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BIOLOGICAL CHARACTERISTICS OF ONE-YEAR-OLD SEA TROUT *SALMO TRUTTA* L. GROWN FRY RELEASED INTO THE STREAM OSÓWKA

CHARAKTERYSTYKA BIOLOGICZNA JEDNOROCZNEJ TROCI *SALMO TRUTTA* L. WYROSŁEJ Z WYLĘGU WSIEDLONEGO DO POTOKU OSÓWKA

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In the spring of 1982 the fry of sea trout (*Salmo trutta* L.) were released into the stream Osówka. The fish were caught by electrofishing 8–11 months. The paper presents survival and dispersion of the young sea trout as well as data an length, weight, growth and condition of retrieved fish.

INTRODUCTION

Since 1958 the Western Pomeranian rivers have been stocked with fry of sea trout (*Salmo trutta* L.) in order to produce, under natural conditions, smolts which, after their descent to the Baltic, are intended to increase the stocks of economically valuable fish (Chełkowski et al., 1976). As a rule, the fry are introduced into the mid-part of a river, sometimes downstream and, very seldom, upstream. The accomplishment of such task depends primarily on the suitability of the water-course for the young fish to grow and for smolts to descend unimpeded and on the possibility for the fry to be delivered by trucks from the hatcheries to the places of their release over hard-surfaced roads. The release is usually made directly into the water-course at one place and involves several thousand individuals of sea trout fry at the final phase of yolk sac resorption. However as recommended by Sakowicz (1955), it is desirable to release 1–2 individuals per 1 m^2 of bottom area of stream suitable for yuvenile fish growth. The survival rate of released seatrout fry up to the smolt phase in Pomeranian rivers, under natural conditions, as established on the example of the river Molstova one of the constituents of the Rega system, was 1%, according to Chełkowski et al., (1981). The survival rate of the sea trout fry, introduced into the Pomeranian rivers in the first year of life, has not hitherto been

assessed. For this purpose the upper course of the Osówka was stocked with sea trout fry in spring 1982, and in the late autumn 1982; and subsequently in winter 1983 the catches of young fish, at the parr phase, were commenced. Simultaneously the migration of the released young fish in the stream was observed too. The paper provides data on length, weight as well as growth and condition of the recorvered fish.

MATERIAL AND METHODS

Osówka is a smoll stream. It is known to be a second order, left-bank tributary of the Lower Odra. The streamhead is in the Warszewo hills 131 meters above the sea level, and after proceeding over the course of 13 km the stream drains into the Western Odra within the area of Szczecin. The Osówka flows at the bottom of a distinct valley. The study reported on concerns the upper (k–i) 4-km long stretch of the Osówka (Fig. 1). The

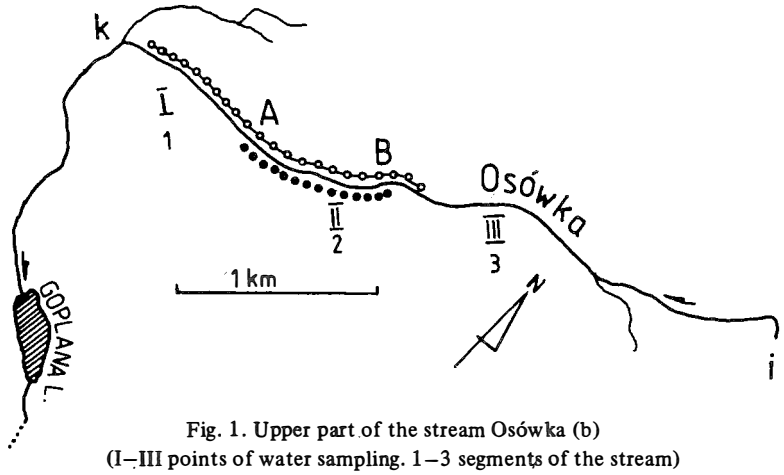

Fig. 1. Upper part of the stream Osówka (b)
(I–III points of water sampling. 1–3 segments of the stream)
. . . stream segment stocked with seatrout fry,
o–o– stream segment where young fish (parr) occured

other part of the Osówka's course, from the point „k" down to Lake Goplana, runs through a concreate trough, while the farther stretch serves as the city sewer. The springs of Osówka lie at the altitude of 109.21 m above the sea level, whereas the ordinate of the stream bottom downstream (at the point "k"), his 33.50 m above the sealevel. The head difference of levels (n) is 75.91 m. Thus, the average grade $(\frac{n}{L})$ of the stream segment used in the experiment is 19°/$_{oo}$. Almost over its entire length the stream is regulated with faggotting; quite frequently there are numerous river bars. At present the regulation is extensively damaged. The stream bed is furrowed; both banks are generally ratther steep. The width of the stream bed varies from 0.5 m to 2.5 m, the depth being from some to several cm. The current speed is rather variable, ranging from 0.3 to 1 m/s. The bottom is

