Progress Report on the Implementation of the Master Plan Migratory Fish in the Rhine Bordering States 2010-2012

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Summary

The "Master Plan Migratory Fish Rhine" (ICPR report no. 179, www.iksr.org) indicates how self-sustaining, stable populations of migratory fish can again be settled in the Rhine catchment within reasonable time and at reasonable costs. The salmon serves as symbol representing many other migratory fish species (such as sea trout, sea lamprey, allice shad, and eel). Furthermore, measures aimed at reintroducing migratory fish have positive effects on the incidence of many more fauna and flora species and are suitable for improving the entire ecology of the Rhine. This considerably supports the main objective of the European Water Framework Directive (EU-WFD) to achieve a "good status" or a "good potential" of water bodies.

This reports summarizes the implementation progress of the "Master Plan Migratory Fish" during 2010 to 2012.

Between 1990 and end 2012, more than 6,900 adult salmon were counted returning from the North Sea to their spawning waters in the Rhine tributaries.

Figure 4 (see Table in Annex 4) documents the returning salmon per section of the Rhine with its relevant tributaries. Most salmon were counted in the R. Sieg system at the counting station in Buisdorf/Sieg and at Iffezheim and Gambsheim on the Upper Rhine. The other numbers were determined during random electro fishing campaigns, result from telemetry studies or from random observations so that the real number of returnees is estimated to be considerably higher.

A sustainable constitution of a self-sustaining salmon population which, on the long term, will not require any stocking measures presupposes a **natural salmon reproduction**. In almost all waters, in which salmon spawning grounds are accessible, such natural reproduction has been detected: On the Lower Rhine above all in the tributaries to R. Sieg: Agger, Nister, Naafbach and Wisserbach; along the Middle Rhine in the rivers Ahr, Saynbach-Brexbach, Nette and Wisper; along the Upper Rhine in R. Wieslauter, Lauter, Alb, Kinzig, Murg, Bruche, Moder and Upper Ill (see Annex 3 and corresponding map). A further **improvement of habitat quality** is aimed at further supporting natural reproduction of migratory fish in the programme waters.

Following the continuous detection of natural spawning in some tributaries of the R. Sieg system, there will, in the near future, not be any artificial stocking exercise in one model river (e.g. R. Agger, Naafbach), so as to observe the natural development of a self-sustaining salmon population not depending on stocking.

Due to the **restoration of river continuity** in the programme waters for migratory fish, more and more habitats become accessible for fish ready to spawn returning from the sea. Based on mappings, the potential of suitable spawning habitats for salmon and sea trout in the programme waters designated so far in the Rhine catchment is estimated to well 1,000 ha. The accessible habitat surface has been increased from 216.3 ha (2008) to 256,3 ha (2011) amounting to 20 % (2008) resp. 25 % (2012) of the potential habitat surface.

In the meantime, many of the planned measures listed in the annex to the "Master Plan" have been implemented. By 2005, the continuity at 126 transverse structures in the Rhine and its upstream tributaries had been restored for fish; by the end of 2012, their number had increased to 481. An important access to the river systems of the Rhine and the Meuse, the Haringvliet sluices, will be opened for migratory fish in 2018, once vast compensatory measures will have been implemented ("de Kier" project). The preparatory work for the construction of a fish passage at the Strasbourg barrage has been accomplished and it is expected that the new fish passage will start operating by mid-2015. The preparatory work for the fish passage at the Gerstheim barrage in the Rhine has been accomplished, it is expected to be put into service in 2016. Within the new license for the Kembs hydroelectric plant on the Rhine, the new, higher residual flow is now flowing into the o ld Rhine / residual Rhine as planned. River continuity has been or

is being considerably improved at several hydroelectric plants on the Rhine between Basel and the mouth of R. Aare. Important measures have equally been implemented in the following tributaries: Lower Rhine tributaries Wupper, Dhünn, Sieg and Agger; Middle Rhine tributaries Moselle (Koblenz) and its tributary R. Sure; R. Main (Kostheim); Upper Rhine tributaries Kinzig, Alb, Murg and the Bruche, a tributary to R. Ill; High Rhine tributary R. Biber.

Hydroelectric plants in the programme waters pose a problem for the **downstream run** of juvenile salmon into the North Sea and the Atlantic Ocean. In general, turbines cause varying mortality rates of juvenile salmon due to severe injuries or instant death. Thus, injuries caused to fish on their downstream run in the turbines may in particular endanger the stock of migratory fish populations.

Annex 2 shows the waters in the Rhine catchment, where **stocking measures** were implemented and which salmon strain was used at what stage. In 2010 and 2011 respectively, more than one million, in 2012 more than two million fry (Atlantic salmon, to a lesser degree sea trout) were released into the programme waters and were partly marked. Depending on the spawning habitat concerned, eggs, different stages of salmon spawn or smolt ready for their downstream run were released. The map in Annex 5 illustrates the coordinating unities of the salmon programme, the hatcheries for the stocking measures and the monitoring and catching stations. Apart from the imported strains form the R. Ätran (Sweden) and Allier (France), increasingly, fish returning into the Rhine and the different stocking rivers are used to constitute a stock and their progeny is then used for further stocking. These salmon are better adapted to the river system than imported stocking material and thus present a higher survival rate.

If the problem of **by-catches and illegal catches** of salmonids could be solved, it would be possible to increase the rate of returnees. In the entire Rhine catchment and in the Dutch coastal area, there is a legal ban on catching salmon and sea trout. Additionally, in the Netherlands, since 1st April 2011, there is a (3 year) ban on professional fishing for eel with fyke-nets and drag nets in the major part of the catchment of big rivers and in several big navigation channels corresponding to the most important migration routes of salmonids. Skilled persons have been required to punish infringements in the Netherlands, in North Rhine Westphalia, in Rhineland Palatinate, in Hesse and in Luxembourg. However, these controls did not result in any precise information on intentional illegal salmon fishing. The information on migratory fish for sportsfishers and other target groups has been reinforced and flyers with corresponding information are being distributed.

In 2010, two protected fish zones were established at the outlets of the rivers Sieg and Wupper, including among others a general ban on fishing during the main upstream salmon run from 1st September until 31st December. There is a general ban on fishing at the Gambsheim barrage which is here and there being controlled by the police.

Predation due to predatory fish and birds feeding on fish may constitute a limiting factor for smolt on their downstream run (among others in the Rhine delta). This makes it even more important to allow rapid downstream migration around transverse structures. For different smaller rivers, first experience is available on the downstream river continuity at hydroelectric plants, but downstream migration remains at challenge, as far as big hydroelectric plants are concerned. In Switzerland, a research programme is going on aimed at improving downstream migration for fish at big hydroelectric plants.

For the Alpine Rhine and Lake Constance, the **Lake Constance lake trout** is to be considered as indicator species for migratory fish. After 3 years of continuous growth of the number of lake trout catches in Lake Constance, professional fishermen and anglers registered a marked decline in 2010; the number of catches was below the mean value for 10 years. This negative trend is not confirmed by the registration of the number of sea trout migrating up the fish ladder under continuous video surveillance at the Reichenau power plant in the Alpine Rhine. The 992 lake trout registered in 2010, 625 in 2011 and 1253 in 2012 document comparable results to those of previous years.

Compared to previous years, catches of broodstock in other waters do not indicate any decline. Figures 5 and 6 show the most important characteristic values concerning the lake trout fishery in Lake Constance and the Alpine Rhine during 2010 to 2012.

Between 2008 and 2012, about 7.9 million allice shad (Alosa alosa) larvae were brood in France, marked with Oxytetrazylin and stocked in the Hessian and North Rhine Westphalian section of the Rhine within the LIFE project, since 2011 the Life+ project for the reintroduction of the allice shad, a formerly frequently occurring herring species, into the Rhine. In the autumn of 2010 and 2011, all in all 31 juvenile allice shad were detected in the Lower Rhine. This proves that juvenile allice shad can develop in the Rhine and migrate downstream towards the estuary in the autumn. The constitution of a potentially self-sustaining brood stock presupposes continued stocking for at least 15 years. Financially, continued stocking of 1.5 to 2 million allice shad annually is secured until 2015 within the Life+ follow-up project. Investigations into habitat requirements, food and growth of juvenile allice shad and into the ideal design of fish passages are supposed to result in insights into the hitherto largely unknown allice shad ecology. In Germany and France, pilot installations for maintaining a broodstock have been put into service in order to make research on the possibilities of producing stocking material for reintroduction and species protection projects.

The **houting** is considered to be a migratory fish species which has been successfully restored in the Rhine and for which no further stocking measures are required. Since 1996, juvenile houting have systematically been stocked in the Lower Rhine. From 1999 on, more than 100.000 individuals were annually stocked and finally amounted to 2.3 juvenile houting by 2006.
In the meantime, a vigorous and self-sustaining population has established in the Rhine.

Just as the Atlantic salmon, the **sea lamprey** (Petrozymon marinus) is an anadromous migratory fish spawning in freshwater and profiting from the hydro-morphological measures implemented for salmon, in particular the restoration of river continuity. For many years, there has been natural reproduction of sea lamprey in the R. Bruche downstream of Avolsheim as well as in the R. Lauter, Ill and Moder. This is presumably also true of the gravel banks downstream the Iffezheim barrage. Since the fish passage at the Iffezheim barrage was put into operation, more than 1,300 sea lamprey have been registered on their upstream run. In 2010, during a fish monitoring operation at the water intake for the Philippsburg power plant, several thousands of downstream migrating sea lamprey were counted within few hours. Natural reproduction is also reported from the tributaries Alb, Murg, Kinzig on the right bank of the Rhine as well as from the R. Sieg system on the Lower Rhine. Mortality of sea lamprey due to fishing is considered to be low.

In the Rhine catchment, the **European sturgeon** (Acipenser sturio) died out in the 1940s / 1950s. Projects aimed at its restoration have started in different catchments, among others in that of R. Elbe. The sturgeon used belong to the last reproductive sturgeon population in Europe in the Gironde-Garonne-Dordogne system in France. In Germany, the habitat quality of the Lower Rhine has been checked as potential target water for sturgeon. In May 2012, associations in the Netherlands equipped about 50 juvenile sturgeon with transponders and released them into the R. Waal near Nijmwegen and upstream of Rotterdam.

In line with the EU regulation no. 1100/2007 the EU states in the Rhine catchment with natural stocks of eel have drafted national plans for the management of the endangered **stocks of eel**. In the Netherlands, in Germany and France, different models aimed at calculating the rate of downstream migration into the sea required by the regulation amounting to at least 40 % of the biomass of silver eel compared to the natural stock have been developed. According to estimates made for Luxembourg, a downstream migration rate of 90 % has been achieved for 8 years. However, on their further migration downstream into the sea (passing by the Moselle and the Rhine), the further losses among these eels are unknown. Long standing data on the occurrence of glass eel on the Dutch coast reveal a dramatic decline. Almost everywhere, commercial catches

and sportsangling have been limited by fish protection periods (between September and November and all year), minimum fish size (50 cm) and/or a ban on professional fishing gear. Due to an excess of dioxin contents and contents of PCB similar to dioxins, eel catches have been completely prohibited in the catchments of big rivers in the Netherlands and have almost completely stopped in Germany. Due to their PCB and mercury content, a ban on selling and eating eel from the Rhine, the Grand Canal d'Alsace, the Ill and its tributaries has been issued. In the Netherlands and in Germany (except for the High Rhine) different state organisms, professional fishermen and fishing associations carry through stocking measures. Many eel protection measures are partly carried out at transverse structures (in all Rhine bordering countries) and pumping stations (Netherlands) until 2015, partly until 2027. Fish passes are being built, (fine) grids are installed in order to protect downstream migrating eels and during the main eel run, the turbine management is adapted with a view to protecting eels. Priorities were set for certain waters particularly suitable for eel. There is research on fish-friendly turbine management, on the main migration period and on readiness for downstream migration of eels, on infrasound barriers and reporting systems, on mortality and migration behaviour of eel at hydroelectric plants and on artificial eel breeding. On the Moselle and Sure, in the Main and the Neckar eel protection measures including catching and transporting are implemented.
Examinations of eels in the states of the Rhine catchment carried out in 2000/2011 sometimes resulted in a considerable contamination of the fish with dioxins, furanes, dioxin-like PCBs, fluorosurfactants (PFT), in particular perfluorooctane sulfonate (PFOS), occasionally also with indicator-PCB, hexachlorobenzene (HCB) and mercury. Since the 1970s, a considerable reduction of the HCB contamination of yellow eel could be stated in the Delta Rhine. In the 1st river basin management plan according to the WFD for the international river basin district Rhine the states committed themselves to restore heavily contaminated river sediments as far as possible (Overall sediment management strategy). At the time being, discussions on possible sources of contamination with PCB and other pollutants and on national remedial measures are going on. Furthermore, a note of the International Commissions for the Protection of the Moselle and the Sarre on the contamination of fish with PCB is available (http://www.iksms-cipms.de, "publications").

During the past years, all Rhine bordering countries have made considerable efforts - partly within the implementation of the WFD - to improve the living conditions for migratory fish in the catchment. The target course set out in the "Master Plan Migratory Fish Rhine" in 2009 is thus being followed. The next major challenges will be to restore river continuity at the remaining transverse structures in the main stream of the Rhine and in those tributaries presenting the greatest habitat potential for migratory fish. Furthermore, fish stocking is an important element of the sustainable constitution of stocks of migratory fish and should be continued on a longer term and be reinforced in certain waters where colonization was previously not possible. The effects of climate change on the living conditions of migratory fish should be observed. Also, the required close linking of the implementation of measures in freshwater (according to WFD) and in the marine environment (according to the Marine Strategy Framework Directive - MSFD) in order to enhance natural life-cycles and habitats for migratory fish must be pointed out.

Introduction

The "**Master Plan Migratory Fish Rhine**" (ICPR report no. 179, www.iksr.org) indicates how self-sustaining, stable populations of migratory fish can again be settled in the Rhine catchment as far as the Basel area within reasonable time and at reasonable costs. As a symbol, the salmon represents many other migratory fish species, such as sea trout, sea lamprey and allice shad, while the lake trout is to be considered as indicator species for the Alpine Rhine and Lake Constance. Furthermore, measures aimed at reintroducing

salmon and sea trout have positive effects on the incidence of many more animal and plant species and are suitable for improving the entire ecology of the Rhine. This considerably supports the main objective of the European Water Framework Directive (EU-WFD) to achieve a "good status" resp. a "good ecological potential" of water bodies.

Additionally, and in line with the EU regulation no. 1100/2007, the EU states in the Rhine catchment with natural stocks of eel have drafted national plans for the management of the endangered **stocks of eel**. The state of implementation is given in chapter 2.7.

This reports summarizes the implementation progress of the "Master Plan Migratory Fish" in 2010 and 2012 on a national level. The report is divided into the 3 main fields of action of the programme for migratory fish:

1. Optimization of river continuity for migratory fish; restore accessibility to and improve the quality of spawning grounds and juvenile habitats;
2. Optimize the constitution of stocks of endangered migratory fish species; this includes:
   - stocking measures including maintaining a brood stock in hatcheries and fish farming;
   - monitoring of natural reproduction and of downstream runs into the sea;
   - counting of migratory fish returning from the sea (inventory of the rate of "returnees");

   Measures aimed at constituting a stock of the Lake Constance lake trout, allice shad, houting and eel are treated in separate chapters;
3. Reduction of by-catches and illegal catches as well as predation.

Additionally, chapter 4 includes activities concerning the information of the public and environmental education.

The chapters are split into sub-reports from the coordination units based on technical criteria determined within the ICPR in 2004 (see map in Annex 5):

(1) Coordination unit Lower Rhine / Delta Rhine: Netherlands, DE-North Rhine Westphalia;

(2) Coordination unit Middle Rhine / Moselle / Northern Upper Rhine: DE-Rhineland-Palatinate, DE-Hesse, DE-Bavaria, Luxembourg, France;

(3) Coordination unit Southern Upper Rhine, High Rhine: DE-Baden-Württemberg, France, Switzerland.

1. Restoration of river continuity and improving spawning and juvenile habitats

The restoration of river continuity is of particular importance for the reintroduction of migratory fish in the Rhine system and the migration of anadromous fish from the North Sea towards the spawning and juvenile habitats in the Rhine and its tributaries. Several transverse structures will have to be altered in order to improve upstream migration of sexually mature adult fish and downstream migration of juvenile fish towards the sea. During 2000 to end 2012, river continuity has been improved at 481 dams in the programme waters. Further measures are required for the catadromous eel (see chapter 2.9).

Figure 1 is a survey of implemented and on-going measures aimed at restoring river continuity in the Rhine catchment. The table in Annex 1 gives further information.

