Jürg Bloesch
The Iron Gate dams in the Danube River and their importance for endangered sturgeons

Danube sturgeons are highly threatened (IUCN Red List) and two out of six native species are already extinct. The Sturgeon Action Plan enforced in 2005 in the framework of the Bern Convention signed by all Danube countries, lists 72 actions for sturgeon conservation. First priority is the reopening of the Iron Gate I and II hydropower dams, as these disrupt sturgeon spawning migration from the Black Sea to the Middle and Upper Danube. The situation in the region of the Iron Gate dams is extremely complex (navigation locks, transboundary between Romania and Serbia, sturgeon fishery bans, habitat degradation), and monitoring of migrating sturgeons is just in the beginning. Therefore, in view of limited experience, the design, construction and implementation of fish passages for sturgeons will be very difficult and demanding.
The first steps for the necessary feasibility study were done by a FAO-Mission in 2011 and a Pilot Study performed by a Dutch Consortium during 2013/14. The respective reports will be outlined by Wilco De Bruijne in the sister presentation of this special session introduction. The political background has been prepared by the International Commission for the Protection of the Danube River (ICPDR, Danube River Basin Management Plan), and the Danube Sturgeon Task Force (DSTF) is coordinating sturgeon activities in the frame of the EU Strategy for the Danube Region (Strategy/Program "Sturgeon 2020").
This special session, in particular, the Round Table discussion, is aimed at gathering state-of-the-art knowledge on sturgeon behavior related to crossing fish passes (upstream and downstream).

Wilco de Bruijne
Fish migration at the Iron Gate Dams

In the Danube river basin in Romania, 119 priority fish migration barriers were indicated. In the Danube river basin as a whole, the amount of indicated priority barriers reaches 400 – 500 barriers. The Iron Gate dams were prioritized in the ICPDR Danube river basin management plan as 'utmost priority'.
In 2011, in an assignment for Romania and Serbia (and encouraged by the ICPDR), the FAO conducted a scoping mission to explore general fish migration solutions at the Iron Gates I and II dams. The main conclusion was: provision for migration routes at the Iron Gates dams is technically feasible. Furthermore, the report stated that following steps will have to include the gathering of detailed input from already existing data and from new monitoring activities. The most critical issue will be the choice of the right location of an upstream fish passage entrance: a specific telemetry study on sturgeon is absolutely needed to decide on the location.
In 2012 a consortium of Dutch companies and a Romanian research institute (DDNI) started a project subsequent to the FOA scoping mission under the flag of the Dutch partners for water program. The project consisted of a field visit, data collection and analysis (a.o. dam structure, bathymetry, hydrology, ecology), predesign of the most feasible fish migration solutions, cost estimate, stakeholder meeting, international expert meeting and a sturgeon telemetry study (performed by DDNI). Furthermore a roadmap for following steps was made including a planning.
This presentation will focus on the main outcomes of the FOA scoping mission and subsequent 'Partners for water' project, the project process, key questions and following steps on the roadmap.

Dmitrii S. Pavlov, Victor N. Mikheev, Mikhail A. Skorobogatov
What should we know about behavior of sturgeons to provide their efficient passage?

To provide passage of migrating sturgeons through dams, we have, first of all, to monitor and control their behavior in the water flow. To achieve this, we have to know following behavioral and

ecological traits such as: rheoreaction, threshold and critical swimming velocity, swimming endurance, behavior in the flow velocity gradient, diel and seasonal patterns of spawning migrations, and vertical and horizontal distribution of migrating sturgeons. Such information is needed to determine optimum flow velocities attracting fish to the entrance of a fish pass (FP), FP operation regime, duration of attraction of migrants, location of the entrance to FP downstream the dam, and conditions at the fish release site upstream the dam. Since 1955 to 2005, 16 FP, to enhance fish spawning migration, were built at 11 large dams in the basins of rivers Volga, Don, and Kuban. One of the main functions of the FP was to facilitate spawning migration of sturgeons - *Huso huso, Acipenser gueldenstaedti, A. stellatus*, and *A. ruthenus*. Several types of FP were built: hydraulic (1 FP) and mechanic (2) fish lifts; fish locks (10), natural (spawning) bypass channels (2), and experimental floating FP (1). Most of them were efficient. Efficiency of some FP was as high as 67% (of the number of approached fish; river Don – Kochetovskii powerplant). The number of sturgeons that passed through the Volgogradskaya dam (river Volga) reached 60000 ind. per year (1967); 2050 ind. (Kochetovskaya dam, 1975); 2130 ind. through the Fedorovskaya dam (river Kuban, 1987). In the 1990s, the number of sturgeons in the Russian rivers decreased dramatically, mainly due to heavy poaching. This resulted in an abrupt decrease of the number of passed fish. In consequence, operation of some FP was suspended.

Michael Parsley
Salmon fishways in the Columbia River Basin and their use by white sturgeon

The Columbia River Basin is the most dammed river system in North America. Home to 5 species of anadromous Pacific salmon, the nine mainstem dams on the Columbia River and four on the Snake River were constructed with fishways to enable salmon to return upstream to natal spawning areas. Most of these dams were constructed with two fishways; one adjacent to each riverbank. The fishways have overflow weirs with submerged orifices and some vertical slot structures. Fish lifts constructed at Bonneville Dam in the 1940s were used to pass white sturgeon upstream but their use was discontinued in the 1950s because the lifts were ineffective for passing adult salmon. Fish counting stations were constructed in all fishways. White sturgeon, a resident migratory species native to the Columbia Basin, was not mandated to be counted until 2006 despite knowledge of their presence in fishways dating back to the 1940s. However, due to their charismatic appearance and relative scarcity in fishways, the people counting the fish voluntarily enumerated them and often estimated their size and noted direction of movement within the fishways. Daily passage of white sturgeon from 1998 through present are now available in digital format and I used the data to address specific questions regarding upstream passage by white sturgeon. Mean lengths and peak of timing of white sturgeon counted suggests that current upstream passage is not related to a spawning migration. Differences in white sturgeon lengths and differences in timing of counts between fishways at individual dams suggest that physical or hydraulic conditions influencing approach, attraction, entry, and ultimately passage differ among sites. These findings suggest that further study could provide information on ways to improve upstream passage of white sturgeon.

