

Supplementary materials to the manuscript by D.S. Pavlov, V.V. Kostin, V.N. Mikheev “Selective Removal of Fish from Reservoirs and Lakes: Interaction of Hydraulic and Ecological Factors”.

The data, which were used for the analysis were obtained from published materials (shown in the list of References in the text of paper under numbers: 34, 36, 37, 41, 42):

Pavlov, D.S.; Lupandin, A.I.; Kostin, V.V. Downstream Migration of Fish Through Dams of Hydroelectric Power Plants; Nauka: Moscow, Russia; Trans. Albert, T., Cada, G.F., trans. ed.; ORNL/TR-02/02. Oak Ridge National Laboratory: Oak Ridge, Tennessee, USA, 2002; pp. 1-256.

http://www.sevin.ru/laboratories/Pavlov/Pav_4_%20DMFDHPP_%201999.zip

Pavlov, D.S.; Kostin, V.V.; Nezdolii, V.K.; Gorshkov, N.I.; Lobankov, V.Yu. *Downstream migration of fish from water bodies with slow water exchange*. M: IEMEZH, Russia, 1985; pp. 1-136.

Pavlov, D.S.; Kostin, V.V.; Ostrovskii, M.P. *The influence of the water intake location on the downstream migration of fish from water bodies (Sheksninskoe Reservoir and Lozsko-Azatskoe Lake as examples)*. M: IEMEZH, Russia, 1991; pp. 1-142.

Pavlov, D.S.; Nezdolii, V.K., Khodorevskaya, R.P.; Ostrovskii, M.P.; Popova, I.K. *Downstream Migration of Young Fish in the Volga and Ili Rivers*; Nauka: Moscow, Russia, 1981; pp. 1-320. (in Russian).

Pavlov, D.S.; Mikheev, V.N.; Vasilev, M.V.; Pekhlivanov L.Z. *Feeding, distribution and migration of young fish from the Reservoir “Alexander Stamboliiski” (Bulgaria)*; Nauka: Moscow, Russia, 1988; pp. 1-123. ISBN 5-02-005226-4 (in Russian).

Table S1: Characteristics of the studied reservoirs, lakes and water intakes.

Water body		Coordinates of the water intake	Square, km ²	Volume, km ³	Depth, m		Water exchange rate/year	Distance (m) from water intake to	
					mean	maximum		surface	bottom
Lake Nero		57°12'30.7"N 39°29'14.5"E	51.7	0.08	1.5	4	0.2	0	0
Lake Pleshcheevo		56°47'54.3"N 38°43'23.5"E	51.8	0.58	11.2	25	3.0	0	0
Lake Lozsko-Azatskoe		59°54'27.6"N 37°41'46.7"E	36.2	0.19	5.3	34	0.6	0	0
Sheksninskoe reservoir	Shipping-lock	59°14'12.5"N 38°29'49.1"E	1665	6.52	3.9	26	0.7	2	21
	HPP	59°14'12.7"N 38°29'40.9"E						13	1
Ivan'kovskoe reservoir		56°44'07.5"N 37°07'15.2"E	3278	1.12	3.4	20	13.0	9.5	0.5
Ozerninskoe reservoir		55°44'50.9"N 36°09'45.9"E	0.023	0.14	6.3	21	1.7	16	0.5
Volgogradskoe reservoir		48°49'40.3"N 44°40'09.1"E	3.117	31.45	10.1	40	8.0	17.2	3
Kapchagaiskoe reservoir		43°55'16.5"N 77°05'48.8"E	1847	2.81	15.0	40	2.0	16	0
Usn'-Khantaiskoe reservoir		68°05'21.2"N 87°46'45.8"E	21200	235	11.1	50	13.0	13	3
Tsimlyanskoe reservoir		47°36'32.8"N 42°06'41.5"E	2700	23.8	8.8	35	0.9	15	3
Al. Stamboliiski reservoir		43°07'25.4"N 25°10'16.8"E	10.86	0.22	20.5	46	1.6	26	1
Mostishte reservoir		49°23'40.0"N 16°00'55.2"E	0.86	0.01	12.1	35	5.0	27	1
Nurek reservoir		38°22'12.9"N 69°20'51.5"E	98	10.5	107	300	22.9	50	240

Figure S1: Scheme of the ecological zones of reservoirs and lakes.

