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RESEARCH ARTICLE

The perception of the issue of spawner harvesting in lakes by the owners and managers of the entities authorised to commercial and reacreational fisheries management

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Abstract. In recent years, the issue of spawner harvesting has been frequently addressed by different groups of stakeholders involved in the exploitation of fish resources. The increasingly numerous angling circles, which use these resources recreationally, question the current rules of fish stocking management in Poland, and its legal and economic status has become the focus of scientists' interest. The aim of the study was to present and discuss the results of a questionnaire survey addressed to managers and owners of lake fisheries entities in order to identify the determinants of fisheries management related to spawner harvesting. Questionnaires were collected from a total of 76 entities, and concerned 1921 lakes with a total area of 174,078 ha, which accounts for more than 64% of the total area of lakes used for fishing and angling purposes in Poland. The paper presents *inter alia* the occupational characteristics of the respondents; their positions on the effect of spawner harvesting on lake ecosystem, environmental protection, and social factors; anglers' assessments of spawner harvesting; the actual and potential methods for regulating this harvesting; and the negative and positive effects of the introduction of a prohibition on this harvesting. The results show that the respondents under study generally do not see the need for the introduction of additional (except those already in place) regulations concerning spawner harvesting, most of them notice the adverse effects of their introduction, but they are also aware of the possible changes and their impact on management.

Keywords: lake fisheries entities; spawners; catches; fisheries management

Introduction

Lake fisheries management is an important branch of inland fisheries, as in Poland, the largest country of the Central Eastern European region, the total area of lakes is 2,813.77 km^2 i.e. approximately 0.9% of the total area of the country (Mitchell et al. 2010), and the total area of lakes used for fishing and angling purposes is approximately 2,700 km^2 (Wołos et al. 2015). This management comprises many components, of which three are crucial, namely commercial fisheries, recreational fishing (angling), and properly conducted fish stocking management (Trella and Wołos 2021a). In order to meet the ecodevelopment criteria, fish stocking management should satisfy three basic conditions: it must be ecologically acceptable (safe) while being socially desirable and economically feasible (Leopold and Bnińska 1992,

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Turkowski 2006, Mickiewicz and Wołos 2011, Trella and Wołos 2021a).

In recent years, the issue of spawner harvesting has been very often addressed by different circles using fish resources (Czarkowski and Kapusta 2016), mainly persons using those resources recreationally, who are increasingly critical of the current principles of fish stocking management in Poland. Specialists, who oversee fisheries management under the authority of state institutions, have also begun to address this issue due to the increasing pressure from the angling and environmental circles. These discussions mainly concern the purposefulness or necessity of carrying out these harvesting operations, both in economic and ecological terms, and, with an allowance for how this problem affects the stakeholder groups concerned (anglers, ecologists, politicians), the social impact is also strongly noticeable. The opponents of spawner harvesting, in addition to arguing that these treatments are neither effective or economically justified, give specific examples of failed fish stocking campaigns, and often mention hazards to biodiversity or changes to the natural environments themselves, that can result from irresponsible or inappropriate stocking (Cambray 2003, Johnson et al. 2009, Czarkowski and Kapusta 2016). On the other hand, fish stocking promoters (Mickiewicz 2016) claim that the harvesting of spawners is a key element of fisheries management, and that one of the most important goals of these measures is to maintain or increase the size of economically valuable fish species populations to a level that makes the fisheries management economically viable (Mickiewicz and Wołos 2011, Zakęś and Demska-Zakęś 2011, Trella and Wołos 2021a) and ecologically important, particularly in terms of biodiversity preservation (Diana 2009). In addition, the entities authorised to fishing are required to carry out fish stocking operations (Mickiewicz 2016), therefore, in contrast to angling organisation in e.g. Germany, where stocking is a routine treatment carried out on an annual basis, often due to respect for tradition (Arlinghaus 2018), fish stocking is an obligation on nearly all waters owned by the State Treasury, and the failure to fulfil this obligation can be considered by relevant inspection authorities as carrying out irrational fisheries management operations (Mickiewicz 2014). It is also worth mentioning that there are specialised fish stocking facilities operating in Poland, which create a very thriving sector, as evidenced by the large number of hatchery and rearing facilities (Zakęś and Jarmołowicz 2009, Trella and Wołos 2021a). In recent years, it has become increasingly common to produce fish stocking material in recirculating aquaculture systems (RAS), which allows optimum conditions to be provided for different fish species (Szczepkowski et al. 2012, Budzich-Tabor et al. 2018).

While pursuing the public interest, and moving away from an imperative approach to the issue of solving stocking problems, for the sake of public debate (Dobrowolski 2013), this paper incorporates the main players, namely the entities authorised to fishing, and entities carrying out fisheries and angling management operations on lakes. Therefore, the aim of the study was to present and discuss the results of a questionnaire survey addressed to managers and owners of lake fisheries entities in order to identify the determinants of fisheries management related to the issue of spawner harvesting.

Materials and methods

The analyses were conducted based on the collected detailed questionnaires that had been sent to fisheries entities that carry out fisheries and angling

Table 1
Basic characteristics of the entities under study

Entity type	Number of entities (n)	Lake area (ha)	Average lake area per 1 entity (ha)	% of the area
Fish farms	49	111,985	2,285	64.3
Polish Angling Association (PAA) districts	12	53,976	4,498	31.0
Private firms and institutions	12	4,449	371	2.6
National Parks	3	3,664	1,221	2.1
Total	76	174,078	2,29	100

Table 2
Parameters of the water bodies under study

Parameter	Actual data	M	Me	SD	Range	Proportion (%)
Total area of lakes (ha)	174,078	2,290.5	733.4	3,423.4	13.3-21,553	100
Total number of lakes	1,921	25.3	10.0	39.6	1-186	100
Area of water bodies used for fishing purposes (ha)	135,842	1,787.4	454.4	3,201.9	0-20,008	78.0
Number of lakes used for fishing purposes	897	11.8	5.0	16.7	0-103	46.7
Area of water bodies used for angling purposes (ha)	172,394	2,237.3	733.4	3,419.5	8-21,553	99.0
Number of lakes used for angling purposes	1,876	24.7	8.0	39.6	1-186	97.7

M - mean, Me - median, SD - standard deviation

management operations on lakes. Questionnaires concerning 1921 lakes with a total area of 174,078 ha (Table 1 and 2), which accounts for more than 64% of the total area of lakes used for fishing in Poland, estimated at 270,000 ha (Wołos et al. 2015), were collected from a total of 76 entities (including 12 districts of the Polish Angling Association (PAA)) and analysed.

