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## DISTRIBUTION OF LAKE TROUT IN WDZYDZE LAKE

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ABSTRACT. Lake trout occurred in Wdzydze Lake in summer only in the southern, deep basin. At this time trout was harvested at the depth of over 20 m. For the rest of the year, trout was found in the entire lake complex, in shallow and deep basins. Seasonal changes of lake trout distribution might have been caused by changes of thermal and oxygen conditions in the lake.

Key words: LAKE TROUT, *Salmo trutta morpha lacustris*, WDZYDZE LAKE, DISTRIBUTION

### INTRODUCTION

Despite extensive studies on lake trout in Wdzydze Lake, carried out in the '50 and '60, little information is available on distribution of this species in the lake. Some data may be found in the work on trout migrations (Sakowicz 1961), but only labelled spawners used for artificial spawning were observed in this study, and most fish caught for the second time originated from the river. Some data on that subject may also be found in the study on trout feeding by Wojno (1961).

Fishermen who have fished in Wdzydze Lake for many generations know very well the basins where trout was abundantly caught. In various seasons large numbers of trout were found at different sites. Interesting and detailed information obtained from the fishermen became an inspiration for the analysis of lake trout distribution in Wdzydze Lake, and explanation of its migrations.

### STUDY SITE

Wdzydze Lake is situated in Pomeranian Lakeland, in upper part of the Wda River system (Vistula drainage area), at the altitude of 133 m above sea level. It consists of several interconnected long tunnel-valley reservoirs forming a cross (Fig. 1). Basing on considerable morphometric differences, two main basins of the lake may be distinguished: North Wdzydze – shallow and more productive, and South Wdzydze – deeper, of lower trophy.

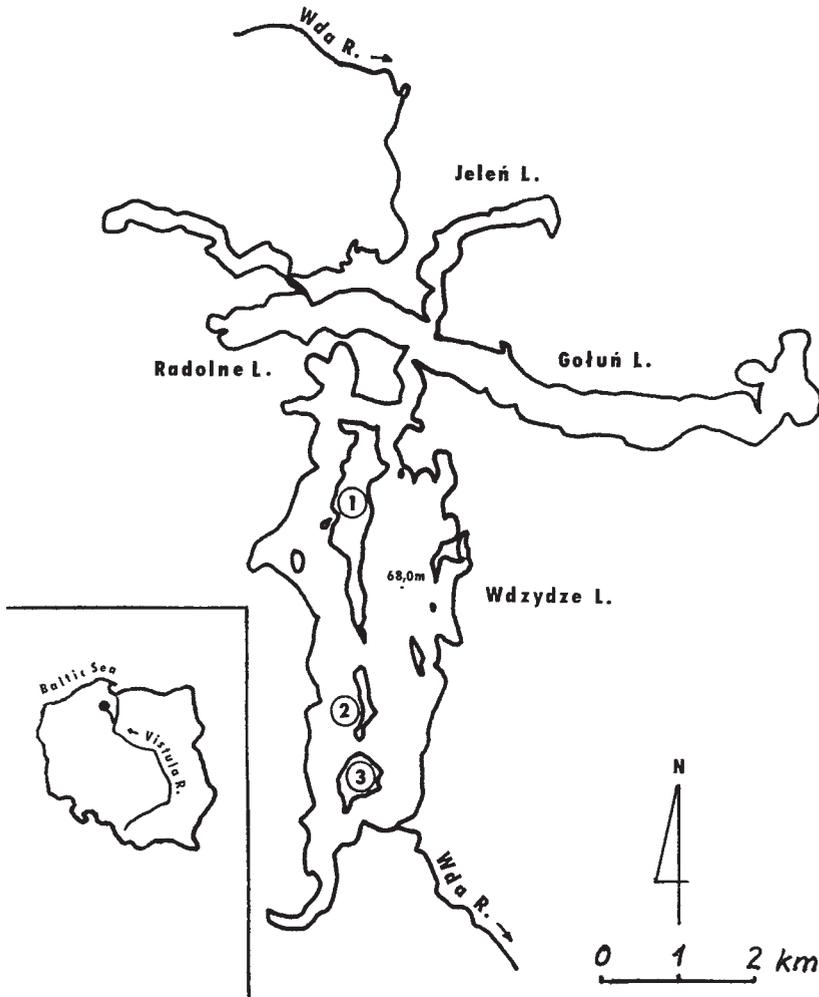


Fig. 1. North Wdzydze Lake (Radolne, Gołun, and Jeleń lakes), and South Wdzydze (Wdzydze Lake). 1-3 – islands: Wielki Ostrów, Glonek, Mały Ostrów.

