ECONOMIC SIGNIFICANCE OF ANGLING FOR FRESHWATER FISHERIES

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A B S T R A C T. Analyses were performed of production and economic data obtained from lake fishery enterprises in the regions of Mazuria, Suwałki, Great Poland, Kujawy and Pomerania. Economic significance of angling was estimated using two basic parameters: income from the sale of angling licences in zł/ha and percentage of this income in total incomes of the fishery enterprises. Fishery enterprises were divided into three groups depending on the level of these parameters. Enterprises in which the role of angling was high, moderate and low were characterised. Global role of angling in lake fishery management was estimated, and attention was drawn to non-fishery values of this form of water use.

Key words: ANGLING, LAKE FISHERY MANAGEMENT, ECONOMICS

INTRODUCTION

Fishery studies frequently deal with various problems related to angling (sport fishery), this being most of all due to its considerable value in a macroeconomic (on a national scale) as well as microeconomic i.e. local scale (in a region, locality, water body, various water users etc.). Data presented by Bennett (1971) are an adequate measure of the first values: in 1965 over 28 million people were engaged in angling in the USA, and they spent almost 3 billion $. According to Canadian data in 1980 every fifth citizen of this country was an angler, and global expenses for angling amounted to 1.1 billion $ (direct expenses) plus an additional 1.3 billion $ for boats, motors, camping equipment etc. (Department of Fisheries and Oceans 1984). New York State may serve as an example of the smaller scale, in which in 1988 the economic value of angling, determined with the willingness to pay method, amounted to 284 million $ (Connelly and Brown 1991). "Salmon" fishery of Ireland measured as gross national product of 1.16 million pounds (O'Connor *et al.* 1974) is also a good example of the latter.

Polish fishery scientists had for many years underestimated the role of such studies; first papers devoted to angling appeared as late as the 80-ies. They were initiated

by questionnaire surveys of Polish anglers, members of the Polish Anglers' Association, and concentrated on sociological problems, angling intensity in particular water categories, its impact on the fish stocks, and the effect of angling on the fisheries management (Leopold *et al.* 1980, Bnińska and Leopold 1987, Leopold and Bnińska 1987). A number of papers by Polish authors appeared in the 90-ies; they dealt with a number of problems related to angling: from the preferences of lake anglers (Wołos 1991), through angling catches in dam reservoirs (Bieniarz *et al.* 1990a, 1990b, 1993), to the estimation of the effect of angling on aquatic ecosystems (Wołos *et al.* 1992). So far, however, there have been no studies on the economics of angling, in this on its effect upon the economy of commercial fishery enterprises.

Considering that the number of anglers fishing in lakes used by commercial fishery is estimated as exceeding 500 thousand (Wołos 1994), and that this must have an effect on the economic results of fishery enterprises, the need for such studies becomes unquestionable. This is confirmed by the results of studies carried out in the first years of the transformation period in fisheries, i.e. during the so-called restructurisation (Leopold 1994), while the most recent data (for 1995) show that economic rank of lake angling - even in this short time - has still increased (Leopold and Wołos 1996).

The aim of this study was to estimate the significance of angling in lake fisheries, and especially to determine its effect on economic performance of commercial fishery lake users, which are referred to in the text as fishery enterprises (although their size, structure and ownership differs). The adopted methodical approach makes it possible to define these characters (parameters) of the fishery enterprises and waters used by them which directly affect incomes from the sale of angling licences, and the effect of these on enterprise rentability.

MATERIALS AND METHODS

Catch statistics and basic data pertaining to production and economics, collected in 1995 from 51 fishery enterprises managing 206.8 thousand ha of lakes, were used as the materials. The data were analysed in two steps. In the first one, basic production parameters were calculated for the whole sample of 51 enterprises. In the second step, which in reality represented the major stage of the analysis, 11 enterprises managing 49.6 thousand ha lakes were excluded as their data were incomplete. Hence, advantage was taken of the data from 40 fishery enterprises managing totally 157.2 thousand

General characteristics of the fishery enterprises in particular regions if the country.

Region	Area		Number of fishery enterprises		Mean area of one enterprise
	ha	%	n	%	ha
Great Poland	38606	24.6	14	35.0	278
Pomerania (with coastal lakes)	47458	30.2	14	35.0	3390
Mazuria	71071	45.2	12	30.0	5923
	157135	100	40	100	3928

ha of lakes. They represented practically all major lake regions of the country. Percentage of these regions in the total area under study, and the number of enterprises and their mean area in each region are given in Table 1.

