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Risks Associated with Fish Culture Intervention as a Management Option for Interior Fraser River fall-run Steelhead Populations

Background and Introduction

The BC Federation of Fly Fishers (BCFFF) are opposed to conservation fish culture as being a potential management option to increase the abundance of interior Fraser River fall-run steelhead populations, which includes Thompson River steelhead. This opinion is based on BC's past experience with conservation fish culture and the emerging science from the US Pacific Northwest, which urges extreme caution with "culture rescues" of wild steelhead. To date, there has been no evidence to suggest that conservation fish culture provides any benefits. In contrast, there is scientific evidence that it can decrease the ability of a depressed steelhead population to remain viable. In our opinion, therefore, attempting conservation fish culture would represent a wasteful use of resources, and may actually jeopardize the overriding goal of preserving the viability of interior Fraser River fall-run steelhead.

We are in agreement that management intervention is required to address the general declining trend of returning interior Fraser River fall-run steelhead, but initiatives must be based on the best available science and must incorporate the precautionary principle. Management options that address and consider key concerns, including (but not limited to) ocean survival rates, the quality of freshwater rearing habitat and interception of returning adults must be given priority. In the following paragraphs, we hope to provide clarification about the risks involved with fish culture intervention and also suggest management options that should be included as part of interior Fraser River fall-run steelhead recovery.

Steelhead Life History Traits and Conservation Fish Culture Concerns

The life history of steelhead is such that populations can be stable during years when relatively few adult fish return. This is related to the fact that there is less competition for freshwater food and habitat, and more juveniles survive as a result. It does not take many spawners, therefore, to "seed" the system to its natural maximum carrying capacity. In years where more steelhead return to spawn, the same carrying capacity would be reached, as survival of juvenile fish would be limited accordingly by the capacity of the habitat. This relative stability of juvenile steelhead was indicated in Levy and Parkinson (2014), where steelhead parrnumbers in the Thompson River and tributaries showed minor variations (217 000 – 307 000 parr), even when spawner abundance showed four-fold variations in numbers.Corresponding smolt production also remained relatively stable in the Thompson River system, based on data collected by the Ministry of Environment (MoE) between 2001 and 2011. This may give a sense of security and stability to the population when considering freshwater habitat capacity, but the fact is that adult steelhead are declining significantly in numbers and the Thompson River steelhead population is approaching the 1:1 replacement level with regard to spawners and recruits to the population (Levy and Parkinson 2014). Once this "tipping point" is reached or exceeded, the population is at a critically low levelconcerning long-term viability.

While the influence of spawner numbers does not greatly influence the resulting number of parr or smolts, the number of steelhead fry is positively influenced by the number of spawners in the Thompson River system (Levy and Parkinson 2014). This limit to steelhead production was aptly described as a freshwater habitat "bottleneck" in Levy and Parkinson (2014), where the numbers of parr are similar, despite what the population of spawners or fry may be in any given year. If the number ofspawners continues to decrease, however, and the productivity of the stock decreases below the1:1 spawner-recruitment level for long enough, the population would become non-viable.

With apparent low ocean survival and/or high mortality of out-migrating smolts and limitations imposed by freshwater habitat carrying capacity, putting more fish into the system through hatchery supplementation will not result in improved adult returns. The more likely result would be a decrease in the numbers of fish returning, as hatchery-raised fish would be less well equipped to survive the rigours of smolt to adult survival, especially given the current low survival rates.In addition to understanding the capacity of freshwater rearing habitat, the key management issues are associated with factors that affect out-migrating smolts and long-term ocean survival. It is extremely important, therefore, to ensure that adult spawners that do survive the hazards of smolt out-migration and inhospitable ocean conditions are allowed to return to spawn.