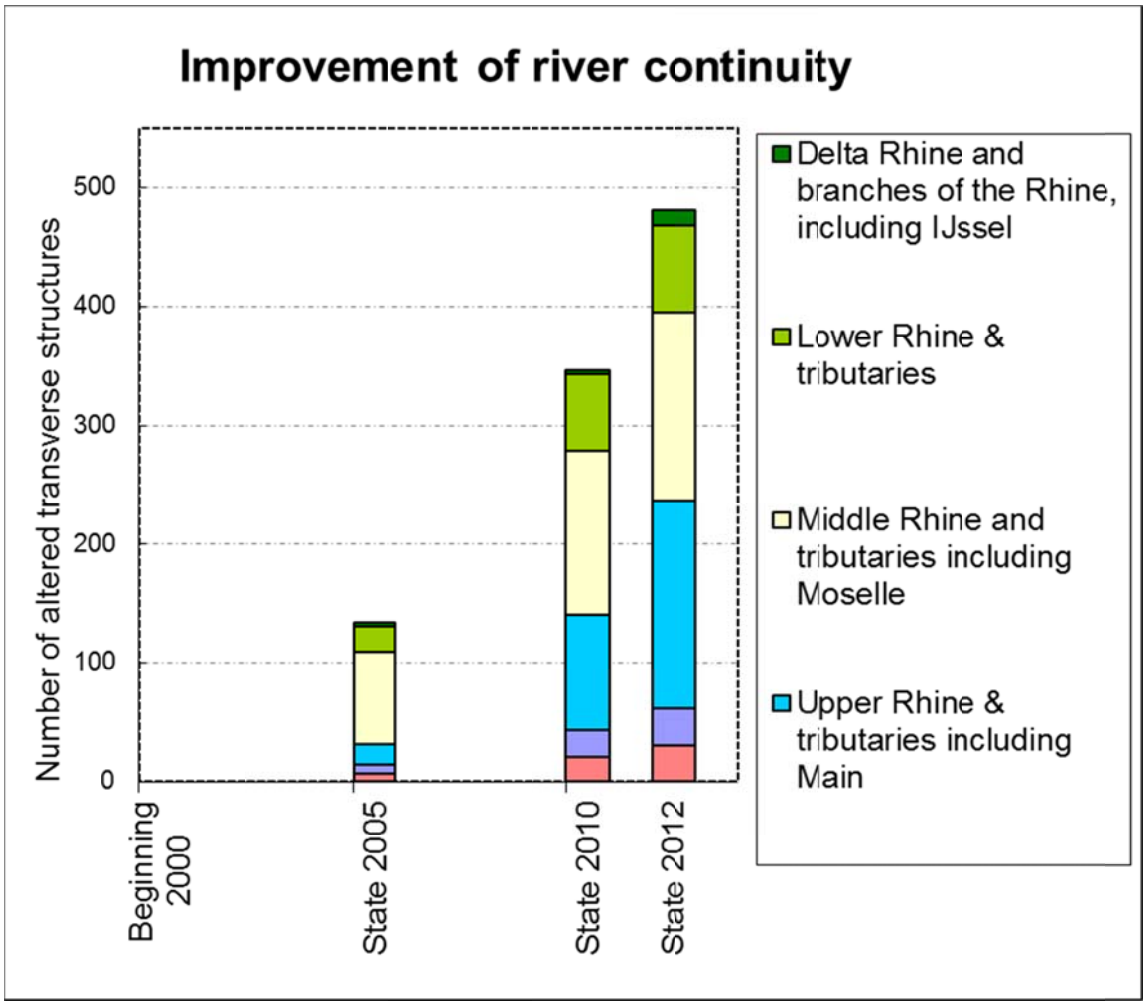


Figure 1: Measures aimed at improved river continuity of the Rhine and its tributaries, in particular of programme waters for migratory fish. State of data: June 2013

1.1 Lower Rhine / Delta Rhine

Delta Rhine, Netherlands

The resolution to partly open the Haringvliet sluices ("de Kier") which the Dutch government had temporarily reversed in 2010 was reconfirmed in July 2011. However, the fish channels which after closer examination proved to be little effective, will be closed. The implementation including the vast accompanying measures is planned for the period until 2017. Thus, "de Kier" should be functioning by 2018.

Lower Rhine, DE-North Rhine Westphalia and DE Rhineland-Palatinate

At the lowermost hydroelectric power plant on the R. Sieg at Unkelmühle/Eitorf, a "Pilot fish protection installation on R. Sieg in NRW" is presently under construction. This is a joint project of the Land and the energy supply company RWE Innogy. The installation of 3 fine screens (10 mm and inflow velocity ≤ 0,5 m/s) with varying design of bars and of bypasses (surface-near flume, 3 eel pipes and bottom gallery) is designed to enable successful downstream migration of diadromous migratory fish. The upstream river continuity can be considerably improved by changing the existing Denil fish passage into a vertical slot pass. At this installation, comprehensive biological monitoring during a three year period is under preparation.

On the Middle Sieg at Wissen (Rhineland-Palatinate) the destruction of the old dam Hoeschwehr began in September 2012. Parts of the dam are being dismantled and will be replaced by rock ramps.

In February 2009, the work at the hydroelectric power plant Sigambria (Kirchen) was accomplished; the up- and downstream fishways are in service. At the hydroelectric power plant Freusburger Mühle (upper weir) a bypass and a downstream fishway are under construction on the right bank

The fish lift existing at the hydroelectric power plan Euteneun is apparently not operating. In order to avoid delays due to an eventual litigation there will not be any constructional modifications before the water rights expire in 2015.

The fish passage at the hydroelectric power plant Scheuerfeld was restored in 2008, but it is still not easily found. The energy supply company RWE is planning a new construction in 2013.

The dismantling of the impoundment at the former weir Frackenpohl (Sieg catchment, NRW) in the R. Naafbach near Lohmar-Kreuznaaf has been accomplished. The Aggerverbrand has completely removed the dam from the river, so that returning salmon can today spawn on more than 10 additional river kilometres. Recent surveys of natural reproduction show that salmon have immediately accepted this and have spawned in many suitable locations upstream the former weir.

The last migration barrier in R. Dhünn (Wupper catchment) before the impoundment Große Dhünntalsperre has been removed. Since the regional administration in Cologne ended the old water rights on hydro power exploitation at the Freudenthaler Sensenhammer in Leverkusen-Schlehbusch and the Wupperverband changed the bed of the watercourse around the remaining weir, river continuity has been completely restored in this location. Thus, apart from in the Saynbach, river continuity has been restored in the entire section of another salmon spawning river colonizable by salmon, the Dhünn.

A new fish passage combined with a new type of fish protection installation (13 mm horizontal screen) has been built at the Auerkotten on the R. Wupper. Its functionality is presently being monitored. Further upstream, at Beyenburg on the R. Wupper, one of the biggest fish passages in North Rhine Westphalia will be put into service in 2013.

1.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

Since the last barrier was redesigned in 2009, the R. Saynbach is the first salmon water - apart from R. Dhünn - without any migration barriers which is entirely accessible to salmon.

The new technical fish passage in Koblenz (vertical slot) with 3 entries (one of which with a connection with the river bottom), a monitoring station (capturing basin & VAKI-fish counting system), a farming possibility and a visitors' centre ("Mosellum", see 4.) has been in operation since September 2011. Upstream fish movement has been designed for salmon and allice shad migrating upstream in swarms. The construction of a fish passage at the upstream barrage Lehmen would open the access to R. Elzbach, the lowermost spawning river for salmon in the Moselle river system. The corresponding preliminary design has just begun.

The functionality of the fishways for up- and downstream fish movement at the hydroelectric plant Kostheim on R. Main was checked between March 2011 and April 2012. Monitoring concerned: the functioning of the bypass river, mortality due to turbines, and use of downstream migration corridors, of the bypass, the eel bypass and downstream salmon run. Results show that vast improvement measures are required to optimize the functionality, as injuries due to the cleaning of the screens and when passing by the screens (loss of scales, haematoma) and injuries in turbines lead to a total mortality of about 50 %. If the new fish pass planned for Eddersheim/Main by 2015 is actually constructed, the lowermost salmon spawning water in the R. Main system, the R. Schwarzbach and the R. Nidda will be accessible as project waters for sea trout. Furthermore, by the end of 2012 and 2013, the authorizations under the Water Act for the hydroelectric plants at the Hessian barrages Offenbach and Mühlheim will end so that upstream fish movement, fish protection and downstream fish movement must here be granted in the near future. Presently, the plans of a hydroelectric plant at the uppermost dam in Hesse (Großkotzenburg) are being conceived.

In 2012, the suitability of the Hessian reach of the tributary Weschnitz (Hesse) on the right bank of the Rhine was tested with respect to a colonization with salmon and delivered positive results.

Moselle and Sure, Luxembourg

At the only migration barrier on the lower Sure, the dam at Rosport-Ralingen, two major fish passages are under construction, one at the main weir and one at the hydroelectric plant (with connection to the re-natured loop of the Sure). In the loop of the Sure, a minimum flow of 3-6 m^3/s are granted. In return, a turbine will be installed using the residual flow. A 10 mm screen will protect fish moving downstream from this turbine.

1.3 Southern Upper Rhine, High Rhine

DE Baden-Württemberg

The construction of 20 fishways for upstream fish movement in re-colonization waters had been planned for 2010. 15 of them were actually built. Additionally, in 2010, five fishways were installed for downstream fish movement. Within a renaturing measure, a dike along the R. Rench was relocated along 700 m, thus creating the structural requirements for spawning and juvenile habitats.

Since then, in watercourses used for recolonizing, river continuity has been restored at most of the transverse structures owned by the Land. Most constructions, where river continuity could not yet be restored are connected to hydroelectric plants. At Willstätt on the lower R. Kinzig a new hydroelectric plant has been constructed, replacing an old one.

Apart from a new fish passage, a basket trap and a monitoring station have been installed.

During the past years, 50 downstream migration installations have been built in Baden-Württemberg, about 30 of which are located in waters used for salmon recolonization. In 2011 the functionality of 10 installations was tested with released smolt. This resulted in valuable findings for optimizing existing installations and for the construction of future downstream fishways. The Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg (LUBW) is working on guidelines for the construction of downstream fish passes in smaller and medium watercourses.

The tendency towards intensified use of hydroelectric power also shows in increased inquiries concerning the possibility of building new small hydroelectric plants in watercourses with migratory fish populations. Often, there is a conflict between such projects and the restoration of the salmon population.

The operation of the 5th turbine at the Iffezheim barrage will presumably change the hydraulic conditions at two of the three entries to the fish pass. The Bundesanstalt für Wasserbau (BAW) is carrying through experiments with hydraulic models in order to adapt the attraction flow around the entrances to the fish passage so as to optimize the functionality of the fish pass for upstream movement.

France

Preliminary work for the construction of the fish pass at the Strasbourg barrage has been accomplished, construction work will begin in 20013; according to the plans, the fish pass will be put into service in 2015. The preparatory work for the fish passage at the barrage Gerstheim has been accomplished, it is expected to be put into service in 2016.

According to the resolutions of the Conference of Rhine Ministers in Bonn in 2007, the restoration of the further migration routes upstream towards Basel is planned step by step for the hydroelectric plants Rhinau, Marckolsheim and Vogelgrün/Breisach and for the mobile weirs in the loops of the Rhine.[1]

River continuity has already been restored at the weir at Märkt/Kembs in the old bed of the Rhine and within the new license, a new fish pass is being built and will be accomplished in 2014.

A fishway, i. e. a bypass has been built at the Avolsheim dam on the Bruche, a tributary to R. Ill.

A marking study is designed to determine the attractiveness of different entries to the Gambsheim fish passage. To this end, 25 sea trout and 3 salmon were marked in Iffezheim. 11 of the sea trout and 1 salmon were detected in Gambsheim. The average sea trout migration time between the two fish passes was 2 1/2 days, the salmon made the way within 22 hours and 7 minutes. Seven fish used the entry at the turbines, two that on the river bank. For 3 fish it was not possible to determine the entry they used.

On the R. Ill and its priority tributaries (Bruche, Fecht, Lauch, Thur, Doller and Weiss) the mortality of downstream moving eel and salmon smolt is estimated according to the type of turbine and other technical characteristics of the hydroelectric plants.

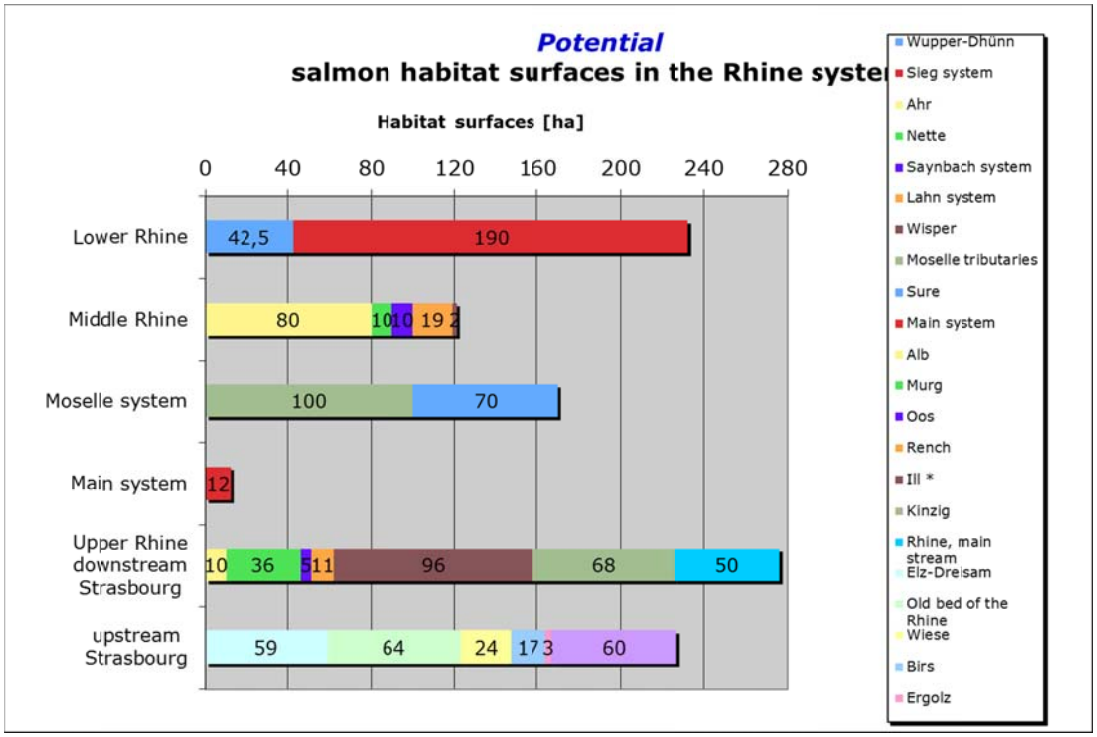
Switzerland

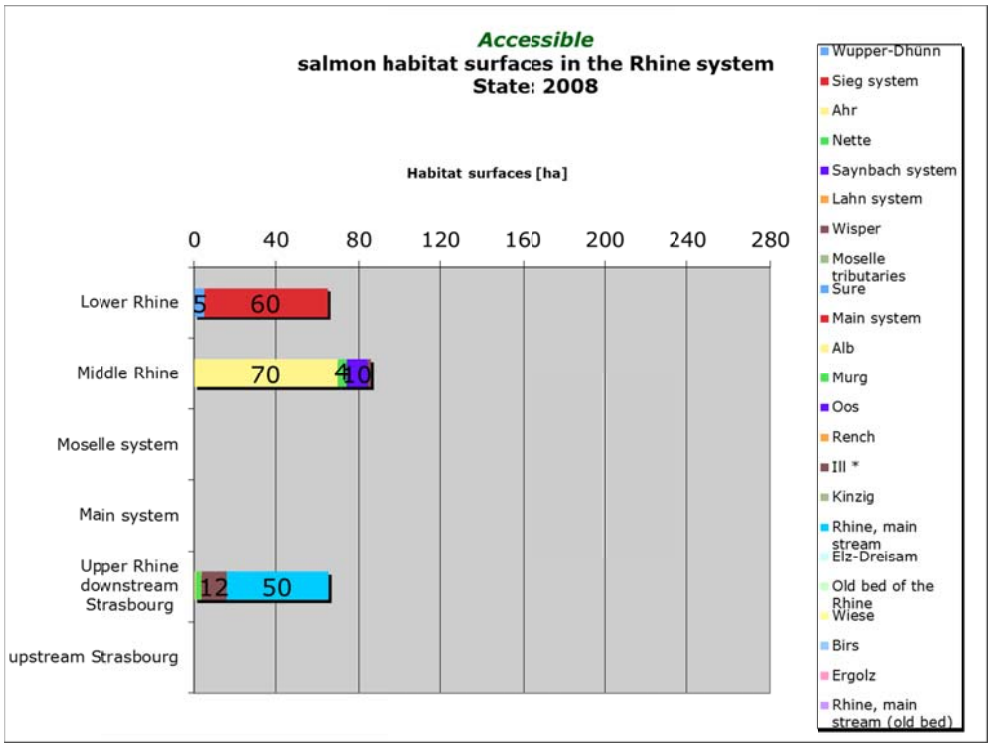
On the Swiss side, the re-licensing process for the Kembs power plant ended in November 2010 and the power plant is operating since December 2010. This means that the higher residual flow is now applied as intended. As a compensatory measure, the R. Wiese is intended to be revitalised along 1.7 km within the flood dams. At the time being, possibilities for an upstream fishway and the restoration of drop structures are being checked.

[1] see Master Plan Migratory Fish Rhine, page 11 & Annex 1 (table).

River continuity for fish migration has been or will be considerably improved at several hydroelectric plants on the Rhine between Basel and the mouth of R. Aare and everywhere at least two well-functioning possibilities for upstream migration will be created: The second technical fish pass at the weir of the Rheinfelden power plant was put into service in 2010 and the large bypass has been accomplished. A new bypass has been decided for the Rhyburg-Schwörstadt power plant and the existing technical fish pass will be improved. Furthermore, bank structures have been improved for the fish fauna. The new bypass at the Albbruck-Dogern power plant was put into service by the end of 2009 and, here too, the existing technical fish pass will be completely renewed and optimized. Negotiations concerning a higher residual flow in the diverted river section at the Rheinau power plant are going on; there is a new operation license for Eglisau and plans for constructing a fish pass and a fish lift are under development. The cantons are obliged to present restoration plans with respect to fish migration for all power plants to the state by 2014. Restoration work of all installations due to restore must be accomplished by 2030 at latest. For all existing installations, costs for the restoration of fish migration are entirely reimbursed.

In the R. Biber, a tributary to the Rhine, different migration barriers have been removed and fish migration has been restored. The slope Kleinbasler Rheinuferböschung has been designed as shallow bank with artificial fish shelters.





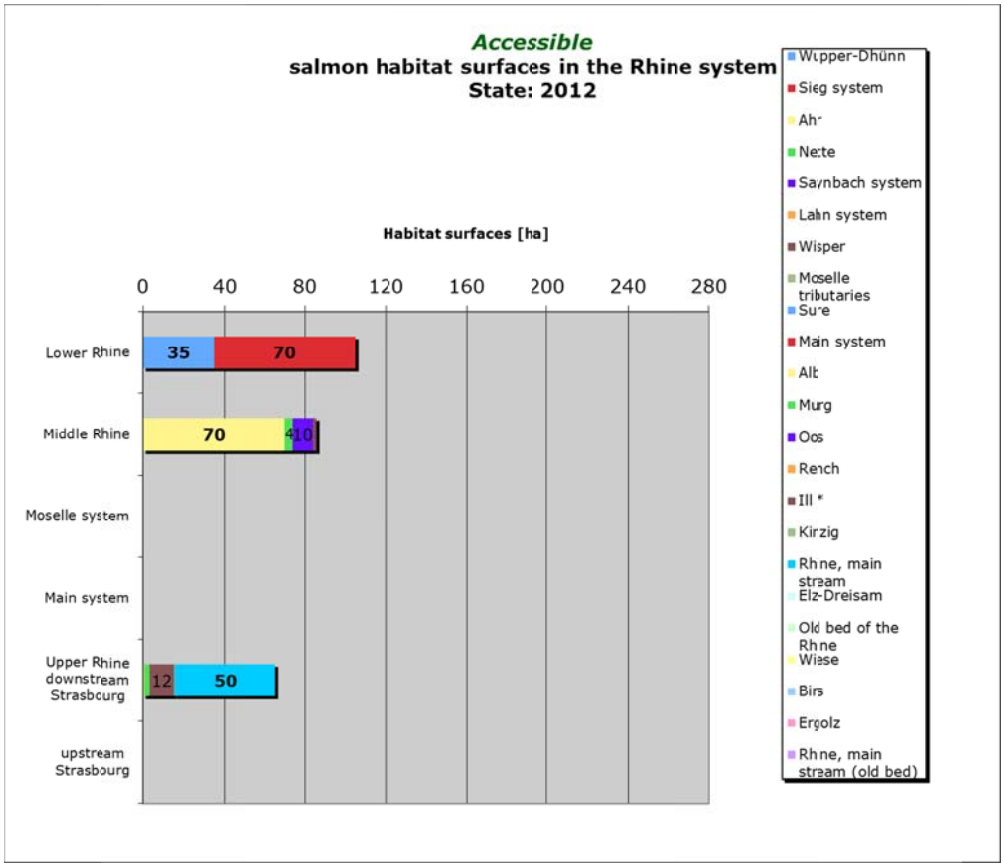


Figure 2: Potential and accessible habitat surfaces for salmon and sea trout in the Rhine system. Following recent mapping, the indications of the ICPR report no. 167 (ICPR 2009a) concerning potentially accessible habitat surfaces have been updated. Today, approx. 25 % of the potential salmon spawning habitats in the Rhine system are accessible. In 2008, 20% were accessible.

