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1. Introduction

Illegal harvesting of natural resources is one of the most crucial issues in modern conservation theory and practice (Gavin et al., 2010; Nuno and John 2014). Some of the most challenging systems to study are artisanal, small-scale, fisheries where illegal activities have become the only livelihood strategy for local fishermen [Moore et al., 2010; Pauly 2006], since in contrast to legal fisheries, it is seldom possible to directly quantify catches and by-catch by independent observers, either on board or at landings.

This article presents the data gathered on illegal sturgeon fishing and related Caspian seal by-catch in the artisanal small-scale fisheries of Caspian Sea. Recently it has been recognized that illegal, unregulated and unreported (IUU) catches have driven rapid depletion of all six Caspian sturgeon species [Pourkazemi 2006; Pikitch et al. 2005], and that by-catch in illegal sturgeon fisheries is a major cause of mortality for the endangered Caspian seal (Pusa caspica) [Dmitrieva et al. 2013]. However, to date there has been little attempt to estimate IUU sturgeon fishing based on field data. Therefore this article should be considered as a response to an urgent need to obtain a rigorous assessment of IUU sturgeon fishing activities in the Caspian in order to help in rebuilding the local sturgeon stocks [Ye and Valbo-Jørgensen 2012].

Thus, the goals of the present study were: (i) to quantify the rates of illegal sturgeon catches caught by sturgeon fishing brigades (SFBs) and seal by-catch in the Caspian illegal fisheries, i.e. to identify the high-risk gear for sturgeons and seals, to identify the rates of sturgeon catches and seal by-catch in relation to season, type of fishing gear and type of the SFB; (ii) to evaluate potential changes in seal by-catch rates to those reported by Dmitrieva et al. [2013] for 2008-9.

The paper begins by introducing the conceptual frameworks, then describing the structure of illegal sturgeon fishing activities in the studied regions and methodology, focusing primarily on the use of anthropological and sociological set of methods. It then sets out the main results, before discussion and concluding remarks close the article.

2. Conceptual frameworks

There are two approaches in the current scientific literature on how to calculate illegal catches and what data one needs to collect in order to obtain more appropriate information on entanglement. The first approach suggests that the use of law enforcement reports, scientific surveys of species abundance, historical data on legal catches, data on catch per unit effort (CPUE) in commercial and amateur fishing and size composition of longline catches, allow bioeconomists and biologists to build statistical models of fish stock biomass, and legal fishing effort [Payne et al., 2005; De Bruyn et al., 2009; Plagányi and Butterworth 2010; Hammond and Trenkel 2005; Needle 2003; Pitcher et al., 2002; Darby 2004]. This approach will generally only be viable for quantifying illegal catch activity in well documented, large-scale official fisheries. As Babayan noted, such methods can accurately estimate changes in stock level only if they are based on an initial set of high quality data and free from abnormally evolved values (outliers) (Babayan et al., 2014).

A second type of methodological approach has been developed by social scientists pre-occupied with studying artisanal fisheries. Gavin et al. (2010) identified eight different techniques on how to study illegal resource use: law-enforcement records, indirect observation, self-reporting, direct observation, direct questioning, randomized response technique, forensics, and modeling (Gavin et al., 2010). Some of them coincide with methods usually used by bioeconomists (law-enforcement records and modeling), but others are completely new for researchers, who only recently paid attention to the use of such techniques when studying the covert nature of illegal fisheries (Moore et al., 2010; Lopez et al., 2003).

Catastrophic declines of all six Caspian sturgeon species and related high rate of Caspian seal by-catch gave a rise to the interest in how to find appropriate methods in order to estimate at least approximate scale of IUU catches in the case of the Caspian. Babayan et al. based on initial field research done by Zykova et al. (Zykova et al., 2000; Babayan et al., 2008; Babayan et al., 2014) generated the index of «poaching fishing effort» comprising total length of confiscated gillnets reflected in law-enforcement reports. These authors argued that such data complemented by data on biomass of fish stock, obtained through scientific surveys of species abundance, would allow researchers to better use the statistical models when estimating the scale of the IUU catches (Ibid., p. 24).