Based on the concept of a carrying capacity and habitat "bottleneck", it is imperative to maintain and increase the viability of freshwater rearing habitat, especially due to the fact that the carrying capacity has likely been reduced as a result of human-induced impacts (e.g. changes in river flows/water temperature due to climate change, loss of riparian habitat, loss of spawning habitat, loss of instream security habitat, water extraction and increased water turbidity/sedimentation). As the number of fry is positively influenced by the number of spawners (as noted in Levy and Parkinson 2014), the importance of freshwater habitat protection and enhancement (especially parr habitat) becomes even more apparent, in order to maximize the number of fry that are able to mature into parr and, ultimately, smolts.

Understanding the interactions between resident rainbow trout and steelhead are critical to managing steelhead populations, as it has been shown in scientific literature that steelhead can produce rainbow trout and rainbow trout can produce steelhead (one and the same species). Management options must consider the fact that during lower ocean survival conditions and/or high mortality of out-migrating smolts(such as is occurring at the current time), a greater number of interior Fraser River fall-run steelhead may remain in freshwater as rainbow trout (as suggested in Levy and Parkinson 2014). The protection of this freshwater bank of viable steelhead, through angling regulations that consider effects on rainbow trout, is critical to the management of steelhead. The importance of resident rainbow trout to steelhead populations further emphasizes the need to protect and enhance freshwater rearing habitat. Managing "steelhead" without considering "rainbow trout" is not scientifically defensible, based on the genetic overlap and the important interactions between the two forms of the species.

Steelhead are naturally equipped to deal with events that decrease the numbers of returning fish, based on the fact that steelhead have the ability to spawn more than once (10% to 20% of returns can be from repeat spawners) and have a diverse life cycle, with 1 to 5 years spent in freshwater and 1 to 3 years spent in saltwater (Ward 2006).Specifically, McGregor (1986; cited in Levy and Parkinson 2014) identified fourteen life history traits in Thompson River steelhead, with freshwater and ocean residence times varying between 1-3 years and 2-3 years respectively. Based on the overlapping generations of steelhead, a population can recover quickly from a low return year through younger or older age classes (Ward 2006). It should be noted, however, that repeat spawning of Thompson River steelhead has been estimated at only 2.8%, due to the incidental capture of kelts returning to the ocean by downstream salmon fisheries (Levy and Parkinson 2014). This extremely negative impact upon one of the steelhead's key life history traits must be addressed to increase the percentage of repeat spawners.

Wild steelhead populations are inherently adapted to their natal system. These adaptations help to ensure the long-term viability of any given population. For example, Thompson River steelhead have been shown to have a very high fecundity, with an average female producing 12,600 eggs (McGregor 2006; cited in Levy and Parkinson 2014). These life history traits that help ensure survival of the species are, unfortunately, only slowing the rate of the apparent population decline(Levy and Parkinson 2014). Managing the main controllable threats to the fish, therefore, is extremely important in order to provide the population with the maximum ability to implement all life history traits and fully exploit itsnatural resilience.

Raising steelhead in a hatchery, even as part of limited conservation fish culture ("hatchery supplementation"), takes away the ability of fish to become naturally adapted to the specific life-requisites needed for survival in a particular system, especially when considering the specific attributes of a population such as the Thompson River steelhead. Artificially raising fish removes the process of natural selection, while also preventing the ability of steelhead to distribute naturally throughout a system, based on fidelity to successful spawning and rearing areas. Ward (2006) noted lower fecundity in female hatchery steelheadin comparison to wild fish, which obviously suggests lower spawning success. Recruitment of wild fish has been shown to be negatively impacted as a result of the presence of hatchery fish (e.g. Ward 2006; Walters 2005). In an extreme case, i.e. when natural recruitment to the population is very low, hatchery fish could potentially replace the wild population, where the resulting population would be much lower, based on the fact that the reproductive success of hatchery fish from which the population originated is inferior (Ward 2006). Studies by Chilcote et al (2011; cited in Pollard 2013) established that the productivity of a steelhead population decreased as the number of hatchery spawners increased, which reduced the ability of a population to rebuild. Christie et al. 2012, Leider 1990, Kostow 2004, McClean et al. 2003, Berejikian and Ford 2004, Araki et al. 2007, 2009 (cited in Pollard 2013) also concluded that hatchery fish were inferior to wild fish with regard to the production of viable offspring. In addition, these studies showed that fish that performed well in a hatchery environment did not perform well in the wild, which suggests that hatcheries are selecting for the wrong behavioural traits. These impacts were shown to be cumulative, as the effects were carried between generations (Araki et al. 2009; cited in Pollard 2013).