1.4 Hydroelectric power and its effects on the stocks of migratory fish

Hydroelectric plants in the programme waters pose a problem for the downstream run of juvenile salmon into the North Sea and the Atlantic Ocean. In general, turbines cause varying mortality rates of juvenile salmon due to severe injuries or instant death. The rate of losses depends on the type of turbine.

In this connection please also refer to the technical ICPR report no. 140 on the "Impact of hydroelectric plants in the Rhine tributaries on downstream fish movement" (2004, available under www.iksr.org). According to this report, injuries caused to downstream migrating fish in the turbines may in particular endanger the stock of migratory fish populations. The sum of mortalities in successive hydroelectric plants in a water system may cause mortality or injuries of the majority of downstream moving fish in the turbines. This is of particular importance in cases when, within the reintroduction of migratory fish species, it is not possible to do without functional spawning grounds and juvenile fish habitats upstream of hydroelectric plants (e.g. case of the salmon) or when an existing migratory fish population, the stock of which is endangered (e.g. eel) has important habitats in such sites.

In river systems, downstream hydroelectric plants have a particularly high impact on the abundance of the species concerned, as the entire population moving downstream from reaches upstream a power plant must pass by this plant.

Due to cumulative effects, a succession of hydroelectric plants in river sections may result in a massive destruction of downstream moving populations.

During the past years, many downstream migration structures have been built at small and medium hydroelectric plants and their functionality was tested. Today, some 60 downstream migration structures are installed at hydroelectric plants in watercourses in Baden-Württemberg.

As a matter of principle, downstream migration structures are split into three ecologically effective components for which a state of the art exists:

- mechanical fish protection at the intake of the power plant
- intake structure
- bypass

These three individual components are connected and functionally interlinked, in order to achieve intact downstream fish migration in a continuous river corridor without causing injuries. Thus, a downstream fish migration structure is only functional if all three components are functional and adjusted both to the target species and to the conditions of construction of already existing hydroelectric plants,

The state of the art of fish protection at the water intake of hydroelectric plants is a technical protection as well as a mechanical barrier preventing target species from entering according to minimal diameter and size of target species to be expected. It may be a rack screen or a perforated plate and must always be combined with an adapted, moderate inflow velocity (< 0.5 m/s). As the fish protection is also supposed to have a guiding function, its situation and slope are to be adapted such that the intake towards the downstream migration structure is easily found. Also, the behaviour of the fish species at barriers must be taken into consideration. The target of the fish protection and guidance structure is to guide downstream fish movement towards the inlet of the downstream migration structure. Not only the situation of the inlet leading towards the bypass, but also the hydraulic design at the barrier and at the inlet are decisive functional elements. The hydraulic situation at the inlet structure must be adapted to the behaviour of the target species. A progressively and regularly increasing flow velocity and non-turbulent transition from the watercourse into the downstream migration structure should be achieved. Controlled and non-controlled inlet structures have been tested. In general, the bypass is an open or closed channel with smooth inside walls in

sufficient size and with sufficient water flow enabling the passage of fish without their suffering injuries and leading them back to the free downstream migration corridor downstream of the barrier.

There are several practical examples for "fish-friendly" turbines at **small hydroelectric plants** with a nominal discharge up to **50 m³/s.** For these hydroelectric plants we also dispose of experience with functional downstream movement structures.

During the past years, many investigations were carried out at **medium sized hydroelectric plants** with a nominal discharge **up to 150 m³/s** without yet having achieved a sufficiently developed state of the art. In these cases a turbine management including periodic shut-down during fish migration periods may be a good option.

On the other hand, for **big hydroelectric plants** with a nominal discharge **above 150 m³/s** and in particular for the big hydroelectric plants along the Rhine there does not exist any satisfactory, implementable technique. At installations of this size, reliable protection mechanisms cannot be implemented using the known and effective components or their implementation would cause excessive costs. There is urgent need for research and development with respect to these aspects. Furthermore, practical design tests are required in order to be able to grant for their functionality.

Compared to a dismantled transverse structure or to a ramp covering the entire watercourse width, even downstream fish movement structures according to the most recent state of knowledge and state of the art present restrictions with respect to how easily they are found, their passability and their operational security and do not offer complete downstream river continuity. All depending on the quantitative functionality of downstream movement structures there do exist limits with respect to combining intensive hydroelectric power production and the constitution and preservation of migratory fish stocks.

Functional tests at the downstream fish movement structure at Kostheim/Main in 2011 revealed the injuries shown below. It is evident that vast improvement measures are required to optimize the functionality of this structure.

Figure 3: Salmonid injuries. Functional tests at the downstream fish movement structure at the hydroelectric plant Kostheim / mouth R. Main; December 2011. Source: BFS

2. Constitution of stocks of endangered migratory fish (habitats and stocking)

In catchments where a species like the Atlantic salmon no longer exists, stocking measures are helpful to restore a stock of the species. Furthermore, stocking may contribute to testing the functionality of ecosystems for the target fish species. Apart from stocking itself, a major part of the programme for migratory fish in the Rhine catchment is monitoring the success of the stocking measures (see chapter 2.3). The

number of salmonids returning from the sea ("returnees") indicates the size of stock and the survival rate of the fish (see chapter 2.4).

In the Rhine catchment, Atlantic salmon (Salmo salar) of two origins are used for stocking. In their home waters, salmon of the "Ätran" strain (R. Ätran in southern Sweden) reach their spawning grounds after a comparatively short distance. Since 2004 they are being stocked in the tributaries of the Lower and Middle Rhine including the Moselle and in those of the northern Upper Rhine. From 2013 onwards, no more salmon of the Ätran strain will be imported, some Ätran salmon still exist in hatcheries on the Upper Rhine.

In 2004, it was convened in the ICPR coordination unit Upper Rhine and High Rhine to only use juvenile salmon of the Loire-Allier strain (France). Salmon eggs for breeding are being imported from the Conservatoire National du Saumon Sauvage in Chanteuges (Allier/Loire area, France) (see Table 2). Fish of this genetic origin mainly spend 2 to 3 winters in the sea and must migrate across great distances in order to reach their spawning habitats.

For several years, progeny of salmon having already spent one winter or more in the sea before returning into the respective waters have been increasingly used in numerous programme waters of the Rhine catchment additionally to salmon of the Ätran or Allier strains. To this effect, returnees are caught and their eggs are collected (see chapter 2.3). In hatcheries (see Table 2) artificial reproduction is started using the eggs and milt of these fish. So these artificially reproduced stocking fish are direct progenies of salmon having migrated upstream into the respective programme waters (or just downstream) and are thus better adapted to the hydro system than imported stocking fish. A small number of this hatched progeny is raised in freshwater until mature to spawn (brood stock fish farming or gene bank) in order to support stocking. The objective of this measure is to produce strains of Rhine salmon which, from a genetic point of view, are increasingly adapted to the Rhine and its tributaries.

2.1 Stocking Atlantic salmon and sea trout

The first salmon stocking in the Rhine catchment dates back to 1988, when salmon were first stocked in two R. Sieg tributaries (Bröl and Naafbach, Lower Rhine, DE-NW). As early as 1990, the first returning adult salmon was detected during an electro-fishing campaign in R. Bröl. Since then, stocking as well as monitoring has been intensified in all programme waters in the Rhine catchment.

Annex 2 informs about what stocking stage was used in which waters in the Rhine catchment; the stocking rivers are listed in Annex 3.

2.1.1 Delta Rhine, Lower Rhine

Delta Rhine, Netherlands

Since the Delta Rhine does not belong to the natural salmon reproduction areas, there are no stocking measures.

Lower Rhine, DE-North Rhine Westphalia

Monitoring carried out so far (success control of individual stocking stages, control of natural redds, determination of the rate of downstream migration and of returnees) in the programme waters for migratory fish in NRW show that in particular juvenile salmon are suitable for stocking. Considering biological and economical aspects, the summer parr (juvenile salmon during its first year of life with a weight of 0.8 - 1.5 g) seem to correspond to the most appropriate stocking stage.

Thus, during 2010 to 2012, mostly summer parr and unfed fry were stocked in the programme waters Sieg, Wupper and Dhünn. To a smaller extent, other, older stocking

stages were used in order to continue to test their appropriateness as stocking material or to find answers to particular scientific questions. Two years old smolt are mainly stocked in order to find answers to the question of successful downstream migration. To this end, transponders are implanted into the fish. Due to a well-developed network of reception stations, salmon may be followed from the waters where they grew up until they reach the North Sea.

In order to approach the target of self-sustaining populations in the programme waters, new strategies are continuously being developed, taking into account the most recent scientific findings. By creating a brood stock consisting of returnees of R. Sieg origin at the LANUV fish hatchery in Albaum it has been possible to produce the required stocking stages for the programme waters and to largely not depend on imported material. In the near future and due to the centre for wild salmon under construction on the R. Sieg it will be possible to completely stop all importation.

Following the continuous detection of natural spawning in some tributaries of the R. Sieg system, there will, in the near future, not be any artificial stocking exercise in one model river (e.g. R. Agger, Naafbach), so as to observe the natural development of a self-sustaining salmon population not depending on stocking.

2.1.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

One year old smolt and 6 months old parr are being used for stocking. In the rivers Ahr, Saynbach, Elzbach (tributary to the Moselle)[2], Nister (tributary to the upper Sieg), Wieslauter, in the R. Main tributaries Schwarzbach and Kinzig and in R. Wisper stocking during 2010 - 2012 was largely unchanged. In R. Lahn which is yet discontinued due to obstacles, stocking was reduced in 2010 and stopped in 2011 because of insufficient availability of stocking material. The salmon were retained and stocked as very big, one year old smolt downstream of Lahnstein. Only few stocking fish of the age class 0+ are released in the tributaries.

As a result of natural reproduction in the R. Sieg and Saynbach, stocking measures have been distinctly reduced. For testing purposes, in 2011, smolt were stocked in the Main upstream the Kostheim hydroelectric plant in order to determine their rate of survival during downstream migration.

[2] On 19 February 2011, due to leaking fermentation substrate from the overhead tank of a biogas installation located near the river, a considerable share of the one summer old stocked salmon and sea trout were killed or injured in a reach of R. Elzbach (Monreal to Möntenich).

Moselle and Sure, Luxembourg

Stocking measures having been stopped in Luxembourg in 2005, about 10.000 Ätran salmon were released in the R. Sure following an agreement with Rhineland Palatinate. In order to avoid predation by overwintering cormorant, smolt ready for downstream migration were chosen for stocking. The reason for this stocking is that, during the next 20 years, river continuity will successively be restored in the Lower Moselle between Koblenz and Trier. The smolt were marked with wire tags in order to be able to recognize eventual returnees originating from stocking in Luxembourg during monitoring in the Koblenz monitoring station (see 2.4.2).

2.1.3 Southern Upper Rhine, High Rhine

DE Baden-Württemberg

The pre-requisites in the programme waters have largely been improved, so that salmon stocking with fry will now be distinctly intensified. Increasingly, progeny of returnees to the Upper Rhine will be used.

The new license for the Kembs hydroelectric plant entered into force mid December 2010 (see 1.3). One of the compensatory measures concerns controlled lateral erosion in the old bed of the Rhine. As a preliminary test, the effects of bed load supply have been looked into within an Interreg-IV project ("feasibility study"). The target is to improve the spawning and juvenile fish habitats.

France

Between 2010 and 2012, about 350,000 fry were annually stocked in the rivers of Alsace (in all 1,074,020). In 2012, 40 % of the suitable habitats in R. Bruche, 45 % of the habitats in the other tributaries of R. Ill and 23 % in the old bed of the Rhine have been used for stocking.

Since 2010, annually 5000 fed fry of the Ätran strain and 3000 of the Allier strain are released into R. Houille, a tributary of R. Meuse. Due to these stocking measures, the quality of salmon habitats in these rivers can be tested.

Switzerland

In order to permanently reintroduce salmon in Switzerland, about 25.000 fry and parr were annually released into the High Rhine and its tributaries Birs, Wiese, Ergolz, Magdenerbach, Möhlinbach, Bachtalbach, Etzgerbach and Aristöferbach during 2010 to 2012. In 2010, the WWF Switzerland designated further suitable water reaches with potential habitats in its publication "Assessment of potential and measures in favour of the return of salmon to the cantons Aargau, Basel, Bern, Solothurn and Zürich".

2.2 Monitoring of juvenile fish and natural reproduction of Atlantic salmon and other anadromous migratory fish

A sustainable constitution of a self-sustaining salmon population in the Rhine system (stock of Rhine salmon) which, on the long term, will not require any stocking presupposes a natural salmon reproduction. "Wild salmon", that is salmon not originating from stocking measures but of natural reproduction are being detected in different tributaries of the Rhine, have partly been detected for many years and in considerable numbers (e.g. Agger, Naafbach, Bröl, Nister, Kleiner Nister, Wisserbach, Saynbach, Wisper; see Annex 3). These salmon must at least be considered to belong to the first generation born in the Rhine.

There is evidence that the survival rate of smolt which grew up in the river is four times higher than that of smolt produced in fish hatcheries, so that, for stocking, it is desirable

to dispose of a large share of early stocked stages (age group 0+) as well as of "wild salmon" of natural reproduction.

2.2.1 Lower Rhine, DE-North Rhine Westphalia

In the tributaries of the R. Sieg system Agger, Naafbach and Bröl, natural reproduction is very regularly detected, partly to a considerable extent. In the very suitable habitats of the R. Agger, Naafbach and Bröl a population density is found comparable to that of a salmon river with a self-sustaining population (> 0.5 ind./m² by end June/beginning July). Due to evidence of continuous natural reproduction of salmon in certain programme waters, a first test will be launched in 2015 meaning that artificial stocking of juvenile salmon will be stopped and natural reproduction and the constitution of a salmon population not depending on stocking will be investigated.

2.2.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

During the most important spawning period in 2010, floods caused difficult fishing conditions in all spawning waters. Nevertheless, 86 redds war mapped in the programme waters; due to floods and permanent turbidity, their detection was only possible to a limited extent.

In the Upper Sieg and the tributaries Nister and Wisserbach, considerable nutrient pollution (algal bloom, pH values up to > 9.5) was detected, the causes of which are at present being investigated. During the low flows in May 2012, very high pH values were again measured in the juvenile habitats of the R. Sieg, Ahr and Nister (Nister: up to pH 9.9). Additionally, at individual hydroelectric plants, lacking overflooding of weirs and insufficient residual water flow led to increased smolt mortality; this has been documented for the Nister.

In the Rhineland-Palatinate section of R. Sieg no evidence was given of salmon spawn; in Nister and Wisserbach the spawn density was below that of previous years. On the other hand, considerable wild salmon spawn has been detected in the 11th year in a row in R. Saynbach. Due to the size of the river and the largely restored river continuity, it is difficult to give evidence of wild spawn in R. Ahr.

In R. Nette, where there has not been any stocking for about 100 years, straying returning salmon and natural reproduction have again been documented in 2010.

Since 2009, evidence is given of natural reproduction along a limited reach of R. Wieslauter on the northern Upper Rhine.

In 2011 and 2011, evidence of salmon reproduction was given at many locations which indicates a great number of spawning fish.

In 2010 and 2011, natural reproduction in the Hessian Wisper could be proved by giving evidence of spawn. Investigations in 2012 did not give any evidence of natural salmon emergence in the Wisper.

2.2.3 Southern Upper Rhine, High Rhine

DE Baden-Württemberg

In 2010, and within the new hydroelectric license procedure for the nuclear power plant Philippsburg, an investigation into the stock of fish was carried out at the water intake. Within few hours, several thousands of downstream migrating sea and river lamprey were counted. With respect to the origin of the juvenile fish, habitats have been identified in the Rhine tributaries as well as in the Rhine itself. Furthermore, it is probable that adult lamprey also use the high quality gravel banks downstream the Iffezheim barrage weir for spawning.

There was no monitoring of juvenile fish in the tributaries of the Upper Rhine; the following random evidence was given: In 2011/12, natural salmon reproduction was detected in R. Kinzig. In R. Murg, redds are found since 2005. In 2011 and 2012 redds were also found in R. Alb in Karlsruhe,

During random control investigations into the development of juvenile salmon in the tributaries to the High Rhine and the Upper Rhine, survival rates ranging between > 50 % to 70 % were found in all river systems between R. Wiese and R. Alb. During fishing in programme waters, reproduction of fish species such as grayling and spirlin was detected in reaches, where these species had hardly or not been detected before implementing improvement measures (regulation of minimum flow, structural improvement, and restoration of river continuity). Thus, the efforts show an effect for anadromous fish and lamprey as well as for regional species typical of the rivers concerned.

France

The mapping of suitable spawning habitats for migratory salmonids resulted in 25 ha in R. Bruche (50 % of which accessible), 76 ha in other tributaries to R. Ill and 64 ha in the old bed of the Rhine (total surface: 165 ha). However, today 94 % of them are not yet accessible.

Monitoring of juvenile fish carried out by the Association Saumon Rhin (ASR) during the fall of 2012 at 27 monitoring stations in Alsace and at 6 in the Vosges/Ardennes (Moselle and R. Houille, a tributary of R. Maas) resulted in a restoration rate[3] between 4 % in the old bed of the Rhine and 40 % in the R. Ill tributaries (17 % in R. Bruche). Numbers distinctly increase in the tributaries of R. Ill, in the other rivers the numbers are comparable to those of previous years. In 2010 a female had been found dead in R. Fecht. Nearby, a redd was found, in 2011 another one was found, in 2012, 12 redds were found. This is evidence of salmon returning upstream into the Departement Haut-Rhin. The successful natural reproduction in the rivers Bruche, Ill and Fecht is being monitored by electro-fishing measures in those spawning habitats where redds of big salmonids have been observed. Juvenile salmon are caught during monitoring. Since stocking measures do not begin before June, it may be assumed that these juvenile salmon are really of natural origin.