However, since the middle of 1990s all law-enforcement authorities in the Caspian have been involved into the local criminal networks that resulted in forming tight corruptive linkages between fishing communities and regulative bodies. Despite the fact that the state tried to improve the situation by implementing the reforms, corruption has remained to be the strong obstacle for researchers limiting access to information bases including the law-enforcement reports.

To overcome such an obstacle Dmitrieva et al (Dmitrieva et al., 2013) deployed an interview – based approach in order to estimate minimum by-catch rates of Caspian seals in artisanal Caspian fisheries, evaluating seasonal variation and the impacts of different fishing gear. They found that 93% of by-catch occurred in sturgeon fishing gear. With at least several thousand seals being entangled each year, by-catch is likely to be the biggest current source of anthropogenic associated mortality for Caspian seals, potentially compromising the long-term existence of the population (Dmitrieva et al. 2013; Goodman and Dmitrieva 2016).

This paper suggests that if artisanal small-scale fisheries are considered as socially embedded phenomena (Standal et al., 2016), then understanding the social context of illegal fishing is key to targeting quantification of IUU catches and examining how sociocultural and economic factors, such as migration and transfer of artisanal technologies, influence the structure of IUU catches arising from illegal fishing.

3. Illegal sturgeon fishing in the Caspian: structure and state policy responses

The recent attempts made by the governments of Russia, Azerbaijan and Kazakhstan to reform the sector has reshaped the organisational structures of fisheries. Thus, the current affairs in the Caspian Sea fisheries could be represented by a threefold model: 1) the regulated fisheries for fresh-water fish, driven by licensed private or state/owned enterprises, in agreement with existing fishing regulations, fishing seasons, issued quota and etc.; 2) hard forms of organised poaching that target sturgeon for meat and caviar; 3) soft forms of poaching, unregulated fishing, typically inshore, conducted without required licenses (Ermolin and Svolkinas 2016). The second model of organised poaching is the most important when dealing with sturgeon poaching. Sturgeon fishermen are typically conceived of as, unregulated, representing artisanal small-scale fisheries, comprising a single boat owner, 3-4 members of crew, operating on self-manufactured small boats (bayda) with lengths up to 11m, powered by outboard engines up to 500 hp (see figure 1) (not 1000 hp as mentioned by Dmitrieva et al. (2013). Organised sturgeon poaching consists of two social organisations: SFB and bayda as a part of SFB. All SFBs could be subdivided into two types: international (multiethnic) that includes fishermen with different ethnic background and kinship (monoethnic) that consists of fishermen with their origins mainly from the same ethnic group.

Fig 1 here:

Taking into consideration that SFB is a social organisation within a local fishing community (Ermolin and Svolkinas 2016), authors of this paper point out that changes occurred in the local social structure since the middle of 2000s, have indirectly influenced their fishing activities in the Caspian and, accordingly, the rates of sturgeon catches and seal by-catch. The main changes that have led to critical depletion of sturgeon population resulted from the mass migration of fishers from Azerbaijan to Russian Dagestan started immediately after the USSR collapsed and just increased after economic crisis hit Azeri economy in 1998 (Eldarov et al., 2007), and, consequently, introduction of bayda and self-made fishing gears into local fishing practices. Thus, Azeri fishers have become the founders of international (multiethnic) type of SFB. The number of international SFBs is a subject of continuous changes and highly depends on specific seasons. Many fishers have part-time jobs in other regions of Russia or in localities close to fishing settlements and do sturgeon fishing from time to time (Karpov and Kapustina 2011). Some members are often attracted by higher incomes and move to other SFBs. Kinship (monoethnic) SFBs are formed by local Nogais, who were deported there from steppe areas during the 1940s. Currently, researchers see kinship SFBs as more coherent and tightly knit than international one in that their members are fully engaged with their work and are able to use remittances transferred from Nogai labor migrants working in the far north of Russia as investments into illegal fishing activities that allow kinship SFBs to constantly renovate fishing equipment and local fleet (Ermolin 2015).

