cm)		Weight (g)	
		A. persicus	*A. stellatus*	*A. persicus*	*A. stellatus*
2011	Mean	17.7	26	20.5	33.6
	±SD	3.2	5.7	13.8	20.9
	Min	10.9	17.8	5	14
	Max	43.6	44.4	200	126
2012	Mean	16.3	21.9	16.7	22.4
	±SD	3.6	2.3	11.7	5.3
	Min	11	14.5	4	8
	Max	31.2	26	98	35

Table 8. Total abundance and biomass of sturgeons caught in 2011-2012.

Year	index	*A.persicus*	*A. stellatus*	Total
2011	Total abundance (number)	11695533	1631631	13327164
	Biomass (tons)	240.2	54.8	295
2012	Total abundance (number)	8817335	5547546	14364882
	Biomass (tons)	146.9	124.1	271

DISCUSSION

The results of the present study showed that the number of fish caught in 2012 has been decreased by 1% compared to 2011. The number of fish caught in 2012 showed 3.7-fold increase compared to that in the winter cruise in 2006 (Tavakoli 2007, 2010, 2013). It was also observed an increase of about 4-fold sturgeon caught compared to summer cruise in 2007 (70 individuals) and 4.8-fold in winter cruise in 2008 (57 individuals) indicating positive effects of the releasing of sturgeon fingerlings in spring and proper living conditions in late summer and early fall. The relative abundance of sturgeons in 2012 showed a slight decline of about 1% in comparison with that in 2011 yet exhibiting 4.6-fold increase compared to the winter cruise in 2006 (1.5 individuals per 30 minutes trawling) (Tavakoli 2007). The relative abundance in 2012 showed 5 and 6 fold increases in comparison with in summer and winter 2007 (1.4 and 1.14 individuals per 30 minutes trawling, respectively) (Tavakoli 2007, 2010, 2013). The abundance of sturgeons in 2012 showed about 7.8% increase than in 2011 which may be due to increased catch of stellate sturgeon and coefficients used to estimate the total abundance. In term of biomass, there was a decrease of about 8.1 % in 2012 than in 2011 which may indicate the catch of individuals with lower weight in 2012 (Tavakoli 2013).

Total abundances of sturgeons in 2012 were 4.8, 10 and 6.4 folds higher than in winter 2006 (2,977,363 individuals), summer 2007 (1,432,398 individuals) and winter 2007 (2,250,105 individuals), respectively.

In terms of total biomass, sturgeons have experienced double increase in 2012, compared to the winter 2006 (131 tons). Biomass of sturgeon in 2012, showed 13% and 53% decreases compared to summer 2007 (312 tons) and winter 2007 (578 tons), respectively which may due to the catch of individuals with higher weight in 2007 (Tavakoli 2006, 2007, 2013).

The results of 2011 and 2012 showed the positive effects of sturgeon artificial propagation on sturgeon restocking. So that, the increased number of produced stellate sturgeon fingerlings to 4000000 in hatcheries in 2012, caused increased proportion of this species in the catch.

Furthermore, due to suitable environmental conditions and food items abundant in the studied depths, sturgeon fingerlings inhabited in these areas and properly distributed. The highest distribution of sturgeon was found from Anzali Port in Guilan province through the Amirabad Port in Mazandaran province.

The low number of sturgeon in the waters off the coast of Golestan province could be due to the regional sea bed, low depth and therefore the rapid impact of waves and temperature on shallow depth and feeding competition.

Changes in the political management of the Caspian coastal countries have been tended a major impact on joint exploitation of common aquatic resources of the Caspian Sea. The catch of sturgeon in the years before the collapse of the Soviet Union (1985) reached to 28.5 thousand tons but due to the lack of a unified management system as well as the over-increasing illegal fishing and also lack of surveillance and control over caviar smuggling, the legal catch reached to less than 800 tons in 2008 (Pourkazemi 2008). Important factors responsible for sturgeon stocks decreasing are sharp decline of natural spawning, a large amount of industrial wastewater and urban drainage in spawning areas, activities related to oil resources, as well as the system of exploitation and management of sturgeon stocks.

The sharp decline in invaluable stocks of the sturgeon in the Caspian Sea caused that in 2000 the sturgeons assigned to place in endangered species list in Appendix II of CITES (Convention on International Trade in endangered species of wild Fauna and Flora).

