

FISH PASSES - THE BULGARIAN TRADITION

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INTRODUCTION

As a nongovernmental organization watching closely the hydropower development and practice in Bulgaria in the last 15 years, we, the members of Balkanka Association Sofia, have vast and negative experience concerning the devastating impact caused to the river ecosystems in our country. Here are some of the major reasons to explain the damage:

- The reduced /or absent/ river flow and the water quality degradation
- The blocked sediment downriver transportation
- The river fragmentation disrupting bio corridors for fish and other aquatic species migration.

Most of these things happened to the Danube River many years ago, when the Iron Gates HP Unit was built. Before that the River was so rich of life that sometimes professional fishermen had troubles taking out the heavy nets full of fish while the author was watching them as a child. Many of the River species are nowadays threatened in the Bulgarian section of the River.

The following article is focused mainly on the fish migration problems in Bulgaria and on the unsuccessful attempts to solve these problems. The so called "E-flow" /it should be called Residual, not Ecological acc. to many modern authors/ will not be discussed in detail, but will be mentioned briefly only in the light of the fish passes functionality, just because some part of the flow, or all of it, is supposed to run through the fish pass by definition.

The goal here is not to produce another guide, or manual on fish passes design, maintenance and monitoring - too many of these are available today. The purpose is to show what's happening in Bulgaria, then to try and find an explanation and to point out some possible ideas for improvement in the future. However, it is possible that most of the problems are the same all around Europe, therefore some explanations are expected to be uniform.

Anyone who reads this document, please be prepared to meet some of the most stupid fish passes on planet Earth - it is the Bulgarian hydro technicians' contribution to the art of the migration of aquatic species science.

NOTE

In the last three years Balkanka Association has set up /with the substantial help of WWF-Bulgaria/ an internet HPP monitoring platform <https://dams.reki.bg/Dams/Map> - where we upload and expose all information that refers to commissioning, design, construction and operation practice of HPP we manage to collect, including pictures and video clips.

At least 80% of the water catchments we have visited and checked in BG are located within the boundaries of Natura 2000 Habitats and/or Birds directive sites.

If anyone would follow the above link, the HPP monitoring platform will display the full beauty of hydropower in Bulgaria. However, since the platform requires some time to be studied in detail, it will be much easier to watch the following videos, showing some Bulgarian operational HPP water catchments in dry months. Watching those dry rivers would make it possible for everyone to understand - why are we fighting the damn things and why won't we ever give up. There are hundreds of videos and pictures like these uploaded on the platform.

<https://www.youtube.com/watch?v=0mz1nGqJ4cw>
<https://www.youtube.com/watch?v=7nlQp272qNs>
<https://www.youtube.com/watch?v=yPAskCMI8KI>
https://www.youtube.com/watch?v=bXtPIM_9n_k
<https://www.youtube.com/watch?v=3UJOIONNOPY>
https://www.youtube.com/watch?v=zk8hcf_QiE0

<https://www.youtube.com/watch?v=Fq4ZVHpjfyA>
https://www.youtube.com/watch?v=OJxOwJP_w50
<https://www.youtube.com/watch?v=4ToGKuEINKY>
https://www.youtube.com/watch?v=4ZcSDw_5cYY
<https://www.youtube.com/watch?v=7ea2k7OrZJU>

I. What is a Fish pass supposed to be?

Here is a possible good definition:

Fish passes are manmade bioengineering structures integrated in or built around migration river barriers, for which it's proven by an independent monitoring¹, that all² migrating³ aquatic species /reported in the past and present nowadays/ can easily and quickly⁴ find the entrance and get in, and at least 80%⁵ of them can reach the exit as fast as possible⁶ and move ahead, both up and downstream the river, all⁷ the time throughout the year.

