

**AN ASSESSMENT OF RECREATIONAL POTENTIAL
OF CHOSEN LAKES OF OLSZTYŃSKIE LAKE
DISTRICT (WARMIA AND MAZURY, POLAND)
FOR ANGLING PURPOSES**

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Key words: lakes, angling, recreational potential, natural determinants, angling management.

Abstract

Angling is one of the most popular forms of recreation in Poland. The aim of the present work was an evaluation of angling potential of chosen lakes in the Olsztyńskie Lake District. Multidimensional comparative analysis was applied in this study. The study included 19 lakes. In the final assessment lakes Tejstymy, Tumiańskie and Dadaj achieved the highest potential for angling with values of synthetic measure over 0.5. The lowest values were achieved by lakes Rzeckie, Rasząg and Krakusy Małe (under 0.2). The best rated lakes were characterized by high values of synthetic measures in both studied groups of features. It was reassumed, that the lakes with low synthetic measure of the group of natural determinants were not worth to be invested. The lakes with not fully utilized natural potential and the lakes with unutilized natural potential (especially worth to be invested) were indicated.

**OCENA POTENCJAŁU REKREACYJNEGO WYBRANYCH JEZIOR POJEZIERZA
OLSZTYŃSKIEGO (WARMIA I MAZURY, POLSKA) DO CELÓW WĘDKARSTWA**

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Słowa kluczowe: jeziora, wędkarstwo, potencjał rekreacyjny, uwarunkowania przyrodnicze, zagospodarowanie wędkarskie.

Abstrakt

Jedną z najbardziej popularnych form rekreacyjnego wykorzystania jezior w Polsce jest wędkarstwo. W ostatnich kilkunastu latach nastąpił jego dynamiczny rozwój, który przyczynił się do opracowania systemu oceny naturalnych zbiorników wodnych pod kątem ich przydatności do tej formy rekreacji.

Celem pracy było oszacowanie potencjału rekreacyjnego wybranych jezior Pojezierza Olsztyńskiego do celów wędkarstwa. W pracy zastosowano metodę oceny opartą na analizie porównawczej uwarunkowań przyrodniczych i zagospodarowania wędkarskiego zbiorników. W badaniach uwzględniono 19 jezior. Wykazano, że największy potencjał wędkarski mają jeziora: Tejstymy, Tumiańskie oraz Dadaj, które uzyskały wartość miernika syntetycznego powyżej 0,5. Najniższe wartości miernika uzyskały jeziora: Rzeckie, Rasząg oraz Kraksy Małe (poniżej 0,2). Najwyżej ocenione akweny charakteryzowały się wysokimi wartościami mierników syntetycznych zarówno pod względem uwarunkowań przyrodniczych, jak zagospodarowania wędkarskiego. Stwierdzono, że nie warto inwestować w jeziora o niskich wartościach miernika syntetycznego dla działu uwarunkowania przyrodnicze. Wskazano jeziora o niewykorzystanym potencjale przyrodniczym, w które szczególnie warto zainwestować.

Introduction

One of the most attractive elements of natural environment commonly used for tourism and recreational purposes are lakes and their shores (HALL and HARKONEN 2006, HALL 2010). According to DEDIO (1989) and ŁAPIŃSKA (1998), lakes are those components of the environment, which decide of its attractiveness for humans. From a recreational point of view an area of water-land contact is important because of its potential for performing various recreational activities. Lakes are primary destinations for leisure, they are responsive ecosystems, sensitive to changes caused by tourism development (COOPER 2006). Multifunctional use of lakes in terms of their ecological, recreational and fishing functions contributed to increase the level of anthropopression on lakes (BNIŃSKA 1992).

Angling is a popular form of human activity, which combines mentioned above functions. According to surveys (FENCZYN 1998, SKRZYPCZAK 2005) angling constitutes the largest group of hobbyists in Poland, which has about 630 thousand registered members (PZW 2016). Angling enjoys a great interest from the society, and this fact is a result of its interdisciplinary nature. It combines many disciplines of life such as sport, tourism and relaxation (FENCZYN 1998).