Catch statistics comprised level of fish catches by species, and in the case of bream, roach and perch - also by size categories. Total weight of the analysed fish catches amounted to 2455 thousand metric tonnes.

Basic economic and production data comprised also: number of lakes managed by each enterprise, fish pond area (if any), total number of employees (in this of lake fishermen), total incomes divided into incomes from lake production, incomes from the sale of angling licences, and the so-called other incomes, and total costs born by the enterprise.

The aim of the study determined the methodical approach. It consisted of analysing all data and indices from the point of view of two basic parameters determining economic importance of angling: **O** - level of incomes from the sale of licences for anglers recalculated into a unit of lake area in each enterprise, and **P** - percentage of these incomes in total incomes of each enterprise. These two parameters (**O** and **P**) were treated as specific dependent variables, so that all other parameters characterising the analysed enterprises as well as the fish catches (and indirectly - also management intensity and state of the lake environment) were related to these two basic variables, thereby enabling estimation of the factors which affect and/or determine them.

Two approaches were adopted in the study. In the first basic version, mean values were calculated of the income originating from the sale of licences for anglers per 1 ha of lake area (**O**), and mean percentages (**P**) of these incomes in total income of the enterprises. All other data and parameters were related to these means viz. assigned as higher or lower than the mean.

This approach made it possible to distinguish three groups of fishery enterprises and their characteristics: those in which incomes from licence sale (**O**) and their percentage in total income (**P**) were higher than the respective means (group A), those in which both **O** and **P** were lower than the means (group C), and those enterprises in which either **O** was higher but **P** lower than the respective means, or vice versa (group B).

The second approach was based on correlation and linear and curvilinear regression (using polynomials up to the fourth degree), taking into account all limitations resulting from the character of the data. The accepted significance level was p=0.05.

RESULTS

OVERALL DATA (51 FISHERY ENTERPRISES)

The analysed enterprises managed 206.8 thousand ha of lakes, this being about 75 % of the total area of Polish lakes used by commercial fisheries. In addition to this, they disponed of 129 fish pond objects of the area 7229 ha. The enterprises employed 1513 people, in this 475 lake fishermen. Total number of lakes was 1683; out of these 45 were the so-called special fishing grounds i.e. water bodies especially attractive for anglers and/or more intensively managed for angling. Total number of special fishing grounds in ponds was 21, their total area 33.24 ha. In 1995 totally 117.25 tonnes of fish were sold at special fishing grounds, in this 111.60 tonnes (95.2 %) of common carp.

ANALYSIS OF THE PRODUCTION AND ECONOMICS (40 FISHERY ENTERPRISES)

Total income of the analysed 40 fishery enterprises amounted in 1995 to 28.60 million zł, in this 22.36 million zł from the basic production, 3.39 million zł from the sale of angling licences, and 2.86 million from other sources (eg. construction of the fishing gear, sale of marine fish, transportation services). Average fish yield from lakes was 15.62 kg/ha.

Table 2 presents production and economic parameters characterising the distinguished groups of enterprises. The method adopted yielded three groups of enterprises which differed considerably as to the role of angling. In group A angling played a

TABLE 2

Production and economic parameters in the distinguished groups of enterprises

	Enterprise group		
	A	B	C
1. Incomes from the sale of angling licences (**O**) - zł/ha	45.81	18.46	10.69
2. % in total incomes (**P**)	22.58	9.71	6.52
3. Number of fishery enterprises	13	15	12
4. Lake area (ha)	36792.2	53062.5	67280.3
5. Mean area of one enterprise (ha)	2830.2	3537.5	5606.7
6. Mean area of one lake (ha)	94.1	116.4	172.5
7. Pond area (ha)	1083.8	1204.4	798.6
8. Mean area of a pond object (ha)	38.7	66.9	33.3
9. Area of ponds/lake area (%)	2.94	2.27	1.19
10. Lake area per 1 employee (ha)	141.5	174.5	180.9
11. Lake area per 1 lake fisherman (ha)	364.3	449.7	448.5
12. Incomes from basic production (zł/ha)	143.42	156.87	129.99
13. % in total incomes	70.70	82.54	79.23
14. Other incomes (zł/ha)	13.62	14.72	3.38
15. % in total incomes	6.72	7.75	14.25
16. Total incomes (zł/ha)	202.85	190.05	164.06
17. Total costs (zł/ha)	187.59	176.52	154.24
18. Incomes/costs (%)	108.1	107.7	106.4
19. Percentage of regions in lake area of the enterprises:			
Great Poland	62.4	15.0	11.4
Pomerania	7.2	50.4	26.9
Mazuria	30.4	34.6	61.7
20. Fish yield (kg/ha)	17.09	14.74	15.51

highly significant role, in group B its role was moderate, and in group C it was low. It should be noted that share of these groups in total lake area of the 40 enterprises was inversely proportional to the role of angling, being 23.4 %, 33.8 % and 42.8 %.