North Wdzydze basin consists of 3 lakes of similar limnologic characteristics: Radolne, Gołun, and Jeleń, of total area 526.0 ha. Maximum depth of this basin is 18.8 m, and average depth – 7.3 m. Bottom of a shallow littoral zone is covered with sand and gravel, with numerous small pebbles. In deeper parts of the lake, bottom is muddy. Wda River drains to the northern part of Radolne Lake. In 1960-1970 bream and roach predominated in the fishery catch in North Wdzydze basin. Also perch, eel, pike, and pike-perch were abundant.

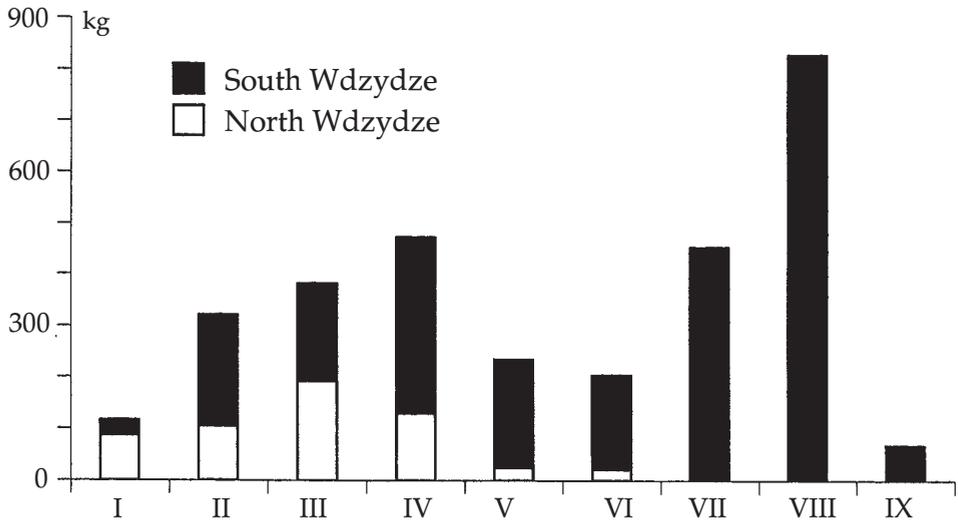


Fig. 2. Monthly trout yields (kg) in Wdzydze in 1961-1969

Area of South Wdzydze basin is equal to 918.8 ha. Maximum depth reaches 68.0 m, and average depth – 19.7 m. The bottom is undulating, with submerged heights and islands. The largest islands divide the lake into two basins: western – shallow, with slight bottom slope, and eastern – deeper, with diversified bottom surface, lacking shallow areas. In deeper parts of South Wdzydze bottom is muddy, and in the littoral – covered by sand, gravel, and pebbles. Numerous large rocks may be found along western shore of the lake. Wda River outlet is situated in the southern basin. Whitefish, bream, roach, and perch predominated in the fishery catch.

## MATERIAL AND METHODS

The values of fishery catches (Fig. 2) were obtained from lake books of the following lakes: Wdzydze, Radolne, Gołuń, and Jeleń. According to market demands, only silvery and big fish (over 2.5 kg, and 60 cm) were taken. The fish were caught mainly with drag-net, the size of which did not change for years:

- maximum height 30 m
- wing length 150 m in summer, 200 m in winter
- trap length 45 m.

Actual net height is about 20 m, and the enclosed area 3-5 ha depending on configuration of the bottom.

