LIMIT REFERENCE POINTS OF FISHING PARAMETERS
IN LAKES AND RESERVOIRS OF KAZAKHSTAN[1]

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Abstract. The article deals with the problems of regulating commercial fishing in the water bodies of Kazakhstan. Analysis of data on fishing in large reservoirs of the Republic of Kazakhstan shows that along with natural changes in the fish stocks (when the water level in the reservoir decreases), the fishing intensity makes the greatest impact on the state of fish stocks. Today a pre-existing limiter as the fishing regime (the number of fishing gear and fishermen) completely has fallen out of the fishing control mechanisms. According to some reports, the catch of fish with fishing gear available to fishermen, increases the established limits by 1.5–2 times. Thus, the possible catch significantly exceeds the registered (official) catch. It is proposed to use the regulation of the fishing regime (the number of fishing gear, fishing vessels, fishermen) as a measure that determines the limits of safe effort and to limit unrecorded fishing on water bodies. The number of fishermen in the pond should not only meet the criteria for safe effort, but also allow fishing organizations to conduct profitable fishing. The calculation of the maximum allowable number of fishing performance indicators (limit reference points of fishing effort) are given.

Key words: fishing, fishery, intensity, water objects, limits of fishing effort, fishing gear.

Introduction

The Code of Conduct for Responsible Fisheries was developed and adopted on October 31, 1995 [1]. To date, the precautionary approach has been adopted by all leading international fisheries management organizations as the basis of its fishing policy. In particular, the states should clearly define for themselves a specific target and limit reference points for a particular fish stock and, at the same time, actions should be taken if the limits are exceeded, right up to the moratorium on fishing. This means that fishing should be allowed only within biologically safe values [2–17]. Allowable fishing intensity in the water bodies of Kazakhstan is determined by the value of total allowable catches (TAC). In practice, the limits and quotas are the only measures to regulate fishing effort in both Kazakhstan and Russia. Unlike Russia, in Kazakhstan users are assigned not catch quotas, but water bodies or part of their water area.

Thus, such a pre-existing limiter as the fishing regime (the number of fishing gear and fishermen) completely fell out of the control mechanisms of fishing.

In 2015–2017, the Fisheries Research and Production Center conducted studies to determine the limit reference points for the stock in order to develop a strategy for careful stock management and sustainable fishing in the main fishing reservoirs of Kazakhstan [18]. It is necessary to establish (and put into practice) the lease of water bodies by users and to conclude the fishing agreements within safe effort that allow, on the one hand, the efficient use of available stocks, and, on the other hand, prevent their reduction.

Materials and methods

The material for our work was studies in the large fishing reservoirs of the Republic of Kazakhstan: lakes Balkash, Zhaysan, Alakol, Sasykkol; Bukhtarma, Kapshagai, Shardara reservoirs, the Small

Aral Sea, the Ural and Kigash rivers during 2015-2019. In total, more than 2000 fishing efforts (catch with fixed nets and seines) were analyzed. The collection of ichthyological material was carried out according to Food and Agriculture Organization (FAO) recommendations and methods accepted in the Commonwealth of Independent States (CIS) [19, 20]. We analyzed not only the number of different fishing gears among users, but also their actual use in different seasons of the year; recorded catch on effort.

Results and discussion

The official catch in Kazakhstan is 45 thousand tons, with an estimated total allowable catch of 60-65 thousand tons, while in the middle of the last century up to 100 thousand tons were caught. The official fish catch does not always correspond to the actual one. As in other countries, in Kazakhstan there is the so-called IUU catch (illegal, unreported and unregulated), which is one of the main problems of the fishing industry. At the same time, there is no mechanism for monitoring and regulating the unreported catch, which, according to experts, is very significant. Table 1 shows our calculations of the possible catch of fish by fishing gear at fishing enterprises in the main fishing ponds (based on materials of 2017).

Table 1

Estimated fish catch in water bodies of Kazakhstan

Ponds	Gear used, units			Amount of efforts	Estimated catch, tons	Official catch, tons
	Fish nets	Fishing vent	Seines			
Ural River and the coastal part of the Northern Caspian Sea	19 285	11 175	24	2 487 765	13 019	6 498
Lake Zhaysan	24 217	–	156	4 874 600	26 256	4 617
Buhtarma Reservoir	2 937	–	22	591 800	1 780	1 931
Lake Balkhash	8 768	–	55	8 89 700	11 102	5 874
Small Aral Sea	1 2620	–	–	3 155 000	12 620	6 469
Shardara Reservoir	–	–	12	7 200	2 160	1 085

The estimated catch is found by multiplying the amount of effort and the average catch by the effort.

