Canadian Rivers Institute

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Fredericton

To CBC News

Re: Group led by Irving, Cooke not giving up on Miramichi salmon stocking program, Published on Jan 24th, 2019.

In response to the article recently published by CBC, we would like to further comment what is known to science about natural selection process during the migration in oceanic environment in Atlantic salmon, and what the proposed SAS research by CAST means with regard to this question.

Sincerely submitted,

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Smolt-to-adult supplementation is a "staying-alive" rather than traditional stocking program

Purpose of the proposed Smolt-to-adult supplementation program in the Miramichi

The primary goal of the smolt-to-adult supplementation or SAS program proposed by the Collaboration for Atlantic Salmon Tomorrow (CAST) is to assess the viability of SAS as a strategy to recover declining salmon populations. The foundation of the CAST program is to enable mature adult salmon to spawn naturally in their natural environment. It is true that stocking salmon has become a contentious issue in recent years. Concerns about the potential consequences of hatchery-rearing and the lack of marine exposure for SAS fish are warranted. However, the potential benefits and negative consequences are precisely what CAST-associated researchers are interested in understanding so that trade-offs can be appropriately assessed when these strategies are required for conservation. There has been a considerable amount of misinformation spread in recent months that deserves to be corrected. In particular, comparisons of SAS fish to aquaculture fish as well as concerns about sea survival genes have been misrepresented and are not based upon the best available science.

Difference between an aquaculture salmon and SAS salmon

Domesticated aquaculture fish have been selected over many generations to enhance growth and related traits. In contrast, SAS fish are wild. They were born and spent their first few years living in the wild before being captured as smolts and brought to a facility. Following two to three years living in captivity, these wild-origin adult salmon will be released back into their river of origin to naturally choose their own mate and spawn. As such, it is important to emphasize that the use of hatchery technology to rear wild salmon in a SAS program does not imply they possess selected traits similar to domesticated fish.

Difference between traditional stocking programs and SAS

There are two main aspects of the proposed SAS program that represent improvements over traditional stocking programs. In traditional stocking, mating pairs are chosen by humans (i.e. think of an arranged marriage). These pairings are often done haphazardly and thus disrupt fish's natural processes of mate choice. Indeed, previous studies using genetic information clearly demonstrated the non-random process of mate choice based on immune genes compatibility, namely. Additionally, unlike conventional hatchery rearing practices, offspring will develop in the wild under natural temperature regimes and natural selection pressure in their natal streams and will properly imprint to those streams.

While recent studies have highlighted the potential for traditional stocking programs to have negative effects on wild populations, the causes of these negative effects are generally not known. The few studies that have looked at genetic differences between stocked and wild fish originating from a same river have generally found no evidence of natural selection acting across thousands of genes.

Instead, these studies have suggested another mechanism that may explain reduced fitness of hatchery-born fish. Generally referred to as epigenetics, they represent a way that adult environmental experience can affect a fish's offspring. CAST associated researchers at University of New Brunswick and Laval University are already hard at work assessing the potential for epigenetic differences between wild and SAS salmon and whether these effects will be negative for offspring.

Is the potential relaxation of sea survival in SAS salmon going to be a problem?

Another frequent criticism of the SAS strategy is that it eliminates selection for marine survival and thus SAS will weaken the whole population because their offspring will not be adapted for sea survival.

Several lines of evidence suggest there is no single gene for survival at sea. First, based on the time Atlantic salmon have been established in North America (>10,000 years), their population sizes, and the strength of selection inferred from estimates of smolt-adult survival rates, any single gene that determined whether individuals survived at sea would be expected to have already become completely selected (i.e. all individuals carry the successful survival version).

Second, there are many causes of marine mortality (e.g. starvation, predation, fishing capture) and the relative importance of each likely varies from year to year. For example, food availability will be more important in some years while in other years predation may be more important for determining marine survival. These different selective forces will certainly target different genes reinforcing the fact that selection for marine survival is not a one gene show. Selection acting on different targets that will vary in time will actually contribute to maintain rather than erode genetic variation, a process called balancing selection.

Finally, the only available evidence for selection at the gene level for marine survival comes from a study done in two Québec rivers that was published in 2014. In each river, researchers looked for differences between the smolt and grilse stage for two separate cohorts at more than 5,000 genes. They found no evidence to suggest individual genes were consistently selected between either cohorts or between rivers. What they did find was a signal of small correlated changes in the same 34 genes in both cohorts for one of the two rivers. These results confirm that selection for marine survival is not always consistent spatially or temporally and when it occurs, it acts by causing small changes at many genes but genetic variation is being maintained, not eroded.

So, what does this mean for SAS fish in the Miramichi? It means that, yes, relaxed selection in the hatchery has the potential to cause genetic differences between SAS and wild fish, although this remains to be rigorously tested. However, based on the best available scientific evidence these changes will be subtle, generally unpredictable from year to year, and most importantly, they will be reversible because genetic variation will be maintained.