Also level of other parameters increases as the incomes from angling (**O**) and their percentage (**P**) in total incomes decrease. And thus, the mean size of one enterprise is bigger in group B than in A by 25 %, and in group C by almost 100 % than in group A. Mean area of one lake shows the same trend, and so does lake area per 1 employee (and practically also per 1 lake fisherman), and the level and share of "other incomes". It should be noted that the latter incomes (Table 2, no. 14) in group C exceed by over 100 % the income from the sale of angling licences.

On the other hand there are many characters "directly proportional" to the decreasing role of angling in particular groups. These are: share of pond area in relation to

lake area, level of overall income, total costs and the index of rentability viz. ratio between total incomes and total costs in per cents. It should be noted that if no attention is paid to group B, the same refers to the incomes from basic (fishery) production and to the fish yield in kg/ha. Considering that in group B the highest income from the fishery production is due to pond fish production, it seems that in this case this group should not be taken into account. The same conclusion results from the fact that average area of pond objects is in this group almost twice higher than in the other two, and amounts to 67 ha. Also level of income from fishery production related to fish yield in kg/ha is higher in group B (despite the lowest yield) by over 25 % compared to the other two groups.

It may be inferred at this stage of analysis that, irrespective of all other factors, in the sequence of enterprises A B C we deal with a relatively decreasing intensity of the fishery management, coupled with a decreasing role of angling.

Table 3 presents the characteristics of fish catches in the three groups of lakes, arranged so as to expose their character and facilitate interpretation.

Apart from eel which is indifferent to many environmental changes, two fractions of fish catches have been distinguished in the table: fraction I, comprising species and size categories which tend to disappear from the environment as its quality deteriorates, and fraction II, which is stimulated by such changes. Absolute (kg/ha) and relative (%) levels of fish catches in these fractions, and especially the relations between them, enable at least a general estimation of the state of lake environment in the distinguished groups.

Data presented in Table 3 show that the three groups of fishery enterprises differed also with respect to the state of their lakes. It seems that quality of lakes in these groups was inverse to the intensity of management and to the role of angling. And thus, enterprises in group A managed lakes characterised by the lowest quality of their environments, those in group C had lakes of the highest quality, while group B occupied an intermediate position. This may be inferred from a number of data presented in Table 3, but a simple comparison of fraction I and fraction II in the sequence A B C, which amount to 66.4 %, 99.6 % and 134.0 %, is quite sufficient to support the statement on considerable differences in lake quality between the three groups.

Level of fish catches, especially of the definite fish groups, also reflects decreasing intensity of fishery management in the enterprise groups A B C. This is especially noticeable in coregonid catches (viz. of the species "susceptible" to unfavourable environmental changes), which paradoxically are the highest in group A and the lowest in

TABLE 3

Commercial fish catches in the distinguished groups of fishery enterprises

Species and size classes	Enterprise group					
	A		B		C	
	kg/ha	%	kg/ha	%	kg/ha	%
Fraction 1						
1. Coregonids (whitefish, vendace)	1.05	6.2	0.90	6.1	0.72	4.6
2. Perch	0.55	3.2	0.77	5.2	1.10	7.1
3. Littoral fish (pike, tench, crucian carp)	1.35	7.9	1.37	9.3	1.35	8.7
4. Big-sized cyprinids (Big and medium bream, medium roach)	3.07	18.0	3.56	24.2	4.12	26.6
5. Other	0.16	0.9	0.15	1.0	0.64	4.1
Total 1-5	6.18	36.2	6.75	45.8	7.93	51.1
Fraction II						
6. Pikeperch	1.03	6.0	0.89	6.0	1.03	6.6
7. Cyprinids and phytophagous fish (common carp, grass carp, bullhead carp)	1.75	10.2	0.96	6.5	0.96	6.2
8. Small-sized cyprinids (small bream, small roach, white bream)	6.52	38.2	4.93	33.5	3.93	25.4
Total 6-8	9.30	54.4	6.78	46.0	5.92	38.2
9. Eel	1.61	9.4	1.21	8.2	1.66	10.7
10. Totally 1-9	17.09	100.0	14.74	100.0	15.51	100.0
11. In this predators (pike, pikeperch, perch)	2.52	14.7	2.51	17.0	3.15	20.3
Fraction I/II (%)		66.4		99.6		134.0