Please note the words marked with superscript numbering, because too many sources, published by different authors, point out different priorities or give different excuses for not achieving some of the objectives laid down in the above definition. Due to the limited space, only the No 1 will be discussed here:

1. Should it be proven by an independent monitoring that fish are passing through or not? Now this is a crucial issue - some authors say that fish may not be motivated at the time of the monitoring (Ovidio et al. 2007), but that can only be due to a wrong time judgment of the experts, other say that the river may not host any fish at all for various reasons - poaching, pollution etc. (Uzunova 2017)

Now here we have to get back to those videos at the beginning, because the absence of any fish gives every hydropower operator such a good excuse for his fish pass to fail the monitoring and at the same time the absence of fish can be achieved so easily. Just extract all the water from the river to kill the fish like in the videos above, or kill it any other way, and the deal is done - your fish pass cannot be assessed as being ineffective, with the excuse that there is no fish in the river.

The other numbers in the above definition point out too many different opinions - some authors propose priority to be given to the protected or priority fish species (Uzunova 2017) and to the conservation status (Prato et al. (2011)); to the mature for reproduction, rather than to the juvenile fish; most discuss only the fish and say nothing about the other aquatic species; percentage of success is really a matter of discussion; only during the spawning migration period or most of the time, at least 300 days per year or less, except for low water periods; priority given only to the pronounced migrants; etc. etc.

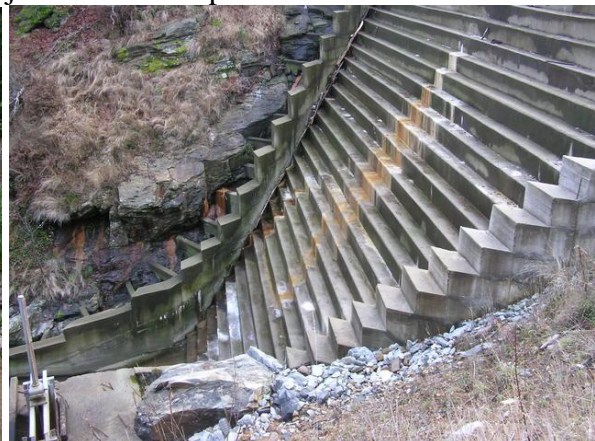
So it turns out that the above definition really presents an ideal case, which is very hard to be achieved. However, the No1 point must not be a matter of discussion - a fish pass is something where fish a. o. species are actually passing through. If there isn't any fish that passes through, the thing is anything, but a fish pass - it is as simple as that.

II. Fish passes in BG - a mitigation measure for the upstream migration or not?

It is a well known fact that fish passes are not a panacea, even the best amongst them are not. They really provide only for the upstream migration of the fish to some extent, sometimes for the migration of other aquatic species as well. If they are properly designed and built that is. The water catchments in Bulgaria however, are usually equipped with strange looking structures that are proudly called "fish pass" by the designers and the HPP operators, but they can fool no one, including the aquatic species and the fish. Here are just a few examples:



1 - Martinovska river



2 - Davidkovska River



3 - Davidkovska River



4 - Davidkovska River

We will discuss only the No3 and No4 here, because for No1 and No2 the problems are quite obvious.

The No3 fish pass at the Hladilnika HPP is the Most Stupid Fish Pass on planet Earth. Should any river fish manage to pass through upstream - it will immediately be killed by the abrupt change of about 10 meter difference in the water pressure at the entry through the barrage /actually no fish can overcome the pressure to get into the lake/. The same will happen if the fish migrates downstream, which is actually impossible.

However, **the No4** fish pass at the Slivka HPP is much more symptomatic. It costs some **100 000€** at the very least and is called a "mitigation measure" in the AA for the HPP project's implications on Natura 2000 Habitats directive site conservation objectives. The fish pass follows strictly the East Aegean RBMP 2010-2015 regulations, which are based upon the famous "*Fish passes design dimensions and monitoring*" - FAO ISBN 92-5-104894-0

Only one small detail to consider though - it's written in section 5.6.1 *Principles* of the FAO document that the conventional "close to nature" and "technical" type fish passes provide for the migration of the fish, when the difference between the water levels is within the limits of no more than 6-10 meters /not mentioning the type of river and the type of fish/, otherwise fish lifts are to be used. Many other modern fish passes Guides say not a word about this issue and such limits for the total water level difference are not even specified.