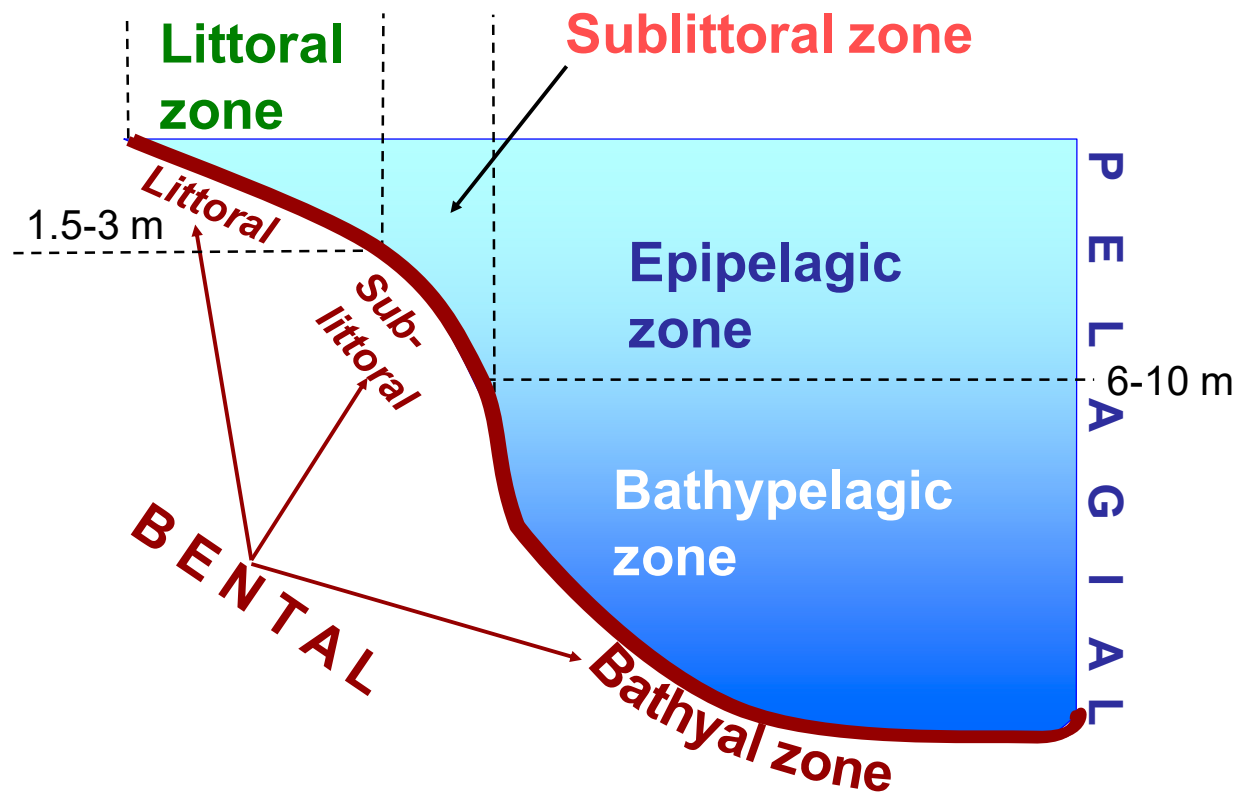


Figure S2: Schemes of interaction of the water intake (hydraulic funnel – red line) with adjacent ecological zones. Calculation of the Eco-Hydraulic Patterns of Interaction (EHPI) between water flow and ecological zones was done on the basis of these data for each water intake. See Pavlov et al., 2002 for more details.

