of floodplains are environmentally degraded (EEA 2021) and the fact that thousands of more dams are planned even in protected areas (Schwarz 2019), it is time to boost removal - especially of thousands of outdated or even obsolete dams.

Today it is common sense to keep our environment free of harmful waste. Abandoned dams are like waste as they harm rivers and reduce their ecosystem services. With that in mind, it should be taken for granted that dams are removed if they are not needed anymore. To do so, formal procedures have to be improved and technical and financial support must be made available.

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Danube Transnational Programme
MEASURES

Managing and restoring aquatic ecological corridors for migratory fish species in the Danube River Basin (MEASURES)

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Danube´s migratory fish species suffer from habitat change, continuum interruption and in some sections also from overfishing and poaching, respectively. All sturgeon species are particularly affected and solutions to save and restore their severely threatened or even extinct populations are urgently needed. Besides these ancient species, Danube shads and potamodromous fish are concerned, too. Transnational cooperation and national endeavors have reached important milestones such as temporary or permanent sturgeon fishing bans in most Danube countries except Slovenia, Croatia and some Austrian provinces, or the construction of fish migration aids in the Upper Danube. But still, many pressures remain.

The Interreg-funded project 'Managing and restoring aquatic Ecological corridors for migratory fish species in the Danube River Basin' (MEASURES) aimed to create ecological corridors by identifying key habitats and initiating protection measures along the Danube and its main tributaries. Sturgeons and other migratory fish species acted as flagship species in support of the project goals. MEASURES acknowledged that sturgeons and other migratory fish species represent a historical, economic and natural heritage of the Danube and are indicators of the ecological status of its watercourses, especially concerning the function of the river as an ecological corridor. Transnational management of these corridors and restoration actions, as well as restocking with indigenous species are essential.

Identification and mapping of key habitats of migratory fish species

MEASURES partners developed and tested joint methods to identify and map spawning, nursery, feeding, wintering and resting habitats of selected migratory species (Cokan et al. 2021). Diverse sources such as reports, field protocols or museum specimens were used to determine potential habitats. Further, maps, aerial and satellite images, bathymetry maps and field measurements were analyzed using ecological traits of species. The actual use of potential habitats was verified by scrutinizing the results of recent field surveys and sampling campaigns during the project. The

