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Stock Enhancement of Sturgeon Fishes in Iran

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1. Introduction

It is essential to the development and management of a sturgeon farm to know the production costs and their evolution, showing the main items on which the cost reduction is worth effort. Production factor costs analysis of a sturgeon hatchery may also helps the manager in decision making and in adjusting to changes. Basically the production cost comprises all expenses incurred during the production process. In Iran, a basic constraint on the study of sturgeon culture development is the lack of reliable economic data, based on inputs and outputs at the farm level both in physical and value terms. Since the sturgeon farming is currently the most important sub-sector of aquaculture in the region and its rapid development has attracted considerable attention for stock enhancement during last two decades, though, determinants of its microeconomic structure in different sturgeon hatcheries and years are addressed in this chapter.

Therefore, a careful investigation of the economics of sturgeon culture would benefit both farm manager and policy makers. The production process in aquaculture is determined by biological, technological, economic and environmental factors, and can be considered in terms of interactions between technological and biological factors and the culture environment (Bjorndal, 1990). As Shang (1990) noted, take out elements such as biology, technology, feed and nutrition, engineering, fish pathology, and institutional factors all affect the economics of production. From a micro-economic view point the primary motivation of a fish farm may be profit making, although these can sometimes be other considerations such as stock enhancement. Research on the economics of sturgeon culture plays an important role in its future development. Economic assessment provides a basis not only for decision making among farm managers but also for formulating government aquaculture and enhancement policies. Economic analysis is essential to evaluate the viability of investment, determine the efficiency of resource allocation, improve existing management practices, evaluate new culture technology, assess market potential, and identify areas in which research success would have high potential payoffs (Shang, 1990).

Several factors such as illegal fishing, damaging aquatic habitats, dam construction, sand exploitation from river beds, petroleum pollution, industrial, agricultural and domestic pollution cause decline in aquatic habitat quality and affect in one way or another the fish stocks, including the sturgeons of the Caspian Sea (Khodorevskaya *et al.*,1996, Lukyanenko