The importance of angling in terms of fishery management in Poland started to rise at the end of the twentieth century. The fishery management based solely on net fishing became unprofitable (SKRZYPCZAK 2005, CZERWIŃSKI 2014, SKRZYPCZAK et al. 2014). It is worth noting that the expenses related to recreation, including angling, not apply to the general principles of economy (MICKIEWICZ et al. 2008). This is due to the fact that people (including anglers) often submit expenses associated with their hobby over other needs (SEWELL and ROSTRON 1970, WOŁOS 2000).

SOŁOWIEJ (1992), claims that any attempts at evaluating tourist space are useful and fully justified. There are many studies that describe the usability of lakes for tourism and recreation (DÁVID 2003, FURGAŁA-SELEZNIOW et al. 2007, HALL 2009, BOROMISZA 2013, TUOHINO 2015). There are some studies devoted to the impact of angling on the water environment and ichthyofauna (SKŁODOWSKI and LIPKA 2011, CZARKOWSKI et al. 2012, WOŁOS et al. 2013, WOŁOS 2014). Economic aspects of the angling were the subject of some analyses too (SIPPONEN 1998, MICKIEWICZ et al. 2008, CZERWIŃSKI 2013, WOŁOS 2014). However publications and scientific research devoted to lakes suitability for angling purposes are scarce. Intensive development of recreational fishing contributes to create the evaluation system of natural water reservoirs for their suitability for angling (SKRZYPCZAK 2005, SKRZYPCZAK et al. 2006).

The aim of the study was to evaluate suitability of chosen lakes of Olsztyńskie Lake District, Poland for angling purposes.

Study area

The study covered a group of 19 lakes situated in the communes of Biskupiec and Barczewo in the Province of Warmia and Mazury. According to the physico-geographical division of Poland into regions, the tested lakes are situated on the macroregion of Masurian Lake District, mesoregion Olsztyńskie Lake District, North-East Poland (KONDRACKI 1998). The lake district was formed during the last glacial period, known as Baltic glaciation.

Lakes with an area exceeding 10 hectares, for which data on fish stocking were available were selected for the study. Basic morphometric parameters of tested lakes in Biskupiec and Barczewo communes were shown in the Table 1.

Table 1

Morphometric parameters of studied lakes in Barczewo* and Biskupiec** communes
(Province of Warmia and Mazury, Poland) (according to JAŃCZAK 1999)

Lake	Surface area [ha]	Maximum depth [m]	Average depth [m]	Lakeshore development
Pisz*	205.9	25.2	5.5	2.34
Tumiańskie*	122.2	17	6.7	1.43
Dobrag*	103.5	8	3.5	1.39
Umląg*	91.9	9.3	3.1	1.79
Kierzlińskie*	91.5	27.9	11.5	1.57
Kiermas*	80.8	11.5	4.6	1.71
Orzyc*	62.1	44.5	11.7	1.41
Świątajno*	23.9	6.6	2.7	1.16
Łęgajny*	19.7	5	1.8	1.30
Dadaj**	976.8	39.9	12.3	3.10
Tejstymy**	198.2	33.0	10.0	1.89
Pierwój**	134.1	26.0	7.7	1.60
Jełmuń**	131.4	7.5	4.0	1.62
Stryjewskie**	67.5	6.2	2.6	1.85
Rzeckie**	59.0	29.0	6.8	2.02
Węgój**	53.7	6.0	2.1	1.52
Kraksy**	44.2	4.0	1.1	1.85
Rasząg**	30.5	5.9	2.9	1.51
Kraksy Małe**	14.1	1.7	0.8	1.35

The Masurian lake District belongs to regions where lakes are a basis for tourism development (SMITH 2003, BANASIK and BUCHOLZ 2010, *Strategia rozwoju...* 2013). In the western part of the region they are rather small lakes not suitable for sailing.