Boyd Kynard
Upstream Passage of Sturgeons at Dams: Behavior of Sturgeons at a fish lift and in a prototype ladder

Attraction of sturgeons to fishway entrances is poorly studied but observations on adult Shortnose Sturgeon, *Acipenser brevirostrum*, entering one of two fish lifts at Holyoke Dam, Connecticut River, MA, USA, indicate the benthic sturgeons need a bottom entrance with a submerged orifice if the water is deep. Sturgeons can pass upstream in nature-like or ramp fishways, or in technical

fishways, like fish lifts, but not so good in traditional fish ladders. Keys to passing sturgeons in fish lifts is 1) attracting fish to the entrance by induced currents, 2) operating the lift during the seasonal (and daily diel period) of migration, 3) cycling the crowder trap within the time period fish will remain at the barrier without departing, and 4) designing the appropriate lift hopper. Adults have a moderate swimming ability and can ascend fish ladders, but they ascend best when the fish ladder design enables them to continuously swim upstream. Unfortunately, most fish ladders (e.g., pool & weir, vertical slot) have cross walls that prevent sturgeons from continuously swimming upstream: an important aspect of their swimming style. Also, observations in an artificial ladder showed a series of ascents and descents before fish reached the top of the ladder. This suggests that any ladder for sturgeons should allow fish to descend without injury and loss of upstream ascent drive. Experiments with several species of sturgeons in a prototype side-baffle ladder allowed fish to swim continuously during ascent and did not harm them during descent. Fish moved freely up- and downstream like they might use a semi-natural channel. Plans are to install the prototype at a dam in 2015 or 2016 to field test the design.

Steve Amaral
Considerations and alternatives for safe downstream passage of juvenile and adult sturgeon at hydro projects

Fish passing downstream through hydro turbines may be subject to mortality rates between 5 and 30%, depending on species, fish size, and turbine design and operation. Juvenile and adult sturgeons may encounter multiple hydro projects during seasonal downstream movements and, consequently, some populations can be susceptible to potentially high rates of turbine passage and mortality. Although most downstream fish passage technologies have been evaluated with a wide variety of freshwater and diadromous fishes, relatively few studies have been conducted with sturgeon species. Turbine passage mortality typically is mitigated through the use of physical screening devices that reduce entrainment and guide fish to alternative downstream passage routes. Several lab and field studies have investigated guidance and exclusion of sturgeon exposed to various configurations of narrow-spaced bar racks and louvers, with effectiveness typically being dependent on bar spacing, structure angle to flow, and approach velocity. Bypass design and location are also important to passing sturgeon safely downstream. Laboratory data suggest bypass entrance velocities should be about 1.5 m/s or greater to effectively attract and pass sturgeon. For fish that pass through turbines, there is evidence that sturgeon may be less susceptible to injury and mortality than many teleost species. This is likely due to their tough integument, lack of scales, and cartilaginous skeleton, all of which probably contribute to lower rates of blade strike mortality. A review of recent studies examining downstream passage alternatives for sturgeon will be presented, as well as assessments of total project survival that account for passage route selection and associated mortality rates. With this information, the need for and feasibility of downstream passage facilities for sturgeon can be evaluated and used to develop appropriate mitigation measures.

Radu Suciu, Mirjana Lenhardt, Finn Økland, Iulian Nichersu, Dalia Onara, Stefan Hont, Marian Paraschiv, Daniela Holostenco, Cristian Trifanov, Marian Iani
Monitoring strategy of sturgeon behaviour to ensure functionality of future fish pass: the Iron Gate II case

A preliminary study on sturgeon behaviour funded by the Dutch Partners for Water Programme and the ICPDR (2014) has proven that beluga and stellate sturgeons still arrive at Iron Gate II dams (Danube R Km 862.8). This is in agreement with sturgeon migration studies in the Lower Danube

presented by Hont et al. in the FITFISH Workshop. High water current and the impossibility to access the Serbian reach of the Danube in the tailrace of Iron Gate II HEP (330 m wide) has prevented us from conducting triangulation with the mobile receiver to detect the sites where the beluga sturgeon male tended to congregate.

The preparatory project funded by the European Investment Bank Luxemburg (2014 - 2015) has adopted a monitoring strategy to achieve the required resolution to positioning the fish pass entrance(s). The strategy is based on four components: (i) detailed 3D bathymetry of the bottom of the river in the area of the tailrace in Romanian and Serbian territorial waters, (ii) water flow velocity profiles recorded at intervals of 100 m, (iii) combined acoustic and radio telemetry tests to identify river sites preferred by adult sturgeons arriving downstream of the dam, and (iv) integration of behavioural data with genetic analysis to distinguish the phylogeny of tagged sturgeons in relation to migration seasons and known population segments.

Telemetry tests at Iron Gate II dams will be conducted by teams from Romania and Serbia under the guidance of a Norwegian expert. Results of this preparatory project will be incorporated in the planning of a three year large-scale study of the behaviour of sturgeons and other migratory fish at the Iron Gate dams and reservoirs.