Spatial and Temporal Dynamics of Spawning Between Native Westslope Cutthroat Trout, Introduced Rainbow Trout, and Their Hybrids, With Implications for Hybridization and Loss of Adaptation

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Populations of many native salmonids in western Nortli America are threatened by introgression with introduced rainbow trout (*Oncorhynchus mykiss*; RBT), yet little is known about the reproductive factors influencing the spread of hybridization in the natural environment. We used radio telemetry to assess spatial and temporal spawning distributions of native westslope cutthroat trout (*O. clarkii lewisi*; WCT; $N = 27$), introduced RBT ($n = 51$) and their hybrids ($n = 47$) in the upper Flathead River system, Montana and British Columbia, from 2000 to 2007. Radio-tagged trout moved upriver towards spawning sites as flows increased during spring runoff and spawned in 29 tributaries. WCT migrated greater distances and spawned as flows declined in headwater streams dominated by snowmelt runoff, whereas RBT and RBT-hybrids (backcrosses to RBT) generally spawned earlier in low elevation streams fed by springs or headwater lakes; WCT-hybrids (backcrosses to WCT) spawned intermediately in time and space. Both hybrid groups spawned over relatively long time periods that produced temporal overlap with spawning WCT in most years. Spatial overlap between parental species occurred in four streams (two streams where F_1 hybrids and two streams where RBT spawned in the same areas used by WCT) and spawning sites used by both hybrid groups overlapped in 17 streams. One stream, Abbot Creek, supported a relatively high proportion of spawning by RBT and RBT-hybrids (47%), and a genotypic gradient was found extending upstream from the site, indicating that this location is likely the ultimate source of introgression in the study area. The spatial distribution of RBT, RBT-hybrids, and F_1 hybrids indicates hybridization is being promulgated upstream by long distance movement of individuals with high amounts of RBT admixture, but the spatial distribution of later-generation backcrosses suggests stepping-stone invasion may also be an important mechanism for spreading nonnative genes, corroborating conclusions from previous genetic studies. Our data suggest that (1) spatial and temporal overlap was occurring in the lower drainage, but streams in the middle and upper drainage still provided reproductive segregation; (2) introgression erodes discrete spawning behavior of migratory WCT, which will likely lead to lead to loss of local adaptation; and (3) the spread of hybridization is likely to continue and

genomic extinction is imminent if hybrid populations with high amounts of RBT admixture are not reduced or eliminated.