TABLE 4

Percentage of large-sized fish in commercial landings of perch, bream and roach (%)

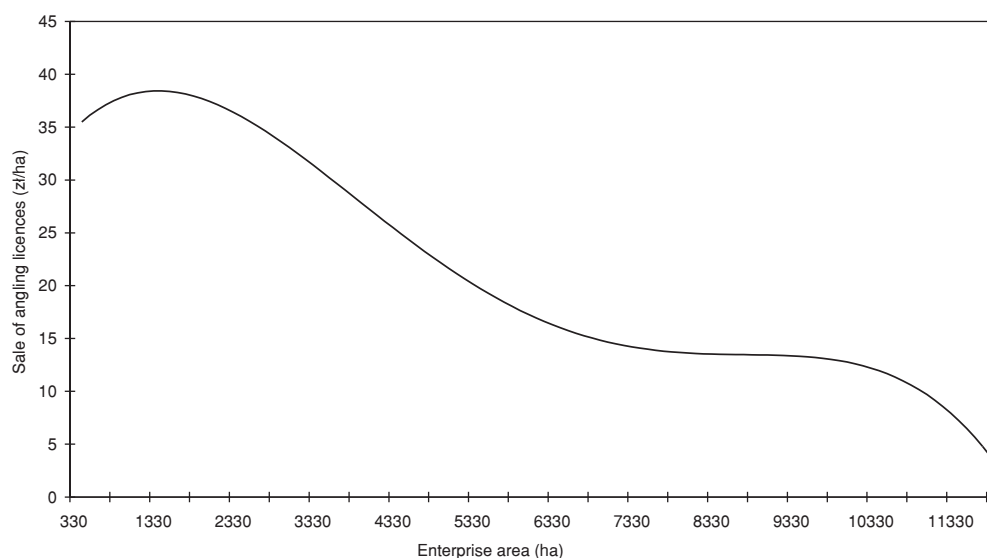|	Enterprise group		
	A	B	C
Big and medium perch	41.3	47.7	67.9
Big bream	17.9	19.4	25.3
Medium roach	16.7	21.2	23.6

Fig. 1. Correlation between enterprise area and incomes from the sale of angling licences

group C, i.e. exactly opposite to the state of lake environments. Undoubtedly this is due to stocking policies: rate of stocking with coregonids is the highest in group A, lower in groups B and C.

Correlation between selected production and economic parameters in the 40 fishery enterprises revealed the following relationships:

A statistically significant correlation (r=0.3759, p<0.05) between area of lake fishery enterprises (variable x) and level of income (in zł/ha) from the sale of angling licences (variable y). The relationship was of a curvilinear character (polynomial of the 4th order); it is presented in Fig. 1. The curve shows a clear maximum, followed by a decreasing trend. Hence, income from "angling" decreased with increasing area if the enterprise. The highest incomes from the sale of licences for anglers (in zł/ha) were obtained by the enterprises having lake area of 1000-2000 ha. Area of 6-9 thousand ha was also characteristic: fishery enterprises with such lake area showed stabilisation of the income from "angling" per 1 ha of lakes. In bigger enterprises (over 9 thousand ha), level of this parameter decreased.