Sea lamprey also naturally reproduce in the R. Lauter, Bruche, Ill and Moder. Table 1 shows the results of the counting of redds between 2010 and 2012.

[3] The reintroduction rate takes into account mortality and migration of stocking fish within the water body. As the stocking surface and the number of stocked salmon is known, the rate of reintroduction corresponds to an estimation of the number of fish present in the reach concerned.

Table 1: Redds of migratory fish in the Ill river system (FR-Alsace) and in R. Lauter in 2010, 2011 and 2012.

	Big salmonids			Sea lamprey		
River	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Ill	4	15				3
Bruche	33	30	20	12	7	12
Fecht	1	1	12			
Moder		2	2			
Lauter		3	3			1
Sum	**38**	**51**	**37**	**12**	**7**	**16**

Switzerland

As the spawning waters are not accessible, there was no particular observation of redds or natural reproduction. Investigations have shown that salmon seems to be less vulnerable with respect to the proliferating kidney disease (PKD) than river trout. In summer, this illness appears at temperatures above 15 °C.

2.3 Withdrawal of adult fish and breeding with a view to salmon stocking

Table 2 lists the fish hatcheries used for the brood stock of Atlantic salmon and sea trout. The map in Annex 5 shows the location of these hatcheries and of those for the brood stock of the Lake Constance sea trout in the Rhine catchment.

2.3.1 Lower Rhine, DE-North Rhine Westphalia

With a view to artificial reproduction, annually, up to 160 upstream migrating salmon are captured at the Buisdorf monitoring station on R. Sieg. The number of returnees caught and which eggs are collected is sufficient in order to support stocking measures on the one hand and to secure polymorphism for the next generation of a fresh brood stock (gene bank) of the LANUV in Albaum.

For the future, it is planned to further reduce importation (at the time being, summer parr of the Ätran strain are still being purchased from a Danish salmon farmer) and to be completely self-supplied with stocking material of returnees of Sieg origin and from the gene bank (adult brood stock at the LANUV Albaum) and the centre for wild salmon presently under construction on R. Sieg. In addition to catches and artificial reproduction of salmon returnees, returning female salmon of Sieg origin are re-conditioned in Albaum after the successful collection of their eggs so that they are available to deliver eggs in the following year as well. This procedure optimizes the use of existing resources.

2.3.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

Due to the large share of spawners in general and particularly of spawners having spent several winters in the sea, in 2011, as during 2007 to 2010, the average number of eggs per spawner was very high. In 2010, 4 spawners and one adult male from R. Lahn and 18 premature milters from R. Weil, a tributary to the Hessian Lahn were stripped by the IG-Lahn. The eggs were bred in the breeding station Aumenau (see table 2). Thus, about 12.000 eggs in the eyed egg stage could be produced. In November 2011, 6 spawners and 2 adult milters from R. Lahn and 25 premature milters belonging to the stock of the breeding station Aumenau were stripped, resulting in about 10,000 fertilized eggs.

In the salmon centre "Hasper Talsperre" a fish hatchery with a brood stock has been created, annually also integrating wild juvenile salmon, particularly of Saynbach and Sieg origin. All in all, since 2004, 6,425 individuals have been introduced into the brood stock. At the time being, the age classes between 0+ and 5+ are represented in the farm.

Table 2: Fish hatcheries for the stocking of Atlantic salmon and other migratory fish in the Rhine catchment

Name of the fish hatchery	Operator (+ co-proprietor)	Location	Use of the stocking material in	Maintaining a brood stock
Coordination unit Lower Rhine and Middle Rhine / Moselle / northern Upper Rhine				
Aquakulturanlage Albaum	LANUV NRW	Albaum (DE-NW)	DE-NW	Yes
Wildlachszentrum Rhein-Sieg	Stiftung Wasserlauf NRW	Siegelsknippen	DE-NW	no
Breeding stations of programme initiatives Wupper and Dhünn	Bergischer Fischereiverein und Sportanglerverein Bayer Leverkusen	Beyenburg, Leverkusen	DE-NW	no
Lachszentrum Hasper Talsperre	"Lachszentrum Hasper Talsperre" e.V.	near Hagen (DE-NW)	DE-NW, DE-RP, DE-HE, FR-Mosel	yes
Breeding station Aumenau	Interessengemeinschaft Lahn	Aumenau (DE-HE)	DE-RP, DE-HE	no
Coordination unit southern Upper Rhine - High Rhine				
Conservatoire National du Saumon Sauvage	Gemeinnützige Genossenschaft	Chanteuges (Haute-Loire / Loire-Allier, FR)	CH; delivers salmon eggs for the breeding stations on the Upper Rhine	yes
Pisciculture „Saumon du Rhin"	Fischereiverband Bas-Rhin (+ Landesfischereiverband Baden-Württemberg e. V. + Association Saumon-Rhin)	Obenheim (FR)	DE-BW, FR-Elsass	yes
Trout farm Rösch	private (Reinhard Rösch)	Gengenbach (DE-BW)	DE-BW	no
Breeding station Karlsruhe	Anglerverein Karlsruhe 1897 e.V.	Karlsruhe (DE-BW)	DE-BW	no
Lachszucht Wolftal	Landesfischereiverband Baden-Württemberg	Wolf (tributary to R. Kinzig), DE-BW	DE-BW	yes
Breeding station „IG Elz"	Interessengemeinschaft Elz	Kollnau (DE-BW)	DE-BW	no
Petite Camargue Alsacienne	Fish breeding association High Rhine	Saint-Louis (FR)	FR-Elsass	yes
Boismont	private (Hermine & Yannick Jouan)	Meurthe-et-Moselle (FR)	FR-Lothringen	no

2.3.3 Southern Upper Rhine, High Rhine

DE Baden-Württemberg

The brood stock farm in Wolftal started operation in 2010. In December 2010, 30 spawners from this farm were mated with milters from the Pisciculture "Saumon du Rhin".

France

With a view to producing fingerlings of the Allier strain, a part of the eggs from the salmon farm Chateuges is being imported and raised in partner fish farms (see Table 2).

Another part of the eggs is produced by brood stock kept in the pisciculltures in Obenheim and Saint-Louis in Alsace. The last and smallest share originates from the reproduction of wildlife fish of the Allier strain which were caught in the Rhine. Before using these specimen for farming purposes, their genetic origin is checked.

51 % of fish stocked in Alsacian water bodies in 2012 were bred in Obenheim, 35 % in Saint-Louis and 10 % in Boismont. These three fish hatcheries which also strive for a maximum genetic diversity of brood stock within their farms, have taken part in the programme from the very beginning on. This reduces the risk is of lacking fingerlings due to possible problems in one of the hatcheries.

Since 2010, 48 salmon caught in the Gambsheim fish passage have been brought to the Obenheim fish farm. Apart from one specimen of Norwegian origin and one of unknown origin all of them belonged to the known Allier strain. In 2012, 14,800 juvenile fish of wildlife brood stock were produced in the Obenheim fish farm. In cooperation with the German partners they were released into the Rhine tributaries. In order to limit mortality in the hydroelectric plants, the French share of 7,400 juvenile fish was released into the lowermost downstream tributary, R. Bruche.

2.4 Evidence of returned Atlantic salmon and of other anadromous migratory fish

Figure 4 gives a survey of the evidence of adult salmon returned into the Rhine system from the sea since 1990; Annex 4 shows the statistics of returnees in numbers. These statistics give an idea of the number of returning fish observed, but they must not be considered as absolute numbers.

Most returnees are registered at control and catching stations (see Table 3). Some control stations use video surveillance, so that different (migratory) fish species can be observed and registered during up- and downstream migration all year around.

The other numbers of returnees have been determined by random electro fishing or refer to evidence of telemetric studies, catches by anglers or random observations (see below), which means that the actual number of upstream moving salmon is estimated to be higher than what is represented in Figure 4.

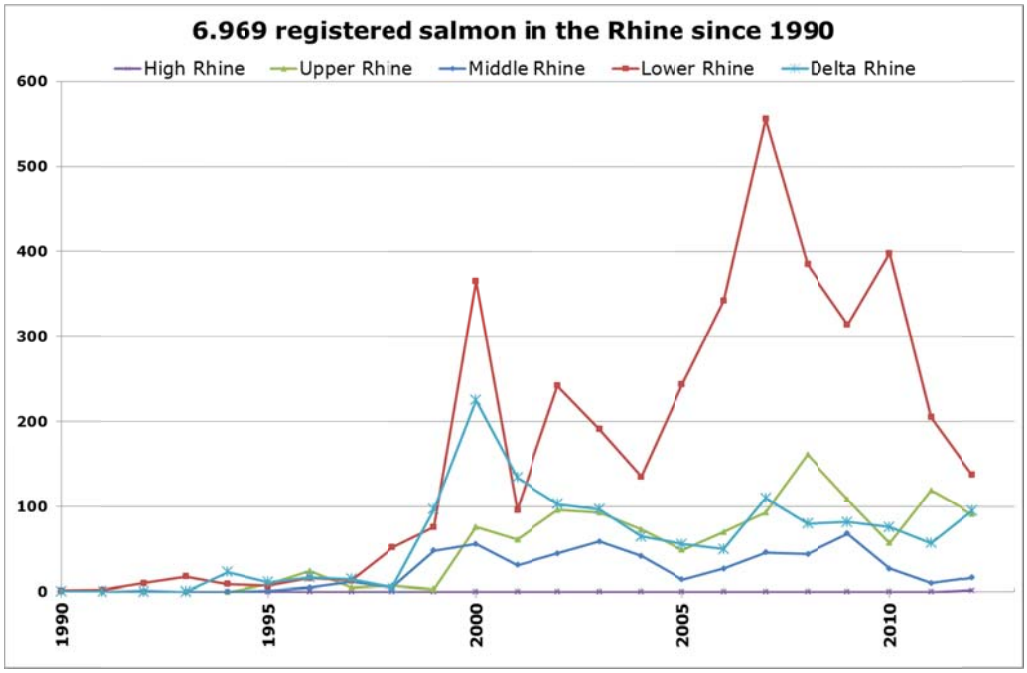


Figure 4: Identification of adult salmon in the Rhine system since 1990 Compilation of national data
State: June 2013

Presumably, there are several reasons explaining the considerable variations in the number of returnees from one year to the next:

- natural variations in the populations;
- varying discharges of the Rhine and the other connected waters (high discharges support fish migration; low discharges, as occurred in the spring and autumn 2011 hamper fish migration);
- the intensity of stocking and natural reproduction in the subsystem concerned 2 or 3 years back;
- limited functionality or unavailability of fish passages due to reconstruction (e.g. Moselle/Koblenz in 2010/2011, Iffezheim in 2009-2013, see below)
- construction work in the port of Rotterdam (Maasvlakte II) may have led to turbidity over a wide area of the estuary preventing migratory fish from entering the Rhine system.

Also, the survival rate and productivity of marine salmon has an effect on the population in the Rhine system (see below). Smaller numbers of returnees into the Rhine system observed after 2010 have also been reported from other European river systems.

Table 3 represents the control and catching stations where migratory fish returning from the sea are registered. The map in Annex 5 indicates the locations of these stations in the Rhine catchment.

It cannot be proved that all returnees detected in the Delta Rhine did reach their spawning habitats further upstream in the Rhine system. Evidence does however point out that fish have returned from the sea. Data from counting stations and monitoring data from tributaries with spawning habitats, eg. R. Sieg and R. Ill are more reliable (see below).

Table 3: Control stations and catching stations registering migratory fish returning to the Rhine catchment from the sea

Rhine section	River	Location	Operating since	Video surveillance
Delta Rhine	Waal	Woudrichem	1994	Not permanently, only 8 weeks during spring and fall
Delta Rhine	Lek	Hagestein	1994	
Delta Rhine	IJssel	Westervoort	1997	
Lower Rhine	Wupper-Dhünn	Auermühle	2002	No
Lower Rhine	Sieg	Buisdorf	2000	Since 2009
Lower Rhine	Agger	Troisdorf	2006	No
Middle Rhine	Moselle	Koblenz	1995	Since 2011 at the new fish passage
northern Upper Rhine	Main	Kostheim	2011	Video surveillance since 2011, fyke-net is being tested
Southern Upper Rhine	Rhine	Iffezheim	2000	Since 2000 (construction area 2009-2013)
Southern Upper Rhine	Rhine	Gambsheim	2006	Since 2006
Southern Upper Rhine	Kinzig	Willstätt	2013	Beginning 2013
Southern Upper Rhine	Alb	Mouth R. Alb	under planning	Under planning

The diadromous migratory fish listed in the Master Plan Migratory Fish Rhine do not only play an important part in the implementation of the WFD, but also when implementing the Marine Strategy Directive[4] (MSD). Some of the important qualitative descriptors for the marine environment are closely connected to the implementation of the WFD, such as (1) biological diversity with respect to species occurring in fresh water and in salt water, such as diadromous fish species. The same is true of the descriptors (5) eutrophication, (7) hydrographic properties, (8) pollutant concentrations and (10) waste. According to the description of the present state of the marine ecosystem, the Dutch coastal areas represent the highest diversity of fish species, including the migratory fish salmon, eel and river lamprey, in the past also allice shad, sturgeon and houting. Apart from a description, the descriptor "Biological Diversity" (1) does not go into any details concerning diadromous fish species; however, they are mentioned in connection with the hydrographic properties (7). According to the initial Dutch assessment the deterioration of the sea bed ecosystem and the decline of diadromous fish species in the coastal areas is partly caused by the permanent hydrographic effects of the Deltaworks (among others the Haringvliet sluices) and by the uses of R. Meuse (port area near Rotterdam).

The drafting of the programme of measures for the implementation of the MSD until 2015 in the Netherlands partly relies on the fisheries policy (sustainable fishery within the framework of the common fisheries policy). However, it is considered to be a task of river commissions to continue measures in connection with biological diversity /diadromous fish species (according to WFD, Birds and Habitat Directive) as well as regarding pollutants and eutrophication (according to WFD). Knowledge must be enhanced with respect to issues of waste, in particular microplastics and their risks which also apply to (migratory) fish.

2.4.1 Delta Rhine, Lower Rhine

Delta Rhine, Netherlands

Telemetric studies show that about one fourth of the upstream migrating salmon does not find its way through the labyrinth of the Delta Rhine with its channels and changing current directions and into the Lower Rhine in Germany but rapidly returns into the North Sea. Details will be clarified in further studies.

Lower Rhine, DE-North Rhine Westphalia

During 2010 to 2012, 764 returning salmon were counted in the Lower Rhine and its tributaries. During the winter 2010/2011, the third largest number of returnees was registered at the Buisdorf control station on the R. Sieg since registration began (2007/2008: 409, 2008/2009: 294, 2010/2011: 284 salmon, 49 sea trout). According to present knowledge, the monitoring station on the Sieg detects 50-70% of the upstream migrating salmon. In November 2010, the number of salmon directly surmounting the weir on R. Agger in Troisdorf was surveyed within an electro fishing campaign along 10 river kilometres immediately upstream the control station located at this weir. Within this reach, 35 salmon were caught, of which only 4 had been marked. This showed that a considerable part of the salmon surmounted the weir directly, comparable to what had been stated at the Buisdorf control station on R. Sieg. Presumably, the number of salmon really moving into R. Agger is considerably higher than evidence given in the control station.

On the whole, 3.709 adult salmon have been detected in NRW since 1990, which is more than half of the number of all salmon detected in the entire Rhine catchment. The greatest number, i.e. 3,326 individuals, has been detected in the R. Sieg system in North Rhine Westphalia.

2.4.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

[4] Directive 2008/56/EC

In 2010 and due to methodical reasons, only 33 returnees were registered (total number since 1992: 642). One reason is that the fish passage, i.e. the control fyke-net at the Moselle barrage in Koblenz did not operate due to construction work. When the new fish passage and the counting station at the Moselle barrage in Koblenz started operating in September 2011, one upstream migrating sea trout was registered, by the end of the year, 15 had been registered. In 2012, at least 5 salmon and 2 sea trout were registered.

In the rivers Ahr, Saynbach and Lahn (DE-RP), the partly distinct increase of catches related to a uniform catching effort (CPUE - catch-per-unit-effort) might indicate increasing numbers of returnees due to a higher share of wildlife specimen (increasing natural reproduction, qualitative improvement of brood stock and restocking fish). In addition, the high number of detected redds (see 2.4) might indicate that the number of returnees was comparatively high in 2010, even though only a small number of specimen was detected. The high discharges in 2010 seem to have been favourable for fish migration. Since high discharges cause methodical problems in particular for wading fishing, the numbers for the Middle Rhine were lower than in previous years.

During the long low water period from September to November 2011, the mouths of the R. Wisper, Nette and Ahr were not accessible, so that fish could not migrate into these tributaries. During the period concerned, returning salmon were only detected in R. Wisper in 2010. None were reported during 2011 and 2012. In 2011, one returning salmon was detected in the fyke-net at the fish passage of the Kostheim barrage and in the downstream reaches of R. Weschnitz (Hesse) so that it may be assumed that no salmon migrated into these water bodies.

2.4.3 Southern Upper Rhine, High Rhine

Switzerland, DE-Baden-Württemberg

For the first time, two salmon were observed at the barrage Rheinfelden in 2012.

Upstream migration was not controlled in the Rhine tributaries in Baden-Württemberg. Apart from for R. Wiese, a tributary to the High Rhine, returning salmon have several times been reported from all programme waters. Today, salmon are in particular regularly moving upstream the R. Murg and Kinzig.

Since the basin passage at the Iffezheim barrage began operating in the summer of 2000, upstream fish migration is continuously being monitored within a German-French cooperation. By end 2012, a total number of 787 returning salmon, more than 1,600 sea trout, more than 1,300 sea lamprey and 34 allice shad were detected. All in all, so far 220,000 fish belonging to 34 species have used the fish passage when moving upstream.

During the construction aimed at installing a fifth turbine, two of the three entrances towards the fish passage in Iffezheim have been closed. Therefore, the functionality of the passage is restricted until the end of the construction period planned for 2013.

France

Between 2010 and 2012, 53.959 eel, 126 salmon, 192 sea trout, 22 sea lamprey and 11 allice shad have been counted in the Gambsheim fish passage. The number of migratory fish using this fish passage varies from one year to the next, but its order of magnitude remains stable.

Video double-countings of eel in Gambsheim give evidence of the reliability of the indicated numbers. In addition, the annual sampling is targeted at following the development of the population properties (size, weight).