Based on the responses obtained in the survey, the following issues, concerning the determinants of spawner harvesting in fisheries and angling entities authorised to use lakes for fishing and angling purposes, were defined and analysed:

- educational background and experience of both the authorised persons and employees of the entities under study;
- positions on the issue of spawner harvesting and its impact on the environment;
- assessment of the potential regulations concerning spawner harvesting;
- positive and negative effects of the introduction on a prohibition on spawner harvesting;
- the ways to compensate for potential losses related to the introduction of this prohibition.

As regards the assessment of both the negative and positive consequences of the introduction of a prohibition on spawner harvesting and the potential compensation for entities, it was possible to select more than one of the proposed answers.

Based on the obtained questionnaire data, the nature of the waters under study, on which fisheries entities carry out fisheries management activities, was analysed after dividing them into waters used for fishing and for angling purposes. Both the areal extent and the percentage of this type of water bodies are provided.

As regards the questions where respondents could indicate a rating scale for a particular regulation (the so-called Likert scale), it was expressed in a range of ranks from 0 to 5, where 0 is a “very poor”, and 5 is a “very good” rating.

The study used basic statistical parameters such as percentages, mean values (M), standard deviations (SD), median (Me), modal value (Mo), and sums of ranks (SR). All calculations and drawings were made using the Microsoft Excel program.

Results

Characteristics of the waters under study, on which fisheries entities carry out fisheries management activities

The majority of users who carry out fisheries management operations on lakes are fisheries enterprises that conduct their activities over 64.3% of the area of the water bodies under study, which are followed by the PAA districts (31.0%), while private firms and institutions, as well as National Parks, carried out management activities on a total of less than 5% of the area (Table 1). The lakes under study, used by 1 entity, fell within the range of 13.3-21,553 ha, and the number of lakes fell within the range of 1-186. The area used for commercial fishing purposes accounted for 78% of the total area, while the proportion of the number of lakes used for fishing purposes was 46.7%. The proportions of both the area used for angling purposes and of the number of lakes were significantly higher and accounted for 99 and 97%, respectively (Table 2). It is worth noting, however, that the smaller proportion of waters used for fishing purposes is due to the fact that the majority of PAA districts do not exploit fishing resources in their waters, which results in the area of water bodies used for fishing purposes being unreported by the vast majority of these entities.

Occupational characteristics of the persons authorised to fishing and employees of the entities under study

Analysis of the educational background and experience of both the authorised persons (managers, farm owners) and farm employees (ichthyologists, manual workers) shows clearly that the vast majority of farm owners have higher education, with more than half of them having a university degree in fisheries, and only

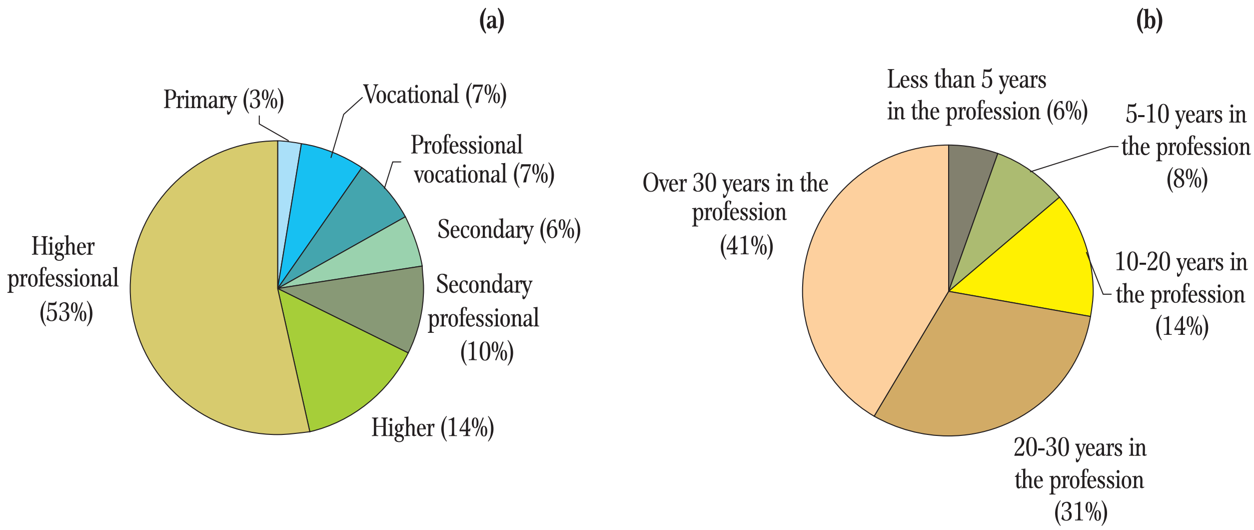

Figure 1. Educational background (a) and experience (b) of the persons authorised to fishing.

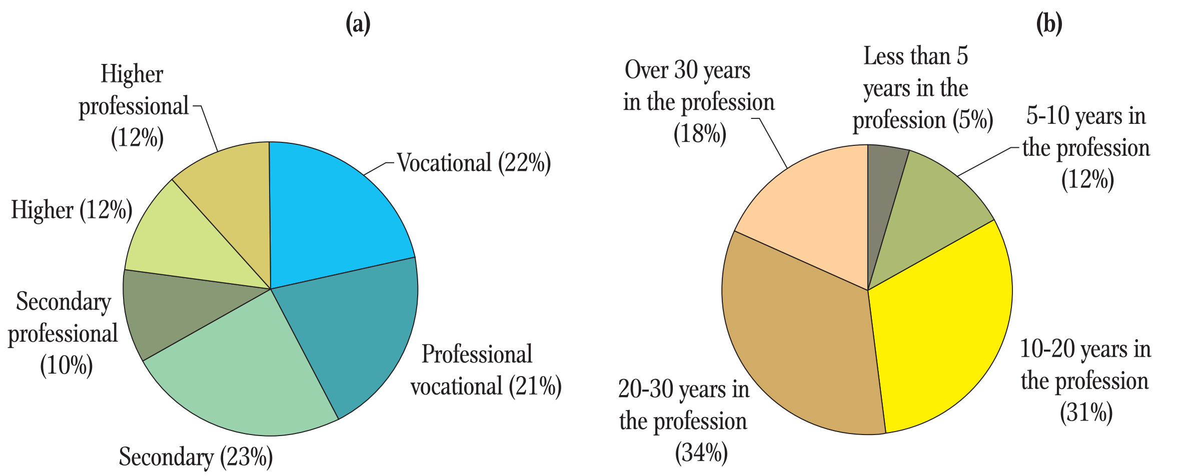

Figure 2. Educational background (a) and experience (b) of employees of the entities under study.

