ESCAPEMENT OF EGGS FROM FARMED COD SPAWNING IN NET PENS AND OFFSPRING INTERMINGLING WITH NATURAL SPAWNED LARVAE

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Introduction

Interbreeding between wild fish and escaped farmed fish (or deliberate releases in enhancement/ranching) could result in genetic changes in the wild populations that reduce overall fitness and productivity (Utter et al. 1993; Utter 1998). Although this problem has been discussed for a long time (e.g. Hindar et al. 1990; Skaala et al. 1990) experimental evidence of harmful effects from interbreeding between cultured and wild stocks has been limited. Recently, however, new knowledge has been established especially for Atlantic salmon (Einum & Fleming 1997; McGinnity et al. 1997; Fleming et al. 2000). A comprehensive 10-year study in Ireland (McGinnity et al. 2003) measured the lifetime fitness of offspring from various crosses between farmed and wild salmon, carried out over two generations. The data obtained demonstrated a dramatic reduction in the lifetime success of the offspring of farmed and hybrids compared to wild salmon offspring.

The problems now being experienced in Atlantic salmon are possibly relevant to most new fish species under domestication. The establishment of the cod farming industry in Norway presents several new challenges. In contrast to salmon, all life stages of cod are bound to the marine environment. This includes spawning in net pens when the farmed cod reach maturation before they are actually harvested for the market. Spawning behavior in net pens has been observed, successful spawning of farmed cod in net pens has not been documented due to lack of appropriate tagging methods. In connection with the large-scale enhancement experiments carried out about 15 years ago, a genetically marked cod strain was developed (Jørstad et al., 1991) and used in a number of release experiments (Jørstad et al., 1999). Offspring from these releases has now been collected and a new genetically marked cod strain has been re-established at the Institute of Marine Research, Austevoll Aquaculture Station, Norway.

Pilot experiment and demonstration of egg escapement

The first experiment of this kind was carried out in Heimarkspollen in Austevoll in western Norway during the 2006 spawning season. This area consists of a nearly land-locked fjord system, of about 3 km^2 surface area and about 80 million m^3 water. The greatest depth is about 120 m, and the connection with adjacent seawater is through two narrow, shallow canals with strong tidal currents. The experiment was based on about 1000 genetically marked fish with a mean size of 3, raised at Austevoll Aquaculture station. A small net-pen facility was established in the inner part of Heimakspollen, and in February the mature fish were transported to Heimarkspollen and transferred to the net pen. Horizontal plankton net surveys were subsequently performed and eggs were collected weekly at nine stations within the area. Hydrographical parameters were also regularly recorded. These surveys continued until the end of April, when the fish were returned to the research station. The density of cod egg was significant higher near the spawning pen, and this was also expected. Considering the whole spawning season, about 25% of all cod eggs in the fjord system were actually found near the net pen.

On the basis of the egg surveys and an evaluation of hatching time, a larvae survey was conducted in April. In all, 132 cod larvae were collected within Heimarkspollen and these were immediately frozen. The larvae were analyzed by simple starch gel electrophoresis and staining for phosphoglucose isomerase, and 33 of the collected larvae (or 25%) had the genetic marker that identified them as offspring from the spawning farmed cod in the net pen. A new survey carried out at the end of April included the main area Heimarkspollen and some of the adjacent area outside. At this time 20% of the cod larvae (a total of 168 larvae analyzed) in the Heimarkspollen were identified as offspring of spawning farmed cod in the net pen. More surprisingly, the genetic analyses demonstrated that about 19% of the cod larvae collected just outside Heimarkspollen were from the spawning pen. Even at a station about 8 km from the net pen a genetically marked cod larvae was found.

The pilot experiment clearly demonstrated that mature, farmed cod do spawn in the net pen during the spawning season, resulting in viable cod larvae that mix with wild offspring. These will possibly compete for food and spread in the same way as wild cod larvae. The experiment also confirmed that eggs and larvae from the net pen are not only distributed through the Heimarkspollen system, but also spread to adjacent areas. Thus the farming of marine species will represent an additional challenge with regards to potential genetic interactions with wild stocks, as discussed by Youngson et al. (2001).

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