Annually, some 31,000 fish belonging to some 30 species are observed. The most common species were eel, bream, barbel, nase and asp (in decreasing order of magnitude).

2.5 Constituting and securing the stock of the Lake Constance sea trout

Alpine Rhine / Lake Constance; Liechtenstein, Austria, Switzerland, DE-Baden-Württemberg; IGKB

After 3 years of continuous growth of the number of lake trout catches in Lake Constance, professional fishermen and anglers registered a marked decline in 2010; the number of catches was below the mean value for 10 years.

This negative trend is not confirmed by the registration of the number of sea trout migrating up the fish ladder under continuous video surveillance at the Reichenau power plant in the Alpine Rhine. The 992 lake trout registered in 2010, 625 in 2011 and 1,253 in 2012 give evidence of comparable results to those of previous years. A first peak of upstream migrating fish was registered as early as June 2010. Compared to previous years, catches of brood stock in other waters do not indicate any decline. Figures 5 and 6 show the most important characteristic values concerning fishery of the lake trout in Lake Constance and the Alpine Rhine for the period 2010 to 2012.

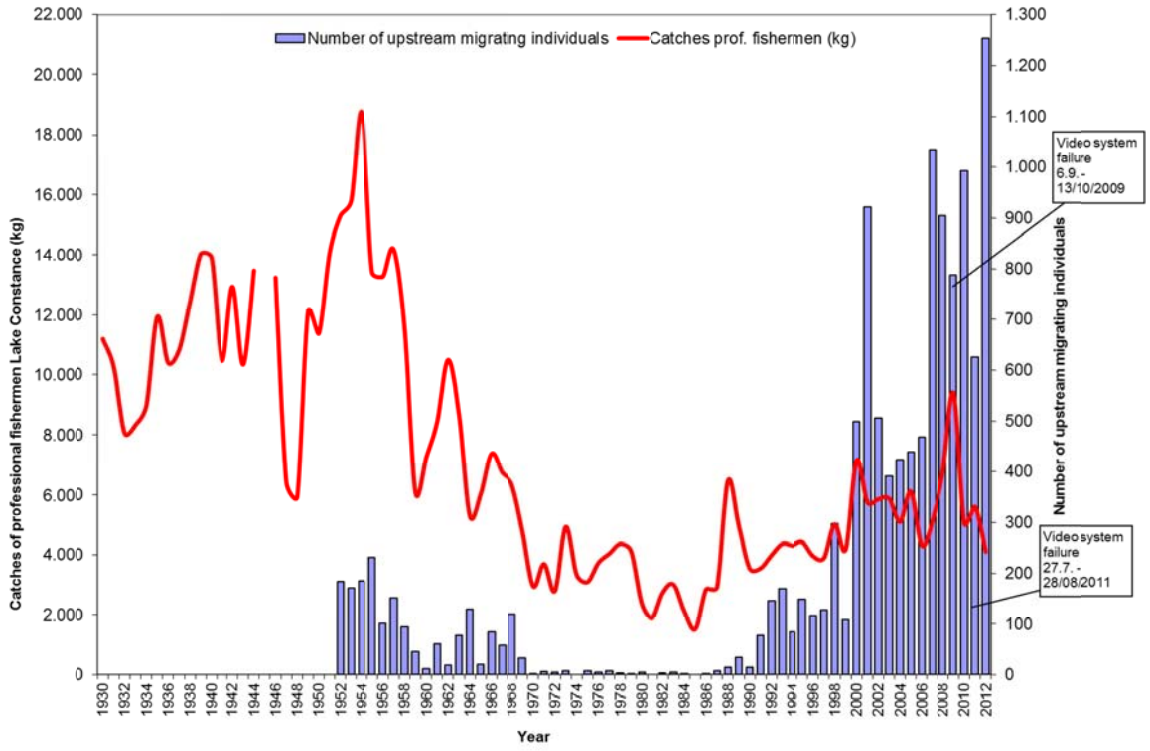


Figure 5: Lake trout catches by professional fishermen in Lake Constance-Obersee and number of fish migrating upstream at the Reichenau power plant: Caught brood stock (until 1999), fyke-net control (as of 2000) and video counting (as of 2007).

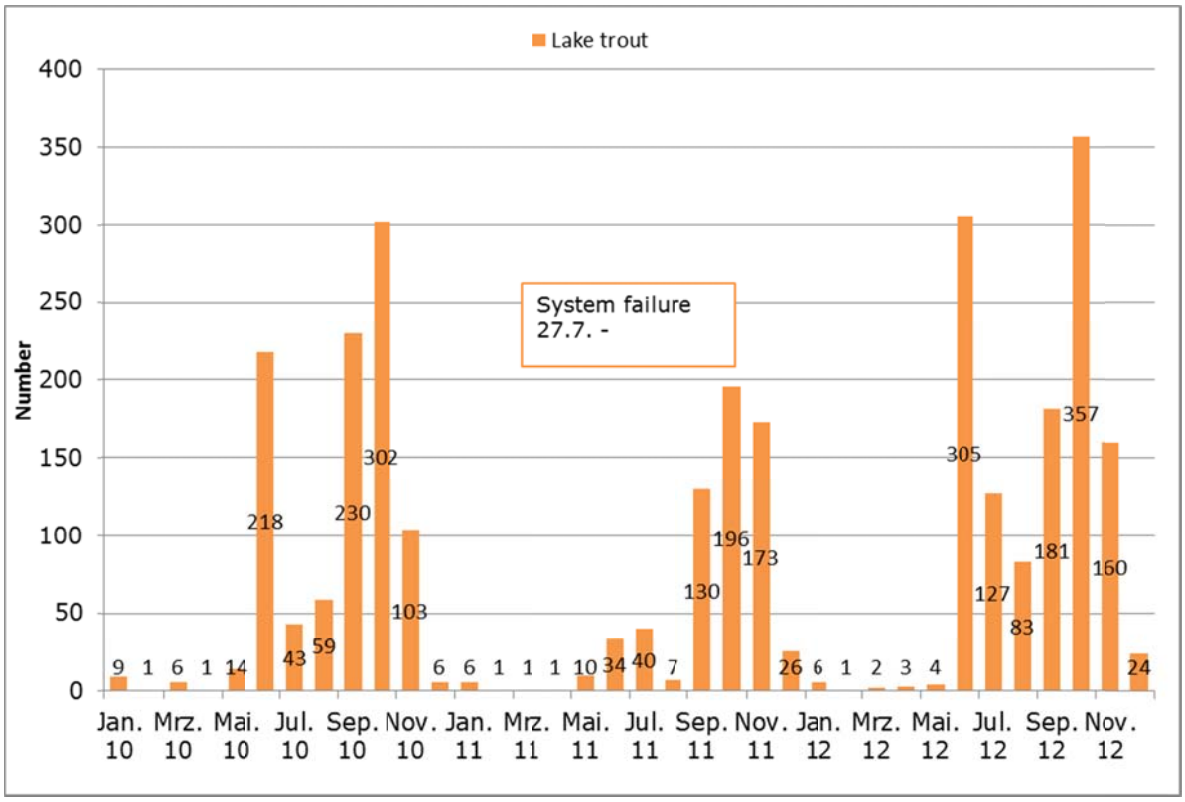


Figure 6: Number of Lake Constance lake trout seasonally migrating upstream the fish ladder at the Reichenau power plant (video count) during 2010 to 2012

2.6 Constituting and securing the stock of allice shad

The LIFE project initiated in 2007 aimed at restoring the allice shad (Alosa alosa), a formerly frequent herring species, and should improve the situation of this species. In the period leading up to 2007, only few individuals of the species had been detected in the Iffezheim barrage and so far, no successful reproduction of allice shad has been registered in the Rhine system.

During 2008 to 2010, a total amount of about 4.8 million allice shad larvae has been bred in France and released into the Rhine in Hesse and North Rhine Westphalia. Their brood stock belongs to the Garonne strain in the south-west of France rich in number of individuals. According to genetic analysis, the few allice shad detected in the Rhine also belong to these populations. The constitution of a potentially self-sustaining stock of parent fish presupposes continued stocking in a comparable order of magnitude covering at least three generations, representing 15 years. The success of the project can only be assessed at the end of this period.

Financially, continued stocking of 1.5 to 2 million allice shad annually is secured for the period 2011 to 2015 within the Life+ follow-up project. Evidence of 30 juvenile allice shad detected by a professional fisherman on the Lower Rhine (near Kalkar, DE-NW) in the fall of 2010 proves that juvenile allice shad are able to develop under today's conditions in the Rhine and migrate downstream towards the estuary in fall. This is a decisive prerequisite for the success of the restoration programme. In 2011 and 2012, further 3.1 million of allice shad larvae were released into the R. Sieg and Lippe in NRW, into the Erfelder Altrhein in Hesse and into an excavation connected to the river. Monitoring carried out in the period following the stocking did not give evidence of any alllice shad near the stocking locations. On the other hand, in October 2011, another juvenile (marked) allice shad was found in the by-catches of the eel schokker near Kalkar. Contrary to 2010 and due to marked low flows and unfavourable fishing positions outside the points of the river with highest flow velocity, schokker monitoring resulted in

few representative catching results. However, schokker and dip net fishing proved to be a well suited monitoring method for juvenile allice shad. Considering repeated detection of adult houting during their spawning runs it seems to be imaginable that dip net fishing may in future also indicate allice shad returning into the Rhine.

No noteworthy numbers of allice shad returning into the Rhine are to be expected before 2014. Considering the vast water surface from the Delta Rhine area until the first transverse structure at Iffezheim, representative monitoring can hardly be granted. Therefore, reports concerning allice shad detected by professional fishermen and leisure anglers are essential in order to collect indications on an increasing number of returnees and their migration routes. If the number of returnees increases, more allice shad should also be registered at the monitoring station in the Upper Rhine (Iffezheim, Gambsheim) and in the Rhine tributaries (Buisdorf / Sieg, Koblenz / Moselle, Kostheim / Main).

Since allice shad released into the Rhine system were marked with Oxytetracycline, the fluorescent inclusion in the otoliths allows to distinguish them from strayers belonging to other strains. The construction of a monitoring network thus requires that caught allice shad (or at least their heads) are deep frozen and handed over to the project management. The possibilities of establishing a genetic identification system for allice shad is under consideration. Such "parental assignment" procedures have, among others, already been successfully established in France in order to differentiate between salmon from brood stock farming and those of natural reproduction. Compared to colouring the otoliths, their great advantage is that fish are identified with the help of scale or tissue samples without having to kill them.

In 2011 and 2012, one (sub-) adult allice shad was detected respectively in R. Ätran in southern Sweden an in Belgian coastal waters. In the first case, marking traces were not recognizable with absolute certainty in the otoliths. Project management was only informed several months after the catch of the allice shad in the immediate vicinity of the Scheldt estuary, which was too late to retrieve the otoliths or any tissue samples. Since anglers in the south-eastern North Sea have caught numerous shad, among them fish, which, given their outer appearance should be recognized as allice shad, the reporting of such catches must be further optimized. Among others, information material is being drafted for fishermen and anglers enabling an unambiguous diagnosis of the species and including contact data for reports of catches or findings.

If a sufficient number of allice shad should migrate into the Rhine system and spawn, a further obstacle for the successful restoration of allice shad in the Rhine would be taken.

Allice shad are characterized by a very conspicuous and loud spawning ritual. In France, a procedure of acoustic monitoring of spawning activity has been developed allowing for conclusions on the number of participating allice shad and thus on the size of the stock. Thus, potential spawning habitats will be observed during relevant periods and under suitable conditions. Given the number (n = 66) and the partly vast surfaces it is planned to collect information and control reports of groups of persons (anglers, water police) which have previously been informed of the sounds generated.

Presumably, knowledge about the causes for the recent abrupt reduction of the stock of the biggest remaining population in the Gironde-Garonne-Dordogne river system will also be of great importance for the restoration of the allice shad in the Rhine catchment. Investigations are going on into which of the existing fish passages are suitable and which design corresponds to the specific needs of allice shad.

These results are not only supposed to result in measures aimed at protecting the Gironde strain but will also contribute to further optimize restoration efforts for the Rhine. Even though, due to an alarming low number of upstream moving allice shad in the Gironde area, it has not yet been possible to carry through these investigations to the planned extent, first results indicate that existing fish passages are only used to a very limited extent. At the time being, it is not possible to assess, whether this is caused by deficits of the installations or due to the low number of spawners and the non-exhaustive use of the spawning areas in the lower reaches of the Garonne and the

Dordogne. Irrespective of the small stock of spawners, it has been possible to give first evidence of juvenile allice shad in their fresh water phase using shove nets. Due to their pelagic way of life and for methodical reasons, monitoring of the juvenile stock had so far never been successful. In order to understand the largely unknown ecology of juvenile allice shad, analysis particularly concentrates on habitat requirements and mortality of 0+ allice shad in their freshwater period and investigations are carried out into their food and growth.

In Aßlar/Hesse a pilot farm aimed at producing an allice shad brood stock has been put into service. Experience from this farm and that gained in the Aquarium La Rochelle/France and parallel investigations into growth and beginning maturity aim at a future use of wildlife stocks for artificial reproduction independently of the Gironde strain and to select a strain adapted to the Rhine system. At the time being, in Aßlar there are about 600 juvenile allice shad from 2011 and 2012, the cohort 2012 being the first bred locally. Given the good growth results and low mortality rate, there is a fair chance of disposing of mature allice shad in the strain by 2015 which, in future, will be used for artificial reproduction and the production of stocking fish.

The technical report on the first LIFE project (programme phase 2007-2010) is available in German, French, Dutch and English at http://www.lanuv.nrw.de/veroeffentlichungen/fachberichte/fabe28/fabe28start.htm.

Figure 7: Adult allice shad from the R. Garonne equipped with a radiotransmitter. Telemetric methods are used for investigating into migration behaviour and the acceptance of existing fish passages. Source: Olivier fazit

Guerri/Epidor

2.7 Constituting and securing the stock of houting

The former houting population (Coregonus oxyrinchus) in the Rhine was considered to have died out; for the Upper Rhine evidence must still be given that the houting used to be found here (regularly). The Coregons which, historically, did appear here, may also have belonged to other species having migrated downstream from the lakes in the alpine region. Therefore, no stocking or restoration programmes are planned for the coordination unit 1 (Upper Rhine).

In Germany (NRW) a project has been going on since 1992 aimed at reintroducing houting of Danish/north German origins. Since 1996, juvenile houting (0+) have systematically been stocked. From 1999 on, more than 100,000 individuals were annually stocked and their number finally amounted to 2.3 million juvenile houting

stocked in 2006. Stocking concentrated on the lower reaches of R. Lippe and on flooded gravel pits connected to the Lower Rhine.

During the past years (since 2001 with a distinct increase in 2005) houting have increasingly been detected in the Netherlands (Lake IJssel and Haringvliet) where adult individuals (40-60 cm) have been equipped with transponders (NEDAP trail system) since 2005. Due to these specimen equipped with transponders, periodic spawn migration has been detected in the IJssel during the winter. Since 2011, adult houting are regularly caught during their spawning migration in the Lower Rhine between Wesel and Rees. Furthermore, different monitoring results give evidence of natural reproduction in the Rhine Delta. The houting is thus considered to be a migratory fish species which has been successfully restored in the Rhine and for which no further stocking measures are required.

A vigorous and self-sustaining population has established in the Rhine. The further constitution of the stock will also be an important issue within reporting on the Habitats Directive. The population development should be followed on the long term, in particular considering the adaptation to conditions in today's Rhine delta.

Today, houting is regularly caught in the Dutch Rhine delta and in the German Lower Rhine. Its dynamics (location, phenology, population dynamics, and genetics) in the Rhine is subjected to great dynamics. Further investigations into migration dynamics in the Lower Rhine, the Rhine delta and the limitrophe North Sea should be made, in particular regarding the limited continuity of the Dutch Rhine delta and genetic drift due to local environmental conditions.

Figure 8: Houting *Coregonus oxyrinchus* (photo: D. Ingendahl)

2.8 Constitution and securing of the stocks of eel

For protection purposes and future management of the endangered eel populations in Europe, the European Union issued a **regulation** (EC No. 1100/2007) focussing on a reduction of eel mortality of anthropogenic origin. According to this regulation, all EU Member States with natural stocks of eel drafted national eel management plans by end 2008 which they handed over to the EU Commission. In the following, the results of the discussions in the EG FISH on the state of implementation of national measures aimed at stabilizing the stocks of eel in the Rhine catchment are summarized.

The obligations resulting from the Eel regulation have been entered into the **fishing laws** of all EU states in the Rhine catchment, apart from Luxembourg, where the regulation is directly implementable ex officio. Switzerland is not obliged to implement the EU Eel Regulation. The harmonization of the equivalent regulations on the High Rhine with Baden-Württemberg does however happen within the cooperation in the Fishing Commission High Rhine.

The environmental target of the regulation is to **secure the downstream migration of at least 40 %** of the silver eel biomass into the sea compared to the natural stock. Models for calculating the rate of downstream migration have been developed in the Netherlands and in Germany. According to estimates made in Luxembourg, a downstream migration rate of 90 % from the Luxembourgian areas has already been achieved for 8 years. In France, the stock of eel (260 million individuals in 2006/2007) and the rate of downstream migration (10-30 % compared to the period before 1980) are equally estimated, but this is not done separately for the Rhine catchment.

Long standing data on the occurrence of **glass eel on the Dutch coast** reveal a dramatic decline. Additionally, the ICES Working Group on Eel (WGEEL) is entering the data from the states in the Rhine catchment into the calculation of the Recruitment Index for glass eel; this index gives evidence of a comparable decline.

Almost everywhere, where it plays a relevant role, commercial **catching** and sportsangling have been limited by fish protection periods (between 3 months in winter and all year), minimum fish size (50 cm) and/or a ban on professional fishing gear. Due to an excess of dioxin contents and contents of PCB similar to dioxins, eel catches have been completely prohibited in the catchments of big rivers in the Netherlands starting April 1st 2011 for a 3-year-period. Because of the known pollution, almost no eel are professionally caught in Germany. Due to the mercury content of fish, a ban on selling and eating eel from the Rhine, the Grand Canal d'Alsace, the Ill and its tributaries has been issued in France. There is no professional fishing for eel in Luxembourg or Switzerland.

In the Netherlands and in Germany (except for the High Rhine) different state organisms, professional fishermen and fishing associations carry through **stocking measures**. In France, there is no release of eel in the Rhine catchment. In North Rhine Westphalia, eel is analysed with respect to *Anguillicoloides crassus* before being released.