Materials and Methods

For the evaluation of angling attractiveness of lakes, a method suggested by SKRZYPCZAK (2005) was applied in this study. It allowed to obtain synthetic measures which achieve numerical values from 0 to 1. Multidimensional comparative analysis is the method in which the objects being examined are described by various features (*Regionalne aspekty...* 1999). The comparative evaluation of the potential of lakes for angling purposes was based on two groups of features: (1) natural determinants for angling and (2) angling management (Table 2) as proposed by SKRZYPCZAK (2005). Depending on what

is the impact of a given feature on the object being examined, the differentiation of stimulants (*S*) and destimulants (*D*) was done. Stimulants are those features whose high value is linked to a positive evaluation of the lake examined. Destimulants include all the features whose low value results in a positive evaluation (*Regionalne aspekty...* 1999).

Table 2
Parameters applied for the evaluation of angling attractiveness of the lakes (SKRZYPCZAK 2005)

Group of parameters	Parameter	Influence of the parameter	Weight of the parameter	Weight of the group of parameters
Natural determinants for angling	the shoreline development index	stimulant	0.10	0.60
	zone of the emergent plants-rushes 1-5 m in width [%]	stimulant	0.25	
	zone of the emergent plants-rushes > 5 m in width [%]	destimulant	0.10	
	forests (fresh and dry habitats)[%]	stimulant	0.20	
	wetlands (marshes and marshy forest) [%]	destimulant	0.10	
	water table accessibility 1-10 m – 1 point 11-20 m – 2 points 21-30 m – 3 points, etc. [points 100 m ⁻¹ of shoreline]	stimulant	0.25	
Angling management	angling piers 1-10 m ² [number 100 m ⁻¹ of shoreline]	stimulant	0.30	0.40
	recreational piers 10.1-25 m ² [m ² 100 m ⁻¹ of shoreline]	stimulant	0.10	
	variety of the stocking material [number of species]	stimulant	0.15	
	mean value of stockings [pln ha ⁻¹ year ⁻¹]	stimulant	0.45	

The procedure used in the present study to evaluate the recreational potential of studied lakes was split into the following steps:

Step 1. Selection of objects (lakes) and features clustered into two groups (natural determinants for angling and angling management) describing them – this is the preparation of a matrix of observations *X*:

$$X = [x_{ij}] (i = 1, \dots, n; j = 1, \dots, m),$$

where:

X – matrix of observations made on the variables describing particular lakes,

n – number of lakes,

m – number of variables.

Step 2. Making all variables homogenous by transferring them into stimulants. In the case of destimulants it was done based on the following formula (*Regionalne aspekty...* 1999):

$$y_{ij} = x_{j\max} - x_{ij}$$

where:

- y_{ij} – destimulant transferred into stimulant,
- x_{ij} – initial, original destimulant values,
- $x_{j\max}$ – maximum of the feature j in studied lakes.

Step 3. Making all diagnostic variables (stimulants and destimulants transferred into stimulants) comparable. It was done using a normalization procedure, based on standardization. The following formula was used:

$$n_{ij} = \frac{y_{ij}}{y_{j\max}}$$

where:

- n_{ij} – normalized value of variable j in lake i ,
- $y_{j\max}$ – maximum of the stimulant variable (feature) j in studied lakes,
- y_{ij} – value of the stimulant variable in lake i .

Step 4. Calculation of the synthetic measure for one group of features as weighted arithmetic mean of normalized values in the group of features according the formula:

$$Md_i = \sum_{j=1}^n w_j n_{ij}$$

where:

- Md_i – the synthetic measure for group d in lake i ,
- w_j – weight of the feature j in group d .

Step 5. Calculation of the final synthetic measure for angling attractiveness of the lakes as weighted arithmetic mean of synthetic measures for groups:

$$MS_i = \sum_{k=1}^l W_k Md_i$$

where:

- k – number of the group,
- W_k – weight of the group k ,
- MS_i – final synthetic measure for lake i .

Data concerning following features: percentage of the emergent plants-rushes of different width, percentage of forests and wetlands in the shoreline, water table accessibility, number of angling and recreational piers were based on expert judgement. The shoreline development index was taken from *Atlas jezior...* (1999). Data on fish stocking performed in lakes were received from the fish farms. The mean values of fish stocking were calculated according to the formula (SKRZYPCZAK 2005):

$$Z = \sum_{j=1}^n G_i k_i$$

where:

Z – the value of the stocking,

n – number of species (i) used for stocking,

G_i – the mean value of the stocking material of a species (i) per year and hectare; prices quoted by the Regional Water Management Authority in Warsaw.

k_i – the weight of the species according the Table 3.