Now, the **No4** fish pass is obviously anything, but a mitigation measure. It actually is a trap. In case a fish is attracted to the entrance, it will never reach the exit - it will fall down on the ground no more than halfway the entire distance to the top, depending on the water speed and to the turbulence. **Then why were all those money spent** - as an excuse to brush and shine somebody's consciousness remains - of the state authorities, of the designer, of the operator, or of all of them together? And more importantly - why weren't the money spent for any other, much more sensible purpose, like river restoration measures for example?

II. What is the possible explanation?

To find an answer we have to study the so called "*Hydropower and Natura 2000 Good Practice Guide*" released for public consultation by the DG Environment of the European Commission in the end of 2016.

Even in that document there are no common European rules for Fish passes design, maintenance and monitoring specified for the different types of rivers and their habitants. In Europe we have many different documents, guides etc., yet none of them is good enough to be accepted in the EU as a mandatory document for all the member states. This is applicable even to the ICPDR guide on fish passes, which is mentioned in the Good Practice Guide.

In Bulgaria we have thousands of river barriers. Hundreds of them have something like a fish pass - at least that's what they are called. Yet no more than 10/ten/ of them are fit for the purpose to some small extent. Ten pieces that is, not 10%!

As for the downstream migration - the EU Guide again says a few words about the possible solutions:

Fish friendly turbines - the scientific data on the matter by far is not sufficient at the moment. Several existing studies display experiments, when the fish /dead or living/ is forced into such turbines /Archimedes screw - single or double/ and afterwards the death rate or the injuries are studied, but that is not the point. The point is - will a wild fish ever enter such a turbine? For the trout we know the answer - not a single wild trout will ever enter a rotating turbine, if it is not artificially forced into the blades. We have watched them blocked downstream in artificial ponds so many times, never reaching the catchment grates - when they get near the grate and feel the flow they always run away. Which raises another question we have read nothing in any modern fish pass guide about - should the water speed at the catchment grates or at the turbines be limited or not? Of course it should be limited, depending on the fish and their ability to swim and to escape.

Fish screens are a measure alright, but they don't provide for the downstream migration, they prevent the fish from entering the turbines - depending on the water speed again, because when it is too high - then the fish can't get away and the screen turns into a trap.

Trap, transport & release - it is worth the efforts only if the fish migrates only once in a lifecycle. In the inland rivers of Bulgaria such kind of fish /eel/ is very rare - only in one or two rivers to our knowledge.

By-pass channel - it is really the best solution, if there is room enough in the vicinity, and if some special measures to attract the fish are undertaken, which is not so easy to be done.

There is however a statement at the bottom line of page 40 of the above EU Guide, concerning the facilities that produce downstream repulsive or attractive stimulus for fish, we totally agree with:

However, in Europe majority of these technologies has not proven efficient yet.

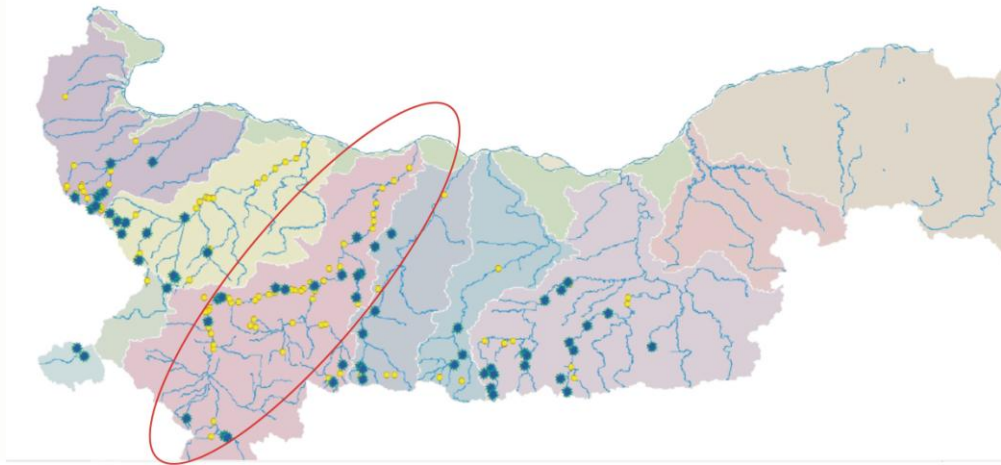
III. Fish passes or "the polluter must pay"?