The number of fishing gear allows fishermen to catch fish 1.5-2 times more than the established limits. Thus, the possible catch of fish by fishing gear available to fishermen significantly exceeds the recorded (official) catch. The Fisheries Research and Production Center has developed recommendations on the introduction of norms for the permissible number of gear, fishing equipment and fishermen for reservoirs and their sections, which served as the basis for the approval in 2018 by the Ministry of Agriculture of the Republic of Kazakhstan "Norms of fishing effort in fishery ponds and (or) areas" (Tables 2, 3).

Table 2

Norms of fishing effort in fishery ponds and (or) areas

Ponds	Amount of nets		Amount of seines		Amount of fishermen		Amount of seiners		Amount of boats	
	1*	2**	1*	2**	1*	2**	1*	2**	1**	2**
Ural River	–	–	2	32	20	320	2	32	6	96
Kigash R.	–	–	4	28	20	140	2	14	6	42
N. Caspian Sea	300	5 400	300	5 400	30	540	2	36	6	108
Lake Zhaisan	200	1 400	8	56	146	1 022	6	42	12	84
Buhtarma Res.	183	2 019	3	33	40	440	1	11	4	44
Shulba Res.	30	300	1	10	10	100	1	10	4	40
Kapshagai Res.	40	800	1	20	10	200	1	20	4	80
Shardara Res.	–	–	2	8	16	64	2	8	4	16
S. Aral Sea	400	7 000	–	–	40	720	2	36	6	108
Syrdarya River	150	600	1	4	15	60	1	4	4	16
Lake Alakol	40	360	1	9	10	90	1	9	4	36
Lake Sasikkol	20	300	1	15	10	150	1	15	4	60
Lake Koshkarkol	60	60	2	2	20	20	–	–	4	4

* – Per 1 fishing site; ** – all fishing sites in pond.

Table 3

Norms of fishing effort on Lake Balkhash

Number of site	Amount of nets	Amount of seines	Amount of fishermen	Amount	
				Boats	Seiners
1	314	15	106	11	30
2	403	10	80	13	20
3	527	11	92	17	22
4	431	7	64	15	14
5	276	1	20	9	2
6	545	5	57	18	10
7	473	2	36	16	4
8	201	1	16	7	2
9	201	1	16	7	2
10	101	1	11	3	2
11	128	–	6	4	–
Total	3 600	54	504	120	108

However, immediately after the introduction of the standards they were sharply criticized by users of fishery ponds and fishing sites. This is understandable, since the possibility of using an unlimited number of fishing gear in a pond has been eliminated. If a certain number of jobs exist at the production site, then it cannot be arbitrarily increased. However, in some cases, the objections of the fishermen are justified. The approved standards do not take into account the important economic component of the fishery – ensuring its profitability, as well as the recommended ratio of passive and active fishing gear.

The number of fishermen in the pond should not only meet the criteria for safe effort, but also allow fishing organizations to conduct profitable fishing. What should be the annual catch for a fisherman, taking into account ensuring the profitability of the enterprise?

One fisherman must catch 10 000 kg (10 tons) of fish per year. This figure must be taken into account when calculating the number of fishermen in the reservoir. Depending on the fish productivity of the reservoir, this figure in different reservoirs can vary in one direction or the other, but not significantly.