3% having primary education. In terms of experience, 41% of the authorised persons have more than 30 years' experience, 31% have more than 20 years' experience, and only 6% have less than 5 years' experience (Fig. 1). On the other hand, the majority of employers of the entities under study have no tertiary education (only 24%, of which 12% have professional education), most of them have vocational education, 21% of which have professional vocational education (Fig. 2). It is worth noting here that none of the employees in this group had primary education, which may be a result of the 1999 school reform that resulted in most people having the opportunity to obtain lower-secondary (i.e. higher than primary) education. 34% of the employees have more than 20 years' experience, 31% have more than 10 years' experience, and only 18% have more than 30 years' experience.

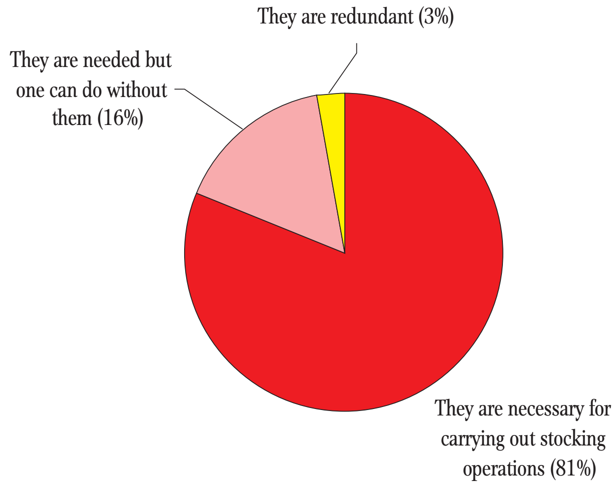

Figure 3. Distribution of responses to the question concerning the purposefulness of spawner harvesting.

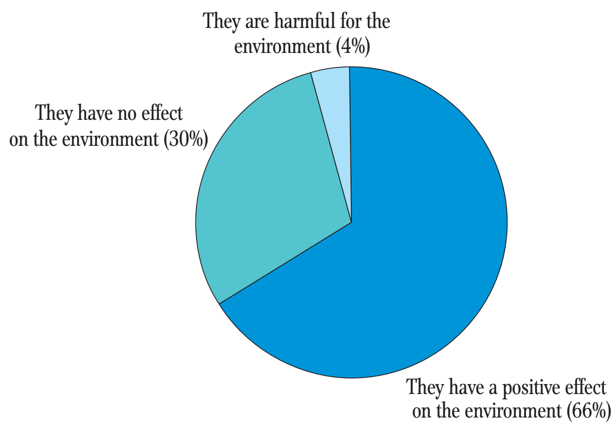

Figure 4. Distribution of responses to the question concering the impact of spawner harvesting on the environment.

The authorised persons' position on spawner harvesting and its effect on ecology and environmental protection as well as social factors

The respondents' position on the sense of harvesting spawners is rather clear, with as many as 81% users of lakes claiming that they are necessary for carrying out stocking, and only 3% claiming that they are redundant (Fig. 3). On the other hand, as regards the environmental impact, 66% of respondents stated that spawner harvesting had a positive effect, nearly one in three respondents indicated that they had no effect, and 4% stated it was detrimental (Fig. 4).

Analysis of the distribution of the responses to the question about the respondents' opinions on the anglers' approach to the issue of harvesting shows that 31.9% anglers rate the harvesting as satisfactory, 31.9% as good, over 27% as poor, over 27% as very poor, and only 8.3% as very good. The majority of respondents (52.1%) rated their relationship with anglers as positive, and only 1.4% of respondents rate this relationship as inadequate. When it comes to the question as to which circles exert the strongest pressure in the matter of spawner harvesting, the majority of respondents agreed that it was mainly environmental organisations i.e. those aiming *inter alia* at maximum animal protection (53.4% of the responses) and anglers (30.0%), while scientists were indicated by only 3.3% of the respondents (Table 3).

Assessment of methods concerning the regulation of spawner harvesting

Table 4 presents the ratings of the particular ways of regulating spawner harvesting. The best rated proposal which scored 209 sum of ranks (SR) points was the *complete freedom for farms to act with regard to spawner harvesting*, which was also the only proposal that was rated overall positively (Table 4). It is

Table 3
Distribution of responses (%) to the question concerning the rating of spawner harvesting by various circles

Question	Distribution of responses (%)				
In your opinion, how do anglers fishing on your waters rate spawner harvesting for the purposes of the farm / PAA district?	very poorly	poorly	satisfactory	well	very well
	8.3	19.4	31.9	31.9	8.3
How do you rate the relationship of your farm / PAA district with anglers?	unsatisfactory	satisfactory	well	very well	
	1.4	27.4	52.1	19.2	
In your opinion, which circles exert the greatest pressure in the matter of the lack of spawner harvesting purposefulness?	anglers	environmental organisations	officials	scientists	
	30.0	53.4	13.3	3.3	

Table 4
Distribution of responses to the question concerning potential regulations on spawner harvesting

Question	A	B	C	D	E	F	G	H	I	J
SR	20	94	123	99	40	61	106	73	134	209
M	0.27	1.31	1.71	1.41	0.56	0.84	1.51	1.00	1.84	2.86
Me	0	1	1	1	0	0	1	0	2	3
Mo	0	0	0	0	0	0	0	0	0	5

Range 0-5, where 0 - a very poor rating, 5 - a very good rating
Issues: A. a total prohibition on spawner harvesting; B. a partial prohibition on spawner harvesting (prohibition concerning certain species); C. spawner genetic monitoring (the selection of spawners for spawning based on genetic analysis results); D. spawner harvesting allowed only in the lakes where spawning is impeded; E. spawner harvesting allowed only in the lakes where anglers or environmental organisations give their consent; F. an obligation to release all spawners (regardless of their condition) back into the lake; G. obligation to carry out spawning while alive; H. a prohibition on the sale of killed spawners; I. a prohibition on trade in live spawners; J. complete freedom for farms to act with regard to spawner harvesting; SR - sum or ranks, M - mean, Me - median, Mo - modal value

worth mentioning here, however, that the proposal to liberalise spawner harvesting was also opposed by a good many respondents, resulting in an average score of 2.86. The other proposals were mostly rated very negatively, hence the modal value (the most frequent rating) for proposals from A to I amounted to 0. However, despite the overall negative rating of the ideas, the proposal to prohibit trade in live spawners scored 134 SR points, and *spawner genetic monitoring* (*the selection of spawners for spawning based on genetic analysis results*) scored 123 SR points. The lowest rated proposals included a *total prohibition on spawner harvesting* (20 SR points) and *spawner harvesting allowed only in the lakes where anglers or environmental organisation give their consent* (40 SR points). As shown in Fig. 5, as many as 31.7% had not heard of any of these potential proposals to regulate spawner harvesting, and only 4% were aware of all of them. The most frequent ones included a *partial prohibition on spawner harvesting (prohibition concerning certain species)*, chosen by 13.9% of the