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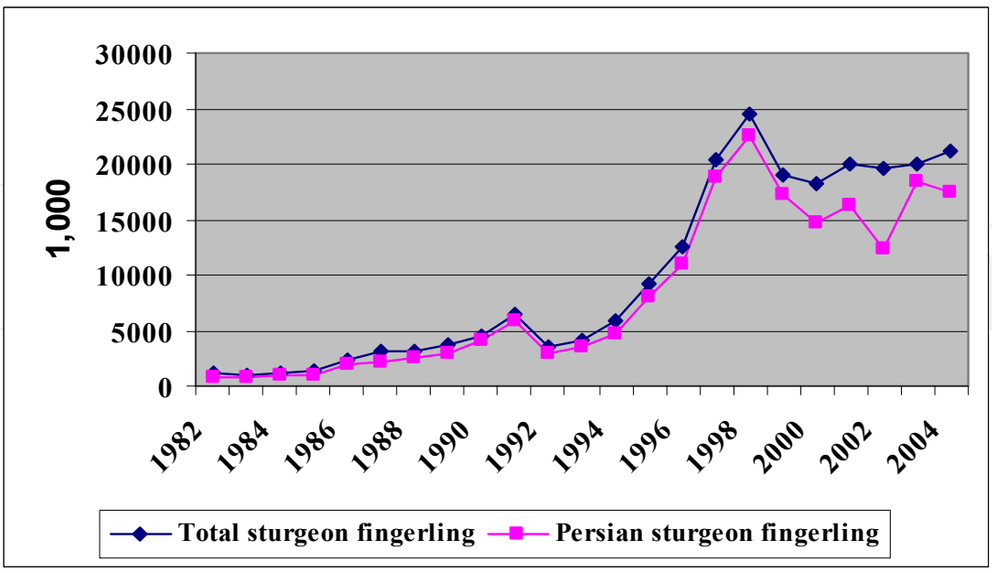
et al.,1999, Ivanov *et al.*,1999; Salehi, 2006; Pourkazemi, 2006; and Moghim *et al.*, 2006). As a result, the harmful human impact has grown at an especially rapid rate. To overcome such devastating effects, one of the options is to construct hatcheries to produce large quantities of fingerlings for stock enhancement. Recently 10% of fingerlings were also marked. Many countries with different methods and various objectives are involved in the stock enhancement activities, or reconstruction of economically valued species. All Caspian countries are involved to protect the Sea and manage the fishermen. To assess the success of stocking, now, in Iran, the best are usually landings result. Since 90% of released fingerlings were Persian sturgeon the contribution of this fish was increased over the recent years. The fish sampling method is trawler research ship. Iran contributes to these efforts through the reproduction and enhancement of thirteen native species, releasing more than 500 million fingerlings into the Caspian Sea and the Persian Gulf annually (Bartley, 1995 & 1999; Shehadeh, 1996; Bartley and Rana, 1998; Abdolhay, 1998 & 2006; Tahori, 1998; PDD, 2006 and Salehi, 2002, 2004, 2005 & 2006). As Figure 1 shows total fingerling production of sturgeon increased from 1.1 million in 1982 to more than 24 million in 1998, declined to 21 million in 2004. The production declined to 10 million in 2005 and 13.9 million in 2006 (Salehi, 2001 & 2005 and PDD, 2006 & 2007). Over the 2000-2004, the contribution of *A. persicus* was 79% of total sturgeon fingerlings production in Iran, followed by *A. nudiventris* 7.5%, *Huso huso* 6.6%, *A. gueldenstaedti* 4.2% and *A. stellatus 3%* (Table 1). On average yearly production of *A. persicus* was more than 15 million fingerlings over the 2000-04 periods, with the maximum production of 18.4 million in 2003 from the lowest level of 12.3 million in 2002. Yearly production of *Huso huso* was 1.57 million fingerlings over the same period, however, the highest level of *H. huso* production was 2.4 million in 2002 and the lowest level was 42075 in 2003, the production of species such as *Huso huso* was mainly depend on availability of brood-stock.



Sources: Abdolhay, 1998 & 2006, Salehi, 2005 and PDD, 2005 & 2006.

Fig. 1. Number of total fingerling production and Persian sturgeon over the 1982-2004 in Iran.

By considering the background of stock enhancement of sturgeon species and the result of fishing data, it seems the increase of the contribution of Persian sturgeon in total catch in Iran were probably be affected from stock enhancement. Keyvan (keyvan, 2002) noted the current situation of sturgeon enhancement plan in Iran has a key role on protecting the Caspian Sea sturgeon. This study from the point of view of economics, could present a developing policy for increasing the productivity and breeding procedure of hatchery production of sturgeon in Southern parts of the Caspian Sea including; Guilan, Mazandaran and Golestan provinces in north Iran, which Iranian Fisheries Organization were expended a huge investment over the last two decades and needs more investment for future development. Overall, the gap between the release fingerlings and the capacity of the Caspian Sea is very deep, it was estimated by Groups of researches.

Species/year	2000	2001	2002	2003	2004	Average yearly	%
Huso huso	1900919	640963	2,372,794	42,075	1570000	1,246,938	**6.6**
A. Persicus	13711199	16278595	12,331,354	18,420,205	17398000	15,177,803	**78.7**
A. stellatus	226373	820136	1,182,902	196,082	322000	635,893	**3**
A. nudiventris	1113826	1782914	1,178,582	1,414247	1300000	1,532,668	**7.5**
A. gueldenstaedti	1327480	447855	1,564,273	-	610000	1,197,307	**4.2**

Sources: Abdolhay, 1998 & 2006, Salehi, 2005 and PDD, 2006.

Table 1. Number of sturgeon fingerlings production by species over the 2000-04 in Iran.