Because these fish species reach sexual maturity at the high age, setting gillnets with small mesh size for catch of bony fishes caused remove of huge number of sturgeon fingerlings. Given the importance of the subject, gillnet fishing ban in the former Soviet Union was established in 1964 (Lukyanenko *et al*. 1999). Due to restocking of sturgeons stocks, Iranian Fisheries Organization has put the artificial propagation and release of sturgeon fingerlings in its agenda since 1972. Maximum release of sturgeon's fingerlings was recorded in 2001 with 20 million fingerlings (Parafkandeh *et al*. 2011).

The effect of artificial propagation and releasing fingerlings on sturgeon stocks was clearly obvious in the late summer and early autumn cruises.

Even changes in proportion of the species propagation can be seen in the cruises results. Sturgeon stocks size are always subject to continual changes due to factors such as birth, growth, mortality, migration and etc., according to the time and place. On the other hand, the sampling instruments and computational methods also provide the possibility of error in the estimates. The error is created due to the moving of fishes, such as daily and seasonal migration and climatic conditions that sampled instruments are exposed to them (Laevastu & Favorite 1988; Gunderson, 1993). Sturgeon stocks is difficult to quantify, especially different species, each with specific ecological characteristics. While the use of trawling for evaluating stocks has some limitations, but it can provide valuable information in the distribution and relative abundance of the stocks (Least & Favorite 1988; Sparre & Venema, 1998). Various factors affecting the amount of catch by trawls that some of them are as follows:

Sturgeon's distribution varies in the Caspian Sea depending on the region, season and different environmental factors. For example, in the southern part of the Caspian Sea, the stellate sturgeon and beluga juveniles occupy deeper waters to feed particularly in winters. Mature Russian sturgeon moves to different depths between 8 to 90 meters for feeding (Khodorevskaya & Krasikov, 1999). Stellate sturgeon migrate into the middle depth and when their length is 20 cm, may feed on marine benthic organisms and organisms in the water column as well as benthophagous fishes.

Young beluga sturgeons migrated to the northern part of the Caspian Sea, with the size of 40 cm, feed on the pelagic fish, such as kilka and sand smelt (Polyaninova 1983; Khodorevskaya & Krasikov 1999).

The catchability coefficient is difference according to fish responses to different fishing instruments.

In some species, it depends on the depth and seasons and in the others, on the vertical distribution patterns (the water column structure). Exposure of a species to the fishing

instrument depends on the size of the fish and effects of age variation on the behavioral characteristics (Laevastu & Favorite 1988). There are seasonal differences in migration of many sturgeon species such as stellate sturgeon. Consequently, the catchability coefficient of trawls will change in different seasons (Khodorevskaya & Krasikov 1999). Unfortunately, time series of such information is not available for sturgeons in the Caspian Sea.

The trawl surveys usually carry out in less developed fishing areas and sampling is insufficient. In areas that stocks have been widely exploited, the distribution of species outside their fishing grounds can be studied using trawl surveys (Laevastu & Favorite 1988). In recent years, some meetings have been conducted by Food and Agriculture Organization of the United Nation (FAO) by participation of some experts from the five littoral countries in order to achieve the appropriate methods for stock assessment of sturgeons with no results. So, we hope adopting a single method for estimating sturgeon stocks and total allowable catch in the Caspian Sea in further meetings.

The Littoral States around the Caspian Sea still employ the methodology adopted in the meeting of experts (Iranian and Russian experts, FAO and CITES) for estimating the abundance and biomass of the sturgeon stocks in the Caspian Sea by trawl surveys, till further achievement of the appropriate method for sturgeon stocks assessment.

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REFERENCES

Gunderson, DR 1993, Surveys of fisheries resources. John Wiley & Sons. New York. In: Laevastu, T, Alverson, DT & Marasco, RJ 1996, Exploitable Marine Ecosystems: Their behavior & Management Fishing News Books. 256 p.

Holcik, J 1989, The freshwater fishes of Europe. Vol. 1, Part 2, Acipenseriformes. AULA-Verlag Wiesbaden .470 p.

Laevastu, T & Favorite, F 1988, Fishing and stock fluctuation. Fishing News Books Ltd., Surrey, 239 p.

Khodorevskaya, RP & Krasikov, YeV 1999, Sturgeon abundance and distribution in the Caspian Sea. *Journal of Applied Ichthology,* 15: 106-113.

Lukyanenko, VI, Vasilev, AS, Lukyanenko, VV & Khabarov, MV 1999, On the increasing threat of extermination of the unique Caspian sturgeon populations and the urgent measures required saving them, 15: 99-102.

Parafkandeh Haghighi, F, Behrouz Khoshghalb, M, Tavakoli, M & Kaymaram F 2011, Evaluation of Iranian fishery strategy in restoration of sturgeon stocks in the Caspian Sea. The First National Iranian Aquaculture Symposium. Anzali, Iran. 660 p. (In Persian).