Table 1

Hydrochemistry of the Osówka

Parameter	Unit	Date of water sampling							
		1978.03.04		1982.06.12			1982.10.15		
		I*	II	I	II	III	I	II	III
Water temperature	^{o}C	3.0	3.5	13.9	14.1	14.0	11.0	11.1	11.3
Dissolved oxygen	mg O_2/dm^3	12.2	12.0	9.6	9.8	9.6	8.9	8.9	8.8
BOD_5	mg O_2/dm^3	1.4	1.3	2.9	2.9	2.9	3.8	3.5	20.0
Chlorides	mg Cl/dm^3	17.7	18.6	18.0	18.0	18.0	20.0	21.0	20.0
Total hardness	mval/dm^3	4.3	4.4	3.6	3.6	3.7	3.6	3.6	3.9
pH	pH	7.59	7.68	8.0	8.0	8.0	8.0	8.0	8.0
Ammonia nitrogen	mg N_{NH_4}/dm^3	0.15	0.04	0.0	0.0	0.0	0.1	0.0	0.1
Nitrate nitrogen	mg N_{NO_3}/dm^3	0.33	0.37	0.2	0.2	0.2	0.3	0.2	0.2
Total iron	mg Fe/ dm^3			0.1	0.1	0.3	0.1	0.1	0.1
Phosphates	mg PO_4/dm^3	0.18	0.20						
Total alkalinity	mval/dm^3			2.1	2.1	2.1	2.1	2.1	2.1

* Sampling site (see Fig. 1)

sandy. Scanty aquatic vegetation occurs only on the sides of the stream bed with speedwell brookline (*Veronica beccabunga* L.) as the dominant species. Trees occurs in compact belts or, less frequently, grow alone along most of the bank length. The stream basin is in 80% overgrown with deciduous-coniferous forests, the remaining parts being meadows in local small valleys. As is evident from investigations of the basic hydromechanical parameters (Table 1), the water in the stream Osówka meets the salmonid requirements and has been qualified as the purity class 1 water (Anonymus, 1975). The release of sea trout fry into the upper Osówka was preceded by catching the fishes living therein. That was done by electrofishing. The catches, carried out on 15 and 28 April 1982, provided 3 species of fish, namely: the ten spined sticleback (*Pungitius pungitius* L.), tench (*Tinca tinca* L.) and sunbleak (*Leucaspius del neatus* Heckel). The ten spined sticleback was found in all segments of the stream, except for an about 1 km-long stretch close to the streamhead. A total of 359 fishes were caught. On the basis of the random sampling of n = 78 fishes, the mean total length was 48.5 mm, and the mean weight 0.98 g. The tench was encountered only in the lower course of the upper Osówka. Altogether 3 individuals were procured, 107 to 130 mm in length (l.t.). The sunbleak was also present in the lower Osówka. The total weight of the fish caught was somewhat over 3 kg. The random sample of n = 178 ind. revealed the mean length (l.t.) of sunbleak to be 44.9 mm, the mean weight being 0.79 g. It is evident from the analysis of gonads that the sunbleak had but one day before spawning would begin. The upper Osówka described was divided into 3 segments: (1) lower, from "k" to A, (2) middle, from A to B, and (3) upper from B to "i" (Fig. 1). More detailed data on the relevant segments of the stream are shown in Table 2. On 6 May 1982, n = 4184 individuals of sea trout fry at the final phase of yolk sac resorption were released into the middle segment of the stream. A few individuals were introduced for every meter of the stream. Since the surface of the segment was 960 m^2, so, on the average, 4.4 fry individuals were stocked per 1 m^2 of the stream.