There is not a single fish pass guide that gives an answer to this question. Actually the question is not even asked. Yet there are many cases in which a fish pass is useless, for example at the big dams. There is no sense in spending money for a fish pass, to let the fish climb from a running river into a big dam, because it hardly will survive there in the warmer steady water and it will not be able to find and reach the upstream section of the river at the upper end of the big dam at all.

That is why Fish lifts are applicable if the lake is very short, otherwise the fish may lose too much time to find the upper section of the river and time is crucial for the spawning spots to be discovered. If there is a natural migration barrier near a future artificial one, there is no sense to build a fish pass at the new barrage again.

Those three HPP barrages at the Davidkovska River shown on the pictures above, display another case in which there is no sense at all. They are in a cascade connection with another HPP lake and the fish is expected to migrate four times passing over barriers at least 30 meters high, even if the barriers were passable? But this is nothing - here is what may to happen to the Iskar River in the Danube region very soon:

HPP at the Iskar river



To be enlarged and studied in detail, the map can be downloaded from the following link, which is essential to be followed, for anyone to get the point:

http://dams.reki.bg/uploads/Docs/Files/HPP_at_the_Iskar_River.jpg

The map is extracted from the BG Danube River Basin Management Plan. In the ellipse it shows the beauty of the future river status with **35 /thirty five/** HPP, for about 120 kilometers from the Iskar Gorge in the Balkan to the Danube to be built. It should be taken into consideration, that each of the HPP lakes will be about 3 - 4 kilometers long at the average...

The big blue dots are the operational HPP and the small yellow dots are the future ones. Then it is obvious that the river will simply cease to exist, while the greatest part of it is located in several Natura 2000 Habitats directive sites, designated for the protection of priority river habitats and species. The state officials who have issued those permits - they obviously have no hearts, let alone the infringements of the law and the EU Directives committed.

Anyway, here is another case in which fish passes are absolutely useless. There is no sense in moving river fish from one lake to another in the warm and steady water with less oxygen if any - thirty five times, one after the other.

Then, following the basic principles of the EU - **the polluter/operator/ must pay**, and the money must be spent for other river restoration measures! Moreover - following the precautionary principle of the EU WFD - if there is no chance for the fish migration to be guaranteed, such projects must not be allowed at all, unless there is a derogation under article 4.7 of the EU WFD as well as under article 6 of the Habitats Directive, concerning the protected areas.

And not a single official document or guide on fish passes says anything about the cases when the fish passes are useless? One major reason for that - all those documents deal only with how to design a fish pass. They don't deal with the cases, in which a fish pass is useless and what do we have to do in these cases, because it is a very good excuse to build as many HPP as possible. But the cumulative effects must be studied and be properly assessed and dealt with? Until the future operators keep paying for the assessments, the "experts" will always prove on paper that everything will be OK, otherwise they won't get paid and those 35 pieces above would not have been allowed at all. There are 16 of them operational already and all 16 of them are equipped with fish passes waiting for the migratory Danube fish to come along. This is another reason for the decrease in Danube fish populations - the fully blocked migration to the tributaries.

Needless to say that there are unsolvable problems expected, concerning the sediment downriver transportation for the Iskar River already. And how about the flood risk - what will

happen if a high wave comes along, after a heavy rainfall in the catchment area of the longest river basin in Bulgaria?