Example. Suppose that the annual TAC on reservoir A is 7 000 tons. Next, we will break down the norms of fishing effort by type of fishing gear and fishermen. According to the results of studies, it was found that in pond A the average catch of 1 seine for effort is 500 kg, and the catch due to the fixed net effort 2.5 kg/day. The fishery's target in large water bodies is to increase the share of active fishing gear (seines) in the fishery, which, in contrast to fixed nets, ensures the fishery's indiscriminate harvesting of all fish species and size groups of fish allowed for fishing. It is necessary to ensure that at least 2/3 of the volume of fish caught in the pond is mastered by active fishing gear. So, on reservoir A, we calculate:

Active fishing gear caught 5,000 tons (about 70% of the total catch). 5 000 000 / 500 = 10 000 fishing efforts / 200 days = 50 seines per pond (there are 7 fishing sites in the pond, then we take 7 seines per 1 site). The catch by fixed nets is 2 000 tons (about 30% of the total catch). 2000000 / 2.5 = 800000 efforts / 200 days = 4000 nets per reservoir. With a norm of 40 nets (1 km in length) per team of two fishermen, the norm for one fisherman is 20 nets. The number of fishermen in reservoir A will be 50 · 10 + 4 000/20 = 700 fishermen. Further, it is already possible to calculate the need for fishing vessels and boats at the rate of two vessels and two boats for one non-water link and two fishermen and one boat for one net link).

Table 4 presents the proposals we have developed to optimize the norms of fishing effort in fishing reservoirs.

Table 4

Recommended fishing effort norms for fishing reservoirs of international and national importance

Pond	Amount, units				
	Nets	Seines	Fishermen	Seiners	Boats
Ural River	–	32	320	32	96
Kigash River	–	28	280	28	84
N. Caspian Sea	2 438	37/400	408	33	204
Lake Zhaisan	4 333	51	727	51	210
Buhtarma Res.	3 200	14	300	14	108
Shulba Res.	767	5	68	5	43
Kapshagai Res.	1 400	15	160	15	65
Shardara Res.	–	25	250	50	75
Small Aral Sea	7 000	35	700	35	245
Syrdarya River	280	6	50	6	19
Lake Alakol	900	1	50	2	45
Lake Sasykkol	720	6	66	12	36
Lake Koshkarkol	–	2	10	4	2
Lake Balkhash	3 600	54	684	108	180

Moreover, the norms have been developed for those reservoirs of international and national importance, where commercial fishing is carried out.

Conclusion

Analysis of data on fishing in large reservoirs of the Republic of Kazakhstan shows that along with natural changes in the state of fish stocks (e.g., when the water level in the reservoir decreases), the intensity of fishing has the greatest impact on the state of fish stocks. Its excessive increase leads to overfishing and falling of fish stocks. The fishing effort just characterizes the absolute or relative intensity of using technical fishing means, its regulation allows to affect the fish stocks. Target indicators of fishing effort serve as a guideline for maintaining various fisheries management systems in working condition. It is necessary to establish (and put into practice of securing sites and concluding fishing agreements) the norms of safe effort (fishing parameters) that allow, on the one hand, the efficient use of available stocks, and, on the other hand, prevent their decline.

REFERENCES

1. *Code of Conduct for Responsible Fisheries. Special Edition*. Rome, FAO, 2011. Available at: http://www.fao.org/3/i1900e/i1900e00.htm (accessed: 12.03.2021).

2. Aquaculture development. 4. Ecosystem approach to aquaculture. *FAO Technical Guidelines for Responsible Fisheries*, 2010, no. 5, suppl. 4, 53 p.

3. Agnew D. J., Pearce J., Pramod G., Peatman T., Watson R., Beddington J. R., Pitcher T. J. Estimating the Worldwide Extent of Illegal Fishing. *PloS ONE*, 2009, no. 4 (2), e4570.

4. Arnason R. Minimum Information Management in Fisheries. *Canadian Journal of Economics*, 1990, no. 23 (3), pp. 630-653.

5. Brooks N. H., Koh R. Selective withdrawal from density-stratified reservoir. *J. Hydraul. Div. Am. Soc. Div. Eng.*, 1969, iss. 95 (HY 4), p. 1369.

6. Cochrane K. L. A fishery manager's guidebook. Management measures and their application. *FAO Fisheries Technical Paper*, 2002, no. 424, 231 p.

7. Evans D. O., Waring R. Changes in the multispecies, winter angling fishery of Lake Simcoe, Ontario, 1961-83: Invasion bu rainbow smelt, Osmerus mordax, and the role of intra- and interspecific interactions. *San. J. Fish. Aquat. Sci.*, 1987, vol. 44, suppl. 2, pp. 182-197.

8. Fowler Ch. W. Management of multi-species fisheries: from overfishing to sustainability. *ICES Journal of Mar. Sci.*, 1999, no. 56, pp. 927-932.