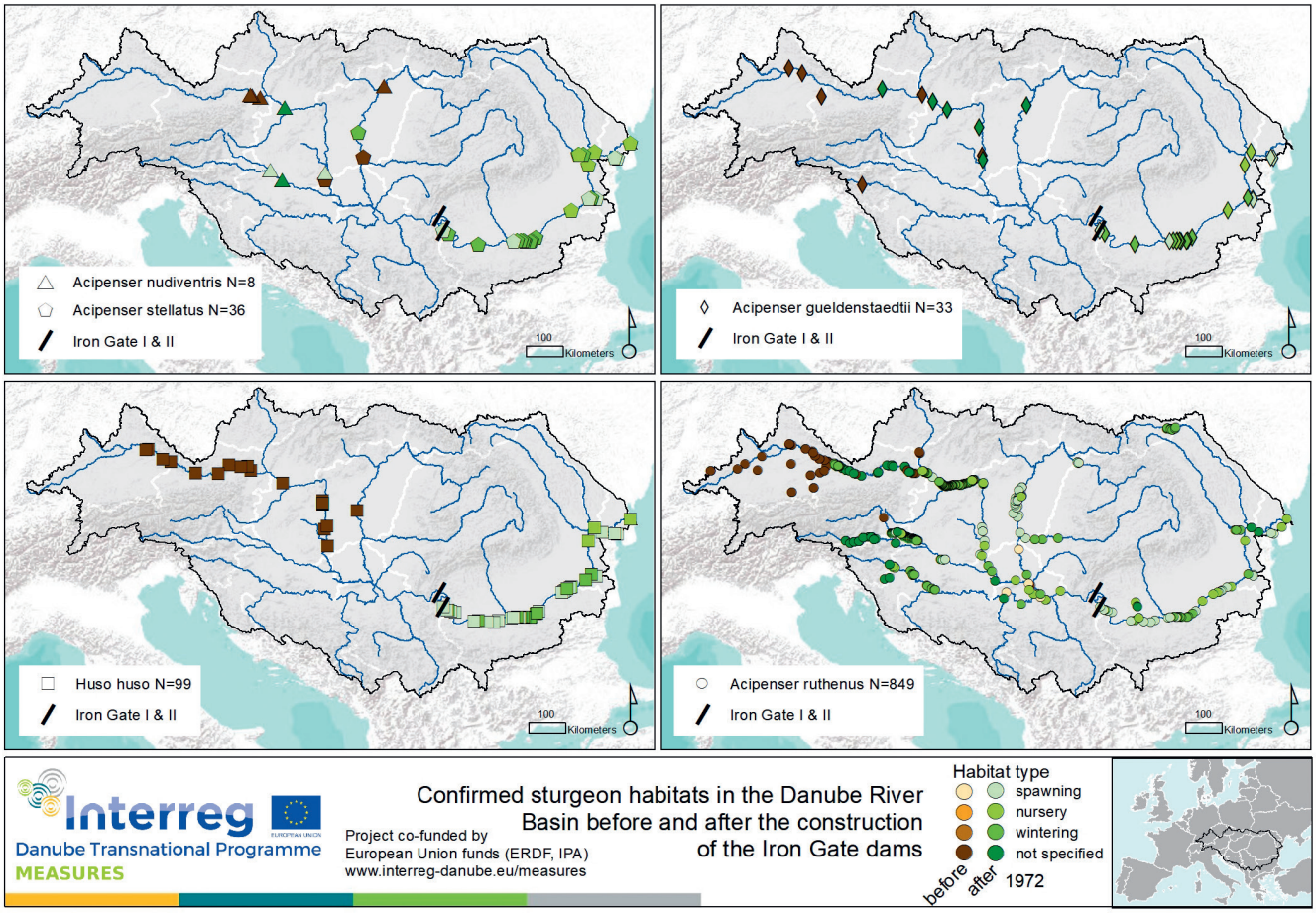

Figure 1: Confirmed sturgeon habitats in the Danube River Basin before and after the construction of the Iron Gate dams

latter included different types of sampling gears as well as tagging. For the 16 migratory fish species considered, about 2200 locations in the Danube and selected tributaries were identified as potential habitats and recorded in a migratory fish database. Roughly 50% of these habitats could have been confirmed as actually used.

A focus was on the Danube sturgeon species, namely on the critically endangered Beluga Sturgeon *(Huso huso),* the Stellate Sturgeon *(Acipenser stellatus),* the functionally extinct Russian Sturgeon *(A. gueldenstaedtii),* the Ship Sturgeon *(A. nudiventris),* which is considered extinct in the Danube and the Sterlet *(A. ruthenus).*

Conservation stocking of two native sturgeon species

Because of the critical situation of the Danube sturgeon species genetic analysis and ex-situ measures are instantly needed to conserve their genetic pools and to strengthen or restore their populations in the wild. During MEASURES, eDNA-markers for monitoring purposes were identified for Sterlet and Ship Sturgeon and tested at selected Danube sites. No proof of ship sturgeon was possible, but the presence of stellate sturgeon, for which an eDNA marker was already available, and sterlet could be documented based on eDNA sampling of the whole Danube River during the fourth Joint Danube Survey in 2019. Further, brood-stocks of the Russian Sturgeon and the Sterlet were collected for scientific hatcheries in Hungary and Austria (NAIK-HAKI 2020). Such ex-situ gene stocks keep viable sturgeon populations under safe and controlled conditions over longer periods. Broodfish are frequently propagated for continuous releases of genetically suitable juveniles that are fit for survival in the wild to strengthen the remaining wild sturgeon populations or for reintroduction into formerly inhabited parts of the system as potential habitats were identified during the project.

Figure 2: Release of young Sterlet in the Hungarian Danube near Ercsi in 2019 (Photo: MATE 2019)

In 2019 and 2020, 6,500 Sterlet juveniles were released in the Hungarian Danube and 24,000 Sterlet fry was released in tributaries. In the same years release of 2,500 juvenile Russian Sturgeons took place in the Romanian Danube. Juvenile fish were individually tagged. Some weeks after, 26 tagged Sterlets were caught downstream in Serbia, which proofs the rapid spread of restocked fish. Also tagged Russian Sturgeons were reported in the Chilia branch in October 2020 (Mozsár et al. 2021).

The MEASURES Information System (MIS)

During MEASURES a free online information tool was developed (http://85.204.145.162/measures/metadata/). The MEASURES Information System (MIS) provides scientists, decision makers and the general public with information about ecological corridors and the connectivity of habitats for long and medium-distance migratory fish of the Danube River Basin. The MIS is an interactive website integrating original data, published papers and grey literature stemming from all Danube bordering states. Its goal is to enhance capacity at national and transnational level through collecting basic information that helps integrating water management and nature conservation by strengthening the conservation of migratory fish and improving ecological corridors. The MIS can be searched using thematic keywords related e.g. to specific locations, data and publication types, media content or for resources in particular languages.

As of July 2021, when the project ended, the MIS metadatabase contained 747 different datasets, out of which 561 were defined as publicly available, 163 as available to MEASURES partners and stakeholders and 23 are marked as for MEASURES partners only due to specific access rules of data owners (Schmidt-Kloiber 2021).

