IJANS International Journal of Agricultural and Natural Sciences
E-ISSN:2651-3617 12(2): 31-37, 2019

Factors affecting on illegal fishing of Persian sturgeon (*Acipenser persicus*) in the southern Caspian Sea

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Abstract

Concerns on illegal, unreported, and unregulated fishing (IUU) are increasing. Therefore, it is essential to assess the factors related to illegal fishing occurrence. Sturgeons of the Caspian Sea are exposed to the extinction risk, and thus, we aimed to identify and investigate factors affecting on illegal fishing of Persian sturgeon (*Acipenser persicus*) in the southern shores of the Caspian Sea. Here, a quantitative data collection survey was undertaken using questionnaire-based interviews. The sample population consisted of volunteer fishers who were individually or collectively engaged in either licensed or unlicensed fishing activities across the Iranian part of the Caspian Sea. Responses were numerical, and in the form of a multipoint Likert -type scale. Questionnaires were completed at fishing sites whilst fishers were undertaking fishing during winter and spring 2016, and after the removal of incomplete questionnaires, data from 350 fishers were used in the analysis. The results showed that parameters such as the lack of maritime security, lack of fines proportionate with the type of illegal activity, reducing job security and increasing poverty and unemployment, the lack of adherence to ethics and the lack of awareness of the fishermen about the status of sturgeon stocks are associated with the increasing rate of illegal fishing.

Key Words: factors effecting, illegal fishing, *Acipenser persicus*, Caspian Sea

INTRODUCTION

The Caspian Sea, with its abundant resources, plays an important role in the socioeconomic development of the region and the littoral states[1].The Caspian Sea, located in the middle of the Eurasian continent, is a unique landlocked water mass that contains exclusive fisheries [2].The Caspian Sea is the world's largest inland body of water or a full-fledged sea which is home to a wide range of species being best known for providing habitats for sturgeons[3]. Sturgeons are highly valuable species because of the increasing demand for their roe, caviar. The sturgeon fishery was historically the most important fishery in the Caspian Sea, but unfortunately sturgeon populations have drastically declined over the past two decades and have now been classified as "critically endangered" by the International Union for Conservation of Nature[4].Persian sturgeon (*Acipenser persicus*), acommercially valuable and critically endangered fish species has been suffering considerable declines in wild populations [5].Rapid loss of this species over the last century has been associated with increasing anthropogenic pressures notably over-fishing, illegal fishing, habitat loss, pollution as well as inherent life history characteristics (long life span, late maturation, and infrequent spawning) [6,7,8].

Sturgeon is one of the endangered families of fish in the Caspian Sea region, where there is up to 80% of their global caching .Unfortunately, increases of pollutants and IUU fishing have been resulted in their total population reduction [9].IUU fishing were as a threat to the marine environment [10]. Agnew et al. (2009) argued that IUU catches are between 13% and 31% of global reported catches, and over 50 percent in some areas, which was estimated between 10 and 23.5 billion dollars per year. As stated IUU fishing is a major problem in the world's fisheries [11].

The rising global demand and the increasing value of fish and fish products have made international illegal fishing a lucrative business. Despite the regulatory measures undertaken internationally, regionally and locally, the problem persists and has significantly impacted fish stocks and the global ecosystem [12]. Nearly 80% of global fish stocks are fully exploited, overexploited or depleted, and illegal fishing is one of the major contributing factors to this problem. Should current rates of depletion continue, most global fish stocks will have collapsed by 2048. Although decline in aquatic resource stocks occurs for various reasons, however, illegal fishing is recognized as one of the largest threats to sustainable fisheries worldwide [13, 14]. IUU fishing refers to fishing activities that do not comply with national, regional, or international fisheries conservation or management legislation or measures [15]. The phenomenon of 'Illegal, Unreported and Unregulated fishing', or 'IUU fishing', is among the most pressing challenges confronting fisheries scientists, managers, and conservationists in the twenty-first century. Such large scale illegal fishing has destructive impacts on fish stocks and habitats threatening marine biodiversity, and can impact management of fish markets, cause errors in determining the capacity of water resources and destabilize seafood production and job security especially in developing countries [16]. Illegal, unreported and unregulated (IUU) fishing activities can have serious detrimental impacts on marine ecosystems and ecosystem services [17]. In addition, IUU fishing exerts additional pressure on fish stocks, which may already be under pressure from unsustainable rates of legal fishing activities, and can thereby contribute further to the depletion of fish stocks [18]. Therefore, minimizing and preventing illegal fishing