9. Gabriel W. L., Sissenwine M. P., Overholtz W. J. Analysis of spawning stock biomass per recruit: an example for Georges Bank haddock. *North American Journal of Fisheries Management*, 1989, no. 9, pp. 383-391.

10. Jackson J. B. C. Historical overfishing and the recent collapse of coastal ecosystems. *Science*, 2001, iss. 293, pp. 1589-1591.

11. Penha J., Lemes Landeiro V., Ortega J. C. G., Mateus L. Interchange between flooding and drying, and spatial connectivity control the fish metacommunity structure in lakes of the Pantanal wetland. *Hydrobiologia*, 2017, iss. 797 (1), pp. 115.

12. Kura Y., Revenga C., Hoshino E., Mock G. *Fishing for Answers: Making Sense of the Global Fish Crisis*. Washington (DC), World Resources Institute, 2004. 140 p.

13. Mau R. M., Beddington J. R., Clark C. W. et al. Management of multispecies fisheries. *Science*, 1979, vol. 205 (4403), pp. 267-277.

14. Murawski S. Definitions of overfishing from an ecosystems perspective. *ICES Journal of Marine Science*, 2000, iss. 57, pp. 649-658.

15. *Overfishing. National Geographic*, 2010, 2010.04.27. Available at: https://www.nationalgeographic.com/environment/article/critical-issues-overfishing (accessed: 12.03.2021).

16. Funge-Smith S. The economic value of inland fisheries. Rewiew of the state of the world fishery resources: inland fisheries. *FAO Fisheries and Aquaqulture Circular*. Rome, FAO, 2018. FIPS/C942, rev. 3 (En). 397 p.

17. Welcomme R. Rewiew of the state of the world fishery resources: inland fisheries. *FAO Fisheries and Aquaqulture Circular*. Rome, FAO, 2011. FIRF/C942, rev. 2 (En). 378 p.

18. Kulikov E. V., Isbekov K. B., Asylbekova S. Zh. Upravlenie rybnymi resursami v vodoemakh Kazakhstana: kurs na sobliudenie mezhdunarodnykh printsipov otvetstvennogo rybolovstva [Management of fish resources in water bodies of Kazakhstan: course towards compliance with international principles of responsible fisheries]. *Rybnoe khoziaistvo*, 2017, no. 1, pp. 37-44.

19. Stock assessment for fishery management. A framework guide to the stock assessment tools of the Fisheries Management Science Programme. *FAO Fisheries Technical Paper*, 2006, no. 487, 263 p.

20. Pravdin I. F. *Rukovodstvo po izucheniiu ryb* [Fish study guide]. Moscow, Pishchevaia promyshlennost' Publ., 1966. 376 p.

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ГРАНИЧНЫЕ ОРИЕНТИРЫ ПАРАМЕТРОВ РЫБОЛОВСТВА В ОЗЕРАХ И ВОДОХРАНИЛИЩАХ КАЗАХСТАНА

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Рассматриваются проблемы регулирования промыслового рыболовства в водоемах Казахстана. Из анализа данных рыболовства в крупных водоемах Республики Казахстан следует, что наряду с естественными изменениями состояния рыбных запасов (например, при понижении уровня воды в водоеме) наибольшее влияние на состояние рыбных запасов оказывает интенсивность промысла. В настоящее время существовавший ранее ограничитель в виде режима лова (количество орудий лова и количество рыбаков) полностью выпал из-под контроля механизмов промысла. Улов рыбы орудиями лова, доступными рыбакам, по некоторым данным, в 1,5–2 раза больше установленных лимитов. Таким образом, возможный улов рыбы значительно превышает зарегистрированный (официальный) улов. Предлагается использовать регулирование режима рыболовства (количество орудий лова, рыболовных судов, рыбаков) как меру, определяющую пределы безопасного усилия и ограничивающую неучтенный вылов на водоемах. Количество рыбаков на водоеме должно не только соответствовать критериям безопасного промысла, но и позволять рыболовным организациям вести рентабельный промысел. Приведен расчет максимально допустимых значений показателей эффективности лова (граничных ориентиров промыслового усилия).

Ключевые слова: рыболовство, промысел, интенсивность, водные объекты, нормы промысловых усилий, официальный улов, орудия лова.

