

Selection of donour stocks to start with

Salmon 2020 - Reintroduction of Atlantic Salmon in the river Rhine system



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Contents



- Historical distribution
- Stocking which source ?
- Reproduction
- Trends and conclusion

Historical distribution of salmon in the Rhine system



Total Salmon catch Germany and The Netherlands







Juvenile habitat suitable for stocking various juvenile life-stages



Salmon stocking

During the past 15 years, more than 16 million juvenile salmon have been released into the Rhine catchment.

Sources: Ireland, France, Sweden, Denmark, Scotland, Spain, Norway

Partly, stocked salmon are the descendants of adult returners

Artificial rearing already supplements the import of eggs and juveniles

Salmon stocking – what source ?





- Distribution in North America from Labrador to New England and Maine
- **Distribution in Europe from Arctic Russia to Portugal (incl. Baltic region)**

=> Significant differences in biotic and abiotic factors affecting freshwater life

All tested strains demonstrated similar life-history patterns in the freshwater phase comparable to the ancient Rhine salmon

Absolute growth of salmon (standard length)

- age 0+ (autumn): 6.2 11.0 cm
- age 1+ (spring): 6.8 11.0 cm
- age 2+ (spring) 12.1 18.0 cm (SCHNEIDER, 1998)

The Upper Modal Group incorporates between 15 - 72% of the age class 1 (SCHNEIDER, 1998)

Smolts are commonly 1 and 2 years old (rarely 3 years)

Emigration of smolts starts in March and ends in May (tributaries)

Proportion of precocious parrs in age classes age 0+: 0-13%; 1+: 8-60%, 2+ (resident): > 95% (SCHNEIDER, 1998)

Generation time is relatively short - the age of returners commonly varies between 2+ and 5+ (but the proportion of MSW is stock specific)







Adaptation and stock differentiation

yesterdays environment dictates tomorrows adaptations (G. de Leaniz)

- Genetic differentiation is based on homing to natal rivers (isolation of populations)
- Natal rivers vary in size, gradient, temperature regime, water chemistry, flow, and many other environmental factors

Spawning time is stock specific and under genetic control...

Spawning time and the selection of a donor-strain



Salmon spawn at different times in different environments



- Spawning time has a high heritability in salmonid fishes
- The timing correlates with water temperature during incubation - spawning time between "cold river" and "warm river" populations differs by 5-6 months (Pechora river; Russia: September, Iberian populations: January-February
- In large river systems spawning in upper (colder) reaches may occur earlier than in lower reaches
- The timing of reproduction ensures optimal timing of hatching and initial feeding for the offspring

Bad timing leads to mass mortality in the first weeks after emergence (starvation, predation, drift...)

Transplanted strains keep their inherited spawning time in the new environment for many generations - spawning time is stock specific. The timing of reproduction ensures optimal timing of hatching and initial feeding for the offspring (Heggberget 1988) and is of selective importance



A common garden experiment - spawning period (lines) and peak-spawning (boxes) of five introduced (= allochthonous) stocks returning to river Gudenau (Denmark) (n= 443) => the Ätran strain demonstrates the closest consistency with the ancient Sieg strain (Middle Rhine).

In 2003/2004 the strategy of introducing mixed stocks in single tributaries was abandoned in favour of using the Ätran strain (Middle Rhine) and Allier (Upper Rhine) only.

Selective importance of timing

Atlantic salmon fry and coexisting trout and charr fry have overlapping habitat requirements and compete for territories and food after emergence from the gravel. Early emerging fry is having an advantage in establishing territories and high growth performance



top: brown trout (*Salmo trutta*) below: Atlantic salmon (*Salmo salar*)

- A female's spawning time will dictate the thermal regime her embryos experience during development and to a large extent, their hatching and emergence time from gravel as fry (Fleming & Petersson 2001)
- The timing of reproduction ensures optimal timing of hatching and initial feeding for the offspring (Heggberget 1988)
- Optimal timing of hatching depends on flow conditions, temperature (limit ≥ 7°C), prey abundance, predator abundance, inter- and intra-specific competition (prior residence effect)
- "Bad" timing leads to mass mortality in the first weeks after emergence (starvation, predation, displacement...)
- Early juvenile life is thus a period of intense selection - which explains the high heritability of population-specific spawning periods.

Donour stocks used in the Rhine system

Ätran (Sweden)



Allier (France)





Collection of data via electro-fishing

Survival rates of stocked fish, natural reproduction, smolt-ratios, and returning salmon are assessed in most river systems using the method of electrofishing.

Results:

Survival rates, growth and juvenile densities are good, sometimes excellent.

Natural reproduction has been successful in various river-systems (e.g. Dhünn, Sieg, Saynbach, Nette, Ahr (Germany), Bruche, III (France) since 9-13 years (!)

Natural reproduction

Natural reproduction has been recorded in almost all accessible tributaries:

- Sieg-system
- Wupper, Dhünn
- Ahr, Nette, Saynbach
- Wisper
- Wieslauter
- Upper Rhine
- III, Bruche

In rivers Sieg (system) and Saynbach densities where particular high in some years.

Reproduction is recorded over more than 12 years

In the rivers Sieg and Saynbach 10 - 30% of the returners are allready 2nd generation (= "wild")

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eproduction in the Rhine system

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achweis unsicher	2

Laichgründe (größtenteils) erreichbar	-
Laichgründe partiellieingeschränkt erreichbar	
Loichgründe nicht/ausnahmaweise erreichber	





Conclusions

Reintroduction is a process of adaptation – nobody knows, how many generations it takes ...

The documented natural reproduction (some years showed high densities of wild YOY) is a clear indicator, that the reintroduction can be achieved.

The Swedish strain Ätran is reproducing successfully in many streams - because of spawning time matching with the environmental condtions?.

Allier salmon so far do not have access to high quality spawning grounds. Data of the performance are insufficient.

The return rate to the spawning rivers is still insufficient, but should improve with the adaptation / evolution of new stocks.

Thank you very much for your attention



Merci beaucoup pour votre attention