The members of SFB use different types of fishing gears. According to our study, the most common type of gear were gillnets with mesh-sizes ranging from 30 mm to 250 mm depending on target fish species. Sturgeon fishing is usually conducted with nets of 110–250 mm mesh-size, set in water depths from 1 to 30 m (Dmitrieva et al. 2013). Fishers also use self-manufactured fishing gears limited by activities in the Caspian. First of them is tjchalka could be described as hook-lines comprising self-catching unbaited hooks which are attached to the main line (see figure 2). There are two types of tjchalka mostly common in the Caspian: river tjchalka that sets in the estuary of the rivers and entangles sturgeons if they pass through the line and open sea tjchalka that sets in the shallow sea waters which are common in the Northern Caspian. The second is kalada that represents hook-lines with the sprat fish used as fishing bait covering an area of several kilometres and mostly used at sea. Usually fishers at SFBs use either the only gillnets or combine gillnets with the use of kalada or tjchalka depending on fishing skills and the area of sea where the boat operates.

Fig 2 here:

In addition to unregulated organised sturgeon poaching there is ineffectual management strategies of official fisheries that along with organised sturgeon poaching led to critical depletion of sturgeon population in the Caspian. Thus, as it is shown in table 1, beluga has shown the sharpest decline among sturgeons since the beginning of the 21-st century. As Khodorevskaya et al. noted, the rates of illegal take of beluga were estimated at 76 (2010) and 127 (2011) times higher than the official catch [Khodorevskaya et al., 2012].

Table 1 here:

4. Methodology

4.1 Data collection

Before the places for in-depth study were chosen, the authors conducted intensive pilot research, focusing on social structure of illegal fishing activities in coastal communities, which sit on the west and north coast of three Caspian littoral countries (Russian coastline, Kazakhstan and Azerbaijan) that allowed them to choose the "key" communities that are most intensively involved in supplying products to the IWT chain in the regions. Thus, the northern part of Republic of Dagestan and several fishing villages along the Volga River Delta in Russia were chosen as the main settlements for further studies. Short-lasting field expeditions (duration from several weeks up to two months) to the settlements were carried out in 2013 – 2016, to capture seasonal variation. Sturgeon catch and by-catch interview were conducted in the Volga River Delta in March 2013 and July 2015, in Dagestan in August and November 2013, March, July – August and December 2014, July 2015 and March 2016.

All in all 82 persons contributed to this study in different forms: 60 of them were non-randomly selected from SFBs (15 bayda or approximately 10 – 11 SFBs), 14 of them represented the families of fishers and 8 more were sturgeon meat traders at fishing markets in studied localities. In total, researchers obtained information on catches and by-catch from 35 trips lasting from one day to one week. Data obtained from families of fishermen were considered as a confirmation of how many trips the fishermen did during a fixed period of time. In eight cases traders confirmed the amount of sturgeon catches delivered by fishermen from SFBs.

Totally, 36 direct face-to-face interviews were conducted with locals, including members of 15 bayda. The specially elaborated questionnaire was designed to cover the full range of questions, including information regarding the types and length of

fishing gears, CPUE, the mesh size of gillnets, catches per trip and the length of each trip, amount of seal by-catch for each trip. Researchers adapted a few questions from Verevkin et al [Verevkin et al., 2008] and Dmitrieva et al [Dmitrieva et al., 2013]. The interview methodology also included measures to assess consistency of participant answers and detect attempts to provide misleading information. The interview questionnaire and further details of the interview protocol can be found in the supplementary information (See full description of interview protocol and interview questions for assessing sturgeon catch and Caspian seal by-catch in attached files).

No ethical approval was required to carry out this research. Having considered that sturgeon poaching is a serious criminal offence in Russia, researchers decided to grant anonymity to all research participants. The interviews were recorded only if informants gave their explicit permission to do so. Researchers developed a system of codification of information, which made it impossible to track sensitive pieces of information to its sources. All relevant information was recorded in a diary (470 pages), including the quantitative information obtained from all groups of respondents and direct observations [Sanjek 1990].