TABLE1

The results of sample fishing with drag-net in Wdzydze lake in 1992-1995

Fishing area	G max.	Summer			Winter		
		z	n1	n2	z	n1	n2
South Wdzydze							
1. Łiska	50,0	2	1	6			
2. Granica od Wdzydz	45,0	1	0	0			
3. Na wyrwa	45,0				1	0	2
4. Rafka	42,5	3	4	7			
5. Brus	40,0	1	0	0			
6. Na Wałdocha	40,0	1	0	0			
7. Jabłonka	40,0				1	9	1
8. Przerośla	37,5				1	0	2
9. Ciszewska Buchta	36,0				1	0	1
10. Buda na Mł.Ostrów	30,0	2	2	0			
11. Kamionki I	30,0	4	1	2			
12. Na Pomarczyn	30,0	4	1	38			
13. Sorkowy Nurt	30,0	3	1	7	1	0	0
14. Na Koufmana	30,0	4	0	0			
15. Pioska	30,0	1	0	0			
16. Koczur	27,5	2	0	7			
17. Kamionki II	25,5	1	1	1			
18. Zdrójki	24,5	3	5	19			
19. Poletko	22,5	1	3	3			
20. Na Cyron	20,0	1	0	0			
21. Kamień	20,0	6	10	5			
22. Koń	20,0	3	1	3			
23. Soren	20,0	1	0	1			
24. Kajaczowy Nurt	17,5	1	0	0			
25. Brzózka-Podgrodzie	15,0	1	0	0			
26. Ustrano	15,0				1	0	0
27. Przebrano	15,0				1	0	0
28. Granica	12,5	1	0	0	1	0	0
29. Buda k. Cyrona	12,5	1	0	3	1	0	0
30. Kozłowiec	12,5	1	0	0			
31. Łążk	10,0	1	0	0			
32. Przytarska Góra	10,0	1	0	0			
33. Jasionek	7,5	2	0	0			
North Wdzydze							
34. Landowski Las	10,0				2	6	4
35. Na Pomosty	10,0				1	0	0
36. Zgon	10,0				2	1	10

G max. – maximal depth, z – number hauls

n1 – number of trouts up to 30 cm length

n2 – number of trouts above 30 cm length

Due to considerable diversity of lake bottom, steep slopes, submerged heights, and rocks, location of the net must be very precise, and each fishing area has its name, used since generations (Breza 1974). Certainly, in such a big lake of relatively low trout density, identification of its typical sites is not possible basing on the fishery catches only. It is particularly difficult now, when trout density in the lake is very low. In 1992-1995, only 168 trouts were harvested during 67 hauls in 36 fishing areas. These data, however, may only partly confirm obtained results (Tab. 1).

It was already mentioned in the introduction that fishing in Wdzydze Lake takes place at precisely defined fishing areas. Detailed information on their locality, and on harvested trouts were obtained from Mr. Józef Tuskowski who has been fishing the lake since 1948 as a fisherman, and in 1958-1978 was an overman. He identified 226 regularly fished areas, 132 in the southern part of the lake, and 94 in the northern one. He also identified typical trout fishing grounds, at which trouts were caught most often, and in the highest numbers and various seasons. In all other areas trouts were not found, or appeared very rarely. Most basins were fished several times a year.

Mr. Tuskowski also estimated amounts of trouts caught at particular areas in 1960-1970 using a 3-point scale (1 – single individuals, 2 – fairly numerous, 3 – very numerous). The scale, described as „efficiency“, relates to the average fish yield, and is used as a measure of trout abundance in the basins. Trout catches in four seasons were estimated: in spring – from April 1 to June 30, summer – from July 1 to September 15, autumn – from September 15 to December 31, and winter – from January 1 to March 31. The same drag-net was used throughout the year, except the period when use of tow nets was prohibited.

Maximum depth of each area was established using bathymetric map, and considered as a maximum depth of the area enclosed by the net.

## RESULTS

Monthly trout yields in 1961-1969 indicate that in North Wdzydze (Radolne, Gołuń, and Jeleń lakes) trout was caught in winter and spring, and it was absent in summer (Fig. 2). In South Wdzydze, on the contrary, trout was caught all year round, except closed season, and the peak abundance was observed in summer.