And how about the effects on global warming - does anyone really believe that hydropower in this case will be of any help? With an average installed capacity of 1.5 MW - the overall power of those HPP will be no more than only 50MW. And some 120km of a running river will be turned into large lakes with higher temperature of steady water, combined with eutrophication processes and the consequent methane release. Methane is some 25 /twenty five/ times more harmful than carbon dioxide, as far as global warming is concerned - did you know that? And the self cleaning ability of the river loaded with pollution and contaminants is absolutely compromised, and so on and so on...

Will all this adversely impact fish survival and migration, or should we focus only on the construction of the fish passes? Obviously we should not - in order to survive and swim, the river fish needs oxygen, you know!

IV. The good, the bad and the evil.

Some fish passes are much more effective than other. It's always best to use the "close to nature" types of course, but in Bulgaria we do not have a single one of these. 99% of the fish passes here are the "Pool" type technical fish passes, which have proven to be absolutely inappropriate for the purpose. We also have only one "Denyl" type fish pass which is also inappropriate for the fish species in BG rivers and only one "Vertical slot" type of a fish pass. Some "Pool" type passes will be shown in the next section and few of their drawbacks will be pointed out. Here is a video of many fish passing through the only "Vertical slot" type fish pass in Bulgaria on the Tunja River, displaying upstream migrating fish:

<https://www.youtube.com/watch?v=upvrGsQ3neI>

And here is a partial photo of the fish pass:



Design, video and photo credit - Mladen Angelov

At a conference held in Sofia in 2016, Austrian *prof.Stefan Schmutz* declared that, after a thorough research in Austria, the only technical type of fish pass allowed there is the "Vertical slot" type and obviously there are many reasons for that - there is no room here for these reasons to be explained. But the "Vertical slot" type is good. As for the evil ones - they are designed to kill the fish - we have shown some of them above and some are coming in the next section.

It should also be pointed out here that the fish pass is not the only important thing that matters for migration. It is also very important how the whole water catchment facility is organized to facilitate migration under different river flow conditions and for different species. We have here in BG three good examples - only three, but really good indeed. Here they are:

1. Mikrevo HPP:



Now this one is very old, but the idea is nearly perfect - with the only shortcoming that it works only for the fish, while the other aquatic species are still blocked. It needs only two small ramps near the river banks to enable the other species to migrate and the bars of the grates need to be closer to one another. But during low water it cannot take any water by definition, and during high water it takes the excess of water, reducing the wild river flow thus improving the options for migration again. There is no problem for the downstream migration too. It also presents a perfect solution for the residual flow discharge we will discuss in the next section. It is applicable for very wide rivers too, only then the number of the water channels must be bigger and the channels should be wider. This barrage is about **0.9m** high in the trout zone and the next video of another barrage shows what the small trout is capable of jumping over - except for the very small ones, the medium fish /25-30cm/ are reaching about **1.6m**, when the weir bellow is deep enough: <https://www.youtube.com/watch?v=nOfPEnDDHPI>

2. Lenishta HPP:



At this barrage there are three spots where the fish can migrate upstream and two spots appropriate for downstream migration. No water is taken at the moment and the river is running free through the floodgate - the fish a. o. species can migrate in both directions. When the floodgate is closed - next to it is the Pool type fish pass, allowing upstream migration for the fish. During high

water, the trout can also jump over the barrage in both directions with no problem at all. Now this one would have been really good, if only the fish pass was a Vertical slot type.

3. Preboinitsa River:



This one is really old and nearly broken, but it has two entries - one for the jumping fish and a ramp on the right hand side with an easy slope for the small fish and the other aquatic species. Is it really still working? We have no thorough observations, but there is a lot of trout /*Salmo trutta*/ and stone crayfish /*Austropotamobius torrentium*/ both below and over the barrage. Judging from the No1 and No3 examples, maybe the hydro technicians in the past knew better how to build such obstacles to migration.