Many eel **protection measures** are partly implemented at **transverse structures** (in all Rhine bordering countries) and pumping stations (Netherlands) until 2015, partly until 2027. Fish passes are being built, grids are integrated in order to protect downstream moving eel and turbine management is adapted during the main eel migration period. Partly, these measures are carried out within new licenses for existing hydroelectric plants. Priorities were set for certain waters particularly suitable for eel. In France, the construction of new transverse structures has been interdicted in certain waters.

Within the implementation of the EU WFD, many hydro-morphological measures are carried out from which the eel also profits.

There is **research** on fish-friendly turbine management (Germany, Luxembourg, France), on the main migration period and the downstream migration behaviour of eel (Netherlands, Meuse area; Germany, Neckar), on infrasound barriers and reporting systems (Germany), on mortality and migration behaviour of eel at hydroelectric plants (Germany, France) and on artificial eel breeding (Netherlands).

On the Moselle and Sure (Germany, Luxembourg), in the Main and the Neckar (Germany) eel protection measures including catching and **transporting are implemented**.

In some German federal states, limited shooting of **cormorant** has been allowed with a view to protecting the stocks of fish.

Analysis of eel in the Rhine catchment states carried out between 2000 and 2011[5] along the Rhine and in many tributaries gave evidence of extensive pollution of the fish with **dioxins, furanes, dl-PCB** and mercury, in some cases also indicator PC or hexachlorobenzene (HCB). In the Delta Rhine, a major decrease in HCB contamination of yellow eel was apparent since the 1970s, from more than 0.1 mg/kg FW to values of

[5] see ICPR report no. 195: Contamination of Fish with Pollutants in the Catchment Area of the Rhine www.iksr.org

about 0.01 mg/kg FW. Fluorosurfactants (PFT) as well as perflurooctane sulfonate (PFOS) also accumulate in eel. So far, little is known of the effect of the different pollutants on the health of the fish; however, a physiological contamination which in particular concerns the long spawning run is assumed. In the 1st river basin management plan according to the WFD for the international river basin district Rhine the states in the Rhine catchment committed themselves to restore heavily contaminated river sediments as far as possible[6]. At the time being, discussions on possible sources of contamination with PCB and other pollutants and on national remedial measures are going on.

National eel management plans for the Rhine catchment:

Netherlands:

- **Ministerie van Economische Zaken**: The Netherlands eel management plan. 15 December 2008, revised in June 2011.

Germany:

- **Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen** (overall responsibility): Aalbewirtschaftungsplan – Flussgebietseinheit Rhein. December 2008 - http://www.portal-fischerei.de/fileadmin/redaktion/dokumente/fischerei/Bund/Bestandsmanagement/FlussgebietseinheitRhein.pdf

Luxembourg:

- **Ministère de l'Intérieur et de l'aménagement du territoire**, Administration de la Gestion de l'Eau, Division de l'Hydrologie: Aalbewirtschaftungsplan Luxemburg (in German and French). Luxembourg, 04 February 2009

France :

- **Préfecture de la Région Lorraine**: Plan de gestion anguille de la France – Volet local de l'unité de gestion Rhin. Application du règlement (CE) n°1100/2007 du 18 septembre 2007

2.9 Information on the European sturgeon in the Rhine catchment states

The European sturgeon (Acipenser sturio) died out in the Rhine catchment in the 1940/1950s and ranges among the worldwide most endangered species.

The only river in which the sturgeon still reproduces is the Gironde-Garonne-Dordogne system in France. The French National Sturgeon Action Plan is concentrating on this river system and does not concern the Rhine catchment[7]. But this ex-situ breeding of sturgeon of the IRSTEA (formerly CEMAGREF) institute since 1981 does support other European sturgeon stocking projects, as that in R. Elbe in Germany[8]. Since 1996 and in cooperation with IRSTEA, the Leibniz-Institut für Gewässerökologie und Binnenfischerei (IGB) (Institute for Water Ecology and Inland Fishery) has established its own brood stock[9].

For the time being and according to an international agreement, the National Sturgeon Action Plan for Germany is concentrating the restoration of the European sturgeon on R. Elbe, which seems to offer the most favourable conditions. Once successful, restoration is also planned for the rest of the former area of distribution; the Rhine is explicitly mentioned as possible target water body. In North Rhine Westphalia, the Rhine has been examined as potential sturgeon habitat.[10] As a matter of principle, the German Lower

6 Comprehensive Strategy Sediment Management; ICPR report no. 175, www.iksr.org.
7 Ministère de l'Ecologie, du Développement durable, des Transports et du Logement 2010
8 http://www.bfn.de/habitatmare/de/spezielle-projekte-wiederansiedlung-stoer.php
9 http://www.igb-berlin.de/pressemitteilungen-nachrichten-alle/items/stoere-auf-dem-weg-in-der-elbe.html
10 Nemitz, A. 2011

Rhine does present suitable habitat structures for sturgeon. Their location, size and quality will have to be designated in particular mappings. However, many potential habitats were lost when they were separated from the main stream; this is also true of potential habitats in tributaries without the continuity required for adult sturgeon. Chemical residual pollution and micro-pollutants, navigation and by-catches range among the additional limiting factors. Therefore, in case of a restoration project, close cooperation with fishery will be strived for. Furthermore, the availability of stocking material is extremely limited. It will last some 5 to 10 years before a "surplus production" of sturgeon planned for R. Elbe will be achieved. Until then, preliminary studies on the NEDAP trail system could be carried through.

In the Netherlands, the WWF released some 50 juvenile sturgeon into R. Waal near Nijmegen and upstream of Rotterdam to celebrate its 50th anniversary in May 2012 together with the ARK foundation and Dutch sports anglers. The fish were of Garonne origin, near Bordeaux and had been equipped with transponders of the NEDAP system. 8 hours after having been released, the first sturgeon were registered at the monitoring station in the Nieuwe Waterweg 60 km from where they had been released; in the meantime, 20 individuals have reached the coastal region. The transponder batteries will last for about 4 years. During this period it will be observed, which habitats the fish will use in the Rhine delta.[11]

Figure 9: European sturgeon *Acipenser sturio* (photo: S. Wieland)

3. Reduction of by-catches and illegal catches as well as predation.

3.1 Measures aimed at reducing by-catches and illegal catches of migratory fish

The rate of returnees can only be increased, if the problem of by-catches and illegal catches of salmonids on the coast, in the Rhine delta and along the further course of the river is solved. In 2009, the ICPR drafted recommendations on the reduction of by-catches and illegal catches.[12] A description of the national implementation of these recommendations is given below.

3.1.1 Delta Rhine, Lower Rhine

Delta Rhine, Netherlands

Legislation: In the Netherlands, there is a ban on catching salmon and sea trout. At the same time, there is an obligation to return salmon eventually caught as by-catches (law on fisheries of 1963, regulations, minimal size and protection periods of 1985, article 2c and 2d). Infringements may be prosecuted.

Information: At the time being, information on migratory fish targeted at sports anglers and leisure anglers is enhanced by the angling license (VISpas) and the behavioural

[11] see www.steureninnederland.nl
[12] see ICPR 2009b

codex on marine sportsfishing. Professional fishermen, fisheries surveillance and persons working for the fish market and fish mongers receive the same information.

River continuity at constructions and other obstacles: The three barrages on the Nederrijn (Dutch Lower Rhine) were equipped with fish passages as early as in 2001 to 2004, so that salmonids may migrate upstream without major delay. The partial opening of the Haringvliet sluices will improve the situation on the coast as of 2018.

Synergy with measures following the Eel Regulation: Since 1st April 2011 there is a three year ban on professional eel and Chinese crab fishing in the major part of the great streams as well as in certain big navigation channels. There is now a ban on professional fishing with fyke-nets and trawls (see the agreement Dutch Staatscourant of 25 March 2011, no. 194017).

Implementation: In 2012, in the rivers Neder-Rijn, Maas, Lek and Overijsselsche Vecht, angling was forbidden along a reach of 75 m downstream a barrage, in fish passages as well as 25 m upstream the upper outlet of a fish passage. The interdiction does not apply to periods when the barrages are not operated. In the Netherlands, 3 anti-poaching teams are operating. During the winter half-year (corresponding to the salmon run) and following the recommendations of the ICPR, the Dutch board of control (VWA) has operated targeted controls of the obligation to release by-catches. No infringements were stated during these controls. Infringements at transverse structures are being established by RWS and reported to the police.

Even though the share of by-catches and illegal catches in the Delta Rhine in the restricted development of the salmon population is not negligible, recent findings from telemetry studies reveal that the disappearing of salmon returning from the Delta Rhine into the sea at an early stage is of much greater importance than mortality due to fishery (see chapter 2.4.1).

Lower Rhine, DE-North Rhine Westphalia

In the past, there were indications of targeted angling at the mouth of the rivers Sieg and Wupper into the Rhine with the risk that big salmonids might equally be caught. Thus, in cooperation with local authorities, the ministry, the Landesamt and fisheries associations and anglers's clubs, the following measures were adopted and implemented:

Legislation: The Higher Fisheries Authority of the regional authority of Cologne has designated two fish protection areas in the mouth of the R. Sieg and Wupper according to the fisheries legislation of the Land. They imply a general ban on angling during the main upstream salmon run from 1st September until 31st December. The two fish protection areas were published in the official journal of the regional authority in Cologne and entered into force on 30 March 2010.

Information: The LANUV has drafted a flyer "Helfen Sie, Lachs & Co zu schützen" (Contribute to the protection of salmon & co) informing anglers. This flyer has been widely spread and made known by fisheries associations.

Increased control: Under the overall control of the local fishing counsellor, fishing was increasingly controlled in the protection areas. However, the latest evaluation of controls did not give evidence of any infringements.

3.1.2 Middle Rhine / Moselle / Northern Upper Rhine

DE-Rhineland-Palatinate and DE-Hesse

In spite of the low discharges in 2011, there were hardly any indications of illegal fishing during 2010 to end 2012.

With a view to informing anglers, the Hessian Ministry of Environment, Energy, Agriculture and Consumer Protection (HMUELV) has published a folder entitled "The salmon is returning - support efforts towards restoring the stock of an impressive fish species".

Luxembourg

In Luxembourg, there is a legal ban on catching salmon and sea trout. So far, there is no evidence of returnees. In 2011, the fishing department organized a training course for customs officers with respect to controlling fisheries. Today, illegal fishery and by-catches are no problematic issues in Luxembourg.

3.1.3 Southern Upper Rhine, High Rhine

Baden-Württemberg

According to § 1 of the fisheries regulation of the Land (Landesfischereiverordnung), salmon and sea trout are protected all year. If still viable, salmon and sea trout caught must immediately be returned into the river. In fish passages and 30 m (in the Rhine 50 m) up- and downstream of their entrance and outlet, there is a ban on any kind of fishing according to § 7 of the fisheries regulations of the Land. During the past years, individual, inadvertent salmon catches have been reported.

France

In the French part of the Rhine catchment there is a ban on catching salmon. As soon as work in connection with the 5th turbine at the Gambsheim barrage will have been accomplished, the access to the fish passage in the Rhine will be interdicted and a fence will be built. Selective police controls are carried through. The introduction of a general ban on fishing downstream of weirs is planned (100 m in the Rhine and 50 m in other rivers).

Switzerland

Together with the cantons and the Federal Office of Environment the WWF Switzerland has distributed an information flyer to fishermen describing what to do when a salmon is observed. This flyer was drafted after a hobby angler had inadvertently caught a salmon in Basel in 2008 which he again released.

3.2 Predation

Predation by fish such as asp, catfish, pike-perch, perch and fish eating fowl (above all cormorant, to a lesser extent heron) is a natural phenomenon. In spawning and juvenile habitats, trout, chub, barbel and bullheads represent a natural predation pressure for juvenile salmon and sea trout which may be a limiting factor for small populations. Transverse structures where salmon cannot immediately continue their migration represent a greater risk of predation.[13] Therefore, fish predating fowl as well as other impairments of waters (related to water chemistry, water biology and hydro morphology, reduced river continuity, e.g. at weirs and hydroelectric plants, etc.) may affect the survival of salmon. In cases of modified communities of fish species, such as already

[13] ICPR 2009a

found in the Rhine or when losing the sense of orientation and time at obstacles, increased predation may be a secondary effect and not the real cause for a regressing population.

In the Rhine delta, a considerable share of the total mortality of downstream migrating smolt may be attributed to fish predating fish (e.g. pike-perch) and fowl (e.g. cormorant).[14] Telemetry investigations in the Delta Rhine have shown that losses increase when marked downstream migrating smolt come to areas with cormorant breeding colonies. Within the programme on migratory fish in North Rhine Westphalia, the predation of juvenile salmon stages and rates as well as causes of mortality in this connection are continuously investigated in cooperation with the Dutch RWS and transponder markings.

[14] Jansen et al. 2008

4. Public relation and environmental education

Apart from the targeted information of professional fishermen and sportsanglers - as described in chapter 3.1 - the wider public has also been informed about the content of the programme on migratory fish in the Rhine catchment:

Delta Rhine

During the "Vismarkt" event on 29/30 March 2012 in Groningen, presentations, workshops and excursions informed the public about measures taken for migratory fish in the Netherlands and Belgium (organizer: Waterschap Noorderzijlvest and STOWA; see http://www.stowa.nl/nieuws__agenda/Agenda/agenda_items.aspx?rId=254).

Lower Rhine / Sieg

The foundation "Stiftung Wasserlauf NRW" was founded with a view to informing the public at large about migratory fish issues. This foundation organizes events and supports pilot projects. There are regular guided tours to the monitoring station in Buisdorf on R. Sieg. Numerous brochures and documents inform about the contents of the programme on migratory fish in NRW, see www.wasserlauf-nrw.de.

Middle Rhine / Moselle

In September 2011, the visitors' centre "Mosellum" at the Moselle barrage in Koblenz was opened (www.mosellum-rlp.de). Here, migrating fish can be immediately observed in the fish passage. The accompanying interactive exhibition informs about the life of migratory fish and the complex relationships with hydro power generation and navigation in the Moselle valley. In 2011 (October to December) 3,564 visitors came to see the "Mosellum", in 2012 (January to mid-April) 2,615 visitors were counted, among them 5 school classes.

The new edition of the book "Fish in Luxembourg" published in 2011 also takes account of the project "Salmon 2020". This book was presented to the press in a grammar school in spring 2012.

Southern Upper Rhine, France

During 2010 to 2012, 195 school classes representing 4,830 pupils participated in the pedagogic programme of the ASR (slide show, breeding aquarium for juvenile salmon and stocking). Accompanied by the Association Saumon-Rhin, 148 school classes and other groups, i.e. more than 4,700 visitors were registered at the Gambsheim fish passage. 11 travelling exhibitions, 5 lectures/presentations, the newsletter "Saumon Rhin Infos", the website www.saumon-rhin.com, numerous articles in the press and TV reports belong to the further public relations work.

Southern Upper Rhine, DE-BW:

Spawning salmon in R. Kinzig near Willstätt and the returnees to R. Murg were extensively covered in the press and television.

High Rhine, Switzerland

The book "Salmon - a fish returning" was published in the Hauptverlag in October 2011.[15]

[15] Mertens et al. 2011

5. Conclusions and outlook

During the past years, all Rhine bordering countries have made considerable efforts - partly within the implementation of the WFD - to improve the living conditions for migratory fish in the catchment.

The accessible share of the potential salmon habitat surface has been increased from 20 % in 2008 to 25 % in 2012. Further measures aimed at restoring river continuity will successively open further spawning habitats to migratory fish.

Natural salmon reproduction has been identified in almost all waters where spawning habitats are again accessible.

The extension and improvement of fish habitats again accessible will successively lead to a reduction of stocking in the Rhine catchment based on imported salmon strains. For the R. Sieg system, this is already planned for 2013, since salmon may already return to this river system since beginning 1990. Following the continuous detection of natural spawning in some tributaries of the R. Sieg system, there will, in the near future, not be any artificial stocking exercise in one model river (e.g. R. Agger, Naafbach), so as to observe the natural development of a self-sustaining salmon population not depending on stocking.

However, long-term stocking is still required in the programme waters on the Upper and High Rhine, as some of these rivers only became accessible a few years ago while accessibility to others is not yet given.

The long-term target is to achieve a stable population of Rhine salmon based on natural reproduction.

In programme waters used for hydro power production, the downstream run of juvenile salmon into the North Sea and the Atlantic Ocean poses a great problem. In particular in cases of successive hydroelectric plants, high loss and injury rates of juvenile salmon in the turbines varying with the type of turbine regularly occur. Technical protection devices avoiding fish to get into the turbines do not systematically exist and if they exist, their effect tends to be insufficient.

Since 2001, upstream river continuity has been improved at 481 transverse structures in the programme waters. In 2014, a new fish passage will be ready for operation at the Kembs/Märkt power plant on the Rhine (higher residual flow into the old Rhine). The further measures now to be implemented concern a partial opening of the sluices on the Haringvliet, the construction of a fish passage at the Strasbourg barrage on the Rhine by 2015 and construction planning for the Gerstheim barrage to be accomplished by 2016. Successively, important improvement measures have been and will be implemented in numerous other programme waters.

River re-naturation within the implementation of the Water Framework Directive will contribute to a general improvement of the habitat conditions for the fish fauna. The target course set out in the "Master Plan Migratory Fish Rhine" in 2009 has been engaged and must be continued.

The next major challenges will be to restore river continuity at the remaining transverse structures in the main stream of the Rhine and in those programme waters presenting the greatest habitat potential for migratory fish.

Furthermore, stocking, an important element within the sustainable constitution of a stock of migratory fish in the programme waters of the upper reaches must be continued on the long term.

Avoiding further transverse structures, in particular new hydroelectric plants in salmon waters is essential. Following the principle "protect the best, restore the rest", and, among others, for financial reasons, the remaining high quality water habitats should

have highest priority with respect to unrestricted preservation. They are the essential basis for a self-sustaining population of Rhine salmon.

The effects of climate change on the living conditions of migratory fish should be observed, including the marine environment. The further implementation of the "Master Plan Migratory Fish Rhine" will be part of the 2nd management plan of the international river basin district Rhine under the European Water Framework Directive.