2. Study structure and methods

A study of fingerling production of sturgeons, input costs and the contribution of cost factors was carried out to help clarify sturgeon fingerling production costs and their difference with location and year. Most of the fe-male fish were killed to separate the eggs and released the sperms on the eggs in tanks. Data were collected for more than two decades, fingerlings were 2-3 months old and 3-5 grammas. Since the relations between the Caspian Sea countries are not developed, unfortunately, the optimal stocking protocol is not developed but totally every countries were involved to protect the Sea and manage the fishermen. Attention is also directed to addressing questions such as: which input is significant in explaining outputs from various regions or year categories? What constraints inhibit increased productivity and production of existing sturgeon culture system? The study cover the three main sturgeon fingerling farming provinces, Guilan, Mazandaran, and Golestan. Over the 2001 - 2005, to determine the costs and contribution of production factors for sturgeon fingerlings for the years 2000 - 2004, a questionnaire was prepared. An expert team comprising of economists, statisticians and aqua culturists completed the questionnaire, while referring all sturgeon centers and other related departments. The criteria for cost of production are calculating the cost for brood stocks. Though, data collection, classification, and analysis cover the years 2000-2004.

3. Results and discussions

Over the 2000-04, yearly production of fingerlings of sturgeon were more than 19.7 million fingerlings. On average 41% of sturgeon fingerlings production belongs to the province of Golestan, followed by 39% in the province of Guilan, and the balance were produced by Mazandaran province. In 2004, two sturgeon centers in Golestan province with the total production of 8.8 million fingerlings were the largest producer, followed by centers in Guilan province with the production of 7.8 million fingerlings, and the sturgeon center in Mazandaran province with the production of 4.7 million fingerlings. Results show, on average, yearly production of sturgeons were 8.1, 7.6 and 4 million fingerlings over the period respectively (Table 2).

Province/ Year	*2000*	*2001*	*2002*	*2003*	*2004*	*Average yearly*	*%*	*SD*
Guilan	8006482	6996793	5,218,715	9,932,584	7781357	7587186	39	1708261
Mazandaran	4022885	3076093	3,457,803	4,850,203	4666528	4014702	20	760613
Golestan	6250430	9897577	10,559,387	5,258,579	8756815	8144558	41	2301952
All	18279797	19970463	19,235,905	20,041,366	21200000	19745506	100	1079547

SD: Standard deviation.

Table 2. Number of sturgeon fingerlings production in hatcheries over the 2000-04 in Iran.

As Table 3 shows, over the 2000-04, total costs per sturgeon fingerling production was averaged Rials 1970 in the province of Guilan, varying from Rials 1224 to Rials 2655. Though, on average, total costs per fingerling production increased 27% per year over the period. Due to expansion of fingerlings production from 5.2 million in 2002 to 9.9 million by 2003, total costs per fingerling production was drastically declined by 35%. Average cost of fertilized eggs were 15% of total costs, varying from 4% in 2000 to 24% in 2004. Average cost of Labor and salary are 52% of total costs, varying from 60 % to 42% over the same period. The other main costs are the cost of 'maintenance' and 'depreciation' averaging 8% and 10% of total costs respectively. There is a little difference in the cost of feed and fertilizer, which averaged only more than 5% of total costs. As Table 4 shows, total costs per fingerling production of sturgeon was averaged Rials 1245 in the Mazandaran province, varying from Rials 477 to Rials 1958. Over the 2000-04, on average, sturgeon center in Guilan paid 59% more than the center of Mazandaran per fingerling production. Though, on average, total costs per fingerling production per year increased dramatically by 73% over the same period. Average cost of fertilized eggs were 24% of total costs, varying from 6% in 2000 to 40% in 2004. Average cost of Labor and salary were 45% of total costs, varying from 48 % to 37% over the same period. The other main costs were the cost of 'feed and fertilizer' and 'depreciation' averaging 10% of total costs. Due to production of other produts such as kutum and carp fingerlings in Mazandaran hatchery, total cost per fingerling production of sturgeon were lower than their counterparts in Guilan and Golestan provinces. As Table 5 shows, over the 2000-04, total costs per fingerling production was accounted Rials 1837 in Golestan province, varying from Rials 1027 to Rials 3358. Though, on average, total costs per fingerling production increased 46% per year over the period. Average cost of fertilized eggs were 28% of total costs, varying from 8% in 2000 to 43% in 2002 and 40% in 2004. Due to

