Available online at www.sciencedirect.com
ScienceDirect
Aquaculture 264 (2007) 59–65
Aquaculture
www.elsevier.com/locate/aqua-online

Genetic variation losses in Atlantic salmon stocks created for supportive breeding

Gonzalo Machado-Schiaffino, Eduardo Dopico, Eva Garcia-Vazquez *

Departamento Biologia Funcional, Universidad de Oviedo, C/ Julian Claveria s/n, 33006-Oviedo, Spain

Received 16 March 2006; received in revised form 19 December 2006; accepted 19 December 2006

Abstract

Conservation of genetic variability is of priority for hatchery stocks employed to supplement natural populations. Supportive breeding of Atlantic salmon is carried out in order to enhance wild populations at the south of the European distribution (northern Spain). In this study we demonstrated that adult breeders chosen for creating hatchery stocks by artificial spawning preserved all genetic variants present in wild Spanish populations for six microsatellite loci. However, significant losses of genetic variability were found in juveniles released to the native rivers. An inadequate strategy of crosses was the cause of genetic variation decrease in these hatchery stocks. Unbalanced sex ratio was identified as one of the causes of genetic erosion. Increasing the number of breeder males was suggested to maximize fidelity of hatchery stocks to native wild genetic patterns.

Keywords: Genetic variability; *Salmo salar*; Stocking; Supportive breeding

1. Introduction

Conservation of genetic diversity in natural populations is one of the most important aims in supportive breeding programs. Even though supplementation has potential benefits, there are several recognized possible problems (Waples, 1991). There is always a risk that genetic diversity is lost in hatchery rearing because of the accelerated rate of genetic drift in potentially small broodstocks (Allendorf and Phelps, 1980; Cross and King, 1983; Allendorf and Ryman, 1987; Ryman et al., 1995). Furthermore, supportive releases could be the cause of a decrease in genetic diversity (Ryman and Laikre, 1991; Waples and Do, 1994; Cross et al., 1998). Stocking programs are carried out in order to enhance many wild fish species, but the consequence is often that native gene pools are compromised by loss of diversity within populations, introgression and eventually extinction of local populations (Ryman et al., 1995).

Atlantic salmon (*Salmo salar* L.) stock transfers from northern Europe took place in Spanish rivers, at the southernmost latitude of the natural European distribution of the species, over more than two decades in order to stop population decline. High fishing pressure together with habitat pollution and reduction of spawning areas seem to be the principal causes of population reduction (Garcia de Leaniz and Martinez, 1988; Garcia de Leaniz et al., 1992). Fry from northern Europe, principally from Scotland but also from other regions (Vázquez et al., 1993), were stocked before 1992, with variable intensity among rivers and years. However,

* Corresponding author. Tel.: +34 985102726; fax: +34 985103534.
E-mail address: egv@fq.uniovi.es (E. Garcia-Vazquez).

0044-8486/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.aquaculture.2006.12.026

Table 1
Details of samples

River system	Fish sample and acronym	*n*	%F	NJ
Sella	Wild adults — SWA	93	63.9%	–
	Broodstock — SB	69	84.1%	–
	Wild juveniles – SWJ	67	–	–
	Hatchery juveniles – SHJ	89	–	150
Cares	Wild adults — CWA	95	44.1%	–
	Broodstock — CB	37	64.9%	–
	Wild juveniles — CWJ	77	–	–
	Hatchery juveniles — CHJ	107	–	160

Sample acronyms (name), samples sizes (*n*), proportion of females (%F) in adult samples, thousands of hatchery juveniles (NJ) released in the corresponding river.

stock transfer has proved to be ineffective for increasing population size, and the risk of disrupting local population adaptation has also been assessed (Moran et al., 2005). As a consequence, foreign stocking was interrupted in these rivers in 1992 and substituted by supportive breeding based on artificial spawning of adults returning to the rivers followed by hatchery rearing of offspring. All offspring produced each year are released in the origin river, without keeping a part for further years. Thus the broodstock is obtained randomly from sea runs every year. The number of adults employed as broodstock represents approximately 5% of wild sea run each year. The mating system usually consists of a multiple paired system whereby each female is mated to two males (pooled milt to fertilize all the eggs from a single female). After fertilization, eggs obtained from different crosses are pooled together in large batches where they are kept until autonomous feeding, then transferred to pools and artificially fed until releasing. Release of hatchery-reared supportive stocks takes usually place in summer (young of the year or 0+ parr stage). To date, there are no studies aimed to evaluating the effects of these enhancement practices on wild population sizes, or even on sport catch numbers.

The aim of the present study was to evaluate the potential effect of supportive programs on Atlantic salmon native genetic variation in northern Spanish rivers. Genetic variation at six microsatellite loci was analyzed in wild adults, in hatchery broodstocks, and in juveniles derived from these stocks, to assess the degree of fidelity of enhancement programs to native genetic pools and evaluate the potential consequences of these management practices on conservation of wild population genetic patterns at the southern limit of the species in Europe.

2. Materials and methods

2.1. Sample collections

Tissue samples (adipose fin clips) of wild Atlantic salmon were collected in two north Spanish rivers, Sella

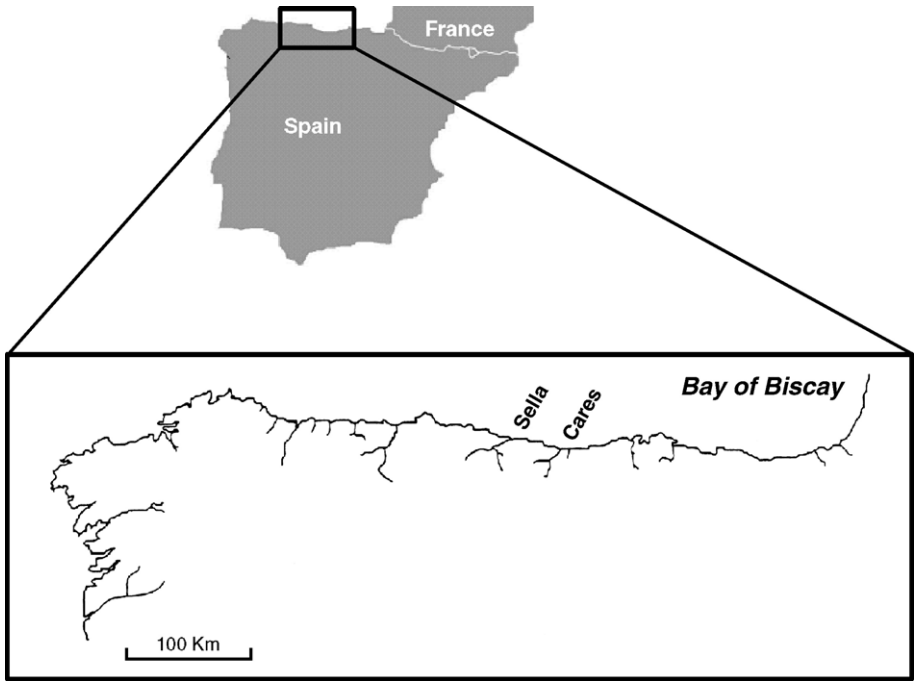

Fig. 1. Map showing the location of the studied rivers in northern Spain.