There was a statistically significant correlation (r=0.5115, p<0.01) between fish yield in kg/ha (variable x) and the income (in zł/ha) from the sale of angling licences (variable y). It was a linear relationship described by the regression equation: $y = -514.37 + 2.044\,x$, showing that incomes from "angling" decreased as fish yield increa-
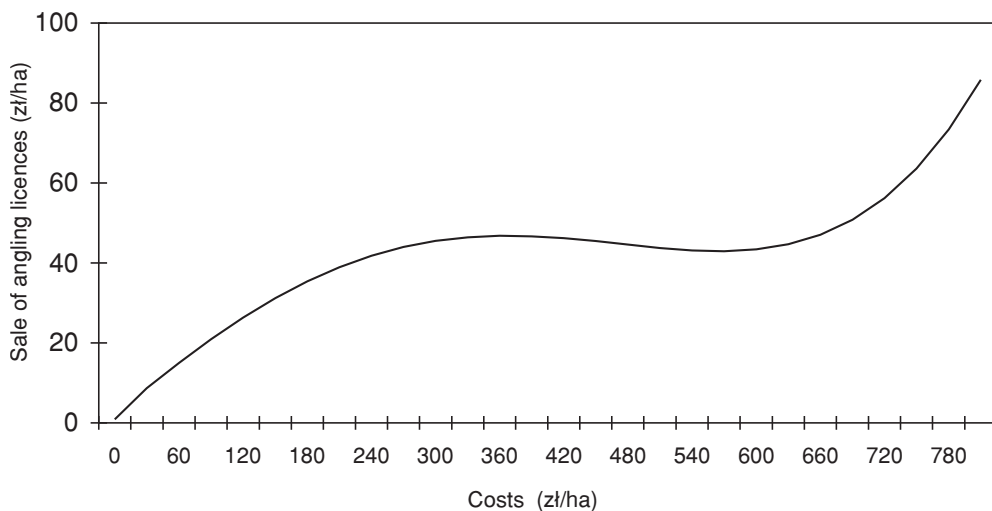
Fig. 2. Correlation between costs and incomes from the sale of angling licences
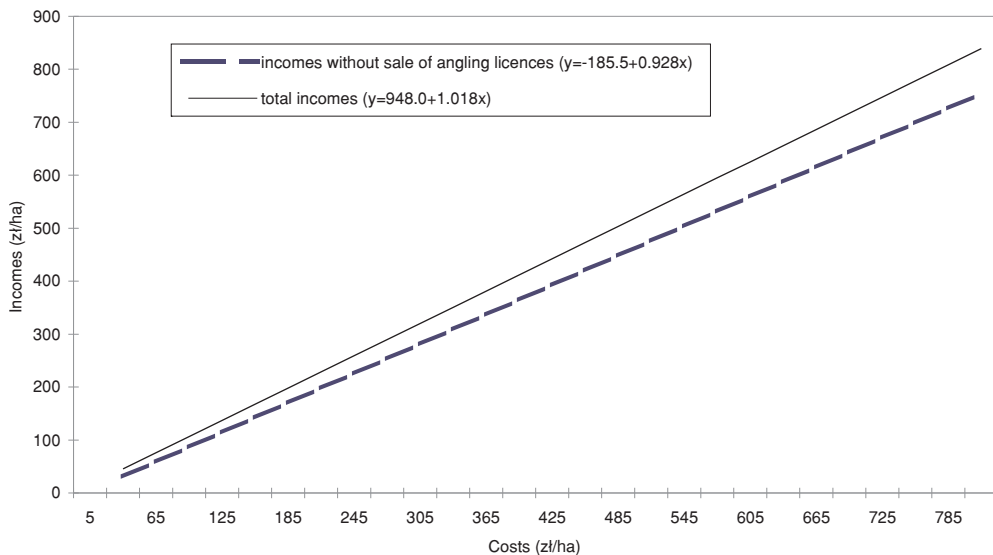

Fig. 3. Correlations: costs-total incomes and costs-total incomes without sale of angling licences

sed. This correlation is also an indirect proof that the income from angling depended on the quality of fishery management by the enterprises.

Statistically significant correlation ($r = 0.6622$, $p<0.001$) of a curvilinear character (polynomial of the 4th degree) was found between total costs in zł/ha (variable x) and income (zł/ha) from the sale of angling licences (variable y). Its graphic illustration is

presented in Fig. 2. The most characteristic section of this curve is observed at high costs, over 600 zł/ha, at which increasing total costs are accompanied by increasing incomes from the sale of angling licences (**O**). This implies that even in unfavourable environmental conditions, which necessitate high expenses (in this for artificial stocking), these expenses allow for maintaining high angling quality of waters, thereby allowing for receiving high incomes.

Finally, there were very significant correlations between total costs (x) and incomes (y). Although this dependence is quite understable, attention should be paid to a general regularity (Fig. 3): total incomes (incomes from the sale of angling licences inclusive) increase with increasing costs (r=0.9953, p<0.001), but at a higher rate than the incomes without sale of angling licences (r=0.9894, p<0.001). The differences is quite high and once again it reveals positive effect of angling on the economics of lake fishery enterprises.