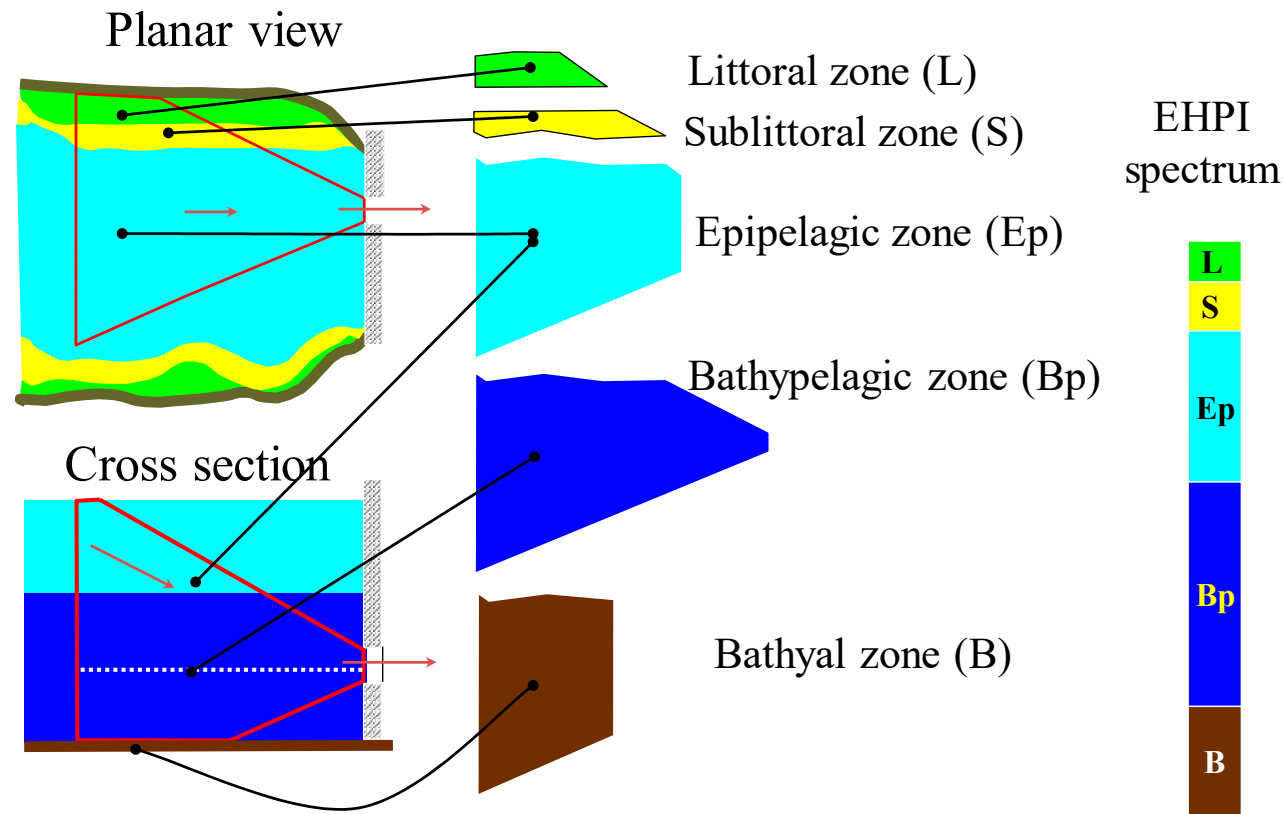


Table S2: Spectra of the Eco-Hydraulic Patterns of Interaction (EHPI) between water flow and ecological zones – relative investment, % of each zone to the total water abstraction. The data were used for the cluster diagram and bars of the Figure 1 in the manuscript. See Pavlov et al., 2002 for more details.

