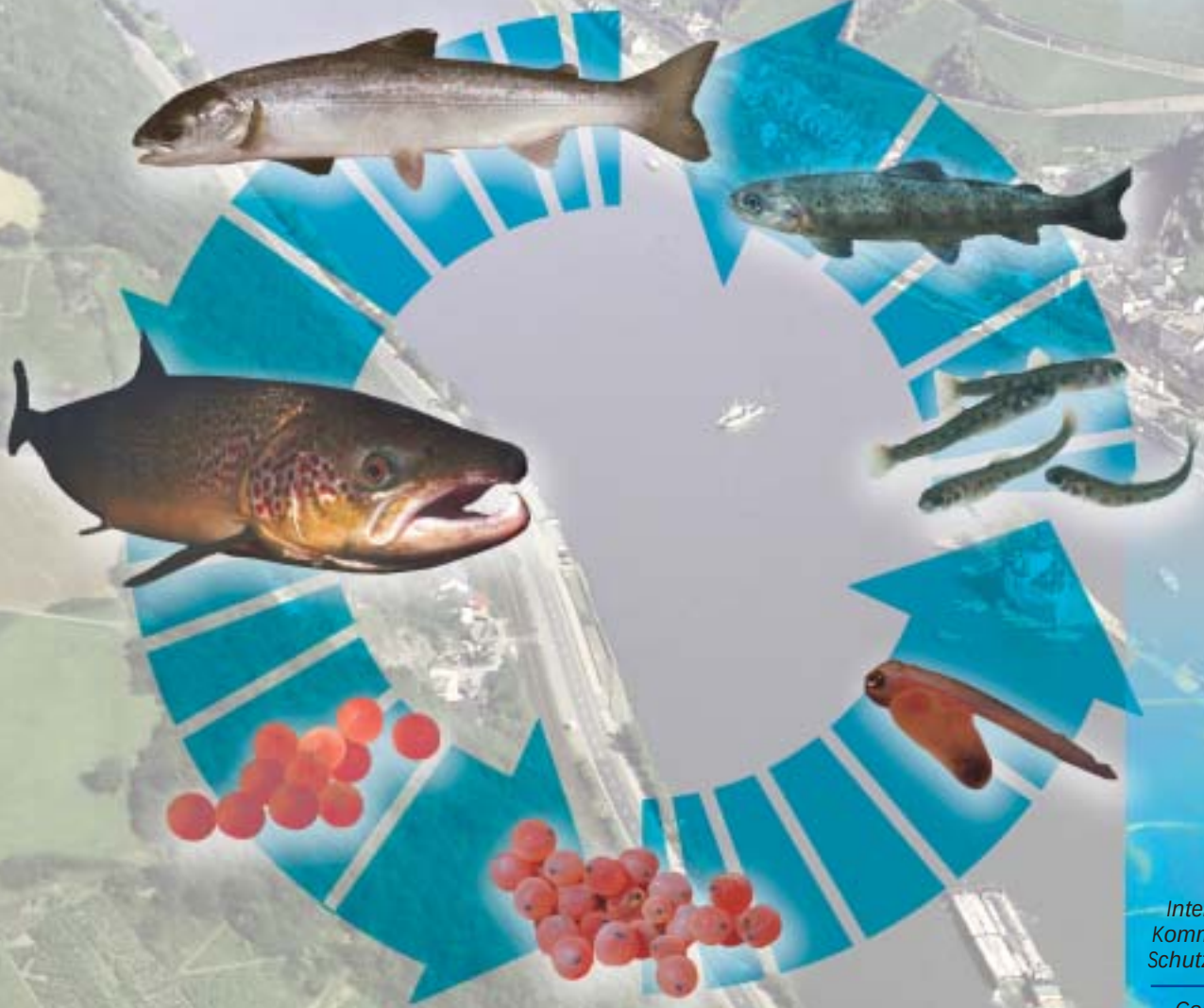
Rhine Salmon 2020



IKSR
CIPR
ICBR

Internationale Kommission zum Schutz des Rheins

Commission Internationale pour la Protection du Rhin

Internationale Commissie ter Bescherming van de Rijn

Auf Perlen schäumenden Weines
Herzliebchen trag' ich dich fort,
Fort zu den Ufern des Rheines,
Dort weiß ich den schönsten Ort.

Dort siehst eine Insel Du ragen
Im hellen Mondenschein,
Die Pfalz die tut sie tragen,
Dort wandern wir dann zu zwei'n.
…
Es schwimmen herbei und lauschen
Die Salme, die leckern Gesell'n,…

„Herzliebchen in der Pfalz"
Heinrich Heine (1824)

Photo: LMZ, H.P. Merten

The island Pfalz near Kaub in the Middle Rhine

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Rhine & Salmon 2020

A Programme for Migratory Fish in the Rhine System

Summary

"Salmon 2000" and its successful actions in favour of migratory fish is being continued in the 21st century. It is part of the new ICPR working programme "Rhine 2020". So visions can become true:

1st vision: Several thousands of salmon in the Rhine

The list of suitable salmon habitats in the Rhine tributaries has become considerably longer. Therefore, the hope of the ICPR to achieve a larger salmon population than what was calculated only five years ago, seems to be justified. Careful estimate: 7,000 to 21,000 salmon annually migrating upstream.

2nd vision: Undisrupted salmon migration as far as Basel

Since 2001, three new fish passages have been opened in the Rhine delta. Numerous weirs have been changed or lowered in the tributaries to the Lower, Middle, Upper and High Rhine. On the Upper Rhine, the Iffezheim fish passage was put into service in 2000. In 2006, the second huge fish passage will open its gates at Gambsheim.

3rd vision: Salmon stocking is self-sustaining

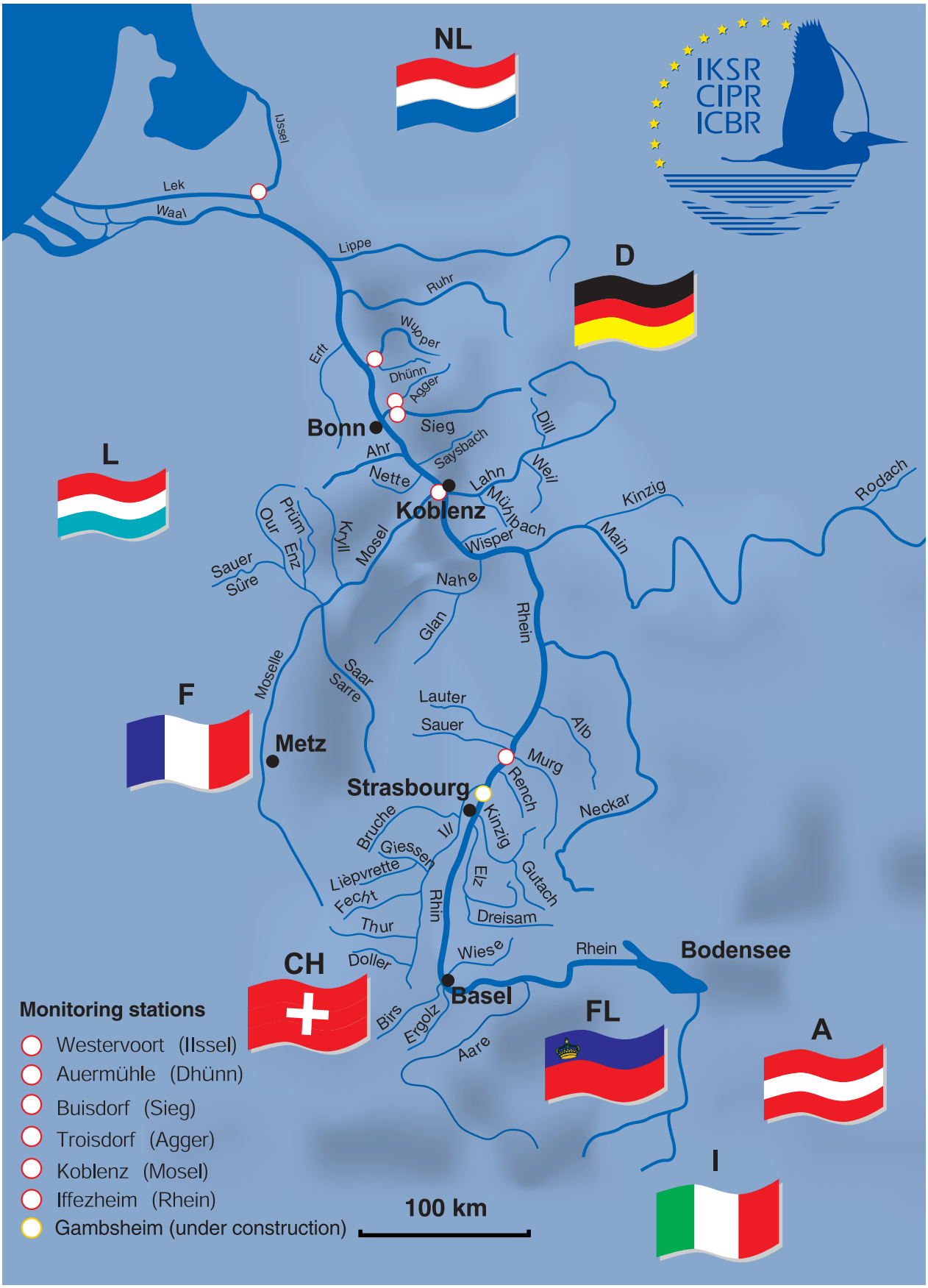
During the past five years, some 11 million juvenile salmon have been released into the Rhine catchment. Partly, they are the descendants of adult returning salmon.

4th vision: Wild salmon in the Rhine in 2020

The return of salmon from the ocean and, above all, their natural reproduction prove the success of this programme. Since 1990, evidence has been given of more than 2400 adult salmon returning and migrating upstream the Rhine system. More than 300 of them used the new fish passage at Iffezheim, 700 km upstream the estuary.

Rhine salmon are not yet independant of human help and stocking exercises. But they already reproduce naturally in several tributaries to the Lower, Middle and Upper Rhine. This raises hopes that stable wild salmon populations may be achieved in the Rhine system by the year 2020.

Map of projects



Introduction

This brochure is published five years after the International Rhine Symposium in Rastatt and the brochure "Has the Rhine again become a Salmon carrying River". In 1999, conclusions were: The Rhine Action Programme and "Salmon 2000" prove to be a great success and have reached the target to enable migratory fish such as the salmon to return to a restored Rhine (ICPR reports 102 +103, 1999).

The salmon has returned, but it is still hiding. We want it to be abundant, as a source of joy!

Mrs Perrin-Gaillard / Deputee from Paris, Rhine Symposium 1999

Photo: H. Stolzenburg

Rhine Symposium in Rastatt, 1999

The great enthousiasm for Salmon 2000 in Switzerland, France, Germany, Luxemburg and right up to the Netherlands has made the programme to a success story

Anne Schulte-Wülwer-Leidig (2000)

Photo: ASR Strasbourg

Atlantic salmon (Salmo salar)

A vision of wild salmon in the Rhine

We must now head for a new, demanding target, which is the development of stable Rhine salmon populations capable of natural reproduction and maintenance of stock without any stocking exercise or other human help. The ICPR work programme Rhine 2020 puts the requirements of the EU Water Framework Directive (WFD) into concrete terms. Its objective is to achieve the good ecological status of all rivers or the maximum environmental potential in case of heavily modified water bodies. Further pan-European regulations, such as the Flora-Fauna-Habitat (FFH) directive help preserve and develop natural aquatic ecosystems.