Table 3

The weight of the species (k) used in stockings according to SKRZYPCZAK (2005)

Fish species	k value
European eel (montee), perch, pike-perch, wels catfish, pike	8
Tench, crucian carp, burbot	5
Common carp and others	1

Results

In the group of features natural determinants for angling five lakes: Pisz, Tumiańskie, Łęgajny, Kierzlińskie and Dobrag obtained the highest value of synthetic measure (over 0.6) and showed favorable natural conditions for angling (Figure 1a). The lakes Pisz, Tumiańskie, and Dobrag were characterised by the high proportion of forests along the shoreline (Table 4). The lakes Łęgajny, Tumiańskie and Kierzlińskie had the best water table accessibility. The lowest (below 0.4) values of natural determinants for angling were calculated in case of five lakes: Rasząg, Kraksy Małe, Kraksy, Rzeckie and Stryjewskie mainly because of difficult water table accessibility (Figure 1a, Table 4). Moreover in four lakes (excluding Kraksy), the zone of the emergent plants-rushes over 5 m in width exceeded 20% of the shoreline.

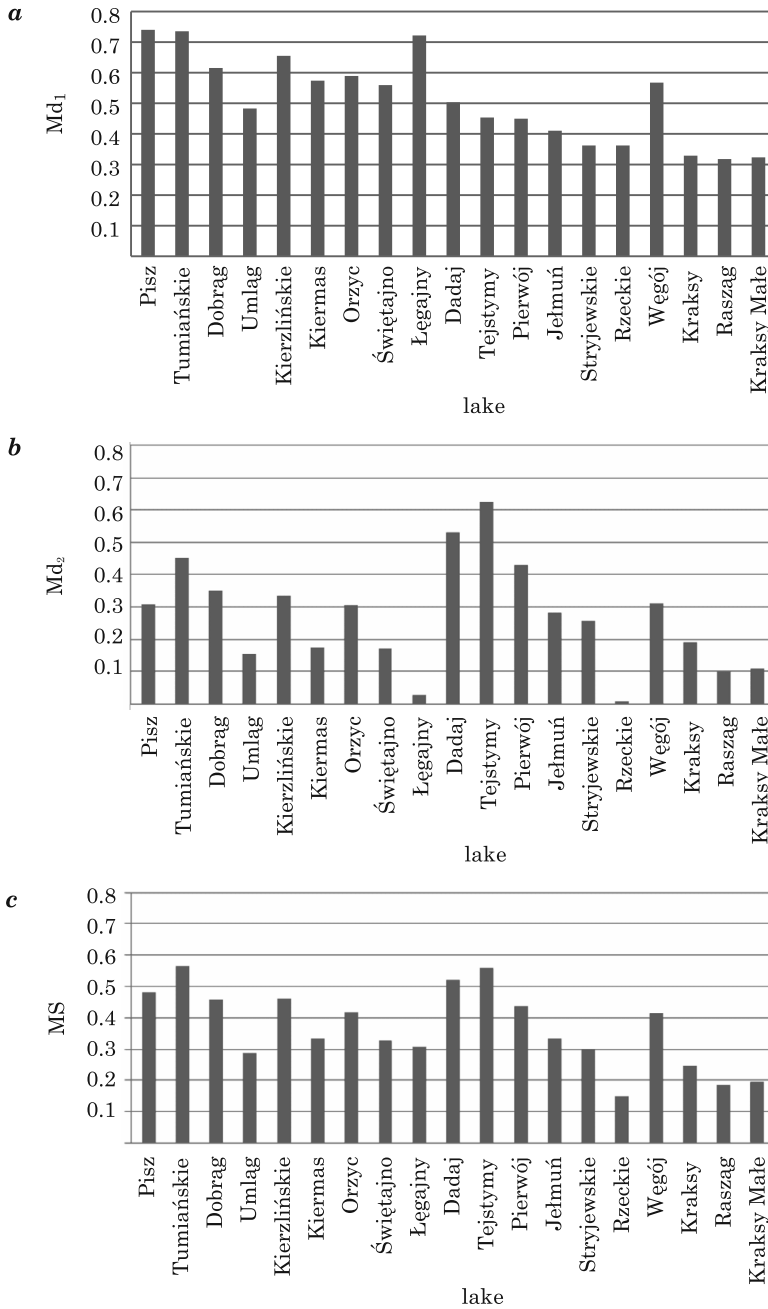


Fig. 1. Structure of the values of the synthetic measures obtained for the lakes in the section of natural conditions for angling (Md_1) (a), in the section of angling management (Md_2) (b), and the final synthetic measures of angling attractiveness (MS) (c) of the studied lakes from Olsztyńskie Lake District

Table 4
Normalized values of variables of two groups of analyzed features

Lake	Natural determinants for angling								Angling management			
	the shoreline development index	zone of the emergent plants-rushes 1-5 m in width	zone of the emergent plants-rushes < 5 m in width	forests (fresh and dry habitats)	wetlands (marshes and marshy forest)	water table accessibility	angling piers	recreational piers	variety of the stocking material	of stockings mean value		