DISCUSSION

Inland fisheries, as the whole economy, has undergone significant changes in the early 90-ies, both of a structural character as well as related to ownership. Transformation of this branch has resulted in a collapse of the formal systems of information. High and constantly increasing number of the fishery lake enterprises which manage their water bodies with a very diversified intensity creates considerable difficulties in gathering the data representative for the whole inland fisheries. This paper is based on the data gathered mostly in fishery enterprises of a large or moderate size. Still it fills the gaps in the knowledge on the effectiveness of lake fisheries and represents the first attempt to determine the economic relations between lake fisheries and angling.

The most noticeable symptoms of the growing importance of angling are: increasing number and area of waters made accessible for anglers by the new enterprises, increasing outlays for stockings with the fish preferred by anglers, and creation of a number of intensively managed special fishing grounds for anglers (Wołos 1996).

These three general statements have not only been confirmed in the present study, but have also been supplemented with appropriate data. A specific paradox noticeable in the three distinguished groups of fishery enterprises consists of a decreasing role of angling in lakes of higher environmental quality. It can be concluded that hig-

her importance of angling is related more to intensive fishery management than to the state of environment.

Assuming that incomes from the sale of licences for anglers and their percentage in total incomes of a fishery enterprise may be treated as a measure of the importance of angling, it becomes clear that the two economic parameters affect positively economic performance of these enterprises. This is well illustrated by the highest index of relative production rentability, amounting to 108.1 % in group A compared to groups B and C (Tab. 2).

Economic role of lake fisheries., measured in terms of total income, was estimated in 1995 at 50 million zł (Leopold and Wołos 1996). Incomes from the sale of angling licences, amounting to 21.54 zł/ha, made possible a rough estimation that in the whole country (i.e. all lakes used by the fisheries) global income from angling amounted in 1995 to 5.86 million zł.

In 1991-1992 incomes from the sale of angling licences represented 9.84 % of the total income, and the mean index of relative production rentability was 111.9 % (Leopold 1994). In 1995 incomes from "angling" increased to 11.84 % of the total income, while the index of relative rentability of fishery production decreased by 38.6 % i.e. to 107.3 % (Leopold and Wołos 1996). This means an increased importance of angling for the lake fisheries management. Share of the sale of angling licences in total incomes of the fishery enterprises increased in course of 3-4 year by 20.3 %. Since this form of fishing is potentially very promising, it is obvious that importance of angling will continue to increase, as is the case in west European countries, in which percentage of anglers is higher than in Poland and amounts to some 5-10 % of the populace (Wortley 1995).

Apart from the described symptoms of the economic importance of angling for the lake fisheries management, there are also social and economic factors pointing to the importance of this activity. First of all, lake management for anglers stimulates development of fish culture as it is related to increased production of the stocking material released to lakes and to the water bodies used as special fishing grounds. Importance of the latter is well exemplified by the sale of over 100 tonnes of common carp caught from such fishing grounds in 1995, not speaking of increased lake stocking with typical "sport" fish as pike, pikeperch and eel. Secondly, increasing number of lakes made available for angling (and recently also of ponds, in this of typical fish culture ones) results in financial benefits for the fishery enterprises, but also creates working places; employment in the analysed fishery enterprises was 1.5 thousand peop-

le. Last but not least, there are many intangible values of angling, which become the subject of a growing number of research projects (Leopold 1979, Wołos 1991, Aas and Ditton 1996).

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STRESZCZENIE

OCENA EKONOMICZNEGO ZNACZENIA WĘDKARSTWA W RYBACTWIE JEZIOROWYM

Poddano analizie dane produkcyjno-ekonomiczne z jeziorowych gospodarstw rybackich z terenu Mazur i Suwalszczyzny, Wielkopolski i Kujaw oraz Pomorza. Do oceny ekonomicznego znaczenia wędkarstwa posłużyły dwa główne parametry: wysokość dochodów z opłat za wędkowanie w zł/ha oraz odsetek tych opłat w dochodach ogólnych gospodarstw. Dokonano podziału gospodarstw na trzy grupy w zależności od wielkości wspomnianych parametrów oraz określono cechy, jakimi charakteryzują się podmioty, w których ekonomiczna ranga wędkarstwa jest najwyższa, przeciętna i najniższa. Oceniono globalną rangę wędkarstwa jeziorowego oraz podkreślono poza-ekonomiczne walory tej formy użytkowania wód.

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