Lake/ reservoir	Water intake	Ecological zones				
		Littoral	Sublittoral	Epipelagic	Bathypelagic	Bathyal
Nero	River source	100	0	0	0	0
Pleshcheevo	River source	60	40	0	0	0
Lozsko-Azatskoye	River source	15	50	35	0	0
Sheksninskoe	Shipping-lock	13.0	35.0	52.0	0.0	0.0
	HPP	0.0	14.5	28.0	28.9	28.6
Ivan'kovskoe	HPP	0.0	11.9	28.9	29.8	29.5
Ozerninskoe	HPP	0.0	12.8	21.6	32.8	32.8
Volgogradskoe	HPP	0.0	0.4	33.2	33.2	33.2
Kapchagaiskoe	HPP	0.0	0.4	33.2	33.2	33.2
Ust'-Khantaiskoe	HPP	0.0	0.3	34.8	34.8	30.0
Tsimlyanskoe	HPP	0.0	0.0	26.9	38.5	34.6
Al. Stamboliiski	HPP	0.0	0.0	0.0	50.8	49.2
Mostiste	HPP	0.0	0.0	0.0	53.8	46.2
Nurek.	HPP	0	0	0	100	0

Table S3: Data on the selective removal (SR-index) of fish from different ecological groups for Figure 2 (upper panel). Types of the Eco-Hydraulic Patterns of Interaction (EHPI) between water flow and ecological zones are indicated. Data from Pavlov et al., 1981; 1985; 1988; 1991; 2002.

Ecological groups of fishes (I, II, III).		Fish species	Types EHPI												
Name	№		1	2	3	3	4	4	4	5	5	5	5	6	6
			Lake Nero	Lake Pleshcheevo	Lake Lozsko-Azatskoe	Sheksninskii Sh-lock	Sheksna HPP	Ivankovskaya HPP	Ozerninskaya HPP	Volgograd HPP	Kapchagai HPP	Ust-Khantai HPP	Tsimlyanskaya HPP	Al.Stamboliiski HPP	Mostishte HPP
Littoral - I	I	<i>Blicca bjoerkna</i>	0.80	0.40	0.75	0.67	0.08	0.50		0.20			0.00		
	I	<i>Carassius carassius</i>	0.40	0.47											
	I	<i>Scardinius erythrophthalmus</i>	1.00	0.13		1.00	0.05								
	I	<i>Abramis brama</i>	0.80	0.60	0.00	0.44	0.20	0.80	0.00	0.00	0.60		0.11		0.40
	I	<i>Tinca tinca</i>	0.80	1.00											
	I	<i>Gobio gobio</i>		0.80											
	I	<i>Rutilus rutilus</i>	0.60	0.67	0.75	0.52	0.10	0.10	0.20	0.30		0.10	0.37		0.00
	I	<i>Carassius auratus</i>		0.53									0.00		
	I	<i>Lepomis gibbosus</i>												0.00	
	I	<i>Cobitis taenia</i>		0.80	0.75										
	I	<i>Esox lucius</i>	1.00	0.93	0.50	0.00	0.00	0.00	0.00	0.00		0.00	0.00		
	I	<i>Leuciscus idus</i>	0.80	0.60		0.52	0.02								

Ecological groups of fishes (I, II, III).		Fish species	Types EHPI												
Name	№		1	2	3	3	4	4	4	5	5	5	5	6	6
			Lake Nero	Lake Pleshcheevo	Lake Lozsko-Azatskoe	Sheksninskii Sh-lock	Sheksna HPP	Ivankovskaya HPP	Ozerninskaya HPP	Volgograd HPP	Kapchagai HPP	Ust-Khantai HPP	Tsimlyanskaya HPP	Al.Stamboliiski HPP	Mostishte HPP
Pelagic - II	II	<i>Gymnocephalus cernuus</i>	0.40	0.47	1.00	0.48	0.78	0.60	0.60	0.60				1.00	1.00
	II	<i>Clupeonella cultriventris</i>								0.60			0.58		
	II	<i>Lota lota</i>	0.00	0.00	0.25	0.44	0.53					1.00			
	II	<i>Coregonus peled</i>			0.50							1.00			
	II	<i>Coregonus sardinella</i>		0.47		0.33	0.69					1.00			
	II	<i>Alosa kessleri</i>								1.00			1.00		
	II	<i>Osmerus eperlanus</i>			0.50	0.15	0.70	1.00		0.50					
	II	<i>Silurus glanis</i>	0.40										0.00		
	II	<i>Sander lucioperca</i>	0.20		0.25	0.59	1.00	1.00	0.40	0.90	1.00		0.37	1.00	0.70
	II	<i>Pelecus cultratus</i>				0.30	0.42						0.26		
Ubiquitous - III	III	<i>Perca fluviatilis</i>	0.60	0.47	0.75	0.85	0.82	0.60	1.00	0.90	0.80	0.80			0.80
	III	<i>Alburnus alburnus</i>	1.00	0.60	0.50	0.89	0.30	1.00	0.20	0.30			0.26		