is of crucial importance for fisheries sustainability [19]. Here we aimed to assess factors effecting on illegal fishing occurrence due to the importance of sturgeons, especially *Acipenser persicus,* and given that having an improved understanding such associations could play an important role in a better fisheries management including planning for the conservation and sustainable exploitation of marine resources. Thus, we propose that the lack of: maritime security, fines proportionate with the type of illegal activity, adherence to ethics, awareness of the fishermen about the status of sturgeon stocks and job security as well as increasing poverty and unemployment rates can be related to the occurrence of illegal fishing.

IUU fishing is also a serious threat for species conservation and global food and job security [20]. As of 2008, 85 % of the world's fish stocks were fully exploited, over-exploited, or depleted, with scholars predicting a complete collapse of fish stocks by 2048 at this [21]. To engage in IUU fishing, a fishing vessel must: (1) access the waters where the fish are, (2) remove the fish from the water, (3) transport the catch to the destination, and (4) offload the illegally caught fish at the destination's port. Each of these steps must be completed without being detected and detained by the authorities, and obstructing any of these steps will jeopardize the entire fishing trip [22].

MATERIALS AND METHODS

Study area

Study area covers the Iranian coast of the Caspian Sea (Fig.2). The Caspian coastline in this region is relatively uniform and surrounded by several known wetlands and bay providing corridors to the sturgeon spawning rivers. The seabed structure in this region is mainly consisted of gravel, sand and mud. Depth ranges of the Iranian coast are variable as large areas of the coast along the southeastern side are shallower than 5 m while other regions cover deeper waters. This coast and its rivers provide critical feeding and spawning grounds for several sturgeon species. Many small and large cities are located in this area with local residents being dependent on sea resources including fisheries.

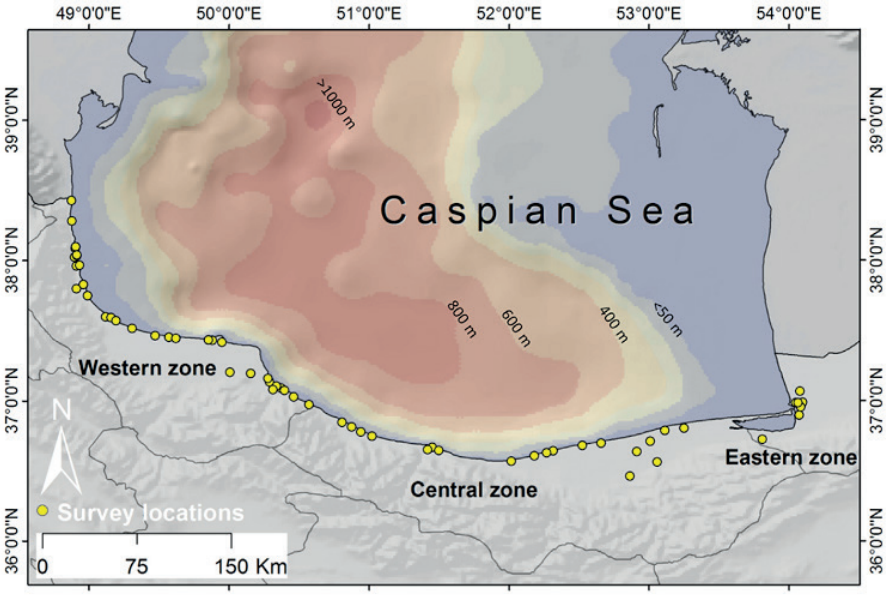

Figure2. Map of the study area in the southern Caspian Sea

Samples and data collection

This study applies a quantitative research design through a cross-sectional survey strategy. Structured questionnaires were distributed among local fisher communities for data collection. The statistical population includes all the fishers in the southern shores of the Caspian Sea which re estimated to be about 20000 fishers involved in fishing activities. The number of samples was chosen using Cochran formula. The sampling method used in this research was the random sampling. Fishers were asked to respond to the questionnaires, and 375 questionnaires were distributed, of which 300 questionnaires were retrieved. The questionnaire was presented to each fisher or a group, and discussed on the contents ensuring the completion of the questionnaire was performed accurately.

