

Metapopulation Structure of Bighorn Sheep in Waterton-Glacier International Peace Park

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Abstract: Metapopulation structure and function are important considerations when managing bighorn sheep. However, detailed studies of bighorn metapopulations are largely lacking, particularly for native herds with intact traditions of seasonal movements, and whose genetic and disease profiles are uncomplicated by artificial translocation. In a 5-year study in Waterton-Glacier International Peace Park, we used 88 GPS-collared animals (45 ewes, 43 rams), nuclear and mitochondrial DNA, and disease assays to study metapopulation structure of a strictly native herd. Telemetry data ($n=142,190$ locations) revealed 10 distinct ewe groups and 6 ram groups, and together with visual observations suggested the existence of several others. At a broader spatial scale, telemetry data also revealed evidence of 4 subpopulations, each comprised of multiple ewe and ram groups, and exhibiting varying degrees of insularity. Evidence of segregation between the North Glacier and South Glacier subpopulations was bolstered by differences in nuclear DNA ($n=8$ animals and 17 microsatellite loci for each subpopulation, $F_{ST}=0.12$), incidences of distinct mtDNA haplotypes (north: $n=11$, incidence of haplotype 1 = 1.00, 95% CI = 0.76-1.00; south: $n=11$, incidence of haplotype 1 = 0.18, 95% CI = 0.02-0.28), and incidences of exposure to *Anaplasma ovis* (north: $n=40$, incidence = 0.53, 95% CI = 0.36-0.68; south: $n=17$, incidence = 0.00, 95% CI = 0.00-0.16). Analyses of DNA from *Pasteurella trehalosi* type 2 non-hemolytic-the form of *Pasteurella* most commonly isolated from oropharyngeal swabs taken during animal captures-revealed a genotype associated solely with animals whose home ranges included Waterton Lakes National Park. Together with our telemetry data, the spatial distribution of this genotype supported the existence of 1 subpopulation straddling the U.S.-Canada border in the area north and west of Belly River, and another occupying areas west of Waterton Lakes. Overall, our findings revealed a surprising degree of metapopulation structure at multiple spatial scales. We discuss some implications of these findings relative to managing and monitoring bighorn populations.

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