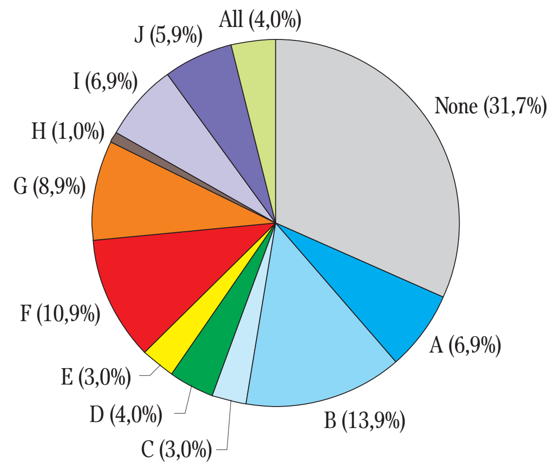

Figure 5. Distribution (%) of responses to the question concerning the knowledge of proposals to regulate spawner harvesting prior to filling in the questionnaire. Descriptions as in Table 4.

respondents, and an *obligation to release all spawners (regardless of their condition) back into the lake* (10.9%).

Assessment of the negative and positive consequences of the introduction of a prohibition on spawner harvesting, and the potential compensation for entities

According to the respondents, the worst consequences of the introduction of a prohibition on spawner harvesting include the *failure to carry out rational fisheries management operations* (75.0% of the respondents), a *drop in stocking rates* (65.8%), and a *reduction in fish population size* (64.5%) (Fig. 6). The least burdensome effects include, contrary to appearances, *the dismissal of fisherpersons* (21.1%) and *farm closure* (8.4%). As regards *other* responses which accounted for less than 4% of their total number, these included no adverse effects or fish dwarfing.

When assessing the positive aspects of the introduction of a prohibition on spawner harvesting, as many as 46.1% of respondents reported that they noticed no positive effects of the introduction of such regulations. On the other hand, 35.5% of respondents indicated that it could contribute to *anglers' satisfaction*, while 19.7% declared that it could contribute to an *increase in the population of large individuals*. An increase in biodiversity, both biological and genetic, was indicated by 3.9% of respondents (Fig. 7).

Should a situation arise that spawner harvesting is prohibited, the majority of owners of the entities under study (56.6%) selected the option of higher fees for anglers harvesting prized fish, including predators, 34.2% selected higher fees for all anglers, and 21.1% would *prohibit taking prized fish from the fishing ground*. It is worth mentioning here that 15.8% of respondents stated that the losses resulting from the introduction of the prohibition concerned could not be compensated. The *other* responses, which accounted for 3.9% of their total number, included the exemption from stocking obligation, or reduction in lease payments (Fig. 8)

Discussion

In order to implement proper management strategies in inland fisheries, including for spawner harvesting, i.e. sustainable exploitation of fish stocks, a basic

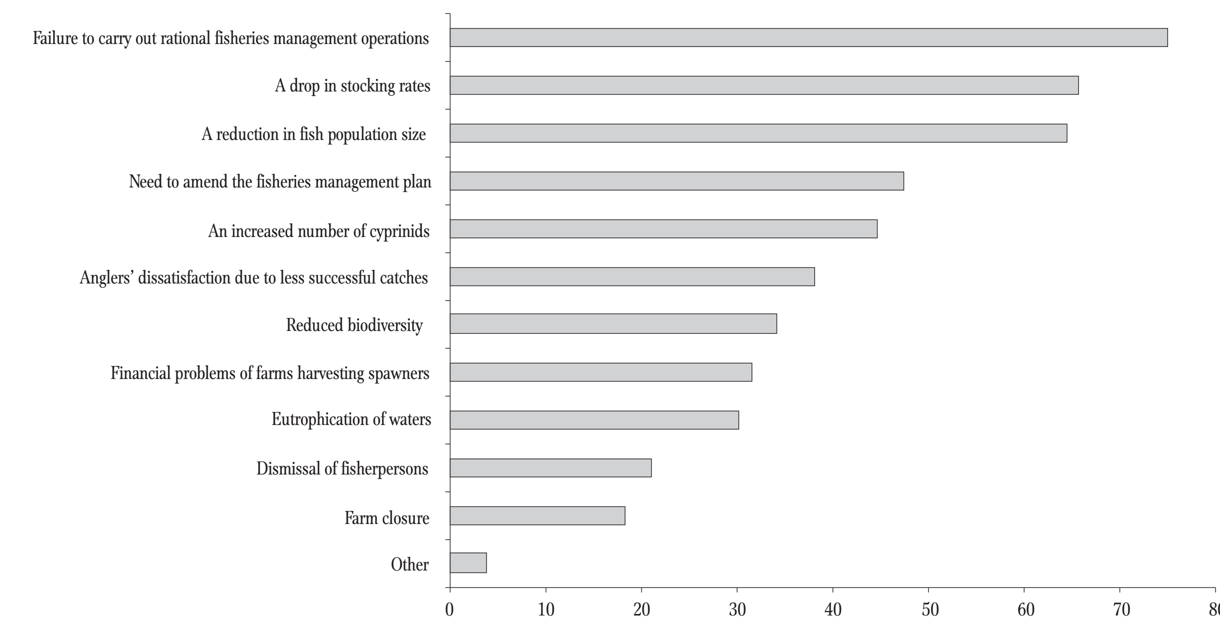

Figure 6. Distribution of responses (%) to the question concerning the negative consequences of the introduction of a prohibition on spawner harvesting.