4.2 Data analysis

Due to the relatively long stay in the field, researchers were able to give detailed quantitative accounts of all variables that allowed them to do accurate calculations of IUU sturgeon catches and seal by-catch. However, as IUU activities in the studied settlements are large in scope, authors decided to pay attention only to 35 trips done by 15 bayda (60 people).

Thus, 35 trips were taken as the minimum documented illegal sturgeon catch and related seal by-catch. Researchers did not record the carcasses of seals left to decompose at sea as well as by-caught by official fishers working in local fishing enterprises. This is because it would be difficult for researchers to observe and count the number of seals' carcasses left at sea due to research ethics and because the amount of seals by-caught by fishers working officially was not significant that it would affect the data obtained from illegal SFBs. Since the sharp decline in sturgeon population occurred and ban on sturgeon fishing was introduced in 2002 and 2005 (Ermolin and Svolkinas 2016), gillnets with mesh- size more than 90 mm are only allowed for scientific catch. Hence, incidental seal by-catch reported by official fishers was insignificantly small.

In order to avoid the over-estimation of catch and by-catch rates, the catch per bayda (3-4 fishers) was taken for analysis. This was also relevant to calculation of CPUE that was calculated from the number of all fishing gears belonged to bayda crew.

Researchers summarised data by using the total sturgeon catches and seal by-catch, means of catches and by-catch rates presented as sturgeons/seals/trip/gear/season, standard deviation (SD), and range. In order to compare such variables over time and define whether there are differences among them, researchers used Wilcoxon rank sum tests with continuity correction based on comparison of means.

5. Results

5.1 Rates of sturgeon catches and seal by-catch in relation to season, type of fishing gear and type of SFBs

Adjusting reports for multiple sturgeon gear sets yielded a total minimum estimate of raw data about 10 491 kg of sturgeons and 788 seals by-caught from 15 bayda for 35 trips lasting from one day up to one week, in 2013–2016. Nine bayda from international SFBs reported 8599 kg of sturgeons and 504 seals as by-catch and six kinship SFBs reported 1892 kg of sturgeons and 284 seals as by-catch.

It is worth emphasising that sample for this study included more international SFBs (9 bayda) than kinship (6 bayda) and the number of sturgeons and seal by-catch reported by international SFBs was still significant. In this case researchers argue that predominance of international SFBs over kinship was defined by the skills and knowledge that fishers from international SFBs possessed. Researchers found that Azeri fishers, who first introduced kalada into the local fishing practices, continued to use kalada as their prime fishing gear and their catches were higher if someone calculates catch per fishing gear used for one trip. As it can be seen from Table 2, average minimum sturgeon catches rates for kalada were at almost 1,5 times higher than those of all other gears combined, although seal by-catch just slightly exceeded that of any other gear. Interview responses and informal conversations showed that Azeri SFBs (including one Russian fisher) caught 2000 kg of sturgeons per trip lasting for week which was the highest CPUE among all gears.

Thus, subdivision into two types of SFBs highly influenced what type of fishing gears the fishers prefer to use when fishing and, accordingly, the number of catches and by-catch fishers deliver for processing at shore facilities or/and leave at sea.

Table 2 here:

However, interview responses also showed that Azeri fishers were among the members of 3 of 9 international SFBs, who used the only kalada. All other international SFBs used either gillnets as it was also the case of all kinship SFBs or tjchalka. As it is seen from table 2, tjchalka did not give significant results and fishers preferred not to use it in many cases. Gillnets showed the most significant results when the amount of catch was recorded as total (7391 kg.).

Researchers found that average length of fishing gear was 33.18 km per trip for kalada and 5.6 km per trip for gillnet. As tjchalka did not give significant results when fishing, researchers did not obtain results for this fishing gear. It means that average catch was 249.73 kg for sturgeons and 37.52 individuals for seals per 5.6 km of gillnet and 425.33 kg for sturgeons and 38.8 individuals for seals per 33.18 km of kalada, respectively. In addition, there was average by-catch of 3.73 seals per every poryadok ranging from 2 to 5 seals. Only 1 or 2 of 3.73 seals survived the by-catch event in gillnets and 2 or 3 of 3.73 survived the encounter with kalada hooks. However, often seals suffer from sustained body injuries from hooks of kalada (‘cryptic’ by-catch (Reeves et al., 2013).