According to the information obtained from the fishermen, small trouts (up to 30 cm) were caught almost all year in most basins of the lake. Only in summer, similarly as older fish, they did not occur in northern part of the lake. Usually only several individuals were

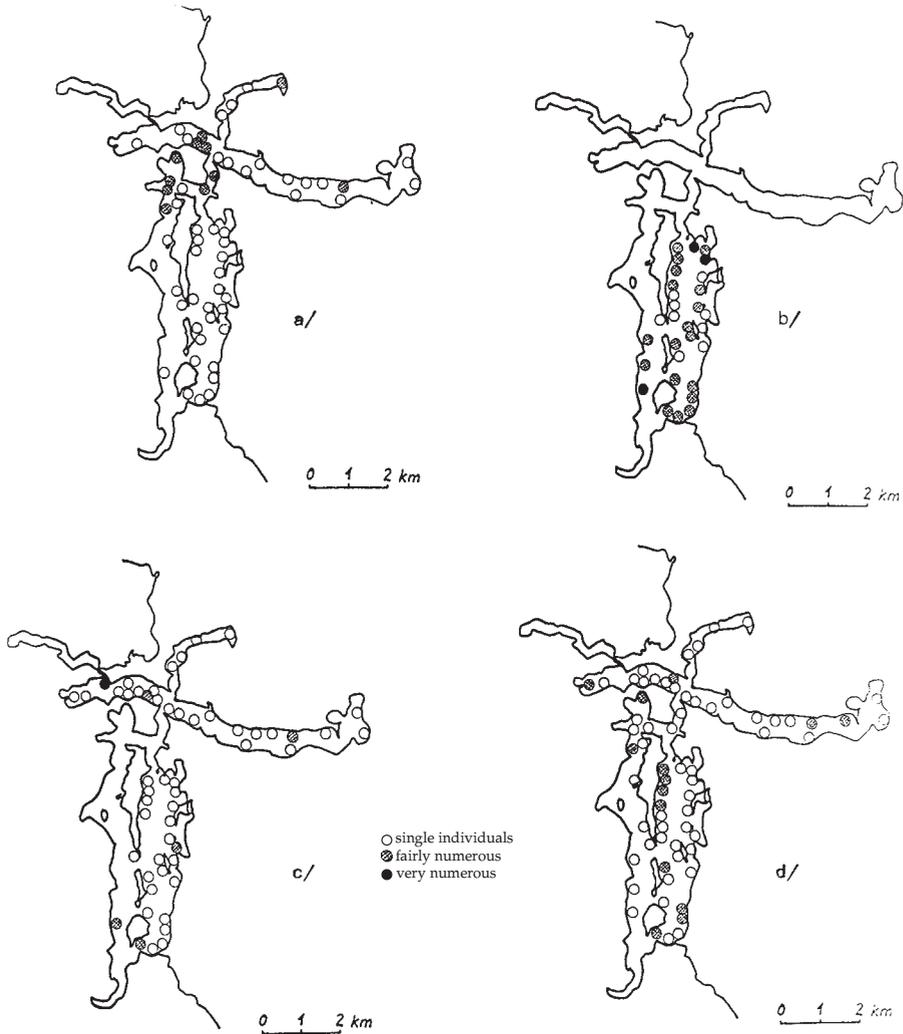


Fig. 3. Situation of trout fishing grounds in Wdzydze Lake: a) spring, b) summer, c) autumn, d) winter.

caught in one haul. Larger trouts gathered in shoals in the lake, and were often caught at some areas. This is confirmed by the fishery results of 1992-1995 (Tab. 1). It should be stressed that these data concern the period of very low trout density in Wdzydze Lake. Moreover, atmospheric conditions were extremely unfavourable (hot summers, no ice cover in winter, low water level), which must have affected fishery results.

Situation of trout basins, according to the information obtained from Mr. Tuszkowski, indicates that the highest density of trouts occurred in spring in southern part of Radolne Lake (North Wdzydze), and in north-western part of South Wdzydze (Fig. 3a). The fish were most often caught in shallow waters, less than 20 m deep (Fig. 4).

In summer, trout occurred only in South Wdzydze (Fig. 3b). The highest numbers of trouts were caught in this season, often accompanied by two whitefish species: *Coregonus lavaretus*, and *C. albula*. Trouts were caught at depths of over 20 m, and most of trout fishing grounds were situated in the eastern, deepest basin (Fig. 4). Trout was also harvested in several shallower spots of south-western part of the western basin (Fig. 3b).

Although from September 15 to the end of December closed season for trout was in force, fishing continued, but trouts found in the net were released. In autumn, trouts were caught in South Wdzydze in the same deep areas as in summer, but they were considerably less numerous (Figs. 3c, 4). They were silvery non-spawners. In North Wdzydze, on the contrary, dark-coloured adults were caught. These fish were migrating towards Wda River mouth for spawning, or had just returned from the spawning grounds to the lake. „Wda mouth“ fishing ground was fished before fish hatching to obtain eggs for incubation (Fig. 3c).