EU water framework directive

- *focuses on biological indicators*
- *defines the good ecological status*
- *fixes 2015 as deadline for achieving the good status in all European water bodies*

Targets Rhine 2020

- *Restore the habitat patch connectivity*
- *Ecological patency of the R. Rhine from Lake Constance to the North Sea as well as of the tributaries listed in the programme on migratory fish.*

IKSR (2001) p. 12

Photo: Wolfram Gonitz

Old bed of the Rhine

Target: biological diversity along the Rhine

So the programme Rhine 2020 looks at the biological diversity of the Rhine system. Apart from the salmon, the target species within this programme are the many typical plants and animals which formerly or today colonize the river, its tributaries and alluvial areas. Other migratory fish species swim in the wake of the salmon, e.g. sea trout, allice shad and river lamprey but also great crested grebe and kingfisher, beaver and otter as well as water nut and water fringe, because all actions targeted at protecting and renaturing the Rhine river system enhance its natural biological diversity.

Rhine Salmon 2020 Actions

1. *Restore habitats*
2. *Activate floodplains*
3. *Improve river structure*
4. *Remove obstacles to free migration and develop a subnatural network of habitats*

Targets of the Flora-Fauna-Habitat (FFH) directive

- *Implement the Rio de Janeiro Convention on biological diversity of 1992*
- *Protect European natural heritage*
- *Preserve endangered plant and animal species within a network of strictly protected areas = NATURA 2000*

Directive 92/43/EEC

Species protected according to the FFH directive, e.g.:

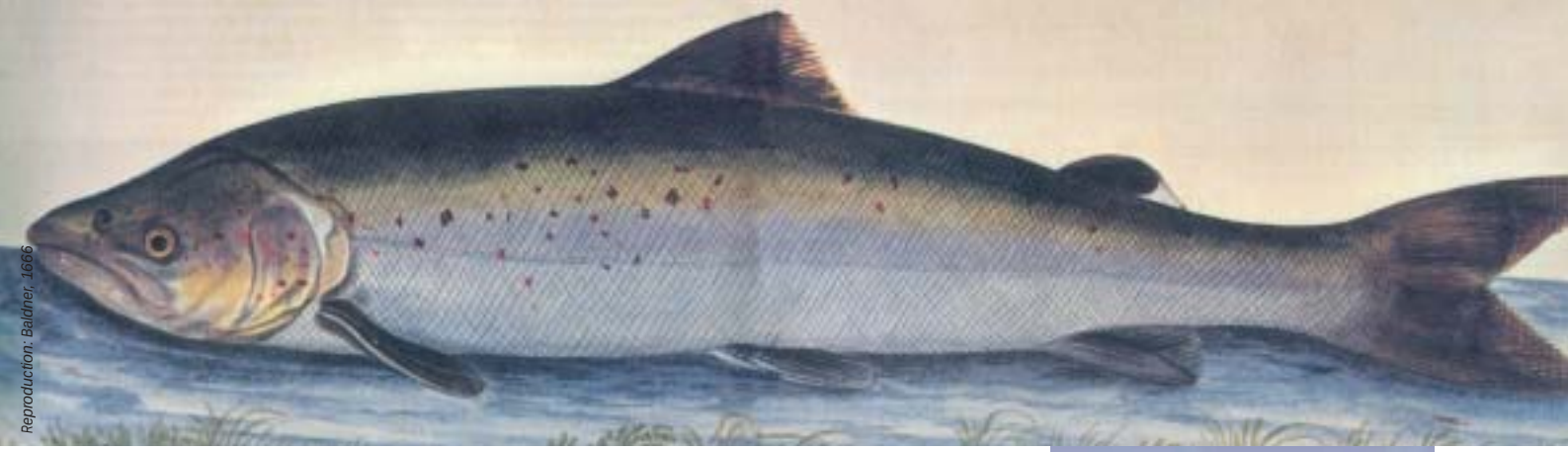
- *Atlantic salmon (and other migratory fish)*
- *river pearl mussel*
- *yellow-bellied toad*
- *beaver*
- *otter*

Otter

Kingfisher

Great crested grebe

Photos: Manfred Delpho, www.delpho.de



Reproduction: Baldner, 1666

Salmon taken from Geßner

The history of salmon fishery...

along the Rhine goes right back to Roman times, some 2000 years ago. As late as the 18th century, the R. Rhine was considered to be the most important and the biggest salmon river in Europe and salmon belonged to staple food. But massive stocking exercises began as early as the 19th century and an international salmon treaty was passed, targeted at "increasing the stock of salmon in the Rhine area" (Reichsamt 1886). Since mill weirs obstructed the access to numerous spawning areas, fishermen demanded the construction of "salmon ladders".

The pollution of the Rhine with domestic and industrial waste water started to be a problem in the 19th century and culminated in the mid 20th century. Rhine salmon died out in the 1950s.

The Salmon

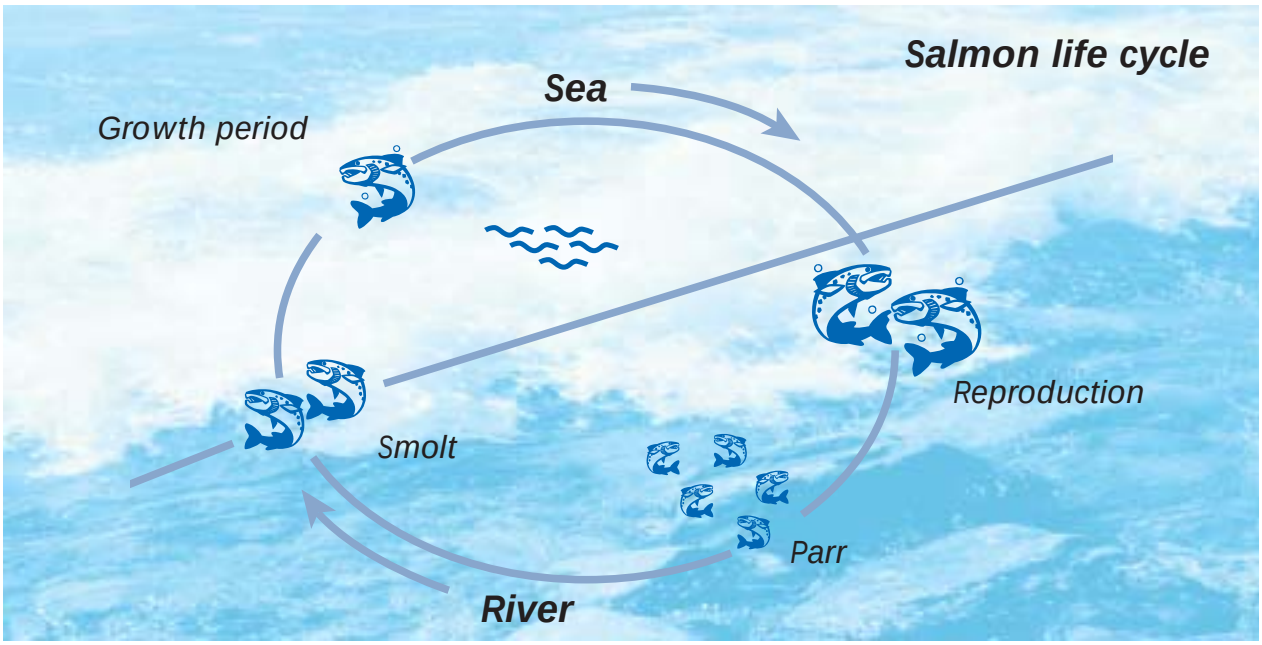
In Siberia, Russia and Scandinavia the salmon is of great importance for public nourishment; for us, it is rather considered to be a delicacy (Rhine salmon) and is sold fresh, smoked and soused.

Meyers Encyclopedia, vol. 10, Leipzig and Vienna (1895)

Due to poor water quality in the lower course of the Rhine, the International Commission for the Protection of the Rhine (ICPR) was then founded. Following the fire of the Sandoz warehouse near Basel and the resulting great fish kills in 1986, the efficacy of the ICPR and its Rhine Action Programme as well as the projects for migratory fish "Salmon 2000" was enormous.

Landmarks Rhine salmon + ICPR

1986	*The disastrous chemical accident in Basel caused fish and invertebrate kills as far downstream as the Lower Rhine*
1987	*The reply of the ICPR is the Rhine Action Programme or Salmon 2000*
1990	*The first salmon migrates from the sea into the Lower Rhine and further into the R. Sieg*
1991	*The ICPR drafts the Ecological Master Plan and a Programme for Migratory Fish*
1994	*First natural salmon reproduction in the R. Sieg system / Lower Rhine*
1995	*The first salmon reaches the Iffezheim barrage on the Upper Rhine*
1997	*First natural salmon reproduction in the Alsacian Ill river system*
1999/2000	*First salmon redds in the R. Ahr and Saynbach / Middle Rhine*
2000	*Iffezheim fish passage and monitoring station put into service*
2000	*Opening of the control station Buisdorf on the R. Sieg*
2000	*EU Water framework directive (WFD) comes into effect*
2000	*Rhine 2020 – Programme on the sustainable development of the R. Rhine adopted by Rhine Ministers*



The life cycle of Atlantic salmon...

starts in spring, when the larvae are hatched from the chorion dug deep into the gravel bed of limpid brooks in Europe and North America. As long as the alevins feed on their yolk sack, they avoid daylight and are largely immobile. Later they wriggle up from the gravel bed and search for suitable habitats in the shallow parts of the river. They feed on microscopic life in the stream and grow to spottet parr. After 1 or 2 years they leave the river as 12-20 cm long silvery smolts and gain the sea. In the Atlantic Ocean they travel to the feeding grounds around Greenland, where they feed on crustaceans and smaller fish and grow rapidly. Multi sea winter salmon having spent several winters in the ocean may weigh more than 10 kilos and grow to a size of 80 to 100 cm. As they become mature, they return over thousands of kilometres from the Atlantic Ocean back to the estuary of their natal river and migrate upstream.

It is believed that it is above all the smell which guides salmon on their way upriver. They travel until they reach the confluence of their "home" tributary where they leave the main channel and continue upriver. Most natural obstacles, such as rapids and smaller waterfalls do not obstruct their migration. Thus they gain the upper reaches of the river where they once hatched, a cool and limpid brook with a gravel bed. That is where they engage in courtship in the fall of the year. While females dig several meter wide redds into the gravel bed, males fight for the best places.

Eggs are fertilized by big salmon with hooked jaws keeping a jealous eye on the procedure and, in some cases, by jacks. These are only 10 to 20 cm long, precocious males dashing out of their hiding places and spreading their milt into the redd. In many cases, half of the hatching breed descends from a precocious father. Most salmon die after spawning. A salmon life cycle ends and after four months in the river gravel bed a new cycle starts the following spring.