Research method

The questionnaire was comprised of two sections with 17 questions. The first section consisted of the respondents' information, while the second section was related to illegal fishing events. Section two was categorized into five groups in accordance with the nature of the questions. The responses were evaluated on a five point Likert-type scale in an order of 1 for being "quite agree" to 5 for being "quite disagree". In order to confirm the validity and reliability of the questionnaire, 25 questionnaires were completed and Cronbach's alpha was first determined. Table 1 lists the Cronbach's alpha coefficient, Average Variance Extract (AVE) and composite reliability (C.R) related to the entire questionnaire with Cronbach's alpha value greater than 0.7 being considered reliable [23]. Another factor in assessing the reliability of the internal consistency of the model is the amount of Composite Reliability (CR). The value of this coefficient is from 0 to 1 with values greater than 0.7 being accepted. The value of this coefficient is also 0 to 1 variable, which is accepted at values greater than 0.5. The total Cronbach Alfa, CR and AVE respectively were 0.84, 0.89 and 0.74 indication validity and reliability.

Table1. Validity and reliability test using Cronbach's alpha coefficient, AVE and C.R.

Cronbach's Alfa	(C.R)	(AVE)	variables
0.933	0.957	0.882	Lack of maritime security
0.736	0.815	0.606	Lack of fines proportionate with the type of illegal activity
0.759	0.847	0.604	Lack of Adherence to ethics
0.887	0.929	0.814	Lack of awareness of the fishermen about the amount of sturgeon stocks
0.912	0.936	0.792	Reducing job security and increasing poverty and unemployment
0.845	0.897	0.74	Total questionnaire

Data analysis

In evaluating factors effecting on illegal fishing occurrence, the Partial Least Square Structural Equation Modeling (PLS-SEM) was used, and a conceptual model designed. PLS-SEM is used for causal predictive analysis using both independent and dependent variables .SmartPLS is one of the prominent software applications for Partial Least Squares Structural Equation Modeling (PLS-SEM). It was developed by Ringle, Wende & Will (2005). The software has gained popularity since its launch in 2005 not only because it is freely available to academics and researchers, but also because it has a friendly user interface and advanced reporting features. Although an extensive number of journal articles have been published on the topic of PLS modeling, the amount of instructional materials available for this software is limited. This paper is written to address this knowledge gap and help beginners to understand how PLS-SEM can be used in marketing research [24].

The PLS-SEM is a multivariate analysis method to calculate variance-based structural equation models [25]. Nevertheless, PLS-SEM presents an opportunity to resolve multifaceted procedure of associations and causal relationships that are otherwise hard to uncover. PLS-SEM handles the data to assessment the path coefficient. The most commonly used application for PLS-SEM is for the analysis of quantitative data. In addition, PLS-SEM handles a distribution from the data using bootstrapping technique to find out the significance value of path coefficient [26, 27]. Using SEM allows the researcher to determine whether the relationship among the constructs in the research framework is significant. SEM is a second- generation of multivariate analysis techniques which combines various techniques in the first generation of multivariate analysis (or known as OLS – Ordinary Least Squares), such as factor analysis (FA), regression and correlation [28].

PLS-SEM is used for data analysis to test the measurements and substantive models of the study and examine the relationships among constructs in the proposed research model. The proposed model is the nascent theoretical development derived from several theories. Thus, the prediction between constructs in the proposed model requires usage of PLS-SEM [27]. In this study descriptive and inferential statistics were employed to analyze the data with the aids of structural equation modeling through Smart pls.

RESULTS

The demographic characteristics of fishers is provided in Table 2. In this respect, high percentage of the fishers were middle-age individuals. Majority of fishers had private occupation and their education level was mostly diploma.