Table 2

Characteristics of the upper Osówka

Segment of stream	Stream segment location* (from-to)	Length	Mean width	Area	Relased fry	
		(m)	(m)	(m^2)	ind.	ind/m^2
Lower	k – A	1100	1.2	1320		
Middle	A – B	800	1.2	960	4184	4.4
Upper	B – i	2100	1.5	3150		

* – see Fig. 1

The parental material of the young population released stemmed from the Pomeranian river Rega. The roe was taken on 7 December 1981, and incubated in the California apparatus at the Goleniów hatchery. The fry were received on 28 March 1982. The loss incurred during incubation was 5.5%. The fry were transported from Goleniów to the Osówka in two 50-l tanks. The water temperature in the hatchery at the beginning of delivery was 11.1°C and 10.3°C at the end of transportation; that of the Osówka, at the stocking site, 10.5°C; the air temperature during transportation was 10.1°C. On the basis of a sample comprising 100 individuals the mean length (l.t.) and weight of the released fry were calculated at 24.9 mm and 3.0 g respectively.

The sea trout were caught from the Osówka by electrofish method. The number of the landed fish was registered, as was their caudal length (l. caudalis) to 1 mm and weight to 1 g.

RESULTS

The catches of the young sea trout population in Osówka were carried out within the period ranging from 2 December 1982 until 28 March 1983 i.e. 8, 9, 10 and 11 months after stocking. The fish were being caught separately in each segment of the stream division adopted three times in the lower and upper, and twice in the middle sections. Table 3 summarizes numbers of juvenile sea trout obtained from the 8 catches. The catches in the lower section of Osówka furnished a total of 182 sea trout individuals: 161 (88.46%), 17 (9.34%), and 4 (2.2) individuals were obtained from the first, second, and third catching event, respectively. The catches in the upper segment of the Osówka supplied altogether 295 sea trout individuals: 214 (72.54%) and 84 (27.46%) were obtained during the first and second fishing, the third fishing failing to produce any fish at all. It should be noted that the second catch proceeded at a low water level, which certainly simplified the procedure. The highest number of young sea trout was received from the middle, stocked segment of the stream. The total yield from this area amounted to 382 fishes, wherein the first catch scored 232 individuals (60.73%) and the second 150 fishes (39.27%). High water level during the first catching event in this section of the river was doubtless an obstacle in retrieving the young sea trout. The low water level during the second eatch facilitated. In view of the very few (or none at all) fish caught during the third fishing event in the upper and lower sections, the third fishing was carried out in the middle one only.

The largest amounts of young sea trout were obtained in each of the three segments of the Osówka during the first catch. The second eatch resulted in capturing fewer fishes, while the third attempt ended in catching only a few fishes or none at all. The exact calculations indicate that the first two electrofishing events yielded 98% of the sea trout individuals.

Table 3

Catches of young see trout in the Osówka

Date of catch	Stream segment						Total no. of ind.
	lower		middle		upper		
	ind.	%	ind.	%	ind.	%	
1982.12.02	161	88.5					161
1983.01.11			232	60.7			232
1983.01.20					214	72.5	214
1983.02.17	17	9.3					17
1983.03.08					81	27.5	81
1983.03.09			150	39.3			150
1983.03.16					0	0.0	
1983.03.28	4	2.2					4
Total no. of ind.	182	100.0	382	100.0	295	100.0	859
Percent contribution	21.1		44.5		34.3		100.0

Out of 4184 individuals that had formed the fry population released into the Osówka in spring 1982, 859 individuals at the parr phase, were recovered 8 to 11 months from stocking, the survival rate being thus 20.5%.

As appears from the hitherto presented data, a part of the released batch of sea trout had migrated from the stocked area up and down stream. The made up 55.5% of the fish, 34.3% migrating upstream and 21.2% downstream. The presence of fish at the nampling sites in the stream demonstrates that the sea trout were moving as far as 280 m upstream and 900 m in the opposite direction (Table 4), the distribution of fish in the lower 900-m-long segment of the stream was not uniform. The young sea trout were found to concentrate most abundantly in the region of the stocked stream segment the frequency of occurrence decreasing with distance from that section in spite of the unchanged nature of the stream. On the other hand, the frequency of occurrence of the young sea trout in the upper, 260-m-long, segment of the stream was rather uniform. Hence the retrieved sea trout population densities were 0.17, 0.4 and 0.7 ind./m^2 of the bottom in the lower, middle, and upper segment, respectively (Table 4). Thus, the density in the middle segment of the stream, from the release of fry to the capture of the young fish, was found decreased elevenfold (4.4 vs 0.4 ind./m^2. With respect to the entire section stocked, the