Different stages in the lives of salmon and sea trout

Alevin	*Feeding off yolk sack (after hatching, before being able to feed independently)*
Fry	*The first weeks after feeding off yolk sack*
Parr	*Juvenile fish, 1 to 3 years old with lateral parr marks*
Jacks	*Precocious parr*
Smolt	*Juvenile fish between the age of 2 and 4 years, mostly migrates downstream in the spring*
Grilse	*Small adult salmon returning to its natal river after 1 winter at sea, which is often the case with salmon and, above all, sea trout*
MSW	*"Multi-Sea-Winter", big returning adult salmon with more than 1 (often 2-3) winter(s) ocean residence*
Kelt	*Fish that has spawned, dies in most cases*

(HUMBORG 1990, LE CREN 1985, PEDROLI 1991)

1 Secure nursery grounds

Rhine 2020 Ecosystem improvement

by protecting and revitalizing intact salmon spawning grounds, juvenile habitats and suitable fish habitats

- *in the main stream*
- *in tributaries included in the programme on migratory fish*

IKSR (2001) p. 13

Photo: Gerhard Feldhaus

Salmon alevin feeding from yolk sack

Juvenile salmon require a great habitat diversity. During the summer they live in the shallow gravely parts of the river offering much shelter, e.g. stones off the river banks. In autumn, young salmon colonize deeper areas with less current. This is when precocious males head downstream, awaiting the females returning from the ocean!

Photo: ASR Strasbourg

Salmon redd

Photo: U. Haufe

Young salmon in the Steinchesbach/Bröl

Children of salmon are demanding

Salmon only successfully reproduce in rivers with clean, cool water rich in oxygen. They prefer the so called hyporhitral, the lower salmonid region of mountain rivers also called the grayling zone after its key indicator species, and the metarhitral, the lower trout region. Natural, unaltered rivers and brooks with high flow velocity are most suitable, since they are de-silted by natural flow dynamics and floods create new gravel beds, scours and shelters.

Foto: Frank Molls

Typical juvenile salmon habitat

Foto: Bernd Stemmer

The grayling is the key indicator species of juvenile salmon habitats

Inventory of juvenile habitats

Formerly, salmon migrated up the main channel until they reached the falls of the Rhine near Schaffhausen. They used to spawn in the southern Upper Rhine as well as in the High Rhine. Since the Upper Rhine has been dammed, the Franco-German old bed of the Rhine is the only river section with considerable spawning habitats. Even though there are barrages in the High Rhine, there are still two unobstructed sections suitable for fish spawning in gravel beds.

Most of the historically proven salmon spawning habitats were located in the Rhine tributaries and their tributaries from the uplands to the pre-alpine regions. The Lower Rhine tributaries Ruhr, Wupper and Sieg from the Bergisches Land, the Sauerland and Siegerland were already considered to be salmon habitats. There were many old salmon rivers in the Middle Rhine region. On the right banks of the Rhine, the R. Saynbach, Lahn and Wisper drain the Westerwald and Taunus. On the left bank the R. Ahr, Nette, Moselle and Nahe draining from Eifel, Hunsrück and Vosges flow into the Rhine. The R. Main and its former salmon tributaries from Odenwald and Spessart are right bank tributaries to the Upper Rhine. Formerly, the R. Neckar used to be a salmon river, just as the Black Forest rivers Alb, Murg, Rench, Kinzig and Elz. On the left banks of the Rhine the salmon migrated from the Upper Rhine into the tributaries Lauter, Ill and its tributaries from the Vosges, among them the R. Bruche.

Foto: BFS Schneider

Salmon habitat in the R. Nister

From the High Rhine the salmon migrated into the right bank tributary Wiese, into the left bank tributaries Birs and Ergolz and via the R. Aare into many pre-alpine tributaries, 1.200 km upstream the Rhine estuary.

Mapping of juvenile habitats

During the last 15 years, intensive investigations were made into which rivers are apt for carrying salmon and sea trout. Today, several additional river sections are considered to be suitable. The sections concerned are parts of the tributaries to the Lower Rhine Wupper with its tributaries Dhünn, Ruhr with Volme and Upper Rhine tributaries from the Black Forest, such as Alb and tributaries to the rivers Murg, Rench, Kinzig and Elz figuring in the programme.

Section of the Rhine	Tributaries	Surface in ha Spawning area	Surface in ha Juvenile habitat
Lower Rhine	Ruhr + Volme etc.	*	3,5
	Wupper + Dhünn	*	42,4
	Sieg + Agger	20,1	150,0
Middle Rhine	Ahr	18,0	90,0
	Saynbach + Brexbach	2,3	7,0
	Moselle: Sauer + Our	5,5	71,0
	Moselle: left bank tributaries		
	Prüm, Kyll + X	12,7	14,8
	Lahn: Mühlbach, Dill, Weil, Banfe	1,5+*	3,0+*
	Lahn: Laasphebach	0,3	4,0
	Wisper	0,3	1,1
Upper Rhine	Main + Hessian Kinzig, Rodach	Kinzig 2,0+*	Kinzig 8,4+*
	Lauter	0,4	4,0
	Ill: Bruche, Lièpvrette, Fecht, Thur, Doller	2,5	70,0
	Old bed of the Rhine	3,5	64,0
	Alb, Murg, Rench, Kinzig in Baden	2,5	180,0
	Elz + Dreisam	*	*
High Rhine	Wiese	0,3	1,2
	Birs	1,0	10,7
	Ergolz	0,2	1,2
TOTAL		**73,1**	**726,3**

* unknown at present

Photo: Hajo Wetzlar

Old bed of the Rhine

Future salmon populations

Unfortunately, many of the reproduction habitats capable of carrying salmon are isolated in the river network. In the tributaries, hydraulic engineering facilities often interrupt subnatural river sections and a chain of barrages cuts off their connection with the main channel. This particularly applies to the R. Moselle, Main, the Upper Rhine upstream of Iffezheim and the High Rhine.
The inventory of suitable spawning grounds and juvenile habitats serves as basis for a rough estimate of the carrying capacity for future salmon populations.
A female salmon deposits at maximum 10.000 eggs on 100 m^2 of gravel bed. About 1 %, that is 100 salmon per 1.000 m^2 juvenile habitat survive to migrate downstream. If later on only 4 of them return from the ocean to spawn, the stock of salmon survives. Probably hardly half of the adults returning from the ocean reproduce successfully.

1 hectare of juvenile habitat may annually produce a population of 10 to 30 adult returning salmon.

According to the present state of knowledge, the Rhine system today hosts 100 ha spawning grounds and 700 ha juvenile habitats. On 100 ha spawning grounds in the Rhine system some 10.000 female salmon may deposit 100 million eggs, about 1 million of which survive to the stage of a smolt migrating downstream. 700.000 smolts may rear on 700 ha juvenile habitat.Once a new stock of Rhine salmon will have developed, it may be expected that 1-2% of salmon return from the sea (ICPR 1994).

Then the salmon population achievable on the medium term will amount to 7.000 to 21.000 adult salmon.

This only represents a fraction of the former population, but is more than the estimate of 1999. Even though habitat improvement measures may on the long run increase this number, the ICPR is perfectly aware of the fact that, due to hydraulic measures and water uses in the Rhine system, the former size of salmon stocks can never be restored.

In the different tributary systems, the ***surface of juvenile habitats is the limiting factor*** as long as it is not about 10 times the surface of the spawning grounds. In the Northrhine-Westphalian R. Sieg system there are 20 ha of spawning grounds as opposed to some 100 ha juvenile fish habitats. Therefore, the potential adult salmon population does not amount to 2-6,000, but only to 1-3,000.
In the R. Saynbach watershed there are only 7 ha of juvenile habitat for 2.3 ha spawning grounds. It is estimated that between 70 and 210 adult salmon may return. In the tributaries to the lower R. Lahn there are 1.5 ha spawning grounds and 3 ha juvenile habitats. This means that 30 to 90 salmon are expected to return.

In the R. Sauer and Our in Luxemburg between 700 and 2,100 salmon are expected to return to the 6 ha of spawning grounds and about 70 ha of juvenile habitats.
In the Alsacian tributaries to the R. Ill some 50 ha of juvenile fish habitats have been mapped. This means that between 500 and 1,500 returning salmon may be expected.

If migratory routes were not disrupted, 600 to 1,800 adult salmon might return to the old bed of the Rhine with its 64 ha juvenile fish habitat.

Photo: Hajo Wetzlar

Old bed of the Rhine

Salmon habitat measures

The high ecological demands of salmon on their spawning and nursery grounds require particular measures for renaturing former salmon carrying rivers. Damming and river training have often reduced flow velocity, silted up gravel banks and, in many cases rivers banks are artificial.

Within the ICPR Salmon 2000 programme, many former juvenile salmon habitats have been prepared: gravel banks have been loosened and cleaned, river bank stabilizations have been removed.

In the R. Sauer in Luxemburg, a tributary to the R. Moselle, former floodplains and a side channel to the Sauer were renatured as a part of ecological flood protection measures. Enlarging the river profile has restored the river dynamics of the Sauer and helped develop natural river bed and bank structures.

If channel bed sills and weirs no longer having any function are lowered, this will improve river patency and dynamics. Additionally, there are different possibilities of renaturing rivers or enhancing their dynamics, even without any excavation:

- *River maintenance should be reduced to a minimum and river bank stabilizations should not be maintained but removed wherever possible.*
- *River bank stripes should remain out of use in order to reduce the input of fertilizer and pesticides.*
- *Dead wood, such as branches, bushes and trees may be placed in a brook on purpose to considerably increase structural diversity. Often gravel banks which salmon prefer for spawning form in the shadow of the current.*

Photo: Max Lauff

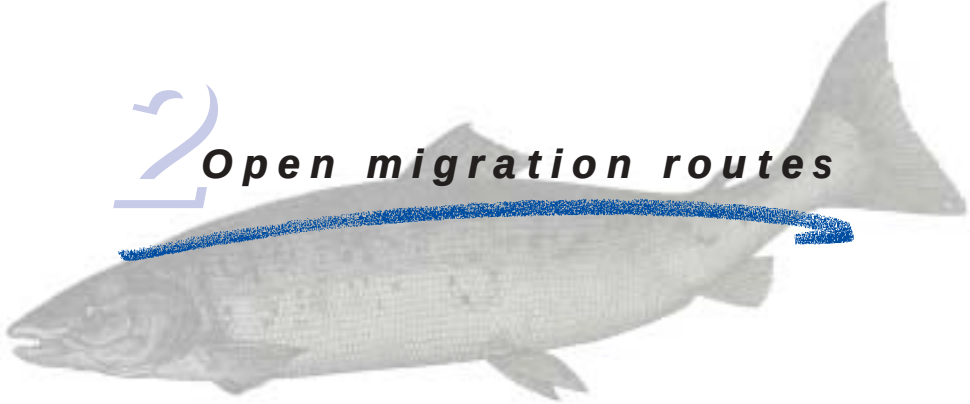
Renatured R. Sauer in Luxemburg

Photo: O. Niepagenkemper

Loosening gravel banks in the R. Sieg

Photo: Bernd Stemmer

Dead wood in the river



2 Open migration routes

With a view to increasing the stock of salmon in our rivers obstructed by several weirs, barrages, mills (...) so that salmon formerly migrating upstream no longer have any access, the construction of salmon ladders (salmon ladders, fish ways, fish passages) is urgently required. Such facilities will permit salmon to reach the overshot water of weirs which are too high to be lept over in order to reach the spawning grounds in the upper regions of the rivers.