6. Literature

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Annex 1: Improved river continuity of the Rhine and its tributaries, in particular of programme waters for migratory fish:
Survey of the Programme "Rhine 2020" for the years 2005 to 2012 State: June 2013

Country	Section of the Rhine / Tributary	Water body / section, name, description of measure	1.1.2000 - 31.12.2005	1.1.2006 - 31.12.2010	Implementation planned by end 2012*	Costs (million Euros)
NL	Delta Rhine	Lek/ Nederrijn: Hagestein, Amerongen, Driel	3			9,2
		Lake IJssel, closure embankment (expenses: 2,5 - 5 million €); preparation of implementation			1	5
	Maas	Haringvliet sluices "de Kier", important access for migratory fish to Rhine and Meuse river system (implementation ongoing)			1	n.s.
	Hollandsche IJssel	Scooping-bucket elevator Katwijk			1	0,17
	Hollandsche IJssel	Scooping-bucket elevator Abraham Kroes			1	0,25
	Nieuwe Waterweg	Scooping-bucket elevator Mr. Dr. C.P. Zaaijer			1	0,11
	Nieuwe Maas	Scooping-bucket elevator Mr. U.G. Schilthuis (in preparation)			1	n.s.
	Nieuwe Maas	Scooping-bucket elevator Schiegemaal (in preparation)			1	n.s.
	Boven Merwede	Scooping-bucket elevator Gorinchem (in preparation)			1	n.s.
	Hollandsche IJssel	Scooping-bucket elevator M. Verdoold Cz (in preparation)			1	n.s.
	Hollandsche IJssel	Scooping-bucket elevator Gouda (in preparation)			1	n.s.
Sum Delta Rhine			**3**	**0**	**10**	**14,7**
Delta Rhine cumulated			**3**	**3**	**13**	
D-NW	Kalflack	Fishway from the Lower Rhine into the Kalflack at the scooping-bucket elevator at Rhine km 852.4 (at the Emmerich			1	1,3
	Wupper	Wupper: Upstream passability in water body for migratory fish from the confluence until km 72.3 is granted. Downstream migration: Presumably need of restoration at 5 sites; tributaries: Morsbach, Gelpe, Eschbach, Wiembach, Murbach	2	5	1	1,5
		Dhünn: River continuity of the water body for migratory fish achieved	1	3		0,8
	Sieg	Rheinische Sieg; monitoring station; pilot fish protection installation Unkelmühle: Accomplishment 2012	3	1	1	10,5
		Bröl	1	1		0,15
		Agger with Sülz and Naaf		2		0,6
D-RP		Sieg, middle section	4	2		1
		Sieg, middle section: Weir Hösch, Freusburger Mühle, weir Scheuerfeld (RWE), weir Euteneuen			2	1
					0	
		Nister, downstream region (23 km)	4	4	1	1,2
D-NW		Sieg, upstream region in North Rhine-Westphalia		8	1	
		Ferndorf, upstream tributary of R. Sieg	7	17	1	
Sum Lower Rhine & tributaries			**22**	**43**	**8**	**18,05**
Lower Rhine cumulated			**22**	**65**	**73**	
D-RP	Ahr	Ahr (70 km)	23	23	2	4
	Nette	Nette, downstream region (6.6 km)	3			0,17
		Nette, upstream	3	6	4	0,75
	Saynbach	Saynbach-Brexbach	6	6		1
Lux	Moselle	Moselle, Koblenz (fishway and visitors' centre in service, construction almost accomplished)			1	5,18
		Elzbach, downstream		1		0,07
		Sauer, Rosport (construction beginning: 2011)			1	1,22
		Sauer, Erpeldange		1		0,11
		Sauer, Bourscheid			1	0,2
		Sauer, Dirbach			1	0,3
D-RP	Lahn	Lahn, lower section (Lahnstein until border RP/HE)	3	1		3,1
		Mühlbach, downstream region (6 km)	4		2	0,3
		Aar, downstream region (13 km)	6	4	0	0,9
D-HE		Lahn, border RP/HE until downstream the mouth of R. Dill	1	4	1	n.s.
		Lahn, upstream mouth of R. Dill until border HE/NW	3	6	3	n.s.
		Elbbach (downstream, 10 km to Hadamar)	6			1,1
		Dill (as far as Dillenburg-Niederscheld)	9	2		2,33
		Weil in the district Limburg-Weilburg until Utenhof	5			0,81
D-RP	Nahe	Nahe (110 km)	5	5	5	5,1
D-HE	Wisper	Wisper, downstream and middle section		1	1	0,22
Sum Middle Rhine and tributaries including Moselle			**77**	**60**	**22**	**26,9**
Middle Rhine cumulated			**77**	**137**	**159**	
DE-HE	Main	Main: Kostheim		1		0,97
		Schwarzbach (Eppstein)		1		0,02
		Nidda (with Usa and Nidder)		10	2	1,2
		Kinzig (with Bracht, Salz, Bieber and Schwarzbach/Kinzig (= upstream Kinzig)	2	10	4	1,5
					8	
					6	

Table 1 (continued) Improved river continuity of the Rhine and its tributaries, in particular of programme waters for migratory fish:

Country	Section of the Rhine / Tributary	Water body / section, name, description of measure	1.1.2000 - 31.12.2005	1.1.2006 - 31.12.2010	Implementation planned by end 2012*	Costs (million Euros)
D-BW	Neckar	Neckar: lowermost transverse structure near Ladenburg**		1		0,49
D-RP	(Wies) Lauter	(Wies)Lauter Bienwaldmühle			1	0,25
		(Wies)Lauter, weir Scheibenhardt			1	0,38
F		(Wies)Lauter, Lauterbourg mill		1		0,16
D-RP		(Wies)Lauter, Berizzi mill	1			0,17
F		(Wies)Lauter, French section near Wissembourg		1	n.s.	n.s.
D-BW	Alb	Alb downstream	1	4	1	1,956
					1	
		Alb upstream to mouth of R. Maisenbach in Marxzell	1	8	1	0,454
					1	
	Murg	Murg, downstream region (20 km)	1	1	3	0,5205
		Murg, upstream region until the mouth of the R. Forbach at Baiersbronn	1	2	2	1,271
					1	
					8	
F / D-BW	Rhine	southern Upper Rhine: Iffezheim, Gambsheim		2		20
		southern Upper Rhine: Strasbourg			1	10
		southern Upper Rhine, Kembs (renewal of concession): Construction of a new fish passage			1	8
D-BW	Rench	Rench	4	8	4	5,3
F	Ill	Ill to mouth of R. Doller		1	1	n.s.
		Bruche, Giessen, Liepvrette, Fecht, Weiss, Doller		2	3	n.s.
D-BW	Kinzig	Kinzig (Baden-Württemberg)	1	18	11	n.s.
	Elz-Dreisam	Elz and Dreisam, downstream regions	6	6		n.s.
		Elz and Dreisam, to km 90		2	16	n.s.
Sum Upper Rhine & tributaries including Main			**18**	**79**	**77**	**52,6**
Upper Rhine cumulated			**18**	**97**	**174**	
CH	High Rhine	Power plant Rheinfelden: bypass river within new concession (reconstruction going on since 2007)			1	n.s.
		Ryburg-Schwörstadt power plant: bypass river for salmon, improvement of fishladder			1	n.s.
		Säckingen power plant: 580 m long bypass river		1		n.s.
		Power plant Albbruck-Dogern: Nature-near bypass river with		1		n.s.
		Eglisau power plant: within the new concession 2 fishways at the weir and the lock			1	n.s.
		Mouth R. Glatt: Construction of fishways in the Glattstollen as compensatory measure within the new concession for the Eglisau power plant			2	n.s.
		Rheinau power plant: Improvement of fish ladders at the auxiliary weirs or dismantling; increase of residual flow; pre-studies accomplished in 2005/2006			1	n.s.
CH	Wiese	Wiese, downstream: Elaboration of pre-project for fish ladder at "Schliesse" (km 3.5) and restoration of drop structures (km 3)			n.s.	n.s.
D-BW		Wiese, middle section and upstream	2	10	2	n.s.
CH	Birs	Birs: downstream section: improved fish migration and revitalisation; replacement of 5 drop structures by block ramps	5	2		n.s.
		Birs, upstream: improved fish migration		1	n.s.	n.s.
	Ergolz	Ergolz		1		n.s.
	Biber	Removal of several obstacles to river continuity and restoration of fish passability		n.s.		n.s.
Sum High Rhine & tributaries			**7**	**16**	**8**	**0,0**
High Rhine cumulated			**7**	**23**	**31**	
D-BW	Tributaries to Lake Constance	Upper and Lower Argen, lowermost hydropower plants		2		n.s.
		Upper and Lower Argen, upstream hydropower plant			n.s.	n.s.
		Schussen, gauging station Lochbrücke / Gerbertshaus		1		n.s.
		Schussen, hydropower plant Berg (accessibility Wolfegger Ach and Ettishofer Ach)			n.s.	n.s.
		Seefelder Aach, hydropower plant Mühlhofen, improve river continuity			n.s.	n.s.
		Stockacher Aach	2	3	2	n.s.
		Radolfzeller Aach	4	4	2	n.s.
D-BY/AT		Leiblach and Rickenbach: Reconstruction of at least 3 transverse structures			3	1,5
D-BY		Oberreitnauer Ach (reconstruction transverse structures)		1	2	0,14
CH	Alpine Rhine	Fish passage power plant Reichenau		1		n.s.
AT		Spirsbach		1		0,5
FL		Liechtenstein inland canal		1		n.s.
AT	Ill	Hochwuhr river km 8.0, fishway power plant with video surveillance since October 2010	1			n.s.
		weir Dabalada, km 20,0			1	1
Sum Lake Constance, Alpine Rhine & tributaries (Lake Constance sea trout)			**7**	**14**	**10**	**3,14**
Lake Constance & Alpine Rhine cumulated			**7**	**21**	**31**	

n.s. = not specified

*Wherever possible, a preview of planned measures was made using the following colour codes:

	"Implementation ongoing": Measures the implementation of which has just begun or just been completed
	"planned": Measures, for which the planning permission procedure has been accomplished and financing is secured
	"scheduled": Measures for which the required work will presumably start before the end of 2012

** The R. Neckar and its tributaries are not central migration routes and habitats for anadromous fish species.

Annex 2: Stocking measures in the Rhine system 2010 - 2012

Stocking measures with big salmonids in the Rhine system 2010				
Country / Water body	**Stocking**			
Switzerland	Kind and stage	Number	Origin	Marking
	Lb (L_a)	15.000	Allier	no
	Lp	10.000	Allier	cwt a/c
France				
Rhine (Old Rhine)	Lb (L0)	26.500	Allier	no
	Lb (L_a)	24.800	Allier	no
	Lb (L_a)	8.300	Allier	no
Doller	Lb (L_a)	30.000	Allier	no
Thur	Lb (L_a)	31.000	Allier	no
Lauch	Lb (L_a)	10.000	Allier	no
Fecht and tributaries	Lb (L_a)	34.550	Allier	no
	Lb (L_a)	8.450	Allier	no
Giessen and tributaries	Lb (L_a)	30.000	Allier	no
Bruche	Lb (L_a)	65.480	Allier	no
	Lb (L_a)	8.400	Rhine	no
Moselle	Lb (L_a)	5.000	Ätran (HAT)	no
Houille	Lb (L_a)	3.000	Allier	no
Luxembourg		0		
Germany, Bavaria		not specified		
Germany, Baden-Württemberg				
Alb	Lb (L_a)	27.540	Allier	no
Murg	Lb (L_a)	48.000	Allier	no
Oos	Lb (L_a)	13.000	Allier	no
Rench	Lb (L_a)	15.000	Allier	no
Kinzig and tributaries	Lb (L_a)	105.800	Allier	no
Elz	Lb (L_a)	8.700	Allier	no
Dreisam	Lb (L_a)	3.000	Allier	no
Wiese	Lb (L_a)	2.000	Allier	no
Germany, Hesse				
Lahn	Lp	3.500	Lahn	a/c
Kinzig	Lp	800	Lahn; Lahn x EFH Sieg	no
Schwarzbach	Lp	9.200	Lahn; Lahn x EFH Sieg	no
Wisper	Ls 1	1.900	EFH Sieg	a/c
Wisper	Lp	8.600	EFH Saynbach	no
Nidda	Mf p	6.500	Wupper	a/c
Germany, Rhineland-Palatinate				
Ahr	Ls 1	9.850	EFH Sieg	a/c
	Lp	34.000	Lahn & Lahn x EFH Sieg (80%), EFH Sieg (20%)	
Lahn	Ls 1	1.600	EFH Sieg	a/c
	Lp	3.000	Lahn	a/c
Moselle	Ls 1	3.300	EFH Sieg	a/c
	Lp	20.000	Lahn; Lahn x EFH Sieg	
Saynbach	Ls 1	3.300	EFH Sieg	a/c
Sieg	Lp	5.000	EFH_Sieg	
	Lp	18.000	EFH Sieg (25%), KFS Sieg (75%)	
	La	11.000	KFS Sieg	
	Ls 1	4.000	EFH Sieg	
	Lp 1	1.000	EFH Sieg	
	Ls 1	3.500	EFH Sieg	a/c
Wieslauter	Lp	2.000	Allier	
Germany, Northrhine-Westphalia				
Sieg and tributaries	Lb (L0)	55.000	Sieg	no
	Lb (L_a)	397.669	Sieg (partly Ätran)	no
	Lp	35.000	Sieg	no
	L1	20.426	Sieg	no
	L1 / Ls	17.292	Sieg	partly cwt a/c
	L1 / Ls	2.290	Sieg	cwt a/c
	L1 / Ls	40	Sieg	Transponder
	L1 / Ls	60	Sieg	no
Wupper and small tributaries	Lb (L_a)	81.000	Sieg	no
	Lp	15.000	Sieg	no
	L1 / Ls	40	Sieg	Transponder
	L1 / Ls	60	Sieg	no
Dhünn and small tributaries	Lb (L_a)	40.000	Ätran	no
	L1 / Ls	40	Sieg	Transponder
	L1 / Ls	60	Sieg	no
cwt = coded wire tags; a/c = adipose clipping; EFH = parent fish keeping;				
KFS = Monitoring and catching station; L e = salmon spawn; L b = Salmon fry; L0 0 unfeeded fry; La = feeded fry;				
L p = Salmon parr; L ps = Salmon pre-smolt; L s = Salmon smolt; L 1 = one year old salmon; L 2 = two years old salmon				
Mf p = Sea trout parr; k. A. = not specified by deadline				
Sum stocking stages		**1.347.547**		

Stocking measures with big salmonids in the Rhine system 2011

Country / Water body	Stocking			
Switzerland	Kind and stage	Number	Origin	Marking
Rhine	Lp	7.000	Allier	cwt a/c
Birs	Lp	1.000	Allier	cwt a/c
Ergolz	Lp	500	Allier	cwt a/c
Riehen Tych	Lp	300	Allier	cwt a/c
Wiese	Lp	1.000	Allier	cwt a/c
Arisdörferbach	Lb (L_a)	3.000	Allier	no
Möhlinbach	Lb (L_a)	6.000	Allier	no
Etzgerbach	Lb (L_a)	2.000	Allier	no
Bachtalbach	Lb (L_a)	1.000	Allier	no
Magdenerbach	Lb (L_a)	2.000	Allier	no
France				
Rhine (Old Rhine)	L0	80.000	Allier	no
	L0	45.700	Allier	no
	La	91.000	Allier	no
Doller	La	2.500	Allier	no
Thur	La	16.750	Allier	no
Lauch	La	22.000	Allier	no
Fecht and tributaries	La	5.760	Allier	no
	La	31.200	Allier	no
Giessen and tributaries	La	12.690	Allier	no
Bruche	La	37.220	Allier	yes 2120 a/a
	La	17.300	Allier	no
Moselle	La	5.000	Ätran (HAT)	no
Houille	Lb (L_a)	3.000	Allier	no
Luxembourg				
Sure (Moselle)	L1	10.000	Ätran (DCV)	cwt a/c
Germany, Baden-Württemberg				
Alb	La	19.800	Allier	no
Murg	La	81.000	Allier	no
	Lp	500?	Allier	no
Oos, Oosbach	La	15.000	Allier	no
Rench	La	12.000	Allier	no
Kinzig and tributaries Erlenbach,	La	121.550	Allier	no
Gutach, Wolf	Ls	4.600	Allier	no
Elz	La	25.000	Allier	no
Dreisam	La	2.000	Allier	no
Wiese	La	5.000	Allier	no
Germany, Hesse				
Lahn, Dill, Weil	-	-	-	-
Kinzig (Main)	Lp	400	Sieg (HAT)	no
Schwarzbach (Main)	Lp	4.600	Sieg (HAT)	no
Main (test fish hydroelectric plant Kost	Ls	2.800	Sieg (HAT)	a/c
Wisper	Ls	1.800	Sieg (HAT)	a/c
Wisper	Lp	4.000	Sieg & Saynbach (HAT)	
Germany, Rhineland-Palatinate				
Ahr	Ls	10.000	Ätran (DCV)	no
	Ls	4.000	Sieg (HAT)	a/c
	Lp	33.500	Sieg (HAT)	no
Lahn, Mühlbach	-	-	-	-
Moselle, Elzbach	Ls	6.000	Sieg (HAT)	a/c
	Lp	2.570	Sieg	no
Saynbach	Ls	3.500	Sieg (HAT)	a/c
Nister, Kleine Nister (Sieg)	Ls	10.200	Sieg	a/c
	Lp	10.000	Sieg (HAT)	no
Nister (Sieg)	Lp	12.800	Sieg (HAT)	no
Wisserbach (Sieg)	Ls	2.400	Sieg (HAT)	a/c
Wieslauter	Lp	7.000	Allier	no
Germany, Northrhine-Westphalia				
Sieg and tributaries	Lb (L0)	176.129	Sieg	no
	Lb (L_a)	192.417	Sieg	no
	Lp 1+	16.550	Sieg	partly a/c
	Lp 1+	24.000	Ätran (DCV)	a/c
	L1 / Ls	5.420	Sieg	cwt a/c
	L1 / Ls	65	Sieg	Transponder
Wupper and small tributaries	Lb (L0)	50.000	Sieg	no
	Lb (La)	66.000	Sieg	no
	L1 / Ls	65	Sieg	Transponder
Dhünn and small tributaries	Lb (L0)	35.000	Sieg	no
	L1 / Ls	65	Sieg	Transponder
cwt = coded wire tags; a/c = adipose clipping; EFH = brood stock keeping; HAT = Hasper reservoir and dam				
KFS = Monitoring and catching station; L e = salmon spawn; L b = Salmon fry; L0 0 unfed fry; La = fed fry;				
L p = Salmon parr; L ps = Salmon pre-smolt; L s = Salmon smolt; L 1 = one year old salmon; L 2 = two years old salmon				
Mf p = Sea trout parr; k. A. = not specified by deadline DCV = Danish Center for Vildlaks (Wild salmon)				
Sum stocking stages		**1.371.151**		