Table 4

Occurrence of young sea trout in the Osówka

Characteristics of the stream				Data for sea trout				
Stream segment	length (cm)	mean width (m)	area (m^2)	no. of ind. caught	density ind/m^2	1 ind. occurs per (m^2)	mean length (mm)	mean weight (g)
Lower	900	1.2	1080	182	0.17	5.9	119.3	20.3
Middle	800	1.2	960	382	0.4	2.5	111.1	16.4
Upper	280	1.5	420	295	0.7	1.4	111.8	17.1
Total			2460	859	0.4	2.9	112.2	17.5

Table 5

Length and weight of young sea trout from the Osówka

	n	M ± m	δ	ϑ	Range of variation
Length	859	112.2±0.25	7.457	6.65	58–185 mm
Weight	859	17.57 ±0.36	10.49	59.81	2.0–81 g

n = number of fish; M = arithmetic mean; m = standard error of the mean; δ = standard deviation; ϑ = coefficient of variability.

Table 6

Mean length and weight of sea trout from respective catches of the Osówka stream

Data of catch	Number of days after release	Segment of the stream					
		lower		middle		upper	
		mm	g	mm	g	mm	g
1982.12.02	210	117.3	18.9				
1983.01.11	250			103.6	14.8		
1983.01.20.	259					106.4	15.0
1983.02.17.	287	140.0	33.7				
1983.03.08	306					126.0	22.8
1983.03.09	307			122.8	18.8		
1983.03.16.	314					–	–
1983.03.28.	326	116.3	20.3				

density was 0.4 ind./m^2 *, the decrease being 4.3-fold in that part of the stream inhabited by the young sea trout (1.7 vs. 0.4 ind./m^2).

The further problem worth studying is that of the area inhabited by the young sea trout in the stocked part of the stream during the months after stocking. The calculations (Table 4) show that one sea trout occupied 2.5 m^2 in the stocked area of the stream, 1.4 m^2 in upper segment, but 5.9 m^2 in the lower segment. On the average, in the stocked part of the stream a single sea trout occupied 2.9 m^2 of the stream area.

The mean length and weight were calculated for the young sea trout (n = 859) caught in the Osówka, extreme values being given. As seen from data shown in Table 5, the mean length (l.c.) was 112.2 mm the balues ranging within 58–185 mm; the mean weight was

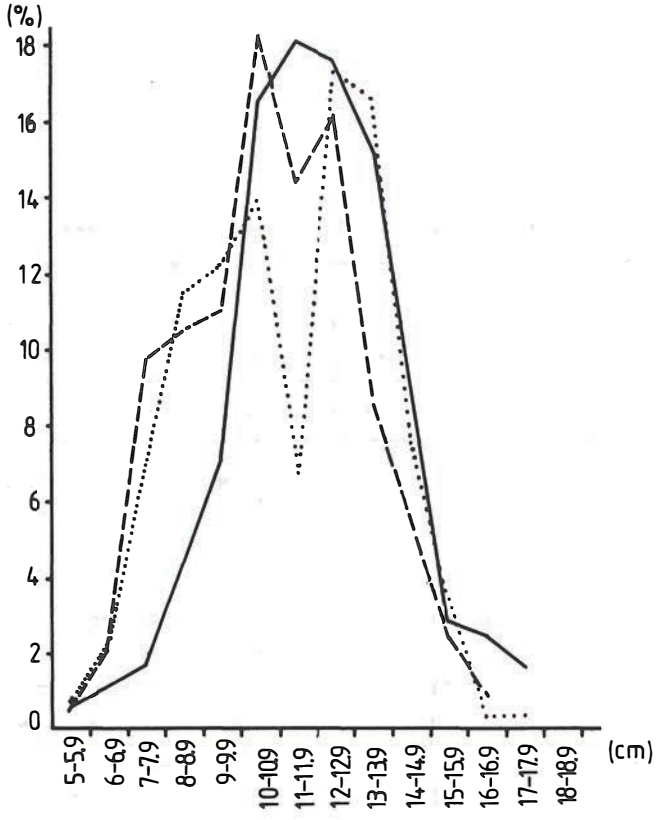

Fig. 2. Length distribution sea trout in the Osówka
(–––––––– seatrout from lower segment of the stream
– – – – – seatrout from the middle segment of the stream,
..... seatrout from the upper segment of the stream)

* Stock of fry the area the young fish occupied: 4184 individuals: 2460 m^2 = 1.7 ind./m^2.