Meyers Encyclopedia, vol. 6, Leipzig and Vienna (1894)

Rhine 2020

Restoration of ecological patency *with the help of bypass rivers or auxiliary migration facilities (fish passages or the like).*

- *of the main stream, e.g. at barrages*
- *of the tributaries figuring in the programme on migratory fish, if necessary by removing weirs which are no longer used*

IKSR (2001) p. 13

More than a hundred years ago, many mill weirs already disrupted fish migration routes. But from time to time the mills did not work, weirs were neither too high nor too sophisticated so that some fish managed to slip through or to jump over. The first fish passages were built. Nevertheless, less and less migratory fish reached the spawning grounds in the Rhine tributaries. This was one of the main reasons for why Rhine salmon died out. River training in the 19th and 20th century targeted at facilitating navigation, at protecting from flooding and at producing hydroelectric power. The side effects of these measures on nature were underestimated. Many fish are heavily injured on their way downstream through rotating turbines of hydroelectric power plants. But, above all, river training proves to be a considerable obstacle for fish migration - leading to a mortal infarctus.

Today, one of the prerequisites for reintroducing migratory fish is to open migration routes. Many reproduction habitats still exist but are not accessible. Some of the "Salmon 2000" projects are designed to put things right. In a first step, and parallel to the proceedings for habitats, ***obstacles to migration*** *have been inventoried and mapped. Within the inventory demanded by the Water Framework Directive, new weir registers are drawn up and will be presented in the beginning of 2005.*

Photo: BFS, J. Schneider

Salmon smolts after passing through turbines

Weirs of hydroelectric power plants obstruct upstream fish migration, turbines are problematic for downstream travelling, even though fish passages exist. Often, fish ladders were misconstructed and too little attraction water made it difficult for fish to find the entrance to the ladder (PEDROLI 1991). Fish protection facilities for downstream migration bypassing by turbines are urgently required.

The re-establishment of linear river patency, that is of up- and downstream fauna migration in the Rhine and its side channels has made variable progress and is often still in the planning phase. However, many examples prove that it is worth while the effort. More and more salmon spawn upstream places where obstacles have been removed.

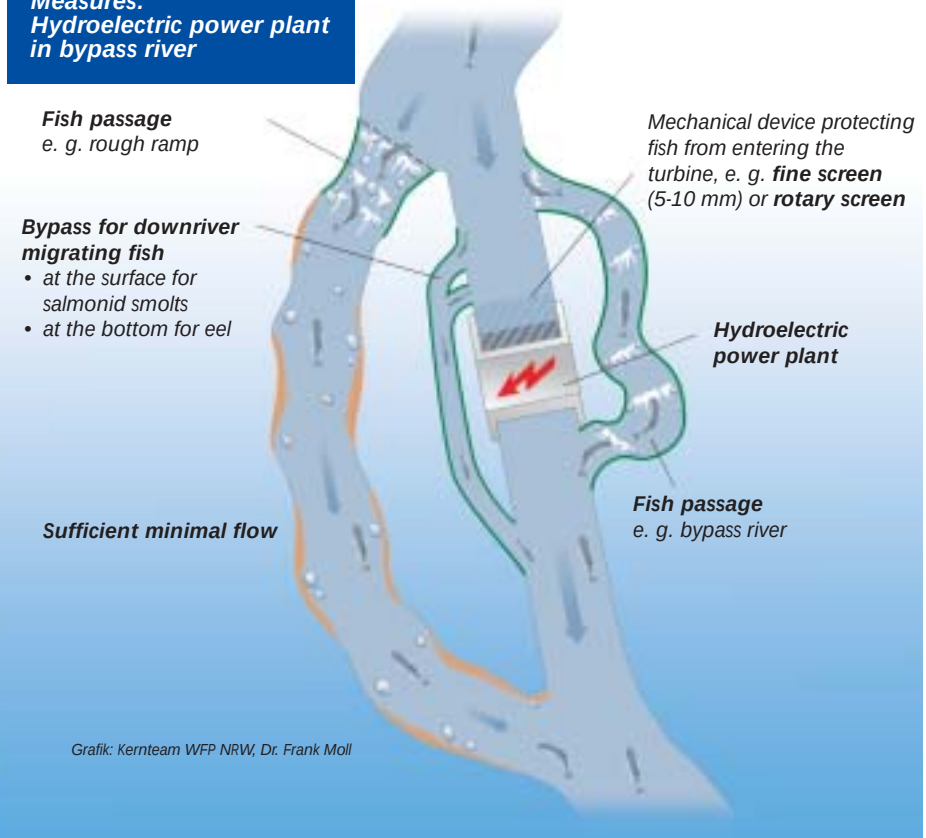
The ICPR demands to develop subnatural solutions when removing obstacles in the river. Precise proposals have been made to remove all weirs without water rights and to build subnatural fish passages, such as block ramps, bypassing the remaining weirs. Technical solutions such as Denil or vertical slot passages have also proved to be efficient in places, where there is little room. Some fish passages should be equipped with fish viewing windows and monitoring stations.

Rhine delta

In the Netherlands, the Rhine splits into the three branches IJssel, Nederrijn / Lek and Waal. Additionally, near the estuary, the Meuse is connected to the Waal. At the time being, fish can travel upstream from the ocean through the Nieuwe Waterweg, pass by the port of Rotterdam, through the R. Waal and into the Rhine without coming across any obstacle. But the other gates to the Rhine, the sluices at the closure embankments of Haringvliet and IJsselsea are accessible to a limited extent only. It is planned that, from 2008 on, the Haringvliet sluices will be partly opened. The extent of opening depends on the discharge of the Rhine and will be monitored until 2012. After this period, a decision will be taken with respect to the question whether the sluices are to be opened more widely, thus also admitting tidal influence (see: www.haringvlietsluizen.nl). Three new fish passages have been built bypassing the barrages in the Lek. By the end of 2001 the first of them, built at the Driel barrage, was put into service. Construction of the fish passages Amerongen and Hagestein was accomplished mid 2004, their functionality will be tested in 2005/6.

Photo:
Fish passage Driel, Tom Buijse
Fish passage Amerongen, Cees Witvliet
Fish passage Hagestein, RIZA Lelystad

Measures: Hydroelectric power plant in bypass river



Grafik: Kernteam WFP NRW, Dr. Frank Moll

Lower Rhine

Further weirs have been altered or lowered in the tributary systems of the Ruhr, Wupper and Sieg. Pilot facilities protecting downstream fish migration are planned for the turbines. They are important not only for salmon and sea trout smolts, but for all river fish species. Further details are given in the North-rhine-Westphalian programme on migratory fish (MUNLV 2003).

Along the Middle Rhine

In 2002, a weir in the R. Ahr in Rhineland-Palatinate was transformed subnaturally and, at the same time, the river bottom was cleared from concrete. Two more weirs have been changed and modifications are planned for another six.

Photo: Georges Muller

Blasting a weir in the loop of the R. Sauer in Luxemburg with aids from Rhineland-Palatinate

Along the R. Nahe downstream the mouth of the R. Glan there are six weirs without any functional fish passages. In the R. Glan, a tributary to the Nahe, the modification of weirs has begun.

In the Saynbach-Brexbach river system, where exemplary modifications were carried out on six weirs between 1996 and 1999, all weirs are supposed to be surmountable for fish by 2005 (Aktion Blau in RP, see VDSF 2003 p. 48).

On the lower R. Lahn in Rhineland Palatinate 8 of 11 weirs disrupt fish migration, among them the lowermost weir in Lahnstein, the salmon "gate to the R. Lahn" belonging to the German navigation administration. In 2002, headlines of the Rheinzeitung read:"When the journey ends at the weir ..." and "No way for salmon to surmount the Lahnstein obstacle".

On the Upper Lahn in Hesse most obstacles are side weirs which fish with a good swimming capacity manage to cross and 16 of the 56 weirs are equipped with fishways. In the R. Dill, a tributary to the Lahn, 12 of the 37 transversal structures have been equipped with fish passages, so that patency is granted along the 30 river km between the estuary and Herborn. Until 2004, all of the 10 weirs on the R. Weil, a tributary to the Lahn, were changed (RP Giessen).

Since 2002 the lower Wisper is patent for migratory fish.

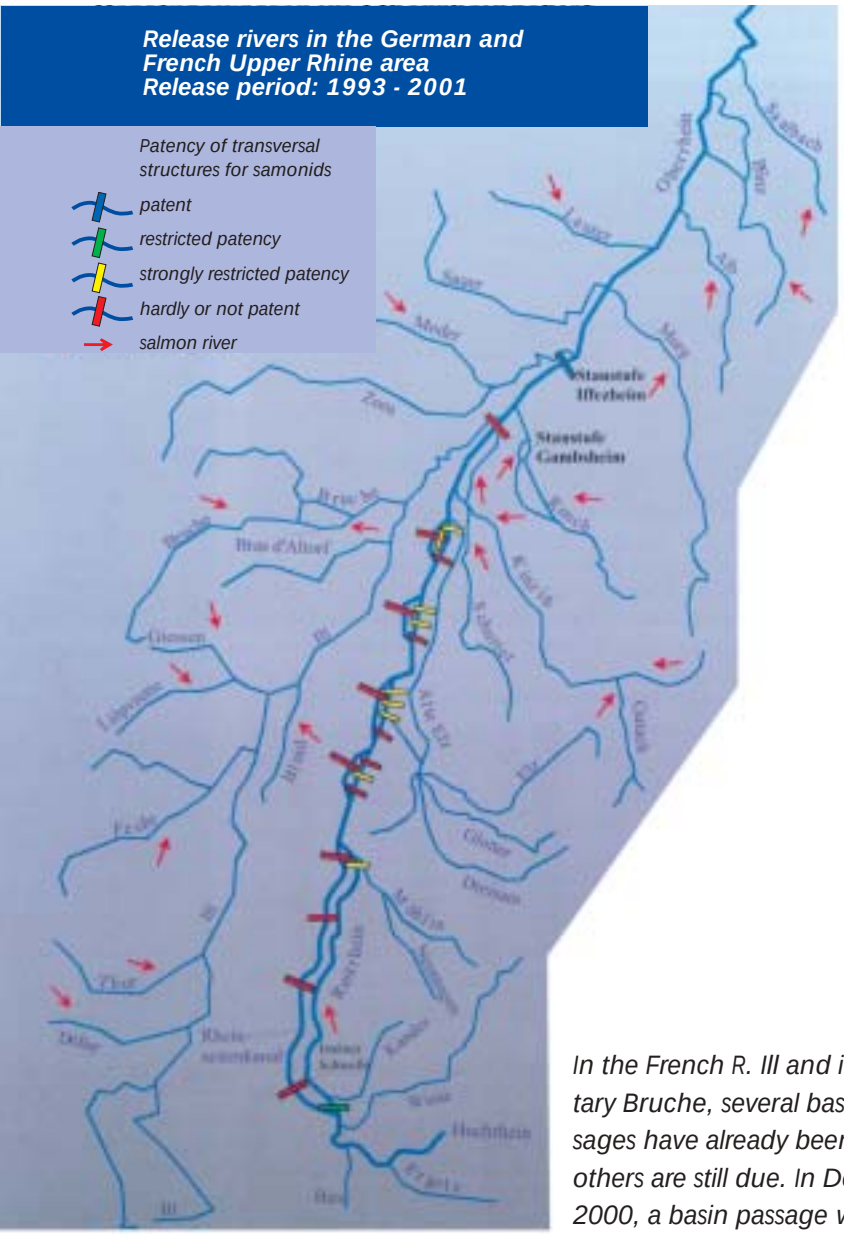
Apart from the first one, the fish ladders at the 10 weirs on the lower R. Moselle are difficult to cross for fish (ICPR 1999, report 103, p. 21). At the time being, Rhineland-Palatinate is working on a study aimed at their alteration. In the R. Sauer, a tributary to the Moselle, 4 weirs have been removed at Rosport-Ralingen in Luxemburg and one fish passage has been modified. 3 weirs on the R. Our, a tributary to the R. Sauer, were altered.