The Living Gene Bank (LGB) program represents an example of supplemental fish culture that was used in an effort to rebuild steelhead stocks on the east coast of Vancouver Island (Keogh, Little Qualicum and Quinsam Rivers). This program did not result in any measurable rebuilding of the stocks of concern and there were also negative impacts associated with freshwater habitat competition from LGB smolts that established a residual population. The recruitment of wild smolts actually improved since the discontinuation of the project (Pollard 2013).

Hatchery steelhead supplementation was also used following the spill of caustic soda into the Cheakamus River in 2005, with a release of smolts occurring in 2007 and 2008. During the out-migration of smolts over this period, it was shown that survival of hatchery smolts was significantly lower (23% to 36%) in comparison to wild smolts (69% to 72%). This trend continued as the smolts transitioned into the ocean environment (Melnychuk et al. 2009; cited in Pollard 2013). Recent studies have shown that rebuilding of the population could have been completed without hatchery supplementation, and that any supplementary-attributable benefits to population recovery were "illusive and undetermined" (Pollard 2013). Pollard (2013) further recommended that hatchery supplementation should not be considered as a potential steelhead population recovery option until the risks and uncertainties have been reduced.

It is also worth considering the risks involved with holding steelhead brood stock in hatcheries over long time periods and also with raising fish in hatcheries in general. Hatcheries and the fish held within them are not immune to human error or natural events that could potentially result in the loss of brood stock or their progeny.

The overwhelming scientific documentation suggests that there is no proven evidence that hatchery supplementation (conservation fish culture) represents a viable option for rebuilding depressed steelhead stocks. Scientific studies actually indicate that there are proven reasons why supplementation should not be used, as it can decrease the inherent natural ability of a steelhead population to rebuild. As there is no evidence to suggest that conservation fish culture results in positive benefits to natural steelhead production, it represents an expensive, wasteful and potentially damaging management option. Management of the interior Fraser River fall-run steelhead population must focus on increasing the ability of the fish to rebuild naturally by removing the existing barriers that jeopardize the effectiveness of the population's life history survival traits. We have provided some potential generalized solutions in the following section, but it should be noted that recent studies carried out on the Thompson River system (e.g. Levy and Parkinson 2014) also contain detailed long-term management initiatives.

Recommended Viable Management Options

The interior Fraser River fall-run steelhead that are successful in returning to freshwater have beaten the odds and have survived the current challenges associated with smolt to adult survival. The protection of these survivors is extremely important and the loss of even a small proportion of returning fish during the current population decline and low ocean survival conditions is not acceptable.While little management control is available to address changes in estuarine/marine ecosystems and how these changes may affect smolt to adult survival, there are management options available for impacts that can be controlled.

