

Identifying Genomic Signatures of Natural Selection on Dall's Sheep

GRETCHEN H. ROFFLER,¹ *Wildlife Biology Program, Department of Ecosystem Sciences and Conservation, College of Forestry and Conservation, University of Montana, Missoula, MT 59812, USA*

GORDON LUIKART, *Flathead Lake Biological Station, University of Montana, Polson, MT 59860, USA*

MICHAEL K. SCHWARTZ, *U.S. Forest Service Rocky Mountain Research Station, 800 E. Beckwith, Missoula, MT 59801, USA*

STEVE AMISH, *Fish and Wildlife Genomics Group, Division of Biological Sciences, University of Montana, Missoula, MT 59812, USA*

ABSTRACT Reliable identification of genes underlying genomic signatures of natural selection is a necessary component of understanding adaptation to local conditions and provides critical information for assessing population resilience. To identify and determine the geographic distribution of adaptively differentiated Dall's sheep (*Ovis dalli*) populations throughout their range, we used next-generation sequencing to develop DNA markers in candidate adaptive genes to test for patterns of selection at the molecular, population, and landscape levels. Using an exon capture re-sequencing approach, we discovered single nucleotide polymorphisms (SNPs) in >3,000 genes and refined the set of candidate adaptive genes to develop a SNP-chip panel for genes associated with known immunological, metabolic, and growth functions in ovids. We then applied this panel to genotype 87 Dall's sheep from 11 sampling locations across Alaska and the Yukon Territory. We detected a total of 12 outlier loci potentially under selection using multiple corroborating computational approaches. We additionally identified 8 SNPs that were significantly associated with precipitation and temperature environmental variables, as well as latitude and longitude, suggesting local environmental adaptation and natural selection. We identified 4 distinct groups at the broad subspecies geographic range based on putatively neutral SNPs that largely aligned with major mountain ranges (pairwise $F_{ST} = 0.159-0.264$). When comparing the patterns of differentiation and variation between neutral and adaptive genetic structure by including adaptive loci, we detected additional genetic sub-structuring in the northwestern and central portions of the Dall's sheep range. Characterizing local adaptations and adaptive gene distributions from novel genetic techniques will facilitate investigation of the influence of environmental variation on local adaptation of a northern alpine ungulate throughout its range.

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¹ E-mail: gretchen.roffler@umconnect.umt.edu