Table2. Demographic characteristics of fisher community in the southern Caspian Sea

Age			Job			Education level		
Under 30 year	30-45 year	Upper 45 year	Employee	Freelance job	Unemployed	Uneducated	Diploma	Bachelor and higher
93	155	102	56	174	120	44	236	70

Calculation of the general fitting index model, R^2 and Q^2 is given in Table 3 Three values of 0.01, 0.25 and 0.36 were considered as the criterion value for weak, moderate and strong GOF values [29].Therefore, achieving a value of 0.69 for GOF indicates a general fit of the model.

China (1998) mentioned three values of 0.19, 0.33 and 0.67 as the criterion value for weak, moderate and strong R^2 values. Accordingly, the adjusted R^2 and R^2 values of the dependent model variables are strong achieving a value of 0.95. Q^2 indicates the predictive power of the model. The values of 0.02, 0.15 and 0.35 respectively indicate weak, moderate and strong predictive power for the endogenous structure. This value has been obtained for dependent variables of research larger than 0.36 (0.58) which indicates a relatively strong predictive capability and a relatively favorable structural model [29].

Table3. Measures of GOF, Q^2 and R^2.

Present Study	Reference values			Evaluation criteria
(Strong)0.95	(Strong)0.67	(Moderate)0.33	(Week)0.19	R^2
(Strong)0.58	(Strong)0.35	(Moderate)0.15	(Week)0.02	Q^2
(Strong)0.69	(Strong)0.36	(Moderate)0.25	(Week)0.01	GOF

Test the hypothesis of the research

The hypothesis test showed a significant effect of the independent variables on the dependent variable. If the value of the statistic t is greater than the magnitude of 1.96, the assumption of a research is assured with a confidence of 95 %. Figure 3 showed the positive direct effect of independent variables on affiliated entities. Moreover, there was a positive direct effect of independent variables on the dependent variable due to the Beta coefficient for all variables being positive and between -1 and +1(Fig 4). A significant effect of the independent variable on the dependent variable was observed, P values less than 0.05 for all independent variables.