In order to increase the numbers of returning steelhead, any incidental impacts associated with all fishery sectors (recreational, aboriginal and commercial) should be reduced to a level where no harm is imposed on returning steelhead, at least during the current inhospitable trends associated with smolt out-migration and ocean survival when it is difficult for the population to recover.Any type of fishing that results in either direct mortality (e.g. harvest) or high stress induced from by-catch (which usually results in post-release mortality anyway) should ideally be eliminated for a period of at least two cycles (eight years). This will take considerable collaborative effort between all user groups and governments, but reducing stress and mortality imposed on returning fish, especially during current low ocean survival conditions, is key to the survival of the species.The fact that by-catch occurs during both the adult steelhead return period and the adult post-spawner (kelt) out-migration highlights the extreme importance of eliminating stress and mortality imposed due to by-catch. Recreational angling regulations can help reduce impacts to returning adults and out-migrating kelts, through modifications to angling techniques, limiting the numbers of fish encountered, and ensuring proper fish-handling techniques (e.g. keeping steelhead in the water prior to release). Modifying angling regulations, however, would be of limited use if other user-groups were engaged in activities that resulted in direct steelhead mortality (whether it is through accidental by-catch or intentional harvest). Conservation measures must absolutely be universally-employed in order to be effective.We understand that this is a difficult proposition, but there is reason to believe that interior Fraser River fall-run steelhead have the innate ability to overcome population decline, if the fish are given a chance to do so.

Based on the apparent current trend of low smolt to adult survival, whether it is as a result of mortality of out-migrating smolts in the freshwater environment or poor ocean survival, it is extremely important to protect rainbow trout and associated habitat throughout the system. Rainbow trout represent a genetic bank of future steelhead production, which allows for increased steelhead returns as and when ocean survival conditions improve.If the productivity of the steelhead population fell and stayed below the 1:1 spawner-recruitment level, rainbow trout may become a significant factor to the long-term recovery of the steelhead population.Angling regulations must consider potential impacts to this important genetic insurance bank, based on the fact that the rainbow trout and steelhead are one and the same species.

Due to limitations imposed by the carrying capacity of freshwater habitat in areas affecting interior Fraser River fall-run steelhead, it is extremely important to preserve the integrity of critical rearing habitat. Levy and Parkinson (2014) have identified the limiting habitat units that are exploited by rearing steelhead parr in the Thompson River system (generally consisting of specific fast flowing riffles and rapids). It is importance, therefore, to restore non-functioning freshwater habitat and also enhance existing habitat to ensure that the carrying capacity can be maximized. Impacts associated with riparian vegetation removal, water withdrawal, loss of cool groundwater inputs and high water temperatures are also negatively impacting the ability of the steelhead population to rebuild. The appropriate implementation of regulations such as the Water Sustainability Act, Fisheries Act and Riparian Area Regulations (e.g. through increased enforcement) would help reduce some of these impacts.

Maintaining the services provided by ecosystems on a watershed basis would ultimately help increase the viability and resilience of freshwater habitat. Intact, functioning ecosystems are more likely to survive the rapidly changing conditions imposed by climate change and associated negative impacts to fluvial systems such as an increased frequency in peak flows, extreme low flows,bank/channel instability and increased sediment movement.

Concluding Discussion

In summary, it is extremely unlikely that the implementation of a conservation fish culture initiative would be of any benefit to interior Fraser River fall-run steelhead. As has been shown in the scientific literature, the very introduction of hatchery fish in a supplementary capacity may actually impede the natural ability of a population to recover and to be viable over the long term. We cannot risk losing the unique life history traits and genetic integrity of steelhead such as the population found in the Thompson River, especially if the fish are currently under stress from uncontrollable external forcing factors (e.g. inhospitable ocean conditions or high mortality of out-migrating smolts). It is at these times that we need to rely on the natural resilience of the population to allow the numbers to rebuild naturally, instead of introducing another factor that may impede that process. During lower return years, it may be tempting to put more fish into the system, but it has been shown that this activity does not necessarily result in the return of more fish, and we run the risk of negatively impacting upon the long term viability of the steelhead population. The approach on intervention should practice the precautionary principle and attempt to eliminate the possibility of harm, and, since there are reasons to believe “conservation fish culture” can do harm, it should be avoided. We need to understand and act upon the current barriers that are reducing the innate ability of the steelhead population to rebuild (e.g. interception, injury or mortality of returning adults). Responsive measures that actually address these barriers must be implemented, as opposed to investing what would be significant monetary and human resources into a management option that has been proven to be ineffective.

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