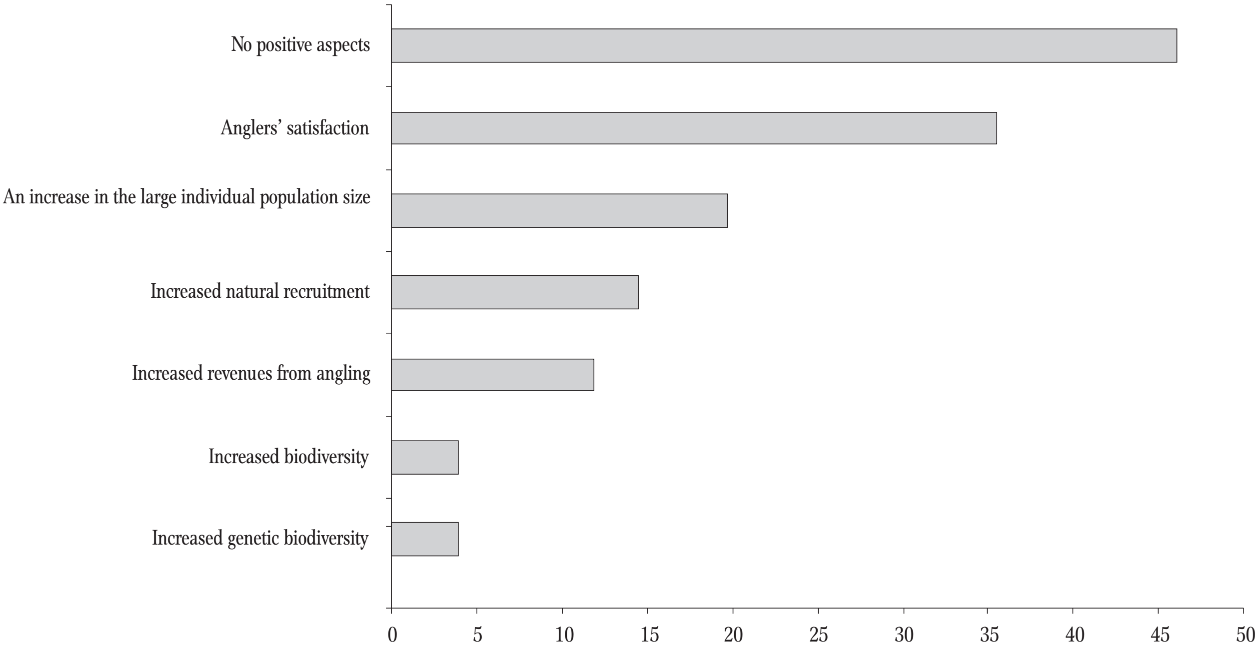

Figure 7. Distribution of responses (%) to the question concerning the positive consequences of the introduction of a prohibition on spawner harvesting.

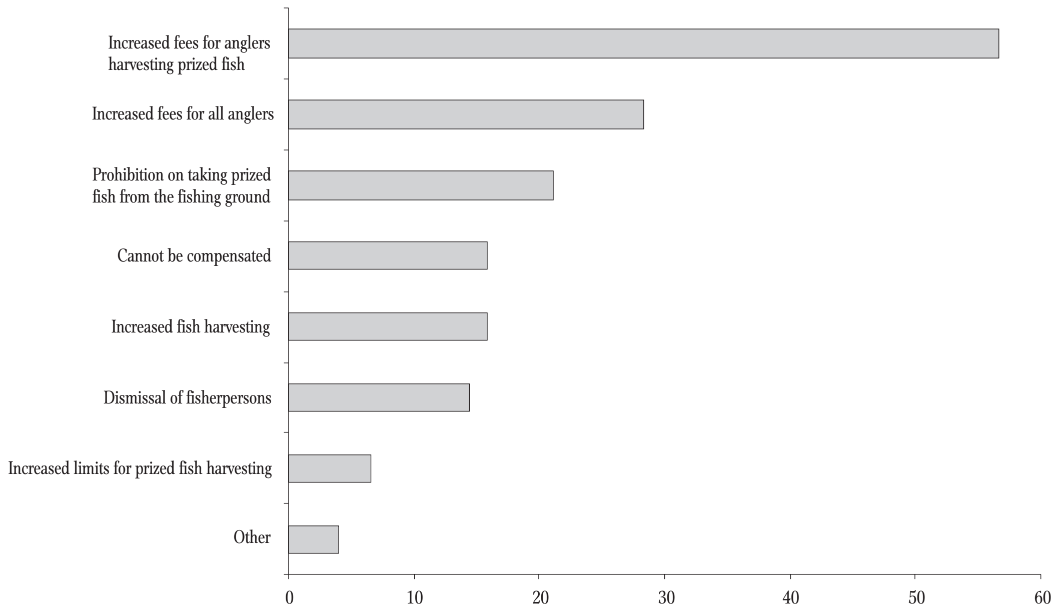

Figure 8. Distribution of responses (%) to the question concerning the possible ways to compensate farms for the prohibition on spawner harvesting.

knowledge of the waters under management is required (Brämick 2002). As can be seen in recent times, in addition to biological aspects, socio-economic and ecological factors are also important, as they are often crucial in making decisions concerning water body management (FAO 1997, Hickley and Tompkins 1998), and inappropriate management of such delicate resources as lakes can result in environmental degradation in their catchments (Hecky et al. 2003). It is therefore not surprising that so many circles are so concerned to ensure that these resources can be used for as long as possible, and that their level of management is of the highest possible standard. The presented study results demonstrate that the majority of entities authorised to fishing have higher fisheries education. They should therefore be prepared to introduce innovations in harvesting spawners and handling them during and after spawning, and yet the so-called classical method for obtaining gametes (Czarkowski and Kapusta 2016) is likely to continue to be used for a long time, even though it potentially reduces the survival rate of the future larvae (Cejko et al. 2015). It should be borne in mind, however, that the method is adopted all over the world, as it is simply inexpensive (Pierce et al. 2012, Hühn et al. 2014, Czarkowski and Kapusta 2016). However, due to the intensive development of aquaculture, larviculture, and controlled breeding conditions, it is now much easier for farms to both acquire the necessary stocking material and produce it on their own, so that the demand for live spawners is expected to decrease.

The application of the above-mentioned innovations may result in a lower demand for spawners, but these methods require not only longer experience and greater labour input but also a greater financial expenditure (Mickiewicz, 2016). A good example of how the price of material affects farms' decisions is the regression in the management of the whitefish *Coregonus lavaretus* (L.), observed for many years (Trella et al. 2012), as the drop in stocking rate was due to the very high price of stocking material, and it is more profitable for fish farms to catch the vendace *Coregonus albula* (L.) and stock waters with this species. The expenditure on vendace stocking is mostly recouped after 2 years, and not 3 or 4 years, as is the case with whitefish stocking (Zacharczyk 2007, Trella et al. 2012).