In winter, trouts were caught in the entire Wdzydze Lake complex, in all trout basins, irrespective of the depth (Figs. 3d, 4). Majority of the fish were still dark-coloured after spawning.

## DISCUSSION

Sakowicz (1961) labelled Wdzydze trout spawners after artificial spawning and released them to the lake. He observed that most of them stayed all winter in northern part of the lake, and migrated in spring to the deeper southern part. The spawners came back in autumn to North Wdzydze and gathered around the Wda River mouth before spawning. Aggregation of trouts in autumn and winter around river mouths was observed also by Buttiker (1986) in Lemán Lake (Switzerland).

Wojno (1961), who studied trout feeding in Wdzydze Lake, noted seasonal migrations of the fish. According to this author, trouts stay in spring in the lake littoral and feed on roach spawners, and - move to deeper waters in summer and autumn. In pelagial, trouts feed mainly on perch and bleak. In winter, the fish return to shallower parts of the lake.

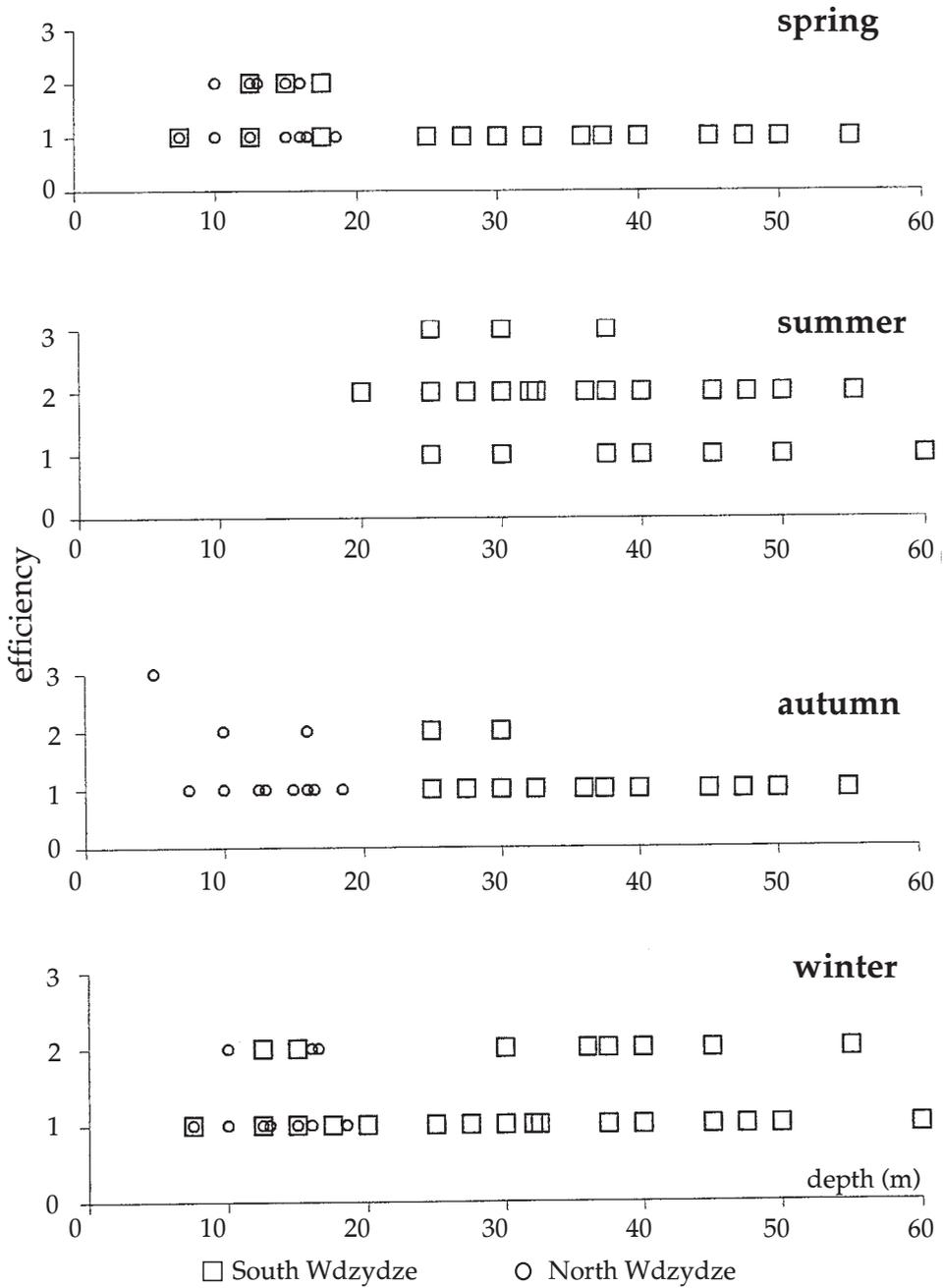


Fig. 4. Depths and yields of trout at the fishing grounds in North and South Wdzydze in four seasons. (Symbols indicate one or more sites of the same depth)

The results of the present study confirm earlier data. In winter and spring, trouts feed in shallow waters of the entire lake complex. In summer and autumn, trouts were caught only in deep waters of the southern part of Wdzydze, and spawners were found in shallow water of North Wdzydze.

In some Norwegian lakes deeper water was inhabited by older fish (Haraldstad, Jonsson 1983, Jonsson, Gravem 1985, Jonson 1989). Migrations of young trouts into deeper feeding grounds in summer were observed by Aravomo (1984) in Loch Leven (Scotland). This author also noted that in winter. According to Thorpe (1974) adult trouts move to littoral in spring and early summer, and in mid-summer larger fish (over 30 cm) stay in inshore waters, and smaller ones – gather offshore.