production of *Huso huso*, the hatcheries in Golestan province paid more than the average for fertilized eggs. Average cost of Labor and salary were 36% of total costs, varying from 46 % to 30% over the 2000-2004 period. The other main costs were the cost of 'feed and fertilizer' and 'depreciation' averaging 10% and 9% of total costs respectively. Overall, total costs per fingerling production of sturgeon was averaged Rials 1667 in Iran, varying from Rials 992 to Rials 2623 over the years 2000-2004. Though, on average yearly growth for the cost of a sturgeon fingerling production was accounted 50% in Iran, varying from 27% in Guilan to 46% in Golestan and 73% in the province of Mazandaran.

Year	2000		2001		2002		2003		2004		Average	
CF	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%
E	49	4	57	4	611	23	394	20	615	24	345	15
F&F	98	8	101	7	106	4	39	2	51	2	79	5
L&S	734	60	877	61	1301	49	946	48	1076	42	987	52
H&Ph	12	1	14	1	27	1	59	3	51	2	33	2
W&E	37	3	43	3	53	2	39	2	77	3	50	3
Main	110	9	129	9	133	5	177	9	256	10	161	8
Misc	37	3	57	4	159	6	138	7	231	9	124	5
D	147	12	158	11	266	10	177	9	205	8	191	10
TC	**1224**	**100**	**1437**	**100**	**2655**	**100**	**1971**	**100**	**2562**	**100**	**1970**	**100**
TC-D	**1077**		**1279**		**2389**		**1794**		**2357**		**1779**	

CF: Cost Factors, E: Fertilization eggs, F&F: Feed &Fertilizer, L&S: Labor & Salary, H&Ph: Harvesting & post harvest, W&E: Water and energy, Main: Maintenance, Misc: Miscellaneous, D: Depreciation and TC= Total Costs.

Table 3. Average costs (Rials[2] per fingerling) of sturgeon fingerling production over the 2000-04 in Guilan province.

Year	2000		2001		2002		2003		2004		Average	
CF	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%
E	29	6	38	8	518	29	551	36	783	40	384	24
F&F	105	22	85	18	18	1	61	4	98	5	73	10
L&S	229	48	250	53	840	47	658	43	724	37	540	45
H&Ph	14	3	9	2	54	3	15	1	39	2	26	2
W&E	14	3	14	3	18	1	15	1	39	2	20	2
Main	19	4	19	4	71	4	61	4	78	4	50	4
Misc	10	2	9	2	89	5	31	2	59	3	40	3
D	57	12	47	10	179	10	138	9	137	7	112	10
TC	**477**	**100**	**471**	**100**	**1787**	**100**	**1530**	**100**	**1958**	**100**	**1245**	**100**
TC-D	**420**		**424**		**1608**		**1392**		**1821**		**1133**	

CF: Cost Factors, E: Fertilization eggs, F&F: Feed &Fertilizer, L&S: Labor & Salary, H&Ph: Harvesting & post harvest, W&E: Water and energy, Main: Maintenance, Misc: Miscellaneous, D: Depreciation and TC= Total Costs.

Table 4. Average costs (Rials per fingerling) of sturgeon fingerling production over the 2000-04 in Mazandaran province.

[2]On average, 1US$= 8,000 Rial over the 2000-04.