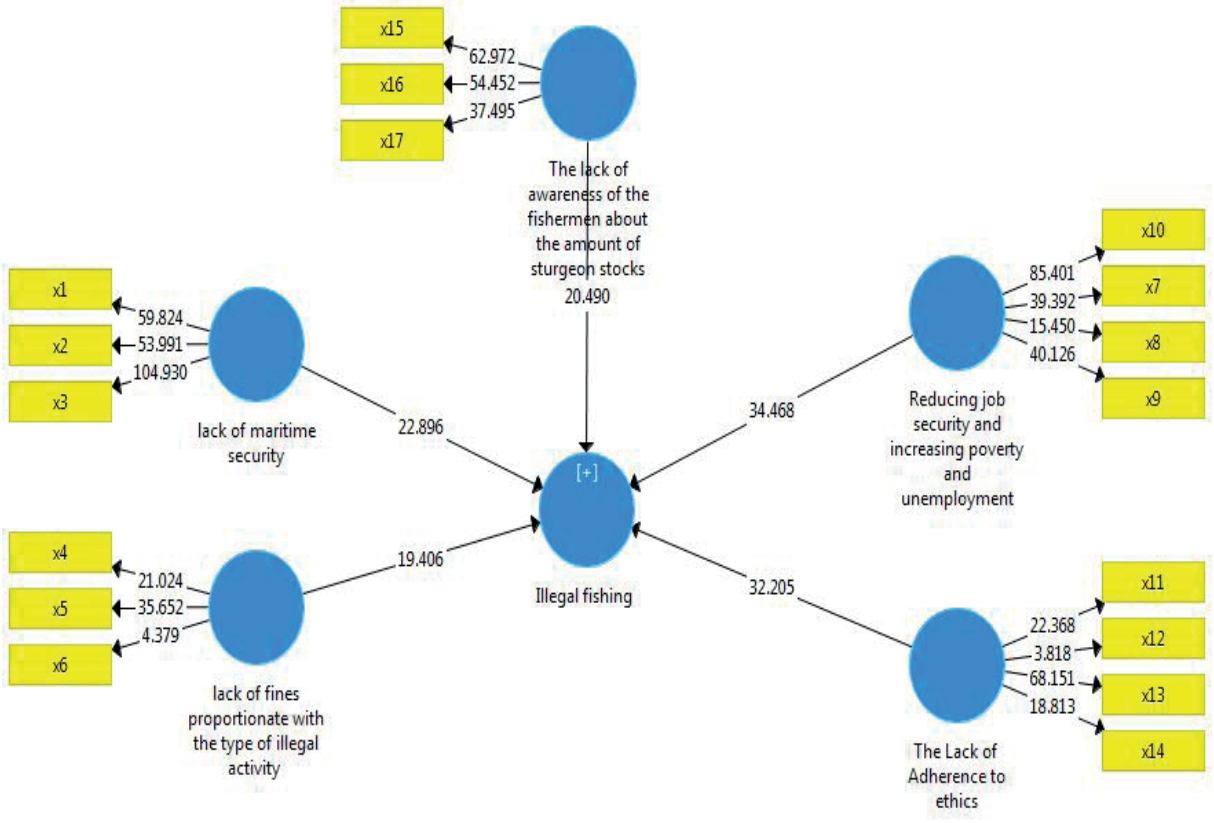

Fig 3. Effect of direct effect and statistics t

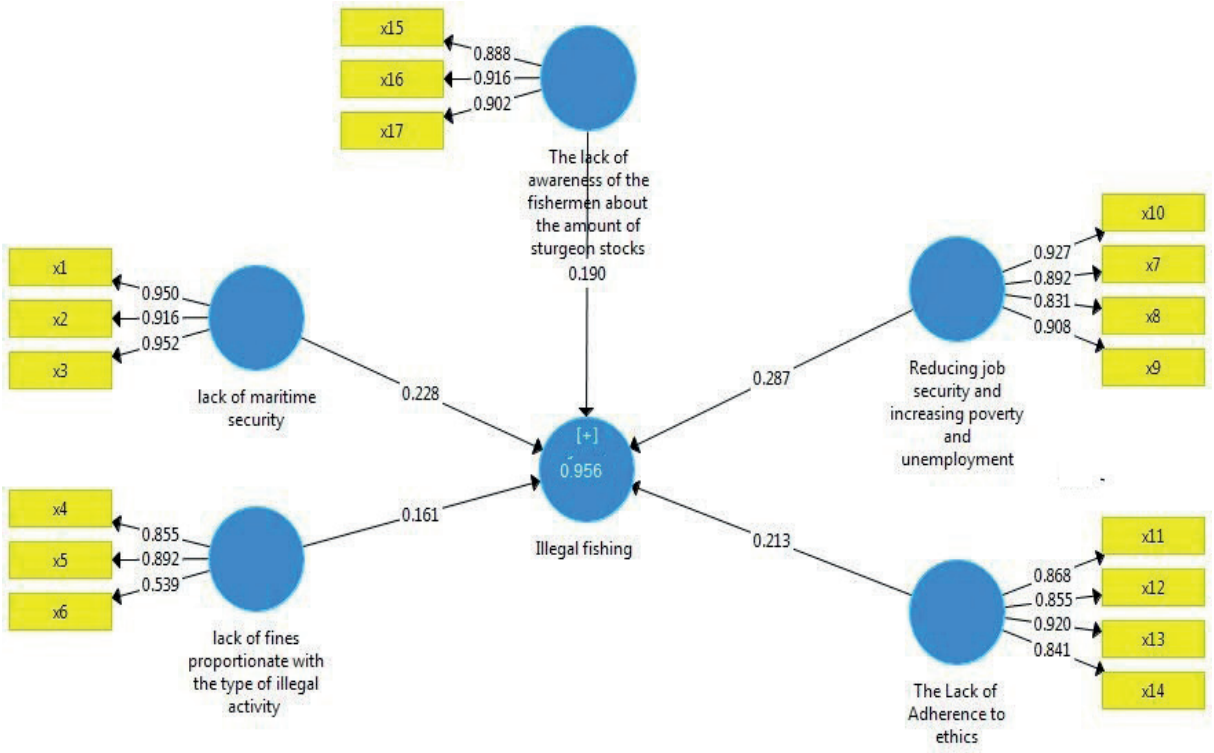

Fig 4. Effect of direct effect and Beta coefficient

Table4: Test results of hypotheses

Hypothesis	Test statistic			Result
	P<0/05	Beta coefficient	T>1/96	
Hypothesis 1. Lack of maritime security will be positively related to Illegal fishing	0.000	0.22	22.89	Confirmation
Hypothesis 2. Lack of fines proportionate with the type of illegal activity will be positively related to Illegal fishing	0.000	0.16	19.40	Confirmation
Hypothesis 3. Lack of Adherence to ethics will be positively related to Illegal fishing	0.000	0.21	32.20	Confirmation
Hypothesis 4. Lack of awareness of the fishermen about the amount of sturgeon stocks will be positively related to Illegal fishing	0.000	0.19	20.49	Confirmation
Hypothesis 5. Reducing job security and increasing poverty and unemployment will be positively related to Illegal fishing	0.000	0.28	34.46	Confirmation

DISCUSSION AND CONCLUSION

Based on the results obtained in this research, the results of the assumptions test showed that lack of maritime security, lack of fines proportionate with the type of illegal activity, Lack of Adherence to ethics, Lack of awareness of the fishermen about the amount of sturgeon stocks and reducing job security and increasing poverty and unemployment have a positive and significant effect on the illegal fishing. This achievement is consistent with previous. In this respect previous investigations on Mesolonghi Etolikon lagoons (Ionian Sea, Greece) showed The high contribution of the recorded infringements was due to absence of fishermen/vessel licenses, fines are not proportionate with the type of illegal activity, and the number of the recorded infringements represented a very small percentage of the estimated number of fishing days conducted by both professional fishermen and people not having fishing/vessel license are effecting on illegal fishing [19]. Also Kim showed ensuring the effective exercise of law enforcement and the safety of officers and fishers are can be effect on decrease illegal fisheries [30]. IUU fishing is due to respective government's lack of awareness of their maritime domain, reflected in the dearth of human resource and inadequate financial investment to solve the problems of maritime security [10]. Previous research also revealed that the social issues such as low literacy can contribute to the occurrence of crime against wildlife