Different observations were made by Ball and Jones (1961) (after Thorpe 1974) in Llyn Tegid Lake. They noticed that adult individuals spent winter and spring in littoral, and were found in deeper parts of the lake in summer. The authors concluded that trouts left the littoral zone in May, when water temperature exceeded 12°C.

Similar situation was observed in Wdzydze Lake, when in May and June trout yield decreased in the shallower northern part of the lake, and increased in summer in deeper South Wdzydze (Figs. 2, 5a).

Seasonal and diurnal changes of vertical distribution of salmonid fish in lakes may be explained by changes of physical environmental conditions, mainly temperature (Levy 1990, Levy et al. 1991, Reynolds, Casterlin 1979). Considerable seasonal differences of temperature and dissolved oxygen concentration occurred in Wdzydze Lake between North and South part of the lake (Fig. 5). In North Wdzydze, summer thermal stratification lasted from June to August, and high hypolimnion temperatures were observed (Patalas 1961). In South Wdzydze summer stratification lasted twice longer, from June to November (Fig. 5a). In North Wdzydze, dissolved oxygen level in August dropped below 1 mg/l at the depth of 10 m, and in September all water body contained already 7 mg/l. Oxygen depletion was less pronounced in South Wdzydze, and in November 6 mg/l of DO was observed just above the bottom in the eastern basin. In this part of the lake, oxygen depletion occurred in summer at the depth 10-20 m, and lasted until September (Fig. 5b).

Presumably, all these differences affect distribution of trout in the lake. Thus, absence of trout in summer in North Wdzydze may be explained by too high water temperature and low DO level. For the same reason trouts were not caught in shallow waters of South Wdzydze. Summer metalimnetic oxygen depletion down to 20 m may explain why trouts were found only in deeper waters. Presence of trouts in summer in