17.51 g for the range of 2.0–81.0 g. The data presented refer to the fish captured 8 to 11 months after stocking; meanwhile as seen from the further studies, the fish were growing in weight and length.

Additionally, mean length and weight were calculated for the fish caught from different sections of the Osówka. The calculations performed reveal the mean length and weight values to be similar for fish from the lower, middle and upper segments the difference between the means being small and amounting to 8.2 mm for length, and 3.9 g for weight (Table 4). However, the highest mean length and weight were recorded for the fish caught in the lower segment (M = 119.3 mm and 20.3 g) of the lowest density of the young sea trout (1 ind. per 5.9 m^2 of the stream). Somewhat lower mean length and weight were obtained for the fish staying in the middle segment (M = 111.1 mm and 16.4 g) as well as in the upper one (M = 111.8 mm and 17.1 g) where higher population density of fish was recorded (1 ind. per 1.4 m^2 in the upper segment of the stream and per 2.5 m^2 in the middle stretch.

The length distribution of the young sea trout in the respective segments of Osówka is presented Fig. 2. The analysis of data represented by curves shows that in the three segments of the Osówka the fish length ranges were similar. However the length distributions discussed of demonstrate that in the lower segment of the Osówka, with a lower fish population density, there were fewer fishes in the lower length classes as compared with those from the middle and upper segments of the stream where the population densities were higher.

In addition mean length and weight of fish from consecutive catches were calculated, and the data obtained, with reference to the period (days) elapsing since the stocking

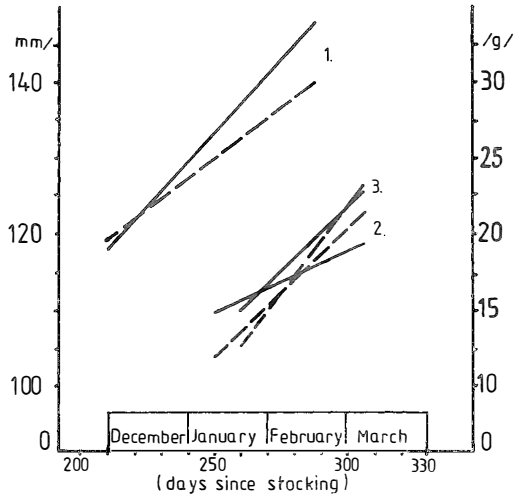

Fig. 3. Growth of length and weight of young sea trout from the Osówka during the period of December-March
(------ weight; – – – length)
1. Fish from the lower segment of the stream
2. Fish from the middle segment of the stream
3. Fish from the upper segment of the stream

operation, were compiled separately for the fish populations from the lower, middle and upper segments of the stream (Table 6). The data so presented permit tracing the increase in length and weight of the young sea trout in the Osówka between the catches made during the period of December-March, or between day 210 (Fig. 3) and day 326 after the fry release. The diagram allows the conclusion that during autumn and winter the young sea trout staying in the Osówka grow in length and weight. It should be added that those fish from the lower segment of Osówka, attained greater increments of length and weight, the fish population being lower there density as compared to those fish inhabiting the middle and upper segments of the stream, with higher density.

The mean lengths obtained for fish from different catching operations may facilitate determining the mean growth rate of the young sea trout in their first year of life in the Osówka for the period of May–March. With this aim in mind, growth rate of the in young sea trout as found for the catches is shown in the diagram (Fig. 4) and the mean growth rate is denoted by the resultant ($\bar{x}$). It seems that young sea trout attains the length of 134 mm in the their 11th month (310 days) of life in the Osówka.

If the mean length of the released fry (24.9 mm) is subtracted from the value given above, the length increment by the end of the first year of life in the Osówka, under natural conditions is 109 mm.