Currently, the species that is dominant in terms of the stocking of lakes, rivers, and dammed reservoirs in Poland is the pike *Esox lucius* L. (Trella et al. 2019, Trella and Wołos 2021a, Trella and Wołos 2021b). These measures are due to the fact that the pike is the species most preferred by anglers (Wołos 2000, Trella and Wołos 2021c) but also a species of high ecological importance (Lampert and Sommer 2001, Craig 2008, Forsman et al. 2015), as it is the main predator in many water bodies that plays a significant ecological role in regulating the populations of other fish species, especially cyprinids (Craig 2008, Trella and Wołos 2021c). Trella and Wołos (2021a) demonstrated that the area of open waters in Poland, stocked with pike since 2008, was over 80%, and during the study period of 2005-2019, it exceeded the value of 87% by as many as 5 times. The pike will probably remain the key species for years to come, and the harvesting of its spawners will continue to be a necessity for fisheries management, not only for lakes (Trella and Wołos 2021a, Trella and Wołos 2021b, Trella and Wołos 2021c). The expenditure on stocking with this species will continue to be high, with an increasing trend observed by Trella and Wołos (2021a), which may be related to the relatively high cost-effectiveness of fish stocking, as demonstrated by Mickiewicz and Trella (2019), with lakes of the Ełk Lakeland serving as an example. It is worth mentioning that the stocking was carried out in order to counterbalance the high angling pressure, fishing catches, and the impact of the cormorant *Phalacrocorax carbo* (L.), rather than to restore the population which was not endangered (Trella and Wołos 2021a). However, studies into the effectiveness of stocking lakes with the pike (Mickiewicz and Trella 2019) and into dammed reservoirs (Trella and Wołos 2021b) showed that there was a limit to the economic profitability of stocking, where an increase in the stocking rate did not translate into higher catches of this species, and sometimes these catches were even reduced.

The fishing users of lakes under study are characterised by a strong aversion to potential changes and innovations regarding the harvesting of spawners, even though genetic monitoring allows high genetic variability of spawning stocks to be maintained (Fopp-Bayat and Wiśniewska 2010, Trella et al. 2012). A serious threat to genetic biodiversity is the stocking with closely related stocking material obtained from a small number of spawners, which can result in inbreeding in the fish population, and the impoverishment of its gene pool (Fraser 2008, Leberg and Firmin 2008, Fopp-Bayat 2010, Trella et al. 2012). It is common for inbred individuals to suffer from a reduction in the quality of certain traits, resulting e.g. in reduced fertility, reduced resistance to disease, and growth inhibition (Trella et al. 2012), and the phenomenon is referred to as inbreeding depression (Wang et al. 2002). This phenomenon is caused by a reduction in heterozygosity, which results in the revealing of recessive genes (Fopp-Bayat 2010). This is why farms themselves should take an initiative with a view to introduce such innovations, in order for the fisheries management *ex definitione* to be more rational.

The reluctance of the entities under study to radically change the situation, i.e. to introduce a complete prohibition on spawner harvesting, is not surprising, as the entities authorised to fishing must primarily fulfil their obligations imposed on them by the agreement with the Regional Water Management Board, and the fisheries impact assessment. Carrying out sustainable fisheries management operations on lakes requires a rational fishing and stocking policy, irrespective of whether it is done with fishing gear or a fishing rod (Vehanen et al. 2002). This is why so many persons authorised to fishing indicated that the introduction of such regulations would virtually prevent them from fulfiling the obligation to carry out rational fisheries management operations. It is appropriate to mention the existing definition of rational fisheries management, as provided in Article 6.1. of the Inland Fisheries Act: *Rational fisheries management involves the use of the productive capacity of waters in accordance with the fisheries impact assessment, in a manner that does not prejudice the interests of the entities authorised to fishing in the same drainage basin, with fish resources being maintained in biological balance, and at a level that allows the future entities authorised to fishing to economically use these resources.* According to these provisions, the productive capacity of waters should be used in all fishing districts, yet due to their diversity, the productive capacity varies drastically and can be used with various intensity and by different methods (Wołos and Falkowski 2003). Would a prohibition on spawner harvesting dramatically improve fish resources and result in a biological balance being maintained if, despite the absence of this harvesting, there still had been high pressure exerted by anglers and fish-eating animals, particularly the cormorant? It is sufficient to mention here the recent study by Napiórkowska-Krzebietke et al. (2020, 2021), with Lake Warnołty with the most numerous cormorant colony in the belt of lake districts serving as the example, where the presence of cormorants (or, more precisely, their excrements) has resulted in a significant increase in the phosphorus content and chlorophyll a levels, and the occurrence of intense cyanobacteria bloom in the lake waters, and, consequently, in adverse changes in the functioning of the entire aquatic ecosystem (Trella and Wołos 2021c).

In turn, it is surprising that so many respondents thought it would be a good idea for there to be complete freedom of farms when it comes to spawner harvesting. At present, liberalisation of law in this respect is completely unrealistic (and irrational), especially as the entire fishing sector is currently under fire from various organisations, not only environmental ones.

It might appear that the problem of the prohibition concerns the PAA to a lesser extent, as, under anglers' pressure, commercial fishing was ceased or discontinued in many districts on waters belonging to this association, which concerns e.g. the Toruń or Szczecin district. As a result of these decisions, in 2019, the total fishing yield in the lakes used by the PAA was only 2.98 kg ha^{-1}, while for company entities it was 7.80 kg ha^{-1} (Wołos 2020). Nevertheless, the above-mentioned PAA district in Toruń which, in 2009, introduced a prohibition on fishing, retained, as an exception, the opportunity to harvest spawners for the purpose of supplying own hatcheries with reproductive material (Wołos and Trella 2017). In spite of these actions, protests are still organised in front of the PAA District Board in Toruń with slogans "Stop the PAA harvesting", in which numerous groups of anglers participate to demand that the spawner harvesting must be ceased, or the fish stocking profile must be changed. Despite a lot of pressure from anglers, more than half of the entities described their relationships with anglers as good, and indicated that it is the environmental organisations, and not anglers, that demand an end to the harvesting of spawners.

Respondents indicated an increase in angling fees as the main compensation for the potential prohibition on spawner harvesting. According to a study by Dawes (2009), which examined the effect of actual price increases on the relationship with customers, in this case with anglers, this would not be a reasonable move, as an increase in prices, even more drastic for prized fish, could imply a loss of the customer (angler), and the cost of their "return" would be many times higher. This is particularly true in view of the fact that a trend towards increased interest in sea angling has been observed in recent years (especially in the Vistula and Szczecin Lagoon, and in coastal zones, in the vicinity of major cities), which is a more favourable alternative in terms of permit prices (Trella 2012, Trella and Mickiewicz 2016, Trella 2018).