Pisz	0.75	0.88	0.91	0.95	1.00	0.26	0.31	0.13	0.67	0.22		
Tumiańskie	0.46	0.72	0.67	1.00	0.86	0.62	1.00	0.41	0.50	0.08		
Dobrag	0.45	0.85	1.00	0.87	0.30	0.22	0.00	0.00	1.00	0.45		
Umląg	0.58	0.80	0.67	0.00	1.00	0.23	0.26	0.00	0.33	0.06		
Kierzlińskie	0.51	0.86	0.91	0.41	1.00	0.47	0.20	0.00	0.83	0.33		
Kiermas	0.55	0.93	0.98	0.00	1.00	0.36	0.15	0.00	0.50	0.12		
Orzyc	0.45	0.77	0.67	0.80	0.72	0.20	0.48	0.24	0.50	0.14		
Świętajno	0.37	1.00	1.00	0.00	1.00	0.29	0.31	0.00	0.33	0.06		
Łęgajny	0.42	0.93	0.98	0.00	1.00	1.00	0.09	0.00	0.00	0.00		
Dadaj	1.00	0.57	0.59	0.08	0.77	0.44	0.20	0.42	0.67	0.73		
Tejstymy	0.61	0.66	0.31	0.55	0.46	0.16	0.13	0.62	0.50	1.00		
Pierwój	0.52	0.83	0.83	0.00	0.10	0.39	0.15	0.10	0.33	0.72		
Jełmuń	0.52	0.67	0.50	0.00	1.00	0.17	0.50	0.33	0.50	0.05		
Strujewskie	0.60	0.61	0.00	0.16	1.00	0.07	0.31	0.67	0.50	0.04		
Rzeckie	0.65	0.62	0.48	0.11	0.60	0.04	0.00	0.08	0.00	0.00		
Węgój	0.49	0.81	0.58	0.65	1.00	0.11	0.33	1.00	0.50	0.08		
Krakusy	0.60	0.82	0.56	0.00	0.00	0.03	0.39	0.12	0.33	0.02		
Rasząg	0.49	0.63	0.16	0.00	0.80	0.06	0.06	0.83	0.00	0.00		
Krakusy Małe	0.44	0.75	0.46	0.00	0.19	0.12	0.20	0.13	0.17	0.02		

In the group of features concerning angling management only the lake Tejstymy peaked at value of synthetic measure over 0.6 (Figure 1b). Following three lakes (Dadaj, Tumiańskie and Pierwój) received the synthetic measure over 0.4. The lowest values of synthetic measure (below 0.1) were noted in three lakes: Łęgajny, Rasząg and Rzeckie (Figure 1b). The results reflected the level of fishery management on the lakes, especially the mean value of stockings (Table 4). The mean value of fish stocking range from 0 (in lakes Rzeckie, Rasząg and Łęgajny) to 1644.5 PLN in Tejstymy Lake. The number of fish species used for stockings in particular lakes ranged from 0 (lakes Rzeckie, Rasząg and Łęgajny) to 6 (in Dobrag).