Year	2000		2001		2002		2003		2004		Average	
CF	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%
E	82	8	73	10	1055	43	557	38	1343	40	622	28
F&F	175	17	73	10	250	5	65	9	269	8	166	10
L&S	472	46	342	47	805	30	389	29	1007	30	603	36
H&Ph	51	5	36	5	56	3	39	2	101	3	57	4
W&E	31	3	22	3	56	3	39	2	101	3	50	3
Main	62	6	51	7	167	4	52	6	134	4	93	5
Misc	41	4	44	6	167	3	39	6	168	5	92	5
D	113	11	87	12	222	9	117	8	235	7	155	9
TC	**1027**	**100**	**728**	**100**	**2775**	**100**	**1296**	**100**	**3358**	**100**	**1837**	**100**
TC-D	**914**		**641**		**2553**		**1179**		**3123**		**1682**	

CF: Cost Factors, E: Fertilization eggs, F&F: Feed &Fertilizer, L&S: Labor & Salary, H&Ph: Harvesting & post harvest, W&E: Water and energy, Main: Maintenance, Misc: Miscellaneous, D: Depreciation and TC= Total Costs.

Table 5. Average costs (Rials per fingerling) of sturgeon fingerling production over the 2000-04 in Golestan province.

Average cost of Labor and salary were accounted 44% of total costs, varying from more than 50% in 2000 to 36% in 2004 (Table 6). Average cost of fertilized eggs were accounted 22% of total costs, varying from 6% in 2000 to 35% in 2004. The other major inputs costs were the cost of 'feed and fertilizer', depreciation and maintenance averaging 8%, 9% and 6% of total costs respectively. Over the 2000-2004, among the operation costs factors the highest variability belongs to the fertilized eggs followed by labor and salary. As Tables 3, 4 and 5 Show, the cost per sturgeon fingerling production in Guilan is higher than the other provinces, at Rials 1,970 followed by Golestan with Rials 1, 837, and only R 1,242 in Mazandaran.

Year	2000		2001		2002		2003		2004		Average	
CF	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%	Rials	%
E	60	6	66	7	561	32	629	31	918	35	447	22
F&F	159	16	112	12	53	3	101	5	131	5	111	8
L&S	506	51	506	54	736	42	811	40	944	36	701	44
H&Ph	30	3	28	3	35	2	41	2	52	2	37	2
W&E	30	3	28	3	35	2	41	2	79	3	43	3
Main	60	6	66	7	70	4	122	6	157	6	95	6
Misc	30	3	37	4	88	5	101	5	157	6	83	5
D	119	12	103	11	175	10	183	9	184	7	153	10
TC	**992**	**100**	**937**	**100**	**1753**	**100**	**2028**	**100**	**2623**	**100**	**1667**	**100**
TC-D	**873**		**834**		**1578**		**1845**		**2439**		**1514**	

CF: Cost Factors, E: Fertilization eggs, F&F: Feed &Fertilizer, L&S: Labor & Salary, H&Ph: Harvesting & post harvest, W&E: Water and energy, Main: Maintenance, Misc: Miscellaneous, D: Depreciation and TC= Total Costs.

Table 6. Average costs (Rials per fingerling) of sturgeon fingerling production over the 2000-04 in Iran.

Average cost of Labor and salary were accounted 44% of total costs, varying from more than 50% in 2000 to 36% in 2004. Average cost for fertilized eggs were accounted 22% of total costs, varying from 6% in 2000 to 35% in 2004. The other major inputs costs were the cost of 'feed and fertilizer', depreciation and maintenance averaging 8%, 9% and 6% of total costs respectively. Over the 2000-2004, among the operation costs factors the highest variability belongs to the fertilized eggs followed by labor and salary.

As Figure 2 shows, total costs per fingerling production of sturgeon was averaged $US 0.21 in Iran, varying from $US 0.12 to $US 0.33 over the years 2000-2004. Though, on average, total costs per fingerling production of sturgeon was increased %175 over the period. The main reason for the growth of a sturgeon fingerling cost might be the effects of inflation rate in Iran, which affected all operation costs factors and the growth of the price of fertilized eggs, which affected by the global growth price of caviar in recent years.