Conclusions

To summarise, the responses obtained from the questionnaires presented a broad view of the owners and managers of the entities under study on the issue of spawner harvesting. Given that the responses were obtained from the users of almost 64% of the total area of the lakes used for fishing and angling purposes in Poland, it can be concluded that this sample is highly representative for the entire lake fisheries management conducted not only in Poland but also in other countries of our geographical region. As can be seen, carrying out fish stocking management activities and the harvesting of spawners require a comprehensive approach, and the respondents themselves are mostly aware of the possible changes and their effects on management. The study was not intended to prove whether this prohibition would be "bad" or "good" but to present the approaches of persons authorised to fishing to these potential changes.

Authors contributions. M.T. and A.W. designed the survey, analysed the data, and drew up the paper. M.T. prepared tables and figures, conducted the literature review, and followed up the publication process. A.W. corrected the paper, and approved the final manuscript.

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References

Act of 18 April 1985 on inland fisheries. Polish Journal of Law 1985 (Dz.U. 2019 poz. 2168) (in Polish).

Arlinghaus, R. (2018). Stocking - 10 rules of conduct. In: Pro-environmental actions in rational fishery management (Ed.) A. Wołos. Wydawnictwo, IRS, Olsztyn, 61-68, (in Polish).

Brämick, U. (2002). Estimation of the Fish Yield Potential of Lakes in North-East Germany. In: Management and Ecology of Lake and Reservoir Fisheries (Ed.). I.G. Cowx .

Budzich-Tabor, U., Rigaud, A., da Silva, S.G., van de Walle, G. (2018). Integrating Aquaculture within Local Communities. European Commission, Directorate-General for Maritime Affairs and Fisheries, Director-General: Brussels, Belgium, 2018.

Cambray, J.A. (2003). Impact of indigenous species biodiversity caused by the globalisation of alien recreational freshwater fisheries. Hydrobiologia, 500, 217-230,

Cejko, B.I., Szczepkowski, M., Szczepkowska, B., Sarosiek, B., Kowalski, R.K. (2015). Pneumatic method of pike oocyte harvest. In: State of knowledge and innovations in wild fish reproduction (Ed.) A. Kowalska, B. I. Cejko, R. K. Kowalski, B. Sarosiek. Wydawnictwo IRZiB PAN, Olsztyn, 95-117, (in Polish).

Craig, J.F. (2008). A short review of pike ecology. Hydrobiologia 601, 5-16.

Czarkowski, T.K., Kapusta, A. (2016). A review of issues related to the management of pike (*Esox lucius* L.) populations, with particular emphasis on spawner fisheries. Komun. Ryb. 3(152), 13-19, (in Polish).

Dawes, J. (2009). The effect of service price increases on customer retention: the moderating role of customer tenure and relationship breadth. Journal of Service Research, 11(3), 232-245,

Diana, J.S. (2009). Aquaculture Production and Biodiversity Conservation. BioScience, Volume 59, Issue 1, January 2009, 27-38, Dobrowolski, Z. (2013). Public Debate as an Instrument for Improving Management of Public Organizations, Studia Lubuskie, Vol. IX, Sulechów 2013, 127-142, (in Polish).

FAO, (1997). Inland fisheries. FAO Technical Guidelines for Responsible Fisheries 6. FAO, Rome: 36 pp.

Fopp-Bayat D. (2010). The practical use of genetic analyses in protection of whitefish biodiversity from Lake Łebsko. UWM Scientific Bulletin no 31 (2010), 11-16, (in Polish).

Fopp-Bayat D., Wiśniewska, A. (2010). Genetic analysis of whitefish (*Coregonus lavaretus*) from Lake Łebsko - application of microsatellite DNA analysis. In: Breeding, rearing, prevention of rare and protected fish and other species (Ed.) Z. Zakęś, K. Demska-Zakeś, A. Kowalska, Wydawnictwo IRS, Olsztyn, 65-72, (in Polish).

Forsman, A., Tibblin, P., Berggren, H., Nordahl, O., Koch-Schmidt, P., Larsson, P. (2015). Pike Esox lucius as an emerging model organism for studies in ecology and evolutionary biology: a review. Journal Fish Biology 87, 472-479.

Fraser, D. (2008). How well can captive breeding programs conserve biodivesity? - A review of salmonids. Evolutionary Applications, 2 s, 1-52,

Hecky, R.E., Bootsma, H.A., Kingdom, M.L. (2003). Impact of land use on sediment and nutrient yields to Lake Malawi/Nyasa (Africa). Journal of Great Lakes Research 29, 139-158.

Hickley, P., Tompkins, H. (1998). Recreational Fisheries: Social, Economic and Management Aspects. Fishing News Books, Blackwell Scientific Publications, (Ed.). Hickley, P, Tompkins, H. Oxford, 310 pp.

Hühn, D., Lübke, K., Skov, Ch., Arlinghaus R. (2014). Natural recruitment, density-dependent juvenile survival, and the potential for additive effects of stock enhancement: an experimental evaluation of stocking northern pike (*Esox lucius*) fry. Canadian Journal of Fisheries and Aquatic Sciences, 71, 1508-1519,

Johnson, B.M., Arlinghaus, R., Martinez, P.J. (2009). Are we doing all we can to stem the tide of illegal fish stocking? Fisheries, 34, 389-394.

Lampert, W., Sommer, U. (2001). Ecology of inland waters. Wydawnictwo Naukowe PWN, Warszawa, 415 p. (in Polish).

Leberg, P.L., Firmin, B.D. (2008). Role of inbreeding depression and purging in captive breeding and restoration programs. Molecular Ecology, 17, 334-343.

Leopold, M., Bnińska, M. (1992). Fisheries management and eco-development. Zesz. Probl. Post. Nauk Rol. 401, 73-79, (in Polish).

Mickiewicz, M. (2014). Fisheries plan as a basis for rational fishery management. In: Principles and conditions of sustainable use of fisheries resources - Part II. (Ed.) M. Mickiewicz, A. Wołos. Olsztyn, Wydawnictwo IRS, 25-40, (in Polish).

Mickiewicz, M. (2016). Ecological, economic and social aspects of fishery and angling management of pike *Esox lucius* L. Komun. Ryb. (3), 20-26, (in Polish).

Mickiewicz M., Wołos, A. (2011). Species, stages, and value of stocking material released into Polish lakes from 2001 to 2009. In: Fish management in a variable water environment (Ed.) M. Jankun, G. Furgała-Selezniow, M. Woźniak, A. M. Wiśniewska, Faculty of Environmantal Protection and Fisheries University of Warmia and Mazury in Olsztyn, Poland, 65-76.

Mickiewicz, M., Trella, M. (2019). Economic effectiveness of pike (*Esox lucius* L.) stocking based on the example of selected lakes in East European Plain with consideration of their natural conditons. Fisheries Aquatic & Life, 27(3), 136-148.