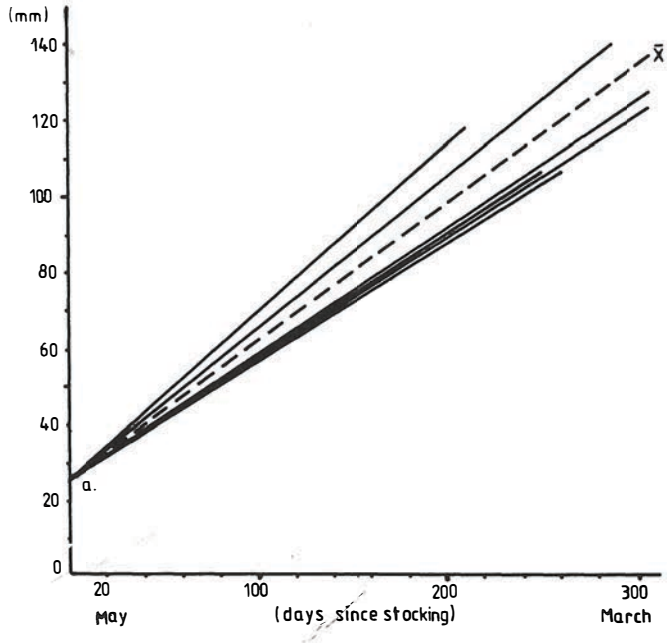

Fig. 4. Growth rate of young sea trout from the Osówka in catches
a – mean length (l.t.) of released young sea trout
$\bar{x}$ – mean growth of retrieved young sea trout

To get a better insight into the young sea trout growth in the Osówka, their condition was defined by Fulton's formula. Such calculations made it necessary to pick out, at random from each 1-cm-length class, 30 individuals, and all the individuals the classes of lower abundance. Thus the calculations were based on a sample comprising 301 individuals making up 35% ot the fish captured in the Osówka. As is apparent from the data compiled in Table 7, the mean condition coefficient of the young sea trout studies was 1.11. The range of the coefficient for 14 length classes demonstrates, however, quite substantial variability: from 0.74 to 1.50. The mean values of the condition coefficient in different length classes are very similar to one another and exceed 1.

Table 7

Weight and condition coefficients (K) of youngs sea trout of Osówka in length classes

Length class (cm)	n	Weight in s		Ranges of variation K	Mean value K
		range	$\bar{x}$		
5– 5.9	5	2.0– 2,7	2.2	1.02–1.38	1.56
6– 6.9	17	2.1– 3.9	3.1	0.88–1.32	1.07
7– 7.9	30	3.1– 6.0	4.6	0.87–1.43	1.12
8– 8.9	30	5.4– 9.9	6.9	0.87–1.50	1.12
9– 9.9	30	7.0–13.7	9.4	0.93–1.41	1.12
10–10.9	30	7.9–17.0	12.1	0.74–1.38	1.12
11–11.9	30	12.1–21.5	17.2	0.91–1.34	1.11
12–12.9	30	15.9–28.0	21.8	0.85–1.34	1.08
13–13.9	30	21.3–31.1	26.4	0.87–1.29	1.09
14–14.9	30	25.6–39.0	31.2	0.93–1.23	1.06
15–15.9	24	30.0–45.0	38.2	0.87–1.15	1.05
16–16.9	8	41.0–53.5	46.9	0.98–1.13	1.08
17–17.9	4	59.9–62.0	60.7	1.12–1.25	1.18
18–18.9	3	65.4–81.0	72.8	1.12–1.30	1.19
total	301	2.0–81.0	17.5	0.74–1.50	1.11

DISCUSSION

According to Mac Crimmon (quoted after Sakowicz, 1955), the survival rate of Salmon fry released in spring (June) into the stream Duffin, after three months, was 12.7%, whereas in the spring of the next year, i.e. after twelve months since stocking it was 9.2%. The survival rate of the sea trout introduced in May into the stream Osówka, was 20.5% after 8–11 months. Thus, the survival rate of the sea trout fry released into the

Osówka appeared to be markedly higher than that of salmon fry in the Duffin. The further studies by Mac Crimmon (after Sakowicz, 1955) on salmon fry introduced into the Duffin, similarly to the study described in the Osówka, indicate that the young fish of these species migrate in their first year of life somewhat downstream and upstream away from to the release site. The range of salmon migration in the Duffin over the period of the first summer did not exceed 14 m, but some individuals migrated as far as 600 m downstream from the place of their release. However, the one-year-old salmon smolts disperse quite extensively: 200 m upstream and 500 m downstream. The sea trout smolts, on the other hand, in the stream Osówka spread, over a somewhat larger distance, 280 m up and 900 m down stream after 8 to 11 months since stocking.