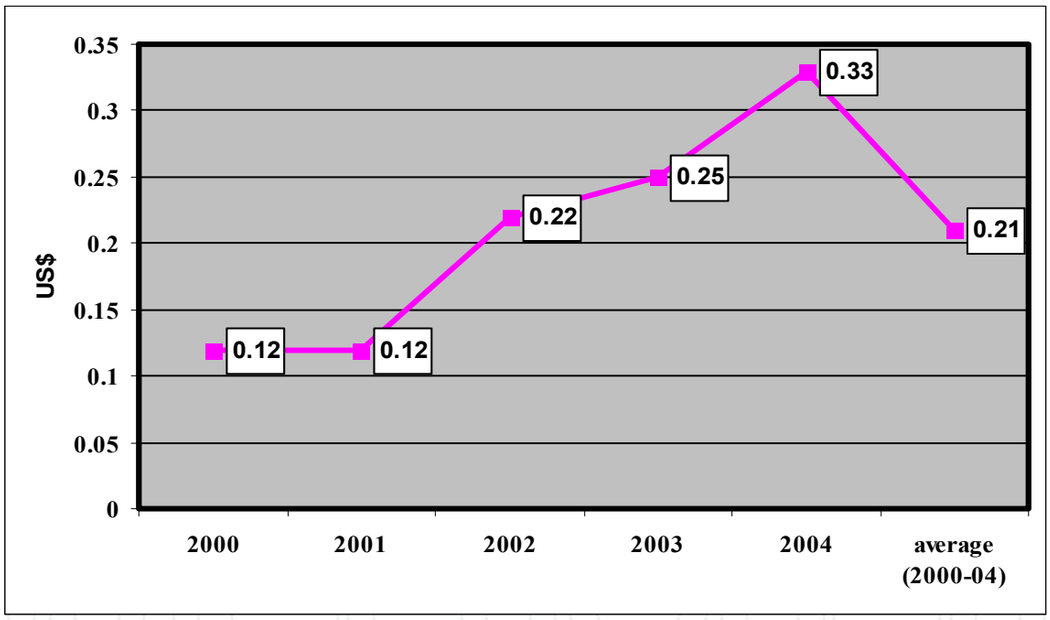


Fig. 2. Average costs ($US) of a sturgeon fingerling production for the years 2000-04 in Iran.

Comparing with other aquaculture activities, the share of labor and salary in hatcheries are very high, which noted by Salehi (Salehi, 1999, 2002 & 2005) for carp farming 12%, trout farming 13%, shrimp farming 17% and shrimp hatcheries due to using foreign experts 26% and sturgeon farming in USA were accounted 12% (Katherine *et al.*, 1985). It seems, the main reason for this higher labor and salary cost, could be justify by inactivity of hatcheries during almost 6 months off season, which could be reduced by adopting extra activities in such hatcheries. The costs sensitivity of hatcheries production of sturgeon shows labor and salary is the most sensitive, followed by fertilized eggs (Figure 3).