Table S4: Data for Figure 2 (lower panel) – types of EHPI (% of water intake) for the studied lakes and reservoirs.

Types EHPI	Ecological zones				
	Littoral	Sublittoral	Epipelagic	Bathypelagic	Bathyal
1	100	0	0	0	0
2	60	40	0	0	0
3	14	42.5	43.5	0	0
4	0.0	13.0	26.2	30.5	30.3
5	0.0	0.3	32.0	34.9	32.7
6	0.0	0.0	0.0	52.3	47.7

Table S5: Data for Figure 3. 3A - Index of selective removal (SR-index, mean \pm SE).

Ecological groups of fish	Type EHPI	
	3	4
	Lock	HPP
Littoral	0.52±0.13	0.08±0.03
Pelagic	0.38±0.06	0.69±0.08

Data for Figure 3B – concentration of emigrants through the Sheksninskii Shipping-lock and HPP, ind/m³.

Mean diel concentration of emigrants through the Sheksninskii Shipping-lock and HPP, ind/m ³ .											
Water intake	April		May			June			July		
Shipping-lock	0.0000	0.0000	0.0010	0.0009	0.0008	0.2750	0.3800	0.4850	0.2520	0.2310	0.0790
HPP	0.0030	0.0005	0.0010	0.0030	0.0020	0.6300	0.9630	1.3120	1.2630	1.0490	0.2350

Mean diel concentration of emigrants through the Sheksninskii Shipping-lock and HPP, ind/m ³ .									
Water intake	August			September			October		
Shipping-lock	0.0620	0.0030	0.0020	0.0010	0.0007	0.0004	0.0005	0.0006	0.0004
HPP	0.0930	0.0870	0.1030	0.0920	0.0630	0.0050	0.0070	0.0060	0.0040

Table S6: Data for Figure 4 – ratio of concentrations of migrants (C_{migr}) and inhabitants(C_{inhab}) for two types of EHPI (type 2 – Lake Pleshcheevo; 4 – Sheksninskaya HPP). Emigration Index, $EI = C_{\text{migr}} / C_{\text{inhab}}$. Data from Pavlov et al., 1985; 1991. Each value of the EI-index shown in the table is the result of averaging from two values.

EI		
Fish species	4 type EHPI	2 type EHPI
Perch	0.2606	0.0808
Roach	0.1786	0.0000
Bleak	0.0531	0.0000
Bream	0.0089	0.0000

Table S7: Data for Figure 5 – vertical distribution and emigration of fish through the Shipping-lock and HPP of the Sheksninskaya power plant. Data from Pavlov et al., 1991; 2002.

Vertical distribution of fish, % at each depth from the total number in the water column.			
Fish species	Depth, m	Day	Night
<i>Sander lucioperca</i>	9.5	11.5	51.9
	4.5	31.7	34.2
	0.45	56.8	14.0
<i>Osmerus eperlanus</i>	9.5	47.6	24.7
	4.5	27.2	33.2
	0.45	25.2	42.1
<i>Alburnus alburnus</i>	9.5	1	17.9
	4.5	1	26.8
	0.45	98	55.4

Emigration of fish, % of the diel total through the two types of intakes.		
	Lock	HPP
Day	69	24
Night	31	76
Day	34	71
Night	66	29
Day	85.6	29.6
Night	14.4	70.4