According to Mac Crimmon (after Sakowicz, 1955), the young salmon migrate in autumn of their first year of life from tributaries to the main stream. However, the present study in the Osówka implies that, 7–11 months after the moment of the sea trout release in autumn and winter of their first year of life, the young sea trout do remain in the stream rather than migrating to deeper parts of the stream.

The sea trout fry were released into the stream over the area of 960 m^2, the stocking density being 4.4 indiv./m^2. However, the young fish in the first year of life dispersed over 2460 m^2 of the stream area i.e. 2.6 times larger than the initial one. Of interest is the fact that the larget stock ing density of sea trout fry was 1.7 ind./m^2 and followed Sakowicz's (1955) stocking recommendations of 1–2 ind./m^2.

Table 8

Condition coefficients (K) of brook trout from streams in Poland

Length l.c. (cm)	Weight (g)	K*
5.0	1.9	1.52
6.0	3.1	1.44
7.0	4.5	1.31
8.0	6.3	1.23
9.0	8.2	1.13
10.0	10.8	1.08
11.0	14.5	1.09
12.0	19.7	1.14
13.0	15.5	1.16
14.0	31.0	1.13
15.0	38.5	1.14
16.0	46.5	1.14
17.0	57.0	1.16
18.0	68.0	1.17
19.0	80.0	1.17
$\bar{x}$		1.20

* K value calculated from data cited by Backiel (1964) concerning the length of fish studied

The weight values of young sea trout from the Osówka in 1-cm-length classes (Table 7) and those of brook trout (*Salmo trutta morpha trutta* L.) in Polish rivers after Backiel (1964). (Table 8) appeared to be similar. Similarity was also detected with regard to condition of the sea trout in the Osówka and the above-mentioned brook trout, as expressed by the mean coefficients (k), both in the length classes as well as throughout the duration of study. The mean length (l.c.) of young sea trout, living in the Osówka for about 11 months, was 134 mm, and is similar to that of the one-year-old sea trout smolts in the river Rega; the males and females of latter, as reported by Chełkowski (1982), reached 134.4 mm and 132.6 mm respectively and 122 mm according to Chełkowski (1978).

CONCLUSIONS

The studies performed have revealed that:

- the survival rate of the young sea trout during the period of 8–11 months after the fry release into the Osówka was 20.5%;
- 44.5% of the young sea trout were retrieved from the Osówka in the region of release, while 55.5% migrated outside the stocked area covering a 1180m-long stretch of the stream; 34.3% migrated up and 21.2% downstream;
- migration of the young sea trout during the 8–11 months after stocking was restricted to 200 m up and 100 m down the stream, in relation to the segment stocked with the fry;
- within the 8–11 months following the fry release, a single sea trout parr occupied 2.9 m^2 of the stream area;
- mean length of the recorved young sea trout was 11.2±0.9 mm;
- mean weight of the captured young sea trout was 17.51±0.31 g;
- mean length increment of the young sea trout during 11 months from rlease was 109 mm;
- mean condition coefficient of the young sea trout was 1.11.

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CHARAKTERYSTYKA BIOLOGICZNA JEDNOROCZNEJ TROCI *SALMO TRUTTA* L. WYROSŁEJ Z WYLĘGU WSIEDLOWEGO DO POTOKU OSÓWKA

STRESZCZENIE

Badania przeprowadzono w potoku Osówka, w górnym 4 km długim jego biegu, który charakteryzuje się spadkiem wynoszących 19‰. W środkową część tego odcinka potoku, długości 800 m o powierzchni 960 m², wiosną 1982 r. wsiedlono małymi porcjami 4184 szt. wylęgu troci tj. 4.4 szt/m². W okresie 8 do 11 miesięcy po zarybieniu wyłowiono ryby zespołem prądotwórczym. Ogółem pozyskano 859 sztuk troci w fazie par, co daje stopień przeżycia wynoszący 20.5%. Występowanie ryb w potoku pozwala stwierdzić, że młodzież rozprzestrzeniła się w stosunku do zasiedlonej części potoku, a zasięg tych wędrówek był niewielki i wyniósł 280 m w górę i 900 m w dół potoku. Około 11 miesięcy po zarybieniu 1 troć zajmowała średnio 2.9 m² powierzchni potoku. Pozyskana z Osówki młodzież posiadała długość M±m 112.2±0.25 mm i masę M±m 17.57±0.36 g oraz współczynnik kondycji M =1.11.

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