Upper Rhine

Upstream the junction with the R. Kinzig, there are five barrages in the lower R. Main without any suitable fish passages. These will be altered or reconstructed by 2006. In the Hessian R. Kinzig itself many weirs have been removed or equipped with fishways. At present, there are only two obstacles left in the lower Kinzig but several weirs subsist in the Kinzig tributaries. In particular, hydroelectric power utilization poses major problems (VSDF 2003, p. 63).

While there are no obstacles from the Rhine estuary through the R. Waal until the Iffezheim barrage some 700 km upstream, 10 barrages obstruct the 164 km of the Franco-German Upper Rhine between Iffezheim and Basel. France, Germany and the operators of the hydroelectric power plant have jointly financed the construction of a fish passage bypassing the lower most barrage at Iffezheim which is operational since June 2000. Subsidised by the EU Life programme, the ICPR participated in financing the construction costs amounting to an overall 8 million Euros. Now salmon and other migratory fish do not encounter any obstacles on their way from the North Sea to the R. Ill in Alsace and the R. Rench in Bade-Württemberg. French and German Industrial Fisheries Boards and administrations jointly monitor fish migration at the Iffezheim monitoring station (see success control p. 24).

Gambsheim, the next upstream barrage, will also be equipped with a jointly financed fish passage. Construction work of the



Map: LFV BW

High Rhine

In the Swiss High Rhine, many barrages obstruct the way towards the last two freely flowing stretches of the Rhine which would be suitable for spawning.

In the High Rhine tributaries Wiese, Birs and Ergolz, eight obstacles have been altered since the mapping of obstacles in 1996 by building bypass channels, ramps, etc. for fish migration.

baffled pass similar to that at Ifezheim began in spring 2004 and the fish passage is scheduled to be operational in the beginning of 2006. Additionally, this fish passage will include a large fish viewing room open to the public.
But there are more barrages in the Upper Rhine between Gambsheim and Basel which, so far, disrupt fish migration. The ICPR has commissioned a feasibility study on the restoration of the Upper Rhine river patency, the results of which will be presented in 2006.

In the French R. Ill and its tributary Bruche, several basin passages have already been built, others are still due. In December 2000, a basin passage was put into operation at the hydroelectric power plant Erstein on the R. Ill, some 30 km south of Strasbourg, opening the Ill tributaries Fecht, Thur and Doller for salmonids.

In the Baden-Württemberg tributaries Alb, Murg, Rench, Kinzig and Elz many weirs have been modified or equipped with fish passages. But the turbines of many small hydroelectric power plants cause considerable problems for downstream fish migration. Additionally, too little water is flowing through many of the bypass rivers.

Energiedienst AG

Model of the fish passage at the Rheinfelden hydroelectric power plant

3 Release juvenile fish

The main ICPR target set out in the "Ecological Master Plan for the Rhine" was to reintroduce migratory fish such as salmon and sea trout (ICPR 1991). As for the sea trout, replenishing of the stock still existing in the Rhine system was to be based on natural reproduction and on the catch of mature adults. Since the salmon died out in Rhine system in the fifties of the 20th century, a new stock of Rhine salmon had to be created.

Therefore, eggs were collected from other wild salmon stocks and raised in fish hatcheries before the juvenile fish were released into suitable habitats. Having thus again started off the salmon life cycle and achieved the aim set out in "Salmon 2000", that is downstream migration, return of adult salmon from the ocean and even natural reproduction, juvenile salmon must all the same still be hatched and released for some time to come. Still, eggs are today partly collected from adult salmon returning from the ocean! The ICPR hopes that, as time passes by, a stock of Rhine salmon adapted to local conditions will develop and naturally reproduce in the Rhine system without any artificial supporting measures. This is one of the targets set out in "Rhine 2020".

Today, salmon migrating several hundreds of kilometres upstream (almost 1000 km) are only found in the French Loire/Allier-system. But, for the last 30 years, even the Loire salmon has been artificially supported (PEDROLI 1991).

In future, the number of stocks of origin from which salmon eggs destined for the Rhine system are imported will be markedly reduced. It is admitted that diverse stocks of wild salmon and a broad genetic variety could offer more room for a natural selection and the adaptation of new salmon populations to present habitats. After all, the former stock of Rhine salmon did not consist of one homogenous, but probably of several different populations living in the different tributaries. However, certain scientists fear that, if different stocks are cross-bred, in particular artificial reproduction may lead to a loss of genetic fitness (Schneider and others 2004).

Photo: Adam Schmitt

Information board for fishermen along the Allier helping them to recognize salmon

All stocking exercises implying migratory fish are documented in a central data base in NRW (LÖBF) which the ICPR may use since 2002. The table below gives an overview over the stocking exercises of the past five years (Stocking exercises 1994-98, see ICPR 1999, report no. 103, p. 32).

Stocking in the Rhine region (1999-2003)	Origin of salmon eggs importation	Returning adults
Germany / NRW	Ireland, Sweden	Yes!
D / Rhineland-Palatinate	France, Sweden, Denmark, Ireland, Spain, Scotland	Yes!
D / Hesse	France, Denmark, Sweden	Yes!
D / Bavaria	Ireland, France	
D / Bade-Württemberg	Ireland, Sweden	Yes!
Luxemburg	France	Yes! (Moselle estuary)
France	France, Sweden	Yes!
Switzerland	France	

Photo: ASR Strasbourg

Children help releasing small salmon

Photo: Armin Nemitz

Releasing salmon alevins

Photo: ASR Strasbourg

In most cases, salmon were released as alevins or parr. ***So, during the past 5 years, some 11 million salmon have been released into the Rhine catchment****.*

According to fisheries experts, this considerable stocking exercise was necessary in order to make up for the high natural mortality of young salmon *(see salmon population estimates p. 12).*

Stocking juvenile salmon in the Rhine river system 1999-2003

Country	*River system*	*Stocking exercise*
Germany/ Northrhine-Westphalia	*Ruhr* *Wupper* *Sieg* *Lahn*	*ca. 5.4 million*
D / Rhineland-Palatinate	*Sieg* *Ahr* *Saynbach* *Mosel / Kyll, Prüm* *Lahn / Mühlbach*	*ca. 2.3 million*
D / Hesse	*Lahn / Dill, Weil* *Wisper* *Main / Kinzig*	*ca. 1 million*
D / Bavaria	*Main*	*ca. 0.2 million*
D / Bade-Württemberg	*Alb* *Murg* *Rench* *Kinzig / Erlenbach,* *Gutach, Wolfach*	*ca. 0.3 million*
Luxemburg	*Sauer / Our*	*ca. 0.2 million*
France	*Old bed of the Rhine* *Ill*	*ca. 1.6 million*
Switzerland	*Rhine*	*ca. 0.3 million*
D, L, F, CH	*entire Rhine*	*ca. 11.3 million*

Rhine delta

In the **Dutch** Rhine delta, there are no suitable salmon or sea trout spawning grounds and thus no stocking exercises. However, big mature salmonids returning from the North Sea are monitored (see p. 27).

Lower Rhine

Annually, about one million juvenile salmon are released into the Rhine tributaries from the low mountain ranges in Northrhine-Westphalia. Most of them are alevins hatched from eggs or few weeks old fry. Apart from that, juvenile parr, yearlings and smolts are released. It is expected that, from 2004 on, the first marked adult salmon of the Swedish Ätran stock used since 2003 will return. That means that, in future, the importation of salmon eggs can be reduced in favour of the "home production". Some salmon manage to pass by monitoring and catching stations and celebrate veritable marriages in nature. Others are let pass on purpose in order to enhance natural reproduction. It has been decided that "with a view to determining the success of natural reproduction" (MUNLV 2003, p. 21) only young marked salmon will be released into certain brooks. This allows to distinguish between stocked salmon and wild descendants. As soon as the count of downstream migrating smolts shows that natural reproduction leads to a sufficient number of descendants, stocking exercises can be stopped.

Photo: Bernd Stemmer

Collecting eggs from returning salmon

Middle Rhine

From 2000 on, salmon of two different origins were used for stocking exercises in Rhineland-Palatinate. Eggs collected from salmon of the French Loire-Allier stock were hatched and raised to parr in a fish hatchery before they were released into the Lahn affluent Mühlbach and into the R. Ahr. Young parr from the Swedish rivers Lagan and Ätran were released into the R. Saynbach. Here too, eggs are collected from salmon returning from the ocean and precocious males, presumably descendants of natural reproduction, are used as sperm donators. Since 2001, and without any previous stocking exercises, the R. Nette flowing into the Rhine between the tributaries Moselle and Ahr is colonized by "straying" salmon (see p. 26, 27). Since 1996 salmon are also released into the Eifel R. Prüm and Kyll flowing into the Moselle. In future, Rhineland-Palatinate and Luxemburg will mainly use eggs of salmon from the Swedish R. Ätran for stocking exercises.

The number of sea trout has increased in the estuaries of Rhine tributaries in Rhineland-Palatinate, and even before the year 2000 their eggs were collected for artificial reproduction and hatching. Due to a natural increase in numbers and probable natural reproduction (e.g. R. Saynbach, Nette) sea trout stocking exercises have been considerably reduced.

Foto: Armin Nemitz

Releasing salmon in the upper R. Sieg

In Hesse, salmon are released into the R. Dill and Weil, both tributaries to the R. Lahn and into the R. Wisper, flowing into the Rhine in the Rheingau. In future, only Swedish Ätran salmon will be used for stocking exercises in these rivers.
Since 2001, salmon are released into the upper R. Lahn near Laasphe in Northrhine-Westphalia.

In **Luxemburg**, salmon are released into the R. Sauer, a tributary to the Moselle and its tributary, the Our. The first descendants of returning salmon were released in 2002. Their parent fish had been caught and eggs had been collected at the first fish passage on the Moselle in Koblenz (D) for hatching in a fish farm in Nassau.

Upper Rhine

Since 2001, salmon are reintroduced into the Hessian Kinzig, a tributary to the R. Main as well as into the Kinzig tributaries. In 1994, and since 1998, young salmon alevins are released into the Francian R. Main and its tributary, the R. Rodach in Bavaria.

In Baden-Württemberg salmon are released into the Rhine tributaries from the Black Forest. Annu-

ally, up to 90.000 young salmon of Irish origin were released into these rivers. An even more intensive co-operation in salmon hatching is planned with France and salmon of homogenous origins are strived for in co-operation with Switzerland. Thus, in future, all returning salmon may be identified by their origins in the Iffezheim monitoring station and their eggs may be collected without taking any genetic risk. (LV BW 2002, SCHNEIDER u.a. 2004).