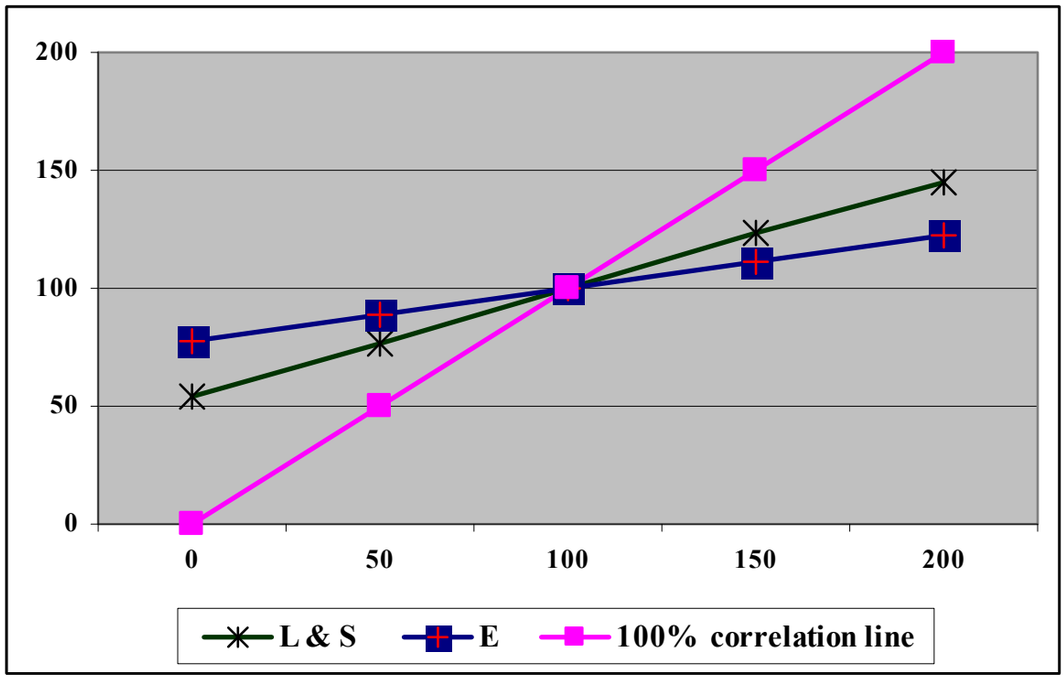


Fig. 3. The cost sensitivity of fingerling production of sturgeons for the years 2000-04 in Iran.

Despite the decline of total landing of sturgeon in the South Caspian Sea, landing indicated the increase the share of Persian sturgeon, as the positive affect of fingerling releasing over the last two decades by Fisheries of Iran. Moreover, the increase the contribution of sturgeon fish which reported by the beach seine net co-operatives is also indicated positive affect of stock enhancement (Abdolhay 1998, & 2006, Tahori, 1998, Fadaee 2002, pourkazemi, 1999 & 2006 and Moghim *et al.*, 2006). The importance of stock rehabilitation in general, and sturgeon enhancement in particular as a means of biodiversity preservation, and as a source of economic activity has been addressed in this paper. Current production and enhancement of sturgeon fingerling and a lot of investment which expended by Fisheries organization of Iran suggests that this sector might be expected to become increasingly important in coming years. Future fingerling production of sturgeons varies widely and will be to a large extent dependent on ability to obtain brood fish from the Caspian Sea and on the other hand the potential of Iranian Fisheries for operation costs to be expended. Overall, the sturgeon rehabilitation industry may benefit from research aimed at developing technically viable production and enhancement systems as did before, improved nutrition, genetic improvement, disease prevention, water quality and industry management. It seems, co-operation of beach seine net co-operatives and other involved organizations in Iran and the close and continued co- operation with other coastal countries in the Caspian Sea might be expected to have an important effect on stock enhancement and biodiversity preservation of sturgeon fish in the coming years.

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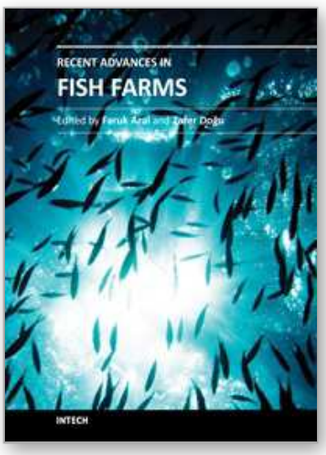

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The world keeps changing. There are always risks associated with change. To make careful risk assessment it is always needed to re-evaluate the information according to new findings in research. Scientific knowledge is essential in determining the strategy for fish farming. This information should be updated and brought into line with the required conditions of the farm. Therefore, books are one of the indispensable tools for following the results in research and sources to draw information from. The chapters in this book include photos and figures based on scientific literature. Each section is labeled with references for readers to understand, figures, tables and text. Another advantage of the book is the "systematic writing" style of each chapter. There are several existing scientific volumes that focus specially on fish farms. The book consists of twelve distinct chapters. A wide variety of scientists, researchers and other will benefit from this book.

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