Pikitch, EK, Doukakis, P, Lauck, L, Chakrabarty, P & Erickson, DL 2005, Status, trends and management of sturgeon and paddlefish fisheries. *Journal of Fish and Fisheries* 6: 233-265.

Polyninova, AA 1983, Feeding and food supply of hatchery produced sturgeon fingerling in the western part of the northern Caspian Sea. In: Biological principals of Sturgeon Culture. Moscow, NAUKA, pp. 200-216.

Pourkazemi, M 2008, Bio-resources of the Caspian Sea and the Convention on Environmental. Central Eurasia Studies. Tehran, Iran, 1: 1-20.

Sparre, P & Venema, SC 1998, Introduction to tropical fish stock assessment. FAO Fisheries Technical Paper, 450 p.

Tavakoli, M 2007, Stock assessment of the sturgeon fish in the southern Caspian Sea. Report to Iranian Fisheries Research Organization, Tehran, Iran, 136 p. (In Persian).

Tavakoli, M 2010, Stock assessment of the sturgeon fish in the southern part of Caspian Sea. Report to Iranian Fisheries Research Organization, Tehran, Iran, 169 p. (In Persian).

Tavakoli, M 2013, Stock assessment of the sturgeon fish in the southern Caspian Sea (Iranian water) 2009-2012. Report to Iranian Fisheries Research Organization, Tehran, Iran, 90 p. (In Persian).

Tavakoli, M, Kaymaram, F, Beruoz Khoshghalb, MR & Parandavar, H 2007, An investigation on the sturgeon Stock in southern Caspian Sea. Iranian Scientific Fisheries Journal 16: 29-36 (In Persian).

ارزیابی ذخایر ماهیان خاویاری جوان در آب‌های ایرانی دریای خزر به روش ترال کف روب

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چکیده

بررسی ذخایر ماهیان خاویاری با هدف برآورد فراوانی نسبی و مطلق، تعیین ترکیب گونه‌ای صید تاسماهیان در اعماق کمتر از ۱۰ متر طی سال‌های ۱۳۹۰ و ۱۳۹۱ (۱۵ شهریور لغایت ۸ مهر ماه) با استفاده از شناور سی‌سرا ۲ در سواحل ایرانی دریای خزر در استان‌های گیلان، مازندران و گلستان انجام شد. در این مطالعه ۴۰ ایستگاه براساس طرح طبقه‌بندی تصادفی انتخاب و از روش مساحت جاروب شده برای برآورد ذخایر استفاده شد. برای نمونه‌برداری، تور ترال ۹ متری مورد استفاده قرار گرفت. مدت زمان ترال کشی در هر ایستگاه ۳۰ دقیقه و با سرعت ۲/۵ گره دریایی بود. میانگین فراوانی نسبی در سال ۱۳۹۰ معادل ۷/۰۳ عدد در هر ترال و در سال ۱۳۹۱ معادل ۶/۹۶ عدد در هر ترال بود. صید در واحد سطح در نمونه‌برداری سال ۱۳۹۰ و ۱۳۹۱ به ترتیب معادل ۱۶۶۲ عدد و ۱۶۴۴ عدد در هر مایل مربع دریایی بود. فراوانی کل ماهیان خاویاری جوان در گشت سال ۱۳۹۰ معادل ۱۳۳۲۷۱۶۴ عدد برآورد شد که سهم تاسماهی ایرانی ۸۷/۸٪ و ازون برون ۱۲/۲٪ بود. در گشت سال ۱۳۹۱ این مقدار معادل ۱۴۳۶۴۸۸۲ عدد برآورد شد که سهم تاسماهی ایرانی ۶۱/۴٪ و ازون برون ۳۸/۶٪ بود. وزن توده زنده ماهیان خاویاری در گشت سال ۱۳۹۰ معادل ۲۹۵ تن تعیین گردید که ۸۱/۵٪ سهم تاسماهی ایرانی و ۱۸/۵٪ سهم گونه ازون برون بود. در سال ۱۳۹۱ این مقدار معادل ۲۷۱ تن تخمین زده شد که سهم تاسماهی ایرانی معادل ۵۴/۲ ٪ و سهم ازون برون ۴۵/۸٪ تعیین شد. نتایج گشت سال‌های ۱۳۹۰ و ۱۳۹۱ نشان‌دهنده حضور قابل توجه ماهیان جوان در اعماق ساحلی آبهای ایرانی دریای خزر است که در صورت حفاظت از این ذخایر ارزشمند، می‌توان شاهد افزایش مولدین در سال‌های آتی بود.

*مولف مسئول