Stakeholder integration and networking for migratory fish

Integrating stakeholders to achieve a shared understanding of the project tasks and results and to ensure support for the implementation of proposed measures at the national and basin level was a core interest of the MEASURES project. Based on a 'stakeholder strategy' developed by MEASURES partners at the beginning of the project, stakeholders from nature protection, conservation and restoration, river management and flood protection, fishery, hydropower, navigation and agriculture were invited to three rounds of national workshops organized in all eight partner countries during the project. These groups form a pool of potential members for future local migratory fish networks, which shall play a key role in the implementation of the measures proposed in the MEASURES strategy (Scherhaufer & Haidvogl 2021).

Figure 3: During the MEASURES project three rounds of national stakeholder workshops were organized in all partner countries. The picture above was taken during the 2nd Austrian workshop (Photo: B. Grüner)

Developing a harmonized strategy

A major output of the MEASURES project is the 'Strategy for ecological corridor conservation and restoration in the Danube catchment', which proposes measures to secure the Danube and its tributaries and relevant areas of the Danube Delta and Black Sea as an ecological corridor for migratory fish and to ensure conditions for stable or growing populations. Thus, the measures address physical connectivity, habitat availability and viable populations via eight general types of measures, which consist of specific activities and priorities. Three of the Types of Measures (ToM) directly address the management of the Danube River and its tributaries as an ecological corridor: (1) Assessing, mitigating or eliminating the negative effects of migration barriers; (2) Protection and restoration of migratory fish habitats; (3) Green infrastructure for flood management and nature-based solutions for navigation. The fourth ToM strives to secure and support viable populations of migratory fish and ToM 5 aims to improve and harmonize the monitoring of habitats and fish populations. Three ToMs are of organisational and supportive nature: developing National Activity Plans for Migratory Fish Species; creating, establishing and facilitating 'Local Migratory Fish Networks' and improving public participation and support for local migratory fish networks (Haidvogl et al. 2021).

Project facts

The MEASURES project lasted from June 2018 to July 2021 and was funded by the Danube Transnational Programme. The consortium consisted of twelve partner institutions from Austria, Bulgaria, Croatia, Hungary, Serbia, Romania, Slovakia and Slovenia. Several national and international institutions and organizations supported the project as associated partners, among others the International Commission for the Protection of the Danube River and the World Fish Migration Foundation. Further project

details and publicly available outputs can be found on the project webpage https://www.interreg-danube.eu/approved-projects/measures.

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Lake Neusiedl and Seewinkel: a hotspot area of long-term ecological research in the Danube River Basin

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Abstract:

The Lake Neusiedl area near Vienna (Austria) has been of scientific interest for a long time. Based on the number of publications, research activity on terrestrial and aquatic ecosystems increased from 1960-1990 and declined thereafter. More interesting is the long-term change in research topics, which reflects the state of science and the impact of human activities, such as agriculture and tourism, on the one hand, and the growing awareness of wetland conservation on the other. During an early epoch, at the time of the last drying up of the lake (1865-1868), faunistic and floristic lists of species around Lake Neusiedl and its soda pans were common. The research focus shifted from 1930-1959 to biocoenological studies of flora and fauna, from 1960-1989 to species conservation issues and from 1990-2020 to themes of habitat conservation. From 2008 onwards, the research emphasis lies on ecosystem services and on the overwhelming impact of global warming.

Figure 1. Soda pan, National Park, 2015 (photo: Katrin Teubner)

Results and Discussion: Ecological research perspectives from 1860 to 2020:

The steppe lake Neusiedl is surrounded by soda pans ('Salzlacken', *fig. 1, 2)* and builds up a wetland impacted by remarkable water level fluctuations (Dinka et al., 2004). Its location near Vienna, the capital of Austria, has already attracted much attention, at least for scientific investigations during two centuries until now. A compilation of plant species from botanical surveys by more than 30 botanists for the Neusiedler See area was published as a species list (page 470 ff 'Pflanzen-Aufzählung', of about 950 plant species) by Szontagh (1864). This publication, however, goes beyond a botanical work and describes the geology and the salt composition of soils of the soda lake area, and thus documents a high level of interest at early times. It was published when the shallow Lake Neusiedl began to dry up. The last complete desiccation of the lake, which had no outflow at all that time, occurred from 1865 to 1868 (Herzig 2014, Tolotti et al. 2021). In the following the Hanság- or Einser-Channel was built between 1909 and 1911, connecting the lake to the Danube River. It was aimed to drain the water body for using the lake area for agriculture, which however has never been achieved. Today the lock in the channel is used to regulate the water level of the lake, to ensure mainly that water level will satisfy tourism activities such as e.g., boating and swimming.

The number of publications shown in figure 3 includes articles in journals, books, university theses and published scientific reports in the Neusiedler See area and refers to the literature database 'Literature Vogelwarte 2' (Lazowski 2020, available at: http://biologische-station.bgld.gv.at/portfolio/interreg-projekt-vogelwarte-ii-2016-bis-2021/)