V. Unsolved migration problems.

Besides the downstream migration, there are many other issues that are not properly discussed in the official guides. One of these is the residual flow discharge and measurement. The question is - should all of it run through the fish pass? In Bulgaria it is a common case wild water running through the fish pass during high water periods - in the spring for instance, when most of the fish in BG rivers are trying to migrate upstream, except for the trout. The water speed and the turbulence exceed by far the limitations and often disoriented fish jumps out of the fish pass on the ground. At the same time there are many cases in which no water is running through the fish pass during low water periods at all. This is particularly specific for the Pool passes in Bulgaria. Here are two sample videos of one and the same Pool pass at Blagoevgradska Bistrica River:

https://www.youtube.com/edit?o=U&video_id=PLV8_DUifWo

<https://www.youtube.com/watch?v=GXdwtw6PtSM8>

And here is a video of a Pool fish pass the fish is often jumping out of:

<https://www.youtube.com/watch?v=rF1mNMazfTc>

The barrage here is old, but the fish pass is brand new. We heard about it from the locals, who claimed that many fish are jumping out on the concrete. Three days later we managed to shoot only one, because the birds have taken the other away. The explanation for the mishap is hidden in the water speed and in the turbulence, which are too high, thus misleading the fish to jump into the wrong direction.

Then it's obvious that the Residual flow management is crucial for the fish passes to be effective. Some sources recommend part of the flow to be discharged right in front of the fish pass entry to attract the fish upstream, while a relatively constant water flow is running through, with the

necessary speed and turbulence within the limits. We have such a Pool fish pass in BG, which an underwater camera has not proven yet to be effective:

<https://www.youtube.com/watch?v=BK0F0n62LI1>

When the river is big, big has to be the residual flow and what part of it should run through the fish pass and what part should be discharged from somewhere else in a way not to distract the fish from the fish pass - no official document has given us an answer yet for the diversion type HPPs. And we are not talking about articles by different authors here, we are talking about official mandatory documents that should be followed, published by the state or by the European Commission. The same goes for the run-off-river HPPs concerning the percentage of the flow that passes through the fish pass. For obvious reasons the fish pass must be situated near the discharged water from the turbines of the run-off-river HPPs, but in Bulgaria they are always at the opposite river bank...

And yet another problem - the Residual flow is crucial for the survival of the river ecosystems. It is the most important requirement set in each Water permit for water abstraction. Then it has to be measured by the operator to follow the restrictions and has to be checked by the controlling authority officers. Therefore special flow measuring equipment has to be installed at the barrage. There is a wide variety of techniques for measurement and some of them can be integrated in the fish pass. The important issue is that the measuring equipment should not chase away the fish or prevent it in any other way from reaching or passing through the fish pass. The task is much more complex when the residual flow is discharged not only through the fish pass. Some barrages in Bulgaria are equipped with measuring rods at the upstream exit of the fish pass or in one of the pools, but these can be manipulated easily by the dishonest HPP operators and they always are. As for the Residual flow itself - there are no common EU regulations again.

VI. Conclusion.

A few of the problems for the river species' migration are discussed here. The main goal was to show what works in Bulgaria, as well as to give an explanation why the vast majority does not. Quite a few questions were also asked and quite a few answers, if any, were given, due to the lack of space. There is one thing for sure though - if we get back to the reasons for the huge Danube River biodiversity loss - a single big river barrier, combined with the increased pollution, with the reduction of the River self cleaning ability and with the fully blocked migration to the tributaries, and here is the result today. And so many people once made their living by professional fishing along the River... Then was it worth and shall we keep repeating on and on the same mistake?

In the end we have to get back to the *Hydropower and Natura 2000 Good Practice Guide* of the EU, which states:

However, in Europe majority of these technologies has not proven efficient yet.

Then it's obvious that the most significant recommendation in any kind of Guide must be - there is a binding need for further exploration on the fish migration problems and solutions, before we keep increasing river fragmentation by building new migration barriers of any kind. Until then, and only if we ever get the right answers, river restoration must be the main objective that has to go ahead instead.

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