СПИСОК ЛИТЕРАТУРЫ

1. *Code* of Conduct for Responsible Fisheries. Special Edition. Rome, FAO, 2011. URL: http://www.fao.org/3/i1900e/i1900e00.htm (дата обращения: 12.03.2021).
2. *Aquaculture* development. 4. Ecosystem approach to aquaculture // FAO Technical Guidelines for Responsible Fisheries. 2010. N. 5. Suppl. 4. 53 p.
3. *Agnew D. J., Pearce J., Pramod G., Peatman T., Watson R., Beddington J. R., Pitcher T. J.* Estimating the Worldwide Extent of Illegal Fishing // PloS ONE. 2009. N. 4 (2). e4570.
4. *Arnason R.* Minimum Information Management in Fisheries // Canadian Journal of Economics. 1990. N. 23 (3). P. 630–653.
5. *Brooks N. H., Koh R.* Selective withdrawal from density-stratified reservoir // J. Hydraul. Div. Am. Soc. Div. Eng. 1969. Iss. 95 (HY 4). P. 1369.
6. *Cochrane K. L.* A fishery manager's guidebook. Management measures and their application // FAO Fisheries Technical Paper. 2002. N. 424. 231 p.

7. *Evans D. O., Waring P.* Changes in the multispecies, winter angling fishery of Lake Simcoe, Ontario, 1961-83: Invasion by rainbow smelt, Osmerus mordax, and the role of intra- and interspecific interactions // Can. J. Fish. Aquat. Sci. 1987. V. 44. Suppl. 2. P. 182–197.

8. *Fowler Ch. W.* Management of multi-species fisheries: from overfishing to sustainability // ICES Journal of Mar. Sci. 1999. N. 56. P. 927–932.

9. *Gabriel W. L., Sissenwine M. P., Overholtz W. J.* Analysis of spawning stock biomass per recruit: an example for Georges Bank haddock // North American Journal of Fisheries Management. 1989. N. 9. P. 383–391.

10. *Jackson J. B. C.* Historical overfishing and the recent collapse of coastal ecosystems // Science. 2001. Iss. 293. P. 1589–1591.

11. *Penha J., Lemes Landeiro V., Ortega J. C. G., Mateus L.* Interchange between flooding and drying, and spatial connectivity control the fish metacommunity structure in lakes of the Pantanal wetland // Hydrobiologia. 2017. Iss. 797 (1). P. 115.

12. *Kura Y., Revenga C., Hoshino E., Mock G.* Fishing for Answers: Making Sense of the Global Fish Crisis. Washington (DC): World Resources Institute, 2004. 140 p.

13. *May R. M., Beddington J. R., Clark C. W. et al.* Management of multispecies fisheries // Science. 1979. V. 205 (4403). P. 267–277.

14. *Murawski S.* Definitions of overfishing from an ecosystems perspective // ICES Journal of Marine Science. 2000. Iss. 57. P. 649–658.

15. *Overfishing* // National Geographic. 2010. 2010.04.27. URL: https://www.nationalgeographic.com/environment/article/critical-issues-overfishing (дата обращения: 12.03.2021).

16. *Funge-Smith S.* The economic value of inland fisheries. Rewiew of the state of the world fishery resources: inland fisheries // FAO Fisheries and Aquaqulture Circular. Rome, FAO, 2018. FIPS/C942, rev. 3 (En). 397 p.

17. *Welcomme R.* Rewiew of the state of the world fishery resources: inland fisheries // FAO Fisheries and Aquaqulture Circular. Rome, FAO, 2011. FIRF/C942, rev. 2 (En). 378 p.

18. *Куликов Е. В., Исбеков К. Б., Асылбекова С. Ж.* Управление рыбными ресурсами в водоемах Казахстана: курс на соблюдение международных принципов ответственного рыболовства // Рыбное хозяйство. 2017. № 1. С. 37–44.

19. *Stock* assessment for fishery management. A framework guide to the stock assessment tools of the Fisheries Management Science Programme // FAO Fisheries Technical Paper. 2006. N. 487. 263 p.

20. *Правдин И. Ф.* Руководство по изучению рыб. М.: Пищ. пром-сть, 1966. 376 с.

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