The beginning of sturgeon fishing season usually starts by the middle of February after the first ice has melted and lasts until April (first category). During the summer, boats operate rarely, doing only several one-day trips per two weeks because the catch would be decomposed fast in hot weather conditions. As illegal trips should be ended at nighttime (in order to avoid being detained by border guards), many boats have to wait for many hours or even days to be disembarked on the shore. Thereby, researchers recorded only four trips with sturgeon catches during July (second category). However, as our observations show, the catch/by-catch rates during July may exceed this value several times over given. In August many SFBs start to work at local official artels targeting the fresh-water fish. Since September the active sturgeon fishing starts again and lasts until the beginning of January when the ice rises (third category).

The total amount of sturgeons caught and seals by-caught was not significantly different between different seasons (Wilcoxon rank sum test for sturgeons, W-value = 21, p – value = 0.25463; Wilcoxon rank sum test for seals, W-value = 25, p – value = 0.078724. See table 3). The highest sturgeons catch rate was reported in autumn, although it just slightly exceeded the rates reported in springtime, while highest percent of seal by-catch was reported during springtime that is consistent with Dmitrieva et al., 2013. Springtime is the season when sturgeons as anadromous fish migrate to the northern part of the Caspian and then to the Volga and Ural rivers to their spawning grounds. During the springtime moulted pups are dispersing from the melting ice and later are dispersing from moulting sites. The pre-wintering migration of sturgeons and seals starts in late August, achieving the highest rates in October and November. The variance between sturgeons caught during summertime and wintertime was not significant and can be explained by the presence of small samples that did not allow meaningful statistical comparison. There was also no data on seal by-catch during summer months.

Table 3 here:

5.2 Direct observation of seals carcasses at the yards of intermediaries and sturgeons at local fishing markets.

Illegal extraction of sturgeons and seals is the first stage of local IWT commodity chain. The second stage is presented by intermediaries responsible for trading seal skins and sometimes blubber from the coast to highland Dagestan and fishing markets situated in the coastal settlements and big towns located nearby where sturgeons meat is considered as the most valuable commodity. At this stage seals trade and sturgeon meat trade should be treated differently as there are two different flows in local IWT. According to this differentiation, researchers decided to conduct two direct observations: first, researchers made observations of sturgeons delivered at local fishing markets, and second, researchers conducted two short-lasting direct observations at the yards of intermediaries in order to calculate the number of seals carcasses delivered at yards by fishers from SFBs. Thus, during the observations conducted at fishing markets in 2013 - 2016 researchers found 11 sturgeons weighing more than 40 kg each which meant that they were more than 30 years old. Simulateneously, authors observed the big amount of yearlings with weight equalled 2 or 3 kg each, however to obtain data on the yearlings was not possible. In July 2015 and March-April 2016 when direct observation was done at the yards of intermediaries, researchers observed 6 seals carcasses delivered for every three days on average that could confirm that sturgeon fishing activities occur during this period of year at a constant rate. In July 2015 fishers delivered six seals, four of which were 2-year-old, whereas two others were 4-5 months-old pups providing intermediaries and craftsmen with the most valuable skins for sale.

6. Discussion

The main goal of this study was to present and analyse the data obtained from studying illegal sturgeon organized fishing activities and correlated Caspian seal by-catch. Large-scale IUU sturgeon fishing has been recognized before as one of the most significant factors influencing the sharp decline in sturgeon population (Pikitch et al. 2005, Pourkazemi 2006, Lagutov and Lagutov 2008, Ruban and Khodorevskaya 2011) and confirmed by approximate estimate of IUU activities done by several researches (Zykova et al., 2000; Bobyrev et al. 2009; Ye and Valbo-Jørgensen 2012). However, all of these studies should be considered as speculations based on assumptions at best.