Photo: Bernd Stemmer

Salmon rearing in the Hasper dam

High Rhine

*Since 1999, young salmon from the Adour-Nive river system in the southwest of France are released into the **Swiss** High Rhine. They are no longer put into the tributaries St. Albanteich, Birs and Wiese, as was the case in the past years, but released near the confluence of these rivers with the High Rhine.*

Photo: ASR Strasbourg

Stocking salmon in the R. Fecht, a tributary to the Ill

*In **France**, Rhine salmon are stocked in the Old bed of the Rhine and the R. Ill. The fry are mostly of Allier origin, partly they come from Brittany or they are descendants of adults returning to the Rhine and which, since 2000, were caught in the Rhine at Iffezheim or in the R. Bruche downstream the Avolsheim barrage. Artificial fertilization produced more than 100,000 eyed eggs. In future, stocking exercises will be based on adults from the Allier reproducing in fish farms and on adults returning from the ocean.*

Volksstimme

DIE ZEITUNG FÜR DAS ORTENAUKREIS

Projekt «Lachs 2020» wurde bei Auggi gestartet

15 000 Lachse schwimmen in der Ergolz

4 Success control

Photo: StVA Köln-Bonn

Buisdorf monitoring station

From the very beginning on, the salmon programme was accompanied by success control and research. This helped to establish and improve the effectiveness of stocking and protection measures. In this connection, as well as in case of stocking measures, voluntary fisheries associations and nature protection associations had a large part in the success.

In its "Ecological Master Plan" the ICPR demanded success control, such as fishery biological inventories and monitoring of new fish passages in order to prove the Rhine ecosystem improvement (ICPR 1991).

Fish viewing window in the Iffezheim monitoring station

Photo: ASR Strasbourg

Monitoring the fish population by drawing up an inventory of spawning grounds, fishery biological inventories based on electro-fishing and fyke nets, marking tests and monitoring stations figure among the success control measures within Salmon 2020. So far, there are six permanent ***monitoring stations*** *for migratory fish. The ICPR recommends to install such monitoring stations near the estuary of each larger tributary.*

Photo: ASR Strasbourg

Iffezheim monitoring station

Future permanent monitoring stations
(six already exist)

Rhine section	Country	River branch, tributary	Weir
Rhine delta	*NL*	*IJssel*	*Westervoort*
		Lek	*Hagestein*
		Waal	*Woudrichem*
Lower Rhine	*D / NRW*	*Dhünn*	*Auermühle*
		Sieg	*Buisdorf*
		Agger	*Troisdorf*
Middle Rhine	*D / RP*	*Moselle*	*Koblenz barrage*
	L	*Lahn*	*Lahnstein barrage*
		Sauer	*Rosport-Ralingen*
Upper Rhine	*F / D*	*main stream*	*Iffezheim*
	F / D	*main stream*	*Gambsheim*
	F	*Ill*	*Straßburg*
	F	*Bruche*	*Avolsheim*
High Rhine	*CH*	–	–

Diversity of migratory fish

Which species return to the Rhine?

- ***Atlantic salmon*** *(Salmo salar) **

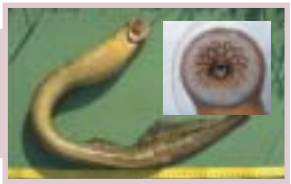
- ***Houting*** *(Coregonus oxyrhynchus)**

- ***Sea trout*** *(Salmo trutta)*

- ***Common sturgeon*** *(Acipenser sturio) † **

- ***Allice shad*** *(Alosa alosa) **

- ***Sea lamprey*** *(Petromyzon marinus) **



- ***Thwaite shad*** *(Alosa fallax) **

- ***River lamprey*** *(Lampetra fluviatilis) **

Photos: ASR Strasbourg, aus Vogel&Hofer, Stefan Staas, Bernd Stemmer

† Extinct in the Rhine *individuals returning* *natural reproduction* *increasing stocks*

** = FFH-species according to directive 92/43/EEC (see p. 6 this brochure)*

- ***Eel***
  (Anguilla anguilla):
  another migratory fish which however spawns in the sea and migrates upstream rivers at the stage of a juvenile fish.

Photo: Peter Rey

Since 1992, migratory fish are monitored in the Dutch Rhine delta. At selected locations, test catches are carried out with nets and the by-catches of professional fishermen are evaluated. Between 1994 and 2003 727 adult salmon and 1327 sea trout were observed (HARTGERS & BUIJSE, WINTER and others 2003).

Between 1996 and 2000 the routes taken by migratory fish returning from the North Sea and travelling through the Rhine delta were subjected to telemetric research. To this end, sea trout and salmon were equipped with radio transmitters. On their way upstream, 34 of the 580 sea trout passed by the estuary dam, 103 by the Nieuwe Waterweg and 70 by the sluices on the Haringvliet (BIJ DE VAATE et al. 2003). So far, 12 of these sea trout and one salmon have been registered heading upstream the R. Sieg towards the spawning grounds.

It has been proved that salmon and sea trout smolts marked in Northrhine-Westphalia and Baden-Württemberg have reached the North Sea.

Many migratory fish, among them a growing number of rare species such as thwaite shad and houting have been caught in the Rhine delta and in the IJsselsea (WINTER et al. 2003).

Along the Northrhine-Westphalian Lower Rhine research into which migratory fish are returning is carried through in the tributary Lippe. A permanent migratory fish monitoring station has been built at the lowermost weir across the R. Sieg near Buisdorf entailing costs of some

650,000 Euro. It was taken into operation in the beginning of 2000 and consists of a basket trap, two rooms for keeping living fish as well as installations to measure fish and collect their eggs.
The station has proved to be performant. Apart from migratory fish – 564 salmon, 205 sea trout and downstream migrating river lamprey – many other fish species were registered until the end of 2003, among them barbel, nase, chub and pike. The highest number of upriver migrating salmon

Photo: Peter Rey

Upriver migrating barbel

was registered in October of every year. Grilse, that is early returning salmon prevailed, measuring between 70 and 75 cm and weighing about 3 kg after one year ocean residence .
Further permanent monitoring

Photo: O. Niepagenkemper

Jumping salmon at the Sieg weir near Buisdorf

stations have been installed near Troisdorf on the R. Agger and at the Auermühle mill in the R. Dhünn.
Between 2000 and 2002 the French and the Germans have

Counts at the Iffezheim barrage between 2000 and 2003[1]

Long distance migratory fish	
Eel (Anguilla anguilla)[2]	1.257
Thwaite shad (Alosa fallax)[3]	1
Atlantic salmon (Salmo salar)	318
Allice shad (Alosa alosa)	11
Sea trout (Salmo trutta trutta)	988
Sea lamprey (Petromyzon marinus)	342
Other fish species	
Grayling (Thymallus thymallus)	5
Brown trout (Salmo trutta fario)	109
Brook trout (Salvellinus fontinalis)	5
Barbel (Barbus barbus)	23.994
Perch (Perca fluviatilis)	21
Bream (Abramis brama)	12.109
Family of bream (small) (Abramis spec.)[4]	83
Chub (Leuciscus cephalus)	624
Graskarp (Ctenopharyngodon idella)	4
Bullhead (Cottus gobio)	3
Gudgeon (Gobio gobio)	6
White bream (Blicca bjoerkna)	135
Dace (Leuciscus leuciscus)	88
Pike (Esox lucius)	1
Crucian carp (Carassius carassius)	3
Carp (Cyprinus carpio)	10
Ruffe (Gymnocephalus cernua)	8
Nase (Chondrostoma nasus)	7.366
Burbot (Lota lota)	1
Asp (Aspius aspius)	6.894
Rainbow trout (Oncorhynchus mykiss, Salmo gairdneri)	18
Roach (Rutilus rutilus)	1.611
Rudd (Scardinius erythrophthalmus)	6
Salmonids (small) (Salmonidae)[5]	73
Tench (Tinca tinca)	10
Bleak (Alburnus alburnus)[2]	317
Wels (Siluris glanis)	15
Vimba (Vimba vimba)	4
Pikeperch (Stizostedion lucioperca)	20
White-eye bream (Abramis sapa)	402
Sum[6]: 34 species	**56.862**

[1] Counting periods: 13.6. - 31.12.00, 1.1. - 31.12.01, 4.3. - 31.12.02, 1.1. - 31.12.03.
[2] Eel and bleak only partly counted.
[3] Thwaite shad not identified with certainty, perhaps allice shad
[4] Specimen belonging to the family of the bream below 30 cm length cannot be identified with certainty (bream, white-eye bream, zope).
[5] Salmonids below 25 cm length cannot be identified with certainty.
[6] The sum of fish counted represents a minimum number of upstream migrating fish using the passage.

by turns counted the fish caught in fyke-net in the monitoring station of the fish passage Iffezheim on the Upper Rhine (s. p. 17, 22). This was done in close co-operation between the Association Saumon-Rhin (ASR), the Conseil Supérieur de la Pêche, the Landesfischereiverband Baden and the Regierungspräsidium Karlsruhe. Until the end of 2001, the Bundesanstalt für Gewässerkunde and from 2002 on the ASR monitored upstream fish migration with video cameras. Since 2000, far more than 50.000 fish belonging to at least 34 species have used this fish passage. Among them, more than 300 adult salmon, almost 1,000 sea trout, more than 300 sea lamprey, 11 allice shad and a new species in the Rhine, more than 400 white-eye bream.

From the Rhine delta to the Lower Rhine

In 1999, 81, respectively 47 sea trout were caught in the R. Sieg system and in the Dhünn, a tributary to the Wupper. 5 of them were marked individuals and revealed their migration route: 4 originated from the "Project migratie zeeforel" in the Netherlands which means that they had been marked in the Rhine estuary, the other one had been marked in Denmark. Since 1999, sea lamprey have repeatedly dug redds in the R. Sieg and Dhünn.

From the Middle Rhine into the tributaries

By the end of 2003, three sea lamprey had been registered after depositing eggs in the R. Saynbach. Since 1996, sea trout, some of which were transported to the subnatural Lahn tributary Dörsbach, have been caught at the Lahnstein weir. Since 1992, 519 sea trout have been caught and marked in the monitoring station at the Moselle barrage in Koblenz before being released further upstream. In April 2000, the first two river lamprey were caught in the Hessian R. Wisper. They had presumably migrated upstream to spawn. River lamprey have also repeatedly been spotted in the R. Nette.

From the Upper Rhine into the Black Forest and Alsace

Sea lamprey, a surprisingly high number of which migrate upstream using the Iffezheim fish passage, have been equipped with radio transmitters before being released into the R. Rench. Evidence has been given of one individual which managed to pass by the vertical slot pass at the Memprechtshofen mill. Redds dug by sea lamprey have been spotted in the R. Murg as well as in the Ill river system.

From the Upper to the High Rhine

In 2003, upon request of the Swiss Bundesamt für Umwelt, Wald und Landschaft, the Association Saumon-Rhin caught sea trout in the Iffezheim fish passage, marked them with radio transmitters and released them into the Old bed of the Rhine upstream of Kembs (see map p. 17) in order to find the answers to two questions:

1. *How do fish behave when encountering the barrages on the High Rhine? - Some sea trout used the fish passage to by-pass the Rheinfelden hydroelectric power plant, some even used the navigation locks of the Birsfelden and Augst-Wyhlen power plants on their way upstream.*
2. *Do fish migrate into the High Rhine tributaries Birs, Ergolz and Wiese for spawning? - Yes, evident proof was given (ASR 2004).*

Downstream migration

According to estimates, the survival rates from the release of salmon alevins to the downstream migrating smolts vary between 5 and 10 %. Therefore, the "smolt production" is estimated on the basis of the sum of released alevins.