including illegal fishing [31, 13]. Sander et al, showed that the structured approach of crime Prevention, Detection, Suppression, and Recovery (PDSR) is important for developing efficient and effective responses to Environmental and natural resource crime (ENRC) in the context of illegal fishing in a real-world scenario [32]. The aim of the ma et al (2018) to clarify the serious problem of IUU fishing and to explore effective

solutions. They showed that Coordination and supervision of rational and sustainable fishing practices is required through appropriate legal controls. The confrontation with IUU fishing may be progressively brought under control with the help of new and modified fisheries laws and regulations such as higher penalties, more rigorous sanctioning, more careful investigation of electric fishing activities, more professional enforcement officers, greater public awareness, more systematic supervision and more successful cooperation between the government and the local population [33]. There are many empirical documents on IUU fishing worldwide, which could be the contribution of the regional managers to combat IUU fishing in the Persian Gulf. For example, Korean government by using a buy-back of vessels program has succeeded in eliminating illegal bottom trawl fishing in the coastal waters of Korea [12].

In conclusion, This research revealed factors affecting on increasing illegal fishing in the southern Caspian sea, and indicated how factors like Lack of maritime security, Lack of fines proportionate with the type of illegal activity, Lack of Adherence to ethics, Lack of awareness of the fishermen about the amount of sturgeon stocks and reducing job security and increasing poverty and unemployment have an effect on the illegal fishing. This information can be useful for governments in establishing more effective conservation policies especially by considering the role of fisher community behavior, awareness an attitude in the occurrence of illegal fishing. Finally, it is critical the need to develop methodologies that can be used directly or indirectly by the responsible institutions in the factors effecting on decreasing illegal fishing. so that ,It is important the expansion of our knowledge about the impacts of illegal activities in *Acipenser persicus* biomes and the collection of data that can be used for developing and implementing conservation policies and law enforcement actions.

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