Our data analysis made it clear that IUU sturgeon catch has not demonstrated significant change since 2013. Although, since 2005 the ban on fishing of sturgeon was imposed, and only scientific catch was possible, researchers argue that the catches in 1000-2000 kg per trip that was very common even in the 2000-s (Bobyrev et al., 2009), now, according to our research, are significantly reduced and calculated at about 300 kg per trip, at the same time increasing the average length of gillnets per trip (range was changed from between 1 km to 4 km in 2008-2009 (Dmitrieva et al., 2013) up to 5,6 km as average net set in 2013-2016. Thus, according to Ermolin and Svolkinas (2016), about 400 bayda operated in the northern Caspian during the fishing seasons in 2013-2014 that allowed researchers to calculate the approximate estimate of sturgeons caught by fishers from Dagestan. If it is considered that 15 bayda took 10491 kg of sturgeons during 35 long-lasting trips, then 400 bayda would take as many as 279 tonnes for 35 trips during 2,5 years, which is equal to 111,6 tonnes per year. This number is still significant if someone takes into account that in the northern part of the Caspian Sea general biomass of beluga was 3600 tonnes (data from CaspNIRKh (2015), Russian sturgeon was 17120 tonnes (2012), sevruga was 5410 tonnes (2011) (Ruban et al., 2015). 5 species of sturgeons are listed as critically endangered by IUCN with the starlet classified as vulnerable.

Caspian Sea Sturgeon Ranching Programme, launched by the USSR in the 1950s, gave a rise to one of the biggest rate of stocked Russian and stellate juveniles in the world fisheries during 1962–91 (Secor et al., 2000). However, as it is seen from the table 4, the work at the hatcheries slowed down between 2007 – 2014 which has mainly decreased the rates of IUU sturgeon catches since the middle of 2000s. The research suggests that if the current level of sturgeons biomass continues to decrease, further IUU sturgeon fishing activities will fully depend on whether hatcheries would be able to release enough amount of juveniles to maintain both sturgeon populations and, as a consequence, presence of SFBs in the Caspian.

Table 4 here:

Unfortunately, it is hard to build up-to-date demographic models for sturgeon population because there is no available data on poaching efforts except data presented by FAO UN (286 tonnes reported in 2009) (FAO, 2011) that is based on unknown sources of information. Further research is needed to better understand the dynamics and scale of IUU sturgeon fishing in the Caspian and estimate population decline rates and plan other conservation actions for sturgeons.

Among the sturgeon fishing gears kalada was the most high-risky gear with highest CPUE, although researchers found gillnets to bring the highest total number of sturgeons caught for 35 trips. Researchers defined that the use of kalada was highly dependent on whether there was Azeri fisher on the board of bayda or not and his skills and knowledge to fish by kalada. Interview responses and informal conversations identified that Azeri fishers shared their knowledge on how to use kalada and how to find a right place in the sea to set the fishing gear through intergenerational transmission. Researchers assume that long-lasting illegal migration of Azeri fishers to Dagestan led to permanent exchange of knowledge and skills among different generations of Azeri fishers and appropriate technology transfer to local fishers. Their skills and knowledge in using kalada as the most high-risky fishing gear have exerted crucial impact on the critical depletion of sturgeon population. The deterioration of the local environment and ecocide in localities through appropriate technology transfer activities were noted by some authors (Pauly 1997; Fabinyi 2012). Our case shows how new entrants (skillful Azeri fishers) have changed socially embedded practices by bringing new technologies and changing the local fishing ethics that Pauly considered as «most worrisome development within small-scale fisheries« (Pauly 1997:3).

The research also showed important results that the seal by-catch should be considered as socio-economic, highly connected to local IWT consumption chain, rather than the only biological phenomenon as it was stated by many other studies (see, for example: Lopez et al., 2003; Read et al., 2006; Peckham et al., 2007). Further research is needed to develop the conceptual frameworks to understand the connection between by-catch and IWT worldwide. The results on seal by-catch are consistent with the results reflected in Dmitrieva et al. (2013), in that sturgeon fishing nets generate high rate of seal by-catch.