Lower Rhine

During the past years, up to 100,000 salmon smolts annually migrated downstream the Northrhine-Westphalian Rhine tributaries into which alevins are released and travelled to the ocean. In 2003, some 15,000 smolts migrated downstream the Sieg river system in Rhineland-Palatinate.

Middle Rhine

In 2003, approximately 8,000 smolts were raised in the Saynbach river system, 500 of them descending from natural reproduction (see p. 27). The same year, some 2000 smolts left the Sauer river system in Luxemburg.

Upper Rhine

According to estimates, annually 25 – 45,000 smolts migrate downstream from the French Rhine catchment. Since 1992, electro-fishing methods have been used to monitor the quality of release sites and of juvenile habitats in the Old bed of the Rhine and the Ill river system. The results are as encouraging as those in the release rivers in Baden, where growth of juvenile salmon has been stated to be very satisfactory.

Return from the ocean

In the Rhine delta, the Dutch have detected adult salmon since 1994, by the end of 2003 their number had grown to more than 700.

In 1990, decennia after the old stock of Rhine salmon had died out, the first salmon migrated upstream and unerringly swam from the ocean through the Lower Rhine and into the Sieg where stocking exercises had started as early as 1990. Since then, there is evidence that by 2003, more than 1000 salmon have migrated upstream the Lower Rhine and its tributaries. Since 1998, individual adult salmon even migrate upstream the R. Lippe, even though juvenile fish have never been released into this river. Salmon also started colonising the R. Ruhr before stocking exercises started in this river.

During 1996 to 2003, evidence was given of some 250 salmon migrating upstream the tributaries to the Middle Rhine in Rhineland Palatinate and Hesse, most of them were found in the Saynbach river system (101). Since 2001, they even stray into the R. Nette to spawn, even though juvenile salmon have never been released into this river. On the other hand, the weirs in the rivers Lahn and Moselle disrupt upstream migration, only few returning salmon succeed in travelling through the navigation locks. Since 1992, 46 returning salmon have been caught in the Koblenz fish passage on the Moselle and have been released further upstream. In the R. Lahn they are caught at the foot of the Lahnstein weir and brought to the IG Lahn fish hatchery where they are used for artificial reproduction.

Since 1995, evidence has been given of some 379 salmon returning to the Upper Rhine. After the Iffezheim fish passage was put into operation in 2000, salmon have also been identified in the R. Rench in Baden and in the Alsacian Ill river system.

Return of salmon to the Rhine (see p. 19)

Section of the Rhine	River branches or tributaries	Stocking exercise start	Stocking exercise[1] (until 2003 in million)	Return start	Returning salmon[2] (until 2003 Individuals)	First larvae[3]
Rhine delta	Waal, Lek, IJssel (NL)	–	–	1994	727	–
Lower Rhine	Lippe (NRW)	–	–	1998	5	–
	Ruhr (NRW)	2003	0,02	2002	4	–
	Wupper (NRW)	1993	2,10	1998	92	2002
	Sieg (NRW + RP)	1988	9,90	1990	991	1994
Middle Rhine	Ahr (RP)	1995	0,82	1999	34	2000
	Nette (RP)	–	–	2000	> 4	2001
	Saynbach (RP)	1994	0,75	1996	138	2000
	Moselle/Sauer, Prüm, Kyll (L, RP)	1992	0,50	1995	46	–
	Lahn/Mühlb., Dill, Weil (RP, He, NRW)	1994	0,90	1997	36	2000
	Wisper (He)	1999	0,18	2002	4	2003
Upper Rhine	Main/Kinzig, Main + Rodach (He, Bay)	1994	1,20	–	–	–
	Alb, Murg, Rench, Kinzig (BW)	1994	0,34	2000	4	–
	Old bed of Rhine, Ill/Bruche etc. (F)	1991	2,80	1995	367	1997
High Rhine	Rhine + Ergolz, Birs, Wiese etc. (CH)	1995	0,60	–	–	–
Sum			ca. 20 millon.		2450	

[1] Juvenile salmon, above all alevins, about 3-5 cm length, able to feed until some weeks old.
[2] Salmon returning from the North Sea, about 50-100 cm length, 2 to 5 years old.
[3] Salmon larvae of naturally reproducing returning salmon.

Photo: ASR Strasbourg

Salmon alevin

All in all 2450 returning salmon have been identified beyond any doubt. The accurate number of returning salmon might be ten times as high. That means, that perhaps 20,000 salmon have migrated into the Rhine river system since 1990. With an estimated release of 20 million juvenile salmon since 1988, and a maximum downstream migration of 2 million smolts, salmon would, according to this estimate, have reached the expected return rate of 1 per cent *(see p. 12, 25).*

Natural reproduction

It is really true: salmon do reproduce naturally in the Rhine system! In 1994, the first salmon larvae were detected in natural redds dug into the Northrhine-Westphalian Bröl, a tributary to the R. Sieg on the Lower Rhine.
Then adult salmon chose to dig their redds into more and more brooks. These natural nursery grounds are called Bruche, Dhünn, Naafbach, Wisper, Ahr, Nette, Saynbach, Brexbach, Elbbach, Sieg, Nister and Wisserbach *(see table p. 26)* *.*
In the winter 1998/99, 12 redds dug by big salmonids were identified in the R. Dhünn, a tributary to the Wupper on the Lower Rhine. In the Sieg system, 9 were detected in the winter 1999/2000. In the R. Naafbach, a tributary to the Agger in the Sieg system, a large number of naturally reproduced salmon alevins was caught and genetically tested in 2001, after their parents had been observed depositing eggs some months earlier. Since 1999, natural reproduction has been observed every year in the Sieg river system in Rhineland-Palatinate.
A research project carried out by the Northrhine-Westphalian ministry of environment looks into the question what rivers must be like for salmon to spawn naturally. A pilot study carried out on the R. Bröl, a tributary to the Sieg, is aimed at producing guidelines for Cleaning up salmon spawning rivers.

Photo: ASR Strasbourg

Evidence of salmon hatch by combining drift net and electro fishing

Photo: BFS, Jörg Schneider

Salmon spawning ground

In the winter of 1999/2000, a redd was detected in the R. Ahr on the Middle Rhine. A genetic test carried out on an alevin taken from this redd revealed it to be a salmon. In the Mühlgraben near Heimersheim on the Ahr three naturally reproduced salmon parr were identified.
In the R. Nette, a tributary to the Rhine located between Ahr and Moselle, straying salmon have been observed since 2001, and they reproduce naturally.
In 2000, salmon stocking was stopped in the Brexbach, a tributary to the Saynbach. Nevertheless, annually 100 to 500 naturally reproduced smolts migrate downstream to the ocean! Since 2001, some 10 to 20 % of the annually downstream migrating smolts in the Saynbach river system are descendants of naturally reproducing adult salmon.
It is highly probable that, in 2003, the first naturally reproduced salmon have migrated upriver from the ocean in order to spawn in the Saynbach where they have participated in digging more than 20 redds. It seems as if, for the first time, the life cycle of a new Rhine salmon population has been concluded.
In the winter of 1999/2000, natural salmon reproduction was proved in the Mühlbach, a tributary to the Rhine. However, the parent fish had been caught in the Ahr and transported to the Mühlbach to which salmon have no natural access.
Since 2002, salmon are returning to the smallest release river, the Hessian Wisper, and natural reproduction has been proved.

On the Upper Rhine, natural salmon and sea trout reproduction has been observed in the Alsacian Ill river system since 1997, and since 2000 migratory fish have unobstructed access to this river system by using the Iffezheim fish passage. In 2000, 21 redds of large salmonids were detected in the Ill tributary Bruche. In 2001, 37 were detected in the Bruche and 7 in the Altorf side channel, in each of the years 2002 and 2003 more than 200 salmon redds were counted.

Assessment and Conclusion

Photo: Jan Kamman

Jumping salmon (red circle)

Success

The results of the programme on migratory fish in the Rhine river system which started as Salmon 2000 and is being continued within Rhine 2020 are impressive, in particular concerning the reintroduction of the extinct Rhine salmon.

■ Returning adults

For years, the number of adult salmon returning into the Rhine from the ocean has been increasing. During 1990 to end 2003, 2450 salmon travelling upstream were counted. It is certain that the real number of upstream migrating individuals is much higher.

■ Natural reproduction

Salmon again reproduce naturally in some of the tributaries and more and more naturally reproduced smolts migrate downstream towards the sea. Evidence has been given that salmon reproduce naturally in at least 12 release rivers. "Straying" salmon start to colonize the tributaries. Many of the salmon released are already the descendants of parent fish from which eggs were collected on their way upstream from the ocean.

■ Iffezheim fish passage

Counts at the new Iffezheim fish passage show that, during the past three years, more than 50,000 fish belonging to 34 species have migrated upstream. Not only long distance migratory fish such as salmon, sea trout, sea lamprey and allice shad use the fish ladder, but this is also true of many middle-distance migratory fish. The results prove that it was worth while to invest such large sums into Europe's biggest fish passage. Since the year 2000, access to the Alsacian Ill and the R. Rench in Baden has been open for migratory fish.

■ Monitoring stations

There are six permanent monitoring stations for migratory fish in the Rhine river system. Others will follow, e.g. at the Gambsheim fish passage on the Upper Rhine, which will be operational in 2006.

■ Renaturing

Structural improvements carried out in smaller Rhine tributaries show that a lot can be done for migratory fish at rather low expenses. Modifications and removal of weirs and renaturation of river banks have turned many Rhine tributaries into suitable salmon habitats.

Problems

■ Weirs and barrages

Many weirs and hydroelectric power plants still limit the movement of migratory fish in the Rhine river system. There are 9 large barrages in the Upper Rhine upstream of Iffezheim and in the Great Alsace Canal and 10 more in the High Rhine.

There is too little water flowing through the old bed of the Rhine, the most important potential salmon habitat in the Upper Rhine area. Within the renewal of the concession for the hydroelectric power plant Kembs, the future minimal flow will be in-

creased, and adapted to natural flow conditions. But still several barrages without any functioning fish passages disrupt migration.
In the main Rhine tributaries, the R. Moselle, Lahn and Main there are too many barrages without suitable fish ladders.

■ Turbines

During their downstream migration, many juvenile salmon as well as other fish, in particular adult eel die in the turbines of hydroelectric power plants. Chains of such power plants have particularly noxious effects.

■ Nursery grounds

Many potential spawning and nursery grounds have great deficiencies, e.g. partly silted gravel beds, stabilized and unnatural river banks. At times, water quality does not fulfil the high demands of salmon and sea trout. Organic pollution my harm the incubation and rearing of salmon eggs and alevins in the gravel bed.

■ Monitoring stations

More monitoring stations are needed to observe migratory fish, e.g. on the R. Ill near Strasbourg and the R. Bruche at Avolsheim. In particular, they are required for recognizing marked salmon returning to the rivers.