Stocking measures with big salmonids in the Rhine system 2012

Country / Water body	Stocking			
Switzerland	Kind and stage	Number	Origin	Marking
Rhine	Lp	6.200	Allier	cwt ac
Birs	Lp	1.000	Allier	cwt ac
Ergolz	Lp	500	Allier	cwt ac
Riehen Tych	Lp	300	Allier	cwt ac
Wiese	Lp	1.000	Allier	cwt ac
Arisdörferbach	Lb (L_a)	3.000	Allier	no
Möhlinbach	Lb (L_a)	6.000	Allier	no
Etzgerbach	Lb (L_a)	3.000	Allier	no
Bachtalbach	Lb (L_a)	500	Allier	no
Magdenerbach	Lb (L_a)	2.000	Allier	no
France				
Rhine (Old Rhine)	L0	119.000	Allier	No
	La	75.000	Allier	No
	La	9.800	Allier	No
Doller	La	31.750	Allier	No
Thur	La	31.150	Allier	No
Lauch	La	10.760	Allier	No
Fecht and tributaries	La	41.500	Allier	650 a/c
Ill	La	3.840	Allier	No
Giessen and tributaries	La	37.900	Allier	400 a/c
Bruche	La	42.320	Allier	2120 a/c
	La	7.400	Rhine	No
Moselle	La	5.000	Ätran (HAT)	No
Houille	La	3.000	Allier	No
Blies	La	3.000	Allier	No
Luxembourg				
Sure (Moselle)		0		
Germany, Baden-Württemberg				
Alb	La	20.500	Allier	no
Murg	La	63.800	Allier	no
Oos, Oosbach	La	11.900	Allier	no
Rench	La	13.300	Allier	no
Kinzig and tributaries Erlenbach, Gutach, Wolf	La	111.600	Allier	no
	Lps	12.600	Allier	no
	La	4.600	Rhine	no
Elz	La	23.000	Allier	no
Dreisam	La	8.400	Allier	no
Wiese	La	12.300	Allier	no
Germany, Hesse				
Lahn, Dill, Weil	Ls	1200	EFH Sieg & Saynbach (HAT)	a/c
Kinzig (Main)	Lp	800	EFH Sieg & Saynbach (HAT)	no
Schwarzbach (Main)	Lp	18700	EFH Sieg & Saynbach (HAT)	no
Main (test fish hydroelectric plant Kostheim)		0		
Wisper	Lp	10000	EFH Sieg & Saynbach (HAT)	no
	Ls	2300	EFH Sieg & Saynbach (HAT)	a/c
Germany, Rhineland-Palatinate				
Ahr	Lp	80.000	EFH Sieg & Saynbach (HAT)	no
Lahn, Mühlbach	Ls	3.000	EFH Sieg & Saynbach (HAT)	a/c
	L2	200	EFH Sieg & Saynbach (HAT)	a/c
Moselle, Elzbach	Lp	16.300	EFH Sieg & Saynbach (HAT)	no
Saynbach	Ls	3.300	EFH Sieg & Saynbach (HAT)	a/c
Nister, Kleine Nister (Sieg)	Lp	12.000	EFH Sieg & Saynbach (HAT)	no
Nister (Sieg)	Ls	10.000	KFS Sieg (HAT)	a/c
	Lp	18.500	KFS Sieg (HAT)	no
	Lp	27.000	EFH Sieg & Saynbach (HAT)	no
Wisserbach (Sieg)	Ls	2.000	KFS Sieg (HAT)	a/c
	Lp	12.000	EFH Sieg & Saynbach (HAT)	no
Wieslauter	Lp	20.000	Allier	no
Germany, Northrhine-Westphalia				
Sieg and tributaries	Lb (L0)	155.455	Sieg	no
	Lb (La)	297.999	Sieg	no
	Lb (La)	214.600	Ätran	no
	Lp (0+)	33.500	Sieg	partly a/c
	Lp (0+)	150.000	Ätran	a/c
	Lp (1+)	9.000	Sieg	no
	L1 / Ls	12.000	Sieg	cwt a/c
Wupper and small tributaries	Lb (L0)	56.000	Sieg	no
	Lb (La)	57.300	Sieg	no
	Lp (0+)	25.000	Sieg	no
Dhünn and small tributaries	Lb (L0)	60.000	Sieg	no
	Lp (0+)	20.728	Sieg	no
cwt = coded wire tags; a/c = adipose clipping; EFH = brood stock keeping;				
KFS = Monitoring and catching station; L e = salmon spawn; L b = Salmon fry; L0 0 unfeeded fry; La = feeded fry;				
L p = Salmon parr; L ps = Salmon pre-smolt; L s = Salmon smolt; L 1 = one year old salmon; L 2 = two years old salmon				
Mf p = Sea trout parr; k. A. = not specified by deadline				
Sum stocking stages		**2.055.802**		

Annex 3: Natural reproduction of Atlantic salmon and sea trout in the waters of the Rhine catchment 1994-2012

Proof of reproduction of salmon returned to the Rhine system

Country	System	Project water - Selection of the most important tributaries (* no stocking)	First salmon stocking	Year of spawning proof (reproduction during the preceding autumn/winter)																		
				1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
D	Wupper-Dhünn	Wupper	1993	/	/	/	/	/	/	/	/	0	/	/	/	/	/	(X)	/	/	/	/
		Dhünn		/	/	/	/	/	/	/	/	0	/	/	X	X	/	/	/	/	/	/
		Eifgenbach		/	/	/	/	/	/	/	/	/	/	/	/	0	/	/	/	/	/	/
D	Sieg	Sieg NRW	Salmon stocking measures in the Sieg river system since 1988, since 1998 in addition to classical umber and barbel regions also in selected smaller and medium sized brooks	X	/	/	/	/	/	/	X	0	XX	/	/	/	/	/	/	/	/	XX
		Agger (lower 30 km)		X	/	/	/	/	/	/	0	0	XXX	XXX	XXX	XX	XXXX	XXXX	XXXX	/	/	XXX
		Naafbach		/	/	/	/	/	/	/	XX	0	/	XXX	XXX	XXX	XXXX	XXXX	XXXX	/	/	XXX
		Pleisbach		/	/	/	/	/	/	/	0	/	/	0	/	/	X	/	X	/	/	/
		Hanfbach		/	/	/	/	/	/	/	/	0	/	0	X	/	/	/	/	/	/	/
		Bröl		X	/	/	X	/	/	/	0	0	XX	XX	0	XX	XXX	/	XXX	/	/	/
		Homburger Bröl		/	/	/	/	/	/	/	0	0	/	XX	XXX	XX	X	/	/	/	/	/
		Waldbröl		/	/	/	/	/	/	/	0	0	/	0	0	XXX	XXX	/	0	/	/	/
		Derenbach		/	/	/	/	/	/	/	/	/	/	/	/	0	/	/	/	/	/	/
		Steinchesbach		/	/	/	/	/	/	/	/	/	/	/	/	0	/	/	/	/	/	/
		Krabach		/	/	/	/	/	/	/	/	/	/	/	X	/	/	/	/	/	/	/
		Gierzhagener Bach		/	/	/	/	/	/	/	/	0	/	/	/	/	X	/	/	/	/	/
		Irsenbach		/	/	/	/	/	/	/	/	0	/	/	/	/	/	/	/	/	/	/
		Sülz		/	/	/	/	/	/	/	0	0	/	/	/	XX	/	/	/	/	/	XXX
		Schlingenbach		/	/	/	/	/	/	/	/	0	/	/	/	/	X	XXXX	XXX	/	/	XXX
		middle Sieg RLP	1994	/	/	/	/	/	/	/	X	0	0	0	X	X	X	XXXX	X	0	?	?
		Nister system	1991	/	/	/	/	/	XX	0	X	X	X	X	X	XXX	XX	XXXX	X	X	X	X
		Wisserbach	1991	/	/	/	/	/	/	XXX	XX	XX	0	X	XX	XXX	XX	XXXX	0	X	0	0
		Elbbach	1995	/	/	/	/	/	/	/	/	0	X	0	/	/	XX	XX	0	0	0	/
		Heller-Daade	1998	/	/	/	/	/	/	/	/	0	0	/	/	/	X	X	x	0	0	0
		Asdorf	1997	/	/	/	/	/	/	/	/	0	0	/	/	/	/	/	/	0	/	/
D	Ahr	Ahr	1995	/	/	/	/	/	/	X	0	0	X	X	0	0	0	?	0	XX	XX	0
D	Nette	Nette *	-	/	/	/	/	/	/	/	X	0	XX	X	X	X	0	X	0	X	0	X
D	Saynbach	Saynbach	1994	/	/	/	/	/	/	XX	XX	XX	XXX	XXXX	XXXX	XX	XXXX	XXXX	XX	XX	XXX	X
		Brexbach	1994	/	/	/	/	/	/	XXXX	XX	X	X	0	0	0	0	XXX	XX	XX	0	0
D	Moselle	Elzbach	2005	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Kyll	1996	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Prüm system	1996	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Lux/D		Sure	1992	/	/	/	/	/	/	/	/	/	0	/	/	/	/	/	/	/	/	/
		Our	1992	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D	Lahn	Mühlbach	1994	/	/	/	/	/	/	(X)	0	/	/	/	/	/	/	/	/	/	/	/
		Weil	1995	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Dill	1995	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D	Nahe	Nahe	2004 (unique)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D	Wisper	Wisper	1999	/	/	/	/	/	/	/	/	0	XX	XX	0	0	XX	XXXX	0	X	XX	0
D	Main	Schwarzbach	2009	/	/	/	/	/	/	/	/	/	/	/	/	/	/	0	0	0	0	0
		Kinzig system (Hesse)	2001	/	/	/	/	/	/	/	/	/	/	/	/	0	/	/	/	/	/	/
D	Alb	Alb	2001	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X	X
D/F	(Wies)Lauter	(Wies)Lauter	1991	/	/	/	/	/	/	/	/	/	/	/	/	/	/	?	?	?	X	X
D	Murg	Murg	2001	/	/	/	/	/	/	/	/	/	/	/	X	X	X	/	/	/	X	X
F / D	Rhine	Rhine downstream Iffezh	-	/	/	/	/	/	/	/	/	/	/	X	/	/	/	/	/	/	/	/
D	Rench	Rench	2001	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
F	Ill	Bruche	1991	/	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XXX	XXX	XXX	XXX
		Fecht	1991	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	XX	X	XX
		Upper Ill system**	1991	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	X	X	X
		Moder	2005	/	/	/	/	/	/	/	/	/	/	/	X	X	X	X	X	X	X	X
D	Kinzig	Kinzig (Baden-Württemb	2001	/	/	/	/	/	/	/	/	/	/	X	/	/	/	/	/	X	X	X
D	Elz-Dreisam	Elz	2005	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Dreisam	2008	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
F / D	Rhine	Old branch of the Rhine	1991	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
CH	Wiese	Wiese	1984	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
CH	Birs	Birs	1995	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
CH	Ergolz	Ergolz	1995	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
				1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012

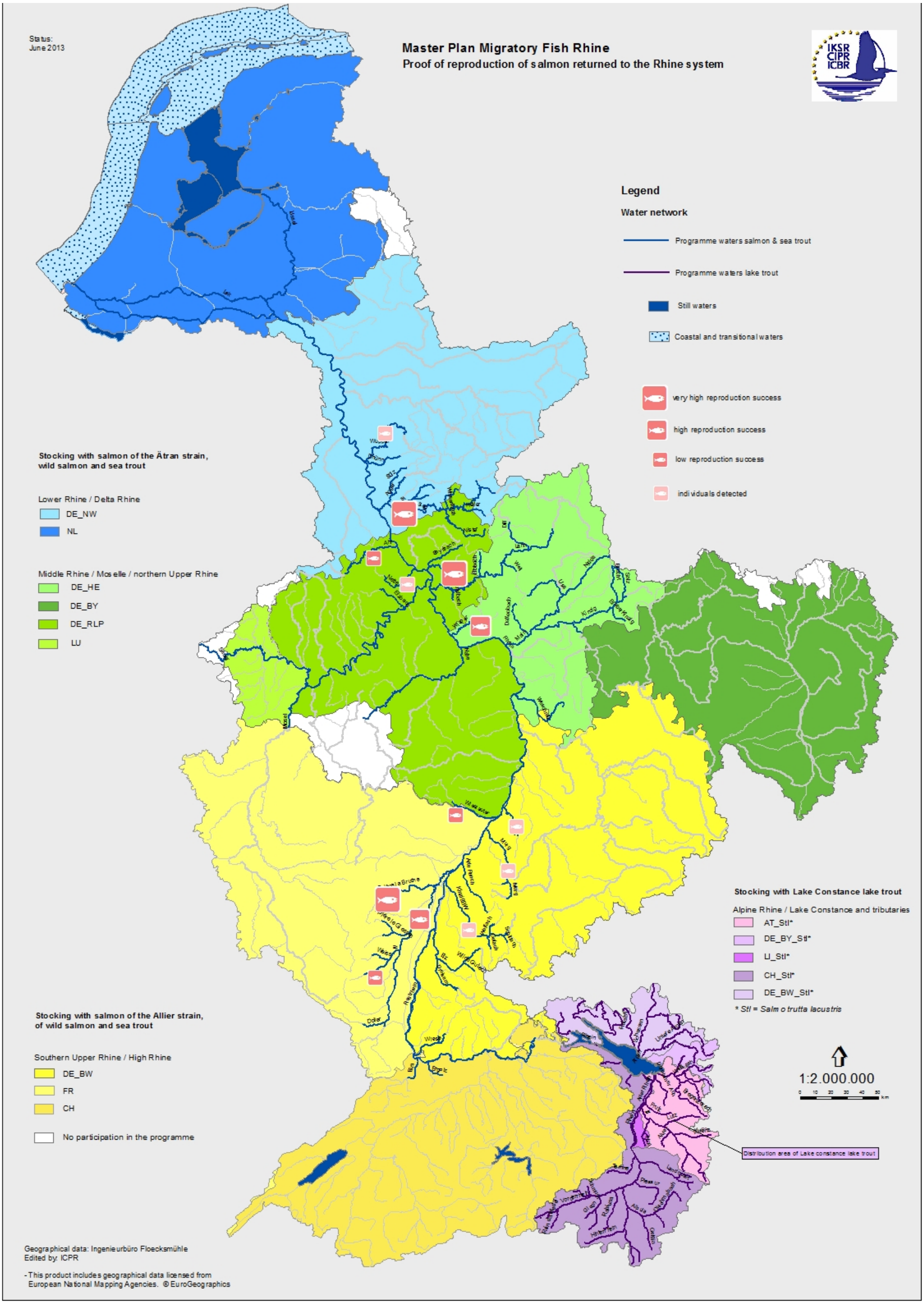
LEGEND

quality proof / individuals detected / samples taken from individual locations	X
qualitative evidence / returnees released upstream of obstacle	(X)
little success of reproduction (1 to ≤ 5 parr/100 m2)	XX
considerable success of reproduction (> 5 - 50 parr/100 m2)	XXX
extremely high rate of success of reproduction (> 50 parr/100 m2)	XXXX
Investigations carried through, no cases detected	0
no investigation	/
Evidence uncertain	?

Spawning grounds (largely) accessible
Spawning grounds partially accessible/accessible to a limited extent
Spawning habitats not accessible/accessible in exceptional cases

** Ill river system without rivers Thur and Lauch

Annex 3: Natural reproduction of Atlantic salmon and sea trout in the waters of the Rhine catchment



Annex 4: Identification of adult salmon in the Rhine system since 1990 (ICPR returnee statistics)

Adult salmon detected in the Rhine system since 1990

Fish of 50 cm or more are considered to be adult (first catches)

Year	Switzerl and	France		*Baden-Württemberg*						*Hesse and Rhineland-Palatinate*									*North Rhine Westphalia*					Netherlands			**Rhine**	Year
	High Rhine	Rhine*, Ill	Gambs-heim	Iffez-heim	Elz-Dreisam	Murg	Kinzig	Rench	Alb	Others **	Main	Wisper	Nette	Lahn	Sayn-bach	Mosel	Ahr	Sieg	Rhine	Sieg	Wupper	Ruhr	Lippe	IJssel	Waal	Lek	**Total**	
1990																1				1							**1**	**1990**
1991																2				2							**2**	**1991**
1992																10				10							**11**	**1992**
1993																0			2	15							**18**	**1993**
1994																0				9					16	7	**32**	**1994**
1995				9												1			1	6					7	4	**28**	**1995**
1996				23						1				0	4	1			1	15					2	15	**62**	**1996**
1997				5										1	8	3				13				2	5	8	**45**	**1997**
1998				7										0	1	4	0	2		42	7		1	0	2	3	**69**	**1998**
1999				3										8	21	7	12	7		53	15		1	0	12	85	**224**	**1999**
2000				75				1						5	35	14	2	8		335	21		1	3	28	194	**722**	**2000**
2001		2		59									1	4	12	4	10	0		84	12			1	23	110	**322**	**2001**
2002				94				1		1		3	0	3	20	11	8	9		213	17	3		3	28	72	**486**	**2002**
2003				90		1				2		2	0	15	37	3	2	8		160	20	1	2	3	44	50	**440**	**2003**
2004				72			1					0	2	8	17	4	11	5		93	37			4	33	28	**315**	**2004**
2005				49								0	2	0	6	1	5	10		195	39			6	38	12	**363**	**2005**
2006			18	47		2	1	1		1		4	1	5	13	4	0	11	1	287	43			4	28	18	**489**	**2006**
2007			27	62		3				1		4	1	12	26	2	1	24		463	69			4	79	27	**805**	**2007**
2008		1	70	86					2	2		1	1	8	21	10	3	9	4	339	32	1		4	43	33	**670**	**2008**
2009		3	46	52	1	3	0	0	1	2	0	7	3	28	21	6	3	2	0	282	30	0	0	4	60	18	**572**	**2009**
2010		8	26	18	1	0	2	0	0	2	0	3	3	10	10	0	1	5	0	385	8	0	0	4	47	25	**558**	**2010**
2011		3	47	50	2	2	12	0	1	1	1	0	0	9	1	0	0	2	1	196	6	0	0	5	8	44	**391**	**2011**
2012	2	3	53	22	1	4	6	1	0	2	0	0	0	3	8	5	1	3	2	127	5	0	0	11	46	39	**344**	**2012**
2013																											**0**	**2013**
Total	***2***	***20***	***287***	***823***	***5***	***15***	***22***	***4***	***4***	***15***	***1***	***24***	***14***	***119***	***261***	***81***	***59***	***105***	***12***	***3326***	***361***	***5***	***5***	***58***	***549***	***792***	***6969***	*Total*

Information according to data of local working groups.
The tributaries of the Rhine indicated include the entire respective subsystem (e.g. Wupper and Dhünn).
* FR: Rhine upstream of Gambsheim
**DE-HE + DE-RP: "Others" includes reports from the Rhine and other tributaries (e.g. Wieslauter, Wied, Weschnitz)

Annex 5: Map: "Master Plan Migratory Fish Rhine" - coordination units, monitoring stations, hatcheries