In 2006 the Caspian Commission on Aquatic Bioresources (an intergovernmental quango) set a total hunting quota of 18000 seals annually across all littoral states, then in 2016 FSBSI Caspian Fisheries Research Institute (CaspNIRKh) – organization that officially sets the quota for sturgeons and seals in the Caspian – set TACs of 12 000 seals across all littoral states and 6000 seals for Russian sector of the Caspian. Such TACs rates were based on the evaluation of total population of seals in 263000 individuals (data gathered in 2012 and modified in 2016). However, taking into account such mass entanglement of seals in sturgeon fishing gears, researchers decided to use the 2005 minimum population estimate in 104000 individuals proposed by Harkonen et al. (Harkonen et al., 2012; Harkonen et al., 2008) and used by Dmitrieva et al.

Thus, our results yields 788 seals caught for 15 trips which is at about 32 percent higher than resulted from the studies done by Dmitrieva et al. in 2008 – 2009 (1215 seals caught for 31 trips). However, the actual total by-catch rates may be of the order of greater. The future estimation of mortality rates should include seals left in the sea as highly decomposed for IWT and the 'cryptic' by-catch.

7. Conclusion

Caspian sturgeon and Caspian seals are flagship species for the conservation of Caspian biodiversity. Therefore mitigation measures should be focused primarily on developing incentives for those involved in poaching activities in both coastal communities supplying IWT products, and communities consuming them in highland Dagestan. Dagestani settlements are important regional hotspots of the IWT in the Caspian. This trade has developed because state reforms in the sectors of agriculture and fisheries have failed to improve local livelihoods (Ermolin and Svolkinas 2016). The lack of economic opportunities makes the transition in economic development much more difficult, especially when there are no sustained actions from the Caspian states and the UNEP Tehran Convention does not work properly. Thus, further efforts should be directed at helping fishermen and traders abandon their illegal activities and fund the development of opportunities for new business activities that are relevant to the local rural conditions. New business opportunities, first of all, aquaculture and fish smokeries, forged as a result of new business schemes should remove a vital link in the IWT in the Caspian. These livelihoods should contribute to poverty alleviation in both the settlements and the region. Researchers suggest that further interventions should reach marginalised sections of the community, particularly those which do not currently benefit from the IWT activity, and which are harmed by it. Such alternative livelihoods/livelihood-focused interventions funded by international development agencies have shown to be partially effective in some post-socialist countries (see for example, Ichinkhorloo and Yeh 2016), where the state was unable to respond towards urgent needs, expressed by the rural communities.

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Supplementary Information

Section 1: Interview protocols

Two trained and experienced researchers collected information in 17 fishing communities on the North-western and Northern coast of the Caspian Sea, including the Volga Delta fishing communities (n=7), and open sea fishing communities of Dagestan (n=10). Face-to-face direct questioning of informants were conducted with fishermen and intermediaries involved in Illegal Wildlife Trade (IWT) operations and direct observation at intermediaries trade yards.

The method of direct face-to-face questioning of informants was chosen as the main method because it has been previously used to tracks operations of illegal activities in natural resource use (Gavin et al. 2009, Smethurst & Nietschmann 1999) and because both researchers had previously established the rapport with fishing communities (Ermolin & Svolkinas 2016), that had been identified as sites of data collection prior to expeditions. When in fishing communities, researchers told to their potential informants by introducing who they were, what the intended purpose of their visit was and why they wanted to speak to fisherman. Researchers emphasized that they were independent researchers with long lasting research interests in the Caspian and did not work for law-enforcement or authorities.

The issue of distrust and tendency for people to remember common event can create bias [Gavin et al., 2009]. Distrust might be deeply embedded within the interaction because sharing of information could be seen as potentially threatening well-established livelihoods and social norms [Nuno and John 2014]. The factors that the authors spoke Russian and had previously acquired research experience in the Caspian region as well as because interviews and observation were conducted on «informant's turf» under informant's premises, could have further contributed to

increased levels of trust between researchers and informants. Thus, the trust the communities had for the researchers meant they were willing to provide information since the interview methodology, and low probability of law enforcement, meant that they would not experience legal consequences from disclosing information.