■ Stocking exercise

The targeted stable salmon populations in the Rhine system have not yet been achieved. For some years still, juvenile fish will have to be released.
The origin of salmon used for stocking and their cross-breeding may be genetically problematic.

Photo: ASR Strasbourg

Summing up

Constructing the Iffezheim (accomplished in 2000) and Gambsheim (construction started in 2004) fish passages is not enough. Further fish passages must follow, by-passing the barrages on the Upper and High Rhine in order to open up the way for migratory fish into the Old bed of the Rhine and to Switzerland.

‚Salmon ladders' are required to by-pass weirs in the tributaries Moselle, Lahn, Main and many of their smaller tributaries.

Many salmon ‚nursery grounds' in the tributaries to the Rhine river system must be cleaned up, e.g. by protecting and developing wide river bank stripes and by enhancing river dynamics. Suitable habitats for migratory fish will only develop once the rivers are given more room.

Hydroelectric power plants must urgently be equipped with protection facilities reducing fish mortality.

More monitoring stations are needed at the estuaries of the large Rhine tributaries.

In future, the coordination of salmon releases into the Rhine system will be improved. Fish of different stocks will no longer be cross-bred in artificial reproduction.

In future, stocking exercises will no longer be necessary in rivers with sufficient natural reproduction.

The target is wild salmon in the Rhine in 2020.

Bibliography

(also see www.iksr.org / publications)

ASR = ASSOCIATION SAUMON-RHIN (2004): *Suivi par radiopistage de la migration de truites de mer sur le Haut-Rhin en dans la région de Bâle (CH). – Rapport intermédiaire pour la Campagne 2003/04. – 46 p. + annexes, Strasbourg.*

ASR (2004): *Bulletin d'information, Saumon-Rhin Infos n°10, 6 p.*

BIJ DE VAATE, A., BREUKELAAR, A. W., VRIESE, T., DE LAAK, G. & DIJKERS, C. (2003): *Sea trout migration in the Rhine delta. – Journal of Biology 63 : 892-908.*

CLAIR, B., SCHAEFFER, F., EDEL, G., EL BETTAH, M. (ASR) (2003): *Suivi de la reproduction des migrateurs amphihalins en Alsace: Lamproie marine – Saumon atlantique, campagne 2003, 30 p. + annexes.*

EDEL, G., SCHAEFFER, F. (ASR) (2003): *Reproduction des grands salmonidés migrateurs – Campagne 2001-2002 – Première mise en évidence de la reproduction de la Lamproie marine, 17 p. + annexes.*

EDEL, G., SCHAEFFER, F., PASTURAUD, O. (ASR) (2001): *Synthèse des actions techniques réalisées par Saumon-Rhin au cours de l'année 2000, 29 p. + annexes.*

EDEL, G., SCHAEFFER, F., VAUCLIN, V. (ASR & Conseil Supérieur de la Pêche) (2002): *Suivi annuel des peuplements de juvéniles de saumon atlantique en Alsace. Résultats 2001, 22 p. + annexes.*

EL BETTAH, M., EDEL, G., SCHAEFFER, F. (ASR), (janvier 2003): *Evaluation des habitats potentiellement favorables au saumon atlantique sur la Doller, 36 p. + annexes.*

EL BETTAH, M., EDEL, G., SCHAEFFER, F. (ASR) (juillet 2003): *Evaluation des habitats potentiellement favorables au saumon atlantique sur la Fecht, 37 p. + annexes.*

EL BETTAH, M., EDEL, G., SCHAEFFER, F. (ASR) (juillet 2003): *Evaluation des habitats potentiellement favorables au saumon atlantique sur la Lièpvrette, 35 p. + annexes.*

HARTGERS, E. M. & BUIJSE, A. D. (2002): *The role of Lake IJsselmeer, a closed-off estuary of the River Rhine, in rehabilitation of salmonid populations. – Fisheries Management and Ecology 9: 127-138.*

HUMBORG, G. (1990): *Der Rheinlachs als Indikator für den Zustand des Ökosystems Rhein - Literaturstudie. - IKSR-Programm: "Rückkehr der Langdistanz-Wanderfische in den Rhein", Teilprojekt: "Zuwanderungsmöglichkeiten und Laichplätze am Oberrhein". 71 S., Univ. Karlsruhe.*

IKSR = Internationale Kommission zum Schutz des Rheins (HG.) (1987): *Aktionsprogramm "Rhein". – APR-Bericht Nr. 1, 18 S. + Anlagen, Straßburg / Koblenz.*

IKSR (1991): *Ökologisches Gesamtkonzept für den Rhein. - Bericht Nr. 24, Text: A. Schulte-Wülwer-Leidig, Farbbroschüre, 23 S., Koblenz.*

IKSR (1994): *Lachs 2000. - Bericht Nr. 61, Text B. Froehlich-Schmitt, Farbbroschüre, 32 S., Koblenz.*

IKSR (1996): *Lachs 2000 - Stand der Projekte Anfang 1996, Bericht Nr. 70, Text B. Froehlich-Schmitt, 48 S., Koblenz.*

IKSR (1998): *Bestandsaufnahme der ökologisch wertvollen Gebiete am Rhein und erste Schritte auf dem Weg zum Biotopverbund – Bericht Nr. 94, 71 S., Koblenz.*

IKSR (1998): *Rhein – Strom mit Beziehungen. - Bericht Nr. 98, Text B. Froehlich-Schmitt, Farbbroschüre, 32 S., Koblenz.*

IKSR (1998): *Lachs 2000 – Wanderfische als Erfolgsindikatoren für die ökologische Wiederherstellung der Habitate und der Durchgängigkeit des Rheingebietes. – IKSR-Bericht Nr. 99, 12 S., Colmar / Koblenz.*

IKSR (1999): *2. Internationales Rhein-Symposium "Lachs 2000" 10.-12.3.99 Rastatt. - Bericht Nr. 102, 311 S., Koblenz.*

IKSR (1999): *Lachs 2000 – Ist der Rhein wieder ein Fluss für Lachse? - Bericht Nr. 103, Text B. Froehlich-Schmitt, Farbbroschüre, 64 S., Koblenz.*

IKSR (2001): *Rhein-Ministerkonferenz 2001. Rhein 2020 – Programm zur nachhaltigen Entwicklung des Rheins. - Bericht Nr. 116, Farbbroschüre, 28 S., Koblenz.*

IKSR (2002): *Rheinfischfauna 2000 - Was lebt zwischen dem Rheinfall bei Schaffhausen und der Nordsee. – 68. Plenarsitzung – 2./3. Juli 2002, Luxemburg, Bericht Nr. 127, 55 S. , Koblenz.*

IKSR (2003): *Stromaufwärts - Bilanz Aktionsprogramm Rhein. – Bericht Nr. 139, Text B. Froehlich-Schmitt, Farbbroschüre, 31 S., Koblenz.*

LE CREN, E. D. (1985): *The biology of the sea trout. - Summary of a symposium held at Plas Menai, North Wales, 24-26 October 1984. - Atlantic Salmon Trust, 42 S., Moulin, Pitlochry.*

LFV BW = Landesfischereiverband Baden-Württemberg (2002): *Wiedereinbürgerung des Lachses am Oberrhein - Projektziele bis 2006. - Autoren R. Höfer u. U. Riedmüller, Farbbroschüre, 51 S. + Tabellenanhang, Freiburg.*

LÖBF (2003): Natur für Lachs & Co. - Herausgeber: *Landesanstalt für Ökologie, Bodenordnung und Forsten NRW, Farbbroschüre, 20 S., Recklinghausen.*

MILLS, D. (1989): *Ecology and management of Alantic Salmon. - 351 S., London & New York.*

MUNLV (2001): *Wanderfischprogramm Nordrhein-Westfalen - Statusbericht zur ersten Programmphase 1998 bis 2002. Herausgeber: Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes NRW, Farbbroschüre 110 S., Düsseldorf.*

MUNLV (2003): *Wanderfischprogramm Nordrhein-Westfalen - Phase 2003 bis 2006. - Farbbroschüre 29 S., Düsseldorf.*

PEDROLI, J.-C., ZAUGG, C. & B. (AQUARIUS) (1991): *Aktionsprogramm Rhein - Rückkehr der Langdistanz-Wanderfische in den Rhein; IKSR, Projekt Nr. 6 Schweizerischer Beitrag, Literaturstudium, 142 S., Neuchâtel.*

REICHSAMT DES INNERN (Hg.) (1886): *Vertrag zwischen Deutschland, den Niederlanden und der Schweiz, betreffend die Regelung der Lachsfischerei im Stromgebiete des Rheins. Vom 30. Juni 1885. – Reichs-Gesetzblatt No 18, S. 192-202, Berlin.*

ROCHE, P. (1990): *Le Saumon du Rhin: Données historiques. - Conseil Supérieur de la Pêche, 65 S., Montigny Les Metz.*

SCHAEFFER, F. (ASR) (2003): *Bilan du piégeage sur la passe à poissons d'Iffezheim en 2002 (4 mars - 31 décembre 2002), 32 p. + annexes.*

SCHAEFFER, F. (ASR) (2004): *Bilan du piégeage et des opérations de communication réalisés sur la passe à poissons d'Iffezheim en 2003 (1er janvier - 31 décembre 2003), 34 p. + annexes.*

SCHAEFFER, F., EDEL, G. (ASR) (2001): *Bilan du piégeage sur la passe à poissons d'Iffezheim en 2000 (13 juin - 31 décembre 2000), 21 p. + annexes.*

SCHAEFFER, F., EDEL, G. (ASR) (2002): *Bilan du piégeage et des opérations de communication réalisés sur la passe à poissons d'Iffezheim en 2001 (1er janvier - 31 décembre 2001), 33 p. + annexes.*

SCHAEFFER, F., EDEL, G., EL BETTAH, M. (ASR) (2003): *Suivi de la reproduction des migrateurs amphihalins en Alsace: Lamproie marine - Saumon atlantique, campagne 2002, 25 p. + annexes.*

SCHNEIDER, J., JÖRGENSEN, L., MOLLS,F., NEMITZ,A., KÖHLER, C. & BLASEL, K. (2004): *Notwendigkeit und konzeptionelle Ausrichtung eines effektiven Monitorings bei der Lachswiederansielung im Rhein – das Monitoring-Einheiten-Konzept. – Fischer & Teichwirt 2/2004, S. 528-531.*

SCHULTE-WÜLWER-LEIDIG, A. (2000): *Wiedereinführung des Lachses in das Rheingebiet. In: VDSF, Fisch des Jahres 2000 - Der Lachs. Verlag M. Faste, 199 S., Kassel.*

SHEARER, W. M. (1992): *The Atlantic Salmon: natural history, exploitation and future management. - Fishing News Book, 244 S. Oxford.*

VDSF = Verband Deutscher Sportfischer e.V. (2003): *Lachse in Deutschland - Dokumentation der Wiedereinbürgerungsprojekte des Atlantischen Lachses (Salmo salar L.) in Deutschland. - Farbbroschüre 135 S., Offenbach.*

WINTER, H. V., TIEN, N. S. H. & WIEGERINCK, J. A. M. (2003): *Jaarrapportage passieve vismonitoring zoete rijkswateren: samenstelling van de visstand op basis van vangsten met fuiken en zalmsteken in 2002. – RIVO rapport C025/03.*

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