The calculations of the final synthetic measure of lake attractiveness for angling purposes showed that lakes Tejstymy, Tumiańskie and Dadaj are the most attractive for anglers (values of final synthetic measure over 0.5) – Figure 1c. The lake Tumiańskie was characterized by high value of natural determinants for angling and moderate level of angling management (Figure 1a, b). The highest angling management synthetic measure was calculated for the lake Tejstymy while the natural determinants for angling for this lake were moderate. The lakes Rzeckie, Rasząg and Kraksy Małe had the lowest potential for angling (the final synthetic measure below 0.2) – Figure 1c.

Discussion

Lakes as a component of the environment have a significant impact for tourism and recreation. Moreover they are one of the crucial elements that influence a touristic potential of the region of their occurrence (SMITH 2003). Therefore all research which are focused on the evaluation of lake's attractiveness for tourism and recreation are valuable for local government. They are helpful in sustainable tourism management (World Lake Vision Committee 2003).

Based on Polish research in this area only DEDIO et al. (1989), SKRZYPCZAK (2005) and SKRZYPCZAK et. al. (2006) have taken attempts to assess the usefulness of water bodies for angling. Selection of lakes by their potential for recreation allows their appropriate use and create attractive destination for tourists.

In this research the highly valued lakes were characterized by favorable location (away from large urban areas and in the proximity of forests), availability of shoreline and with good access to the water table. The research of JORGENSEN and MATSUI (1997), COOPER (2006) and BOROMISZA (2013) showed that shoreline and littoral zone was a zone of highest recreation and tourism impact. Reasonably conducted fish management was an undoubted

advantage of best rated lakes. To increase their potential owners of fishing rights should plan and conduct periodic fish stocking, focused on species, popular among the anglers (ARLINGHAUS and MEHNER 2004, ARLINGHAUS et al. 2016). The most attractive species for anglers are: pike (*Esox lucius*), common carp (*Cyprinus carpio*), tench (*Tinca tinca*) and crucian carp (*Carassius carassius*) (WOŁOS 1994). SKRZYPCZAK (2005) claimed, that the regular fish stocking improves an angling attractiveness of the lake by increasing the probability of catching the fish. The second emerging topic is the investment in angling infrastructure – small bridges and piers in the shoreline of the lake as well as parking places and sanitary buildings near fishery points. This facilities will allow an easier access to the water table and increase the standard of angling conditions (WOŁOS 2000).

The possibility of indicate the influence of individual components of environment and human activity on angling suitability was the advantage of this research. On the base of these results, the owners of fishing rights can decide about profile of lake management. Therefore this method is a helpful tool to modify and improve the lakes management plans. An inclusive planning and management approach that integrates recreation fisheries within the broader scope of aquatic ecosystem management is often needed for sustainable inland fisheries (ARLINGHAUS et al. 2016). COOKE et al. (2016) characterized the scope and magnitude of inland recreational fisheries as a coupled social-ecological system.

In the present study 3 lakes (Rzeckie, Rasząg and Kraksy Małe) were classified as lakes with the lowest potential for angling because of low synthetic measure in two studied groups of features. The comparison of lakes Stryjewskie and Rzeckie showed the identical values of synthetic measure for group natural determinants for angling (0.362). Whereas the synthetic measure for angling management for these lakes differed more than thirty fold (0.255 versus 0.008). However the final synthetic measure for lake Stryjewskie was higher only twice (0.30 versus 0.15). This fact showed that it is not worth to invest in the lake with low natural determinants for angling (below 0.4). The lakes with very high value of synthetic measure for group natural determinants for angling (over 0.6) are worth to be invested even if the angling management level is relatively high (over 0.4) or moderate (over 0.3). Lakes Tumiańskie, Pisz, Kierzlińskie and Dobraż were examples of such lakes with not fully utilized potential.

The potential of many lakes as an angling resource is often not fully realised (HICKLEY et al. 2004). The lakes with high value of synthetic measure for group natural determinants for angling (over 0.5) and with very low level of angling management (below 0.2) are good candidates to be invested at first. Even small investments may bring significant results in this case. Lakes

Łęgajny, Kiermas and Świętajno were examples of such lakes with unutilized natural potential.

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