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Short Communication

Length-weight relationships of grayling *Thymallus thymallus* (Linnaeus, 1758) from Northern European Russia

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Abstract

During 2007-2018, a total of 451 specimens of the European grayling *Thymallus thymallus* from drainage basins of the Neva River, Onega River, Severnaya Dvina River, Pechora River, and the upper Volga River were collected by angling, electrofishing, gill netting, and seine netting. According to the results of the analysis of length-weight relationships, the regression parameter b ranged from 2.83 to 3.25, indicating shifts of the growth pattern, from negative-allometric to positive-allometric. The values of the coefficient of determination were greater than or equal to 0.97. The results of this study are useful for grayling's stock management and conservation efforts in the region.

Keywords: Fish, LWR, linear regression, standard length, total weight.

Introduction

European grayling, *Thymallus thymallus* (Linnaeus, 1758), is considered a Least Concern species according to the IUCN Red List of Threatened Species (Freyhof, 2011). However, this species' broad geographic range is occupied by isolated populations, many of which are severely threatened by pollution, water management, and overfishing (Persat, 1996; Gum et al., 2009; HELCOM, 2013; Mueller et al., 2018).

Analysis of length-weight relationship (LWR) is one of the standard methods employed in fishery biology (Le Cren, 1951; Froese, 2006). Studies on grayling's LWRs are important for more efficient fishery management and conservation efforts, as LWRs have applications in fish stock assessment, population dynamics analyses, and comparative studies of fish populations inhabiting different regions (Froese, 2006; Froese et al., 2011; Mildenberger et al., 2017). In this work, LWRs were calculated for grayling from five drainage basins in Northern European Russia.

Material and methods

We used length-weight measurements of 451 graylings collected in 2007-2018, between May and October. Fish were sampled in 37 small rivers belonging to five drainage basins: the upper Volga River, Neva River, Onega River, Severnaya Dvina River, and Pechora River. The fish collection was performed by angling, electrofishing, gill netting (nets of 20, 25, and 30 mm mesh), and seine netting (5 m and 20 m long nets of 3 mm mesh the bag). Graylings were treated according to the procedure for the use of fishes in the research of the Papanin Institute for Biology of Inland Waters Russian Academy of Sciences, consistent with the applicable international guidelines (Anonimous, 2010). Standard length (SL) and total weight (TW) were measured to the nearest 0.1 cm and 1 g, respectively. LWRs were calculated according to equation $TW = a\ SL^b$, where a is the intercept and b is the slope of the log-transformed relation $\log TW = \log a + b \log SL$ (Le Cren, 1951; Froese, 2006). The log-log plots were examined for outliers, which were then removed. Where applicable, the data were processed with consideration of mature and immature fish separately. Analyses were performed using Excel and Statgraphics software. Raw data supporting this study's results are openly available in the Mendeley Data repository (Komarova & Yurchenko, 2021).

Results and Discussion

Fitted linear models were significant at the 99.99% level in all cases. LWR parameters and descriptive data for pooled and separated (mature/immature fish) samples are given in Table 1. The r-squared statistics indicated that the models as fitted explained from 97% (Onega River basin, mature grayling) to 99.5% (Severnaya Dvina River, pooled sample) of the variability in TW.

The b-values of the LWRs lie within the expected range of 2.5–3.5 (Froese, 2006; Froese et al., 2011). Our results indicated a positive-allometric growth pattern for graylings from the upper Volga River basin (mature and pooled sample), Severnaya Dvina River basin (mature and pooled), and Pechora River basin (only mature fish were available). Close to isometric was the grayling growth pattern from the Onega River basin (mature) and immature grayling from the upper Volga River basin. Immature fish from the Severnaya Dvina River basin showed a negative-allometric growth pattern, as did the Neva River basin population. The latter results are considered preliminary due to the small sample available (three males, one female, and six juveniles). The a-values also lie in the most frequent values of the range provided by R. Froese (2006).

In fish, various factors can modify the LWRs (Jisr et al., 2018; Zuev et al., 2019). For example, changes of LWRs are expected of fish with the onset of maturity (Le Cren, 1951), which were evident in our data, where mature and immature samples were available.

In conclusion, this study's results contribute to the knowledge of grayling populations in Northern European Russia. For example, these data can be used to calculate the relative weight W_{rm} (Froese, 2006) for comparing individuals' conditions across populations of a given species.

Table 1. Descriptive statistics and estimated length-weight relationship parameters for grayling *Thymallus thymallus* from Northern European Russia.

River basin, type of sample	Sample size	Standard length (cm)		Total weight (g)		Regression parameters				
		Min	Max	Min	Max	*a*	95% CL (*a*)	*b*	95% CL (*b*)	r^2
Upper Volga River, mature	117	8.1	19.5	6.1	110.7	0.0068	0.0054–0.0087	3.25	3.15–3.34	0.977
Upper Volga River, immature	27	6.3	14.1	2.9	31.7	0.0121	0.0082–0.0179	3.01	2.84–3.17	0.982
Upper Volga River, pooled	144	6.3	19.5	2.9	110.7	0.0080	0.0068–0.0096	3.18	3.11–3.25	0.984
Neva River, pooled	10	7.1	17.1	5.0	72.0	0.0189	0.0115–0.0311	2.86	2.65–3.07	0.991
Onega River, mature	50	11.2	23.2	17.0	190.0	0.0147	0.0098–0.0220	2.99	2.84–3.15	0.970
Severnaya Dvina River, mature	125	9.0	26.5	6.9	232.0	0.0065	0.0050–0.0083	3.24	3.15–3.33	0.977
Severnaya Dvina River, immature	59	5.0	12.5	1.7	20.5	0.0169	0.0134–0.0214	2.83	2.70–2.95	0.973
Severnaya Dvina River, pooled	184	5.0	26.5	1.7	232.0	0.0112	0.0104–0.0122	3.05	3.02–3.08	0.995
Pechora River, mature	63	17.3	30.0	63.0	321.0	0.0093	0.0062–0.0139	3.07	2.95–3.20	0.975

CL= confidence limit; r^2= coefficient of determination.

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