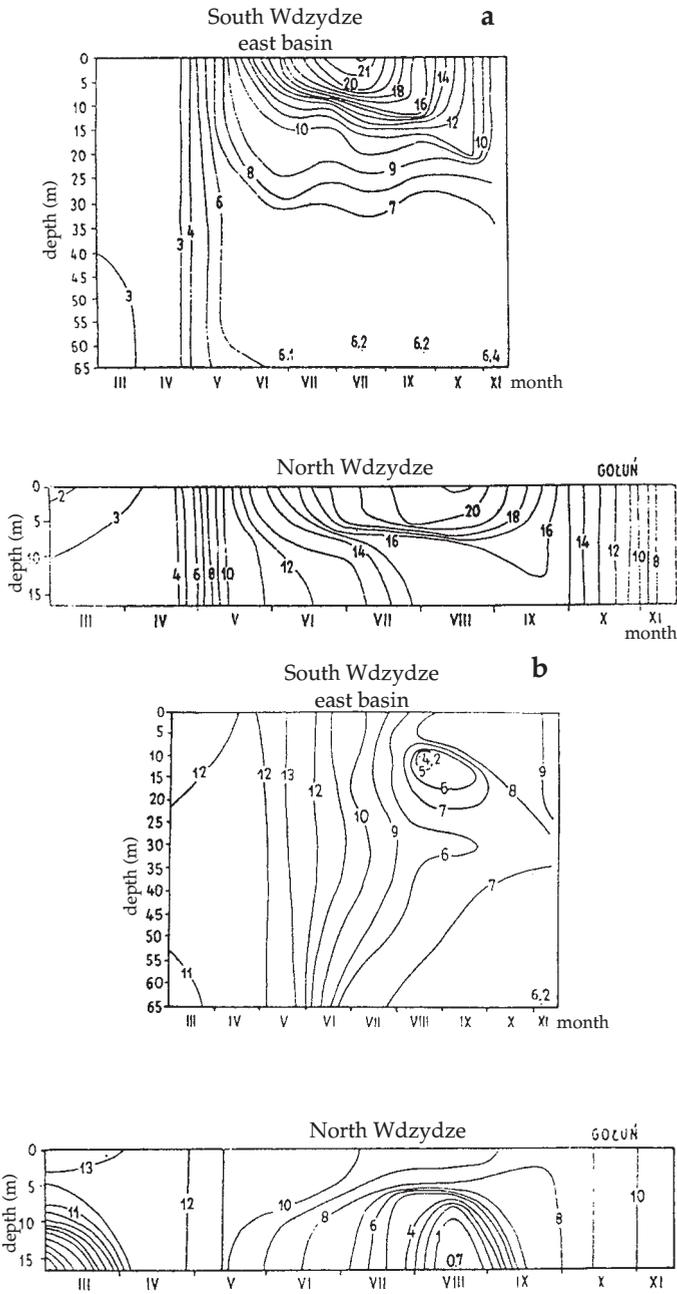


Fig. 5. Seasonal changes of temperature and dissolved oxygen concentration in Wdzydze Lake (after Patalas 1961). a - temperature ( $^{\circ}\text{C}$ ), b - oxygen ( $\text{mg O}_2/\text{l}$ )

shallower western basin was possible related to the presence of underwater bottom springs, numerous in this part of the lake (Churski 1961).

Water temperature decrease, and an increase of DO concentration at the end of September in North Wdzydze allow the fish to return to this part of the lake. At the same time, thermal stratification still persists in South Wdzydze, so in autumn trouts were caught at the same deep sites as in summer. It is interesting that in autumn dark-coloured spawners were caught in northern part of the lake, while silvery, non-spawning fish in southern part. Taking into consideration different thermal and oxygen conditions in both parts of the lake, this indicates different oxygen and temperature preferences of the two fish groups. In winter and in spring, thermal and oxygen conditions are similar in both parts of the lake, thus trouts occur in the entire water body.

Higher abundance of trout in shallow South Wdzydze does not necessarily indicate that number of trouts is lower in deeper waters. It is possible that some trouts escaped from the net during hauling, since its actual height was about 20 m, and in the first phase of lifting the net did not enclose the entire water column.

Due to high environmental requirements of Wdzydze trout, it seems that in the projects of introducing this species to other lakes, thermal and oxygen conditions, particularly in summer, should be taken into consideration.

#### ACKNOWLEDGEMENT

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## STRESZCZENIE

### ROZSIEDLENIE TROCI W JEZIORZE WDZYDZE

Zimą i wiosną troć rozproszona była w całym jeziorze Wdzydze i poławiana była zarówno w płytkich, jak i głębokich toniach. Latem zasięg występowania troci ograniczał się wyłącznie do głębszej, południowej części zbiornika. Maksymalne głębokości typowych toni trociowych w tym okresie przekraczały 20 m. Jesienią we Wdzydzach Południowych troć nadal występowała na głębokich toniach, zaś we Wdzydzach Północnych poławiano dorosłe osobniki gromadzące się najliczniej w okolicy ujścia Wdy. Przemieszczanie się troci latem do głębszych warstw wody wiąże się ze wzrostem temperatury wody i spadkiem zawartości tlenu w płytszych częściach jeziora.

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