The authors assumed that it would be difficult for informants to remember exact numbers of sturgeon catches and seal by-catch, since the previous studies suggested the phenomena to be a common issue [Dmitrieva et al., 2013], especially if it happened many years ago, at a constant rate for a period of time. In order to overcome such bias, we firstly tried to collect data over two years continuously, allowing repeated interviews with the same members of SFB. Thus, researchers mainly asked about fishing in the period concurrent with the visit, thus avoided asking respondents on exact quantities collected in the past, hence it could lead them to the recall bias [Gavin and Anderson 2005]. Conducting such sets of interviews also aimed at strengthening the trust between two parties and increase possibility to get more valid data based on the developed trust [Spiro 1996; see also de Munck 2009]. Second, fishermen were interviewed independently from each other and cross reference data from members of the same boat was used to validate each others responses. It helped yield a wide range of data over time.

Researchers asked fishers to report not only the catch per bayda and length of fishing gears, but also to provide them with the number of sturgeons and seals caught per fishing effort. Unfortunately, researchers were unable to confirm such data on set by means of direct observation. However, they used data on sets to identify high-risky gears for seals and sturgeons. They asked the members of SFBs to identify the sturgeon catch and seal by-catch per 150 m set of nets (commonly known by the Russian acronym poryadok). In order to compare the impact of high-risky gears, researchers also asked their respondents to identify the number of sturgeons and seals caught per 150 m set of kalada taking into account that each hook is attached to the fishing line using about two meters length of line (approximately 75 hooks per poryadok).

Interview responses and informal conversations also brought up the question of seasonality. Researchers divided all responses into three categories according to season reported by fishers:

- from the middle of February til the end of April;
- July-August;
- from September until the beginning of January.

Recruitment for interviews happened in public places of fishing villages, however interviews were conducted in places where a private conversation was possible and outsiders could not distract the conversation. Interviews were recorded only if informant gave his permission to do so. If the permission was not received, than notes were taken on spot. An informant would typically be asked to choose a nickname for the duration of interview (if not he would be assigned one). Not every fisherman was interviewed after being recruited. If fisherman had little or no information on catch and by-catch, interviewing them would not deliver a very efficient way for obtaining

information on the topic of interest.

Additional expedition was organized to collect information on numbers of seals utilized in intermediaries trade yards. Typically intermediaries are individuals who operate on the second level in the proposed chain (if fishermen are considered as first) and would buy up delivered to the shore carcasses of by-caught seals, skin them and sell skins to either craftsmen or other intermediaries for a small profit. In addition to the direct questioning, the method of direct observation was used to crosscheck the information obtained through questioning of fishermen.

Thus, the methods of direct face-to-face questioning of informants, informal conversation and direct observation were chosen as the only realistic approach to gathering the necessary data in this social context.

Section 2: Interview questions for assessing sturgeon catch and Caspian seal by-catch

Questionnaires developed for by-catch research on Ladoga ringed seals and earlier studies of by-catch of Caspian seal done by Dmitrieva were taken into account [Verevkin et al. 2008; Dmitrieva et al., 2013].

1. Type of fish
2. Type of fishing gear.
3. Mesh size.
4. Depth of fishing gear setting
5. How do you choose a specific area of sea for setting gear?
6. Quantity of gear (or length of nets)
7. Fishing area

8. Do you have any tensions due to allocation of specific fishing areas?

9. Season or period of fishing

10. Do you work as fisherman officially employed by local fishing enterprise? During summer months?

11. How many long-lasting trips have you done during this season (two-three months)?

12. What was your highest catch of sturgeons during these trips?

13. How many trips were done without getting any sturgeon / any seal?

14. Fishing seasons when seals by-catch happens.

15. How many seals are caught in your fishing gear during a year/season/one set?

16. How many seals have you left at sea?

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