Mitchell, M., Vanberg, J. and Sipponen, M. (2010). Commercial inland fishing in member countries of the European Inland Fisheries Advisory Commission (EIFAC): Operational environments, property rights regimes and socio-economic indicators. Country Profiles May 2010. Published by the FAO.
http://www.fao.org/docrep/015/an222e/an222e.pdf

Napiórkowska-Krzebietke, A., Kalinowska, K., Bogacka-Kapusta, E., Stawecki, K., Traczuk, P., (2020). Cyanobacterial blooms and zooplankton structure in lake ecosystem under limited human impact. Water 12 (5), 1252.

Napiórkowska-Krzebietke, A., Kalinowska, K., Bogacka-Kapusta, E., Stawecki, K., Traczuk, P., (2021). Persistent blooms of filamentous cyanobacteria in a cormorant-affected aquatic ecosystem: Ecological indicators and consequences. Ecological Indicators, Volume 124, 2021,107421.

Pierce, R. B. (2012). Northern pike: ecology, conservation, and management history. University of Minnesota Press, Minneapolis: 205 p.

Szczepkowski, M., Zakęś, Z., Kapusta, A., Szczepkowska, B., Hopko, M., Jarmołowicz, S., Kowalska, A., Kozłowski, M., Partyka, K., Piotrowska, I., Wunderlich, K. (2012). Growth and survival in earthen ponds of different sizes of juvenile pike reared in recirculating aquaculture systems. Archives of Polish Fisheries, 20, 267-274.

Trella, M. (2012). Trends in the sale of fishing permits in lake fisheries enterprises from 1998 to 2011. In: Sustainable use of fishery resources on the background of their state in 2011 (Ed.) M. Mickiewicz, Wydawnictwo IRS, Olsztyn, 65-75, (in Polish)

Trella, M. (2018). Characteristics of recreational fisheries in the Vistula Lagoon in 2015 during the period of the greatest changes in legislation on recreational fisheries in marine areas. Komun. Ryb. 6, 2-8, (in Polish)

Trella, M., Fopp-Bayat, D., Szczepkowski, M., Polak, A. (2012). Genetic variation of whitefish (*Coregonus Lavaretus*, Linnaeus, 1758) from Lake Vistytis using microsatellite DNA markers. Komun. Ryb. 4, 11-16, (in Polish)

Trella, M., Mickiewicz, M. (2016). Recreational fisheries pressure in the Polish waters of the Vistula Lagoon and considerations of its potential impact on the development of regional tourism. Archives of Polish Fisheries 24, 231-242.

Trella, M., Czerwiński T., Wołos, A. (2019). Determinants of fisheries management in dam reservoirs in Central-Eastern Europe under the influence of climate change. Fisheries & Aquatic Life, 27, 208-223.

Trella, M., Wołos, A. (2021a). The volume and value of commercial catches and pike (*Esox lucius* L.) stocking in the waters of fishing districts in the years 2005-2019. In: Aquaculture as a tool for the protection of ichtyofauna (Ed.) Z. Zakęś, K. Demska-Zakęś, Wydawnictwo IRS, Olsztyn, 175-189, (in Polish).

Trella, M., Wołos, A. 2021b. Assessment of the effectiveness of pike (*Esox lucius* L.) stocking on the example of selected dam reservoirs of southern Poland. In: Activities of fishing and angling entities in 2020 in the light of business, economic and environmental conditions (Ed.) A. Kowalska, A. Wołos, Wydawnictwo IRS, Olsztyn, 43-54, (in Polish).

Trella M., Wołos A. 2021c. Size and selected characteristics of northern pike (*Esox lucius* L.) commercial and angling catches in Polish inland waters over the long term. Fisheries Aquatic & Life 29, 108-123.

Turkowski, K. (2006). Sustainable development and inland fisheries. In: Fisheries, angling and eco-development (Ed.) A. Wołos, Wydawnictwo IRS Olsztyn, 9-19, (in Polish).

Vehanen, T., Marttunen, M., Tervo, H., Kylmälä, P., Hyvärinen, P. (2002). Management of Fisheries in a Large Lake - for Fish and Fishermen. In: Management and Ecology of Lake and Reservoir Fisheries (Ed.). I.G. Cowx.

Wang, S., Hard, J. J., Utter, F. (2002). Salmonid inbreeding: a review. Reviews in Fish Biology and Fisheries, 11(4), 301-319.

Wołos, A. 2000. The economic importance of angling in fisheries entities authorized to lake fisheries. Archives of Polish Fisheries 8, 5-54, (in Polish).

Wołos, A., Draszkiewicz-Mioduszewska, H., Mickiewicz, M. (2015). Volume and characteristics of lake fisheries production in 2014. In: Sustainable use of fishery resources on the background of their status in 2014 (Ed.) M. Mickiewicz, A. Wołos. Wydawnictwo IRS, Olsztyn, 9-20, (in Polish).

Wołos, A., Falkowski, S. (2003). Type of conducted fishing and its rationality. Comments to the Regulation of the Minister of Agriculture and Rural Development of 29 March 2002 on the fishing plan. Komun. Ryb. 2, 1-4, (in Polish).

Wołos, A., Trella, M. (2017). Mandatory registration of angling catches - level of data reliability and its usefulness in determining fish stock status. In: Angling User 2016 - The role of angling management in PZW waters in the light of sustainable development principles (Ed.) M. Mizieliński. Wydawnictwo „Wieś Jutra" Sp. z o.o., Warszawa, 191-210, (in Polish).

Wołos, A. (2020). Volume and characteristics of lake fisheries production in 2019. In: Activities of fisheries and angling entities in 2019. Managerial, economic and environmental conditions (Ed.) A. Wołos, M. Mickiewicz. Wydawnictwo IRS, Olsztyn, 9-18, (in Polish).

Zacharczyk, K. (2007). Where is the whitefish? Wiadomości Wędkarskie 2, 18-19, (in Polish).

Zakęś, Z., Demska-Zakęś, K. (2011). Hatchery practice in the context of biodiversity of aquatic ecosystems. In: Fish management in a variable water environment (Ed.) M. Jankun, G. Furgała-Selezniow, M. Woźniak, A. M. Wiśniewska, Faculty of Environmantal Protection and Fisheries University of Warmia and Mazury in Olsztyn, Poland, 45-52.

Zakęś, Z., Jarmołowicz, S. (2009). Technical condition of buildings and equipment used for fishing. In: Diagnosis of the current state and prospects for development of inland fisheries and coastal fishing areas in Warmia and Mazuria voivodeship (Ed.) A, Wołos, Wydawnictwo IRS Olsztyn, 95-110, (in Polish).