Identifying Umbrella Birds for the Yellowstone to Yukon Reserve Design

JUDY E. MUIR AND SUSAN J. HANNON

LGL Limited, 9768 Second Street, Sidney, BC, V8L 3Y8, Canada, email jmuir@lgl.com

Abstract: The Yellowstone to Yukon Conservation Initiative (Y2Y) is developing a reserve design to maintain and restore avian diversity throughout the Rocky and Mackenzie Mountains. Our study will identify candidate core areas for the reserve design that represent high quality bird breeding habitat in 19 broad habitat cover types that are important to mountain bird communities. We adopted a broad-scale modeling approach to prioritize habitat based on home range habitat selection for a group of 'umbrella' bird species in the Y2Y region. As a first step, we developed a process to select species whose primary habitat collectively represented each of the broad habitat cover types, and whose geographic range enabled them to act as umbrella species for their primary habitat types. We began by using expert opinion and literature reviews to establish primary and secondary broad habitat cover type use for 109 conservation priority species in the Y2Y region. We then applied cluster analysis to determine species assemblages based on similarity in habitat use, and to identify the species that best characterized each assemblage. We subjected these 17 candidates to a suite of secondary tests to ensure that their geographic ranges enabled them to act as effective umbrella species for their primary habitats, and that they had sufficient detections to develop statistical models in the next step of our project. Any candidate that failed the tests was replaced with the species in its cluster that was most similar to it in habitat use, and the tests were rerun. If no species in a cluster satisfied all the tests, we selected the species that provided the best trade-off between the number of detections, range coverage of the Y2Y region, and range overlap with the other conservation priority species having the same primary habitat. Finally, we added 3 species to represent missing habitat types, resulting in 20 umbrella bird species. Our umbrella species provided from 67.0 to 100% range coverage with other Y2Y conservation priority bird species with the same primary habitat.

Key Words: reserve design, birds, umbrella species, cluster analysis, Yellowstone to Yukon Conservation Initiative, Y2Y

Introduction

The Yellowstone to Yukon Conservation Initiative (Y2Y) is developing a reserve design to maintain and restore avian diversity throughout the Rocky and Mackenzie Mountains. The project uses a landscape level approach to reserve core areas of high conservation value that are linked by corridors and surrounded by buffer zones which allow human use to increase with distance from

core areas. Our study identifies candidate core areas for the reserve design that represent high quality bird breeding habitat, defined as habitat that is able to maintain source populations with positive population growth rates (Pulliam 1988) and that has more stable and higher amounts of resources, and lower levels of predation, competition, parasitism, and anthropogenic disturbance (Cody 1985; McLoughlin et al. 2000; Suryan and Irons 2001). The large size and remoteness of the Y2Y ecoregion (Fig. 1) makes it logistically impossible to directly determine avian habitat quality by measuring bird habitat use and breeding success. Instead, we adopted a broad-scale modeling approach to prioritize habitat based on home range habitat selection for a group of 'umbrella' bird species, defined as those species whose requirements include and protect those of sympatric species (Landres et al. 1988; Caro and O'Doherty 1999; Zacharias and Roff 2001). We also adopted a coarse filter approach by identifying high quality habitat in a variety of broad habitat cover types that are important to mountain bird communities. This paper summarizes the process we developed to identify a group of umbrella bird species that represented broad habitat cover types in the Y2Y region.

Figure 1. The Yellowstone to Yukon (Y2Y) ecoregion is approximately 1.36 million km^2 in area. It extends from the Greater Yellowstone Ecosystem in Wyoming and follows the Rocky Mountains to the Mackenzie Mountains in the Yukon and Northwest Territories.

Methods

To support our coarse filter approach, we identified a group of species with complementary habitat use, emphasizing those with specialized use since generalists tolerate a variety of habitats and are not the most effective umbrella species (Linnell et al. 2000; Coppolillo et al. 2004). Bird species selected were those whose primary habitat collectively represented each of the broad habitat cover types, and whose geographic range enabled them to act as umbrella species for their primary habitats. Since we plan to develop a statistical model to rank relative habitat quality for each of our umbrella species based on existing bird survey data we have collected for the Y2Y region, we required our umbrella species to have a minimum of 100 detections. We also aimed to minimize the total number of umbrella species to reduce propagation errors when combining model predictions for each umbrella species in the final stage of our project (Flather et al. 1997; Boone and Krohn 2000). Umbrella species were identified by determining bird species assemblages based on habitat use and then applying a set of rules to select those best able to represent each assemblage. We began with 19 broad habitat cover types (Table 1) and 109 conservation priority species that were selected using the Partners in Flight prioritization method developed previously by avian scientists working with Y2Y (Panjabi 2001). We used literature reviews and expert opinion to create a matrix of habitat use proportions for the conservation priority species, then removed generalists that used more than three habitat types. Using hierarchical and k-medoid cluster analysis methods (Kaufman and Rousseeuw 1990; McGarigal et al. 2000; Everitt et al. 2001), we established cohesive and well-separated species assemblages based on similarity in habitat use for the remaining 67 species, and identified the species that best represented the habitat use characterized by each assemblage. Cluster analysis produced 17 groups based on species that specialize in one of the following habitats—coniferous riparian, willow riparian, lakes, alpine/tundra, grassland and sagebrush steppe habitats—or species with similar use of two habitat types (e.g., grassland/sagebrush steppe, marsh/lakes). More diffuse and less consistent clusters were evident for species that use mixes of the habitat types, but clusters were still characterized by a few predominant habitat types used in varying combinations by the species in the cluster.

The 17 candidate umbrella species were subjected to a suite of secondary tests to ensure they were effective umbrella species for their primary habitats. In order to calculate the amount of geographic coverage a candidate species provided to its cluster members and to other conservation priority species with the same primary habitat, we used *Birds of North America* range maps for five species—gray-crowned rosy-finch (*Leucosticte tephrocotis* [MacDougall-Shackleton et al. 2000]), black rosy-finch (*L. atrata* [Johnson 2002]), Brewer's sparrow (*Spizella breweri*) and timberline sparrow (*S. b. taverneri*) (Rotenberry et al. 1999), and green-tailed towhee (*Pipilo chlorurus* [Dobbs et al. 1998])—and digital species range maps from WILDSPACE™ (2002) for the remaining species. If a proposed umbrella species did not pass the secondary criteria, it was replaced with the species in its cluster that was most similar in habitat use and that had the highest number of detections. If no species in a cluster satisfied all the tests,

we selected the species that provided the best trade-off between the number of detections, range coverage of the Y2Y region, and range overlap with the other conservation priority species that have the same primary habitat. Finally, we checked that all habitat cover types were represented, and added species as needed to include missing habitat types, subjecting them to the same tests described above. Bird survey data from within the Y2Y region was used to verify that each umbrella species co-occurred with species that use the same primary habitat type and with its cluster members more often than other Y2Y conservation priority species. We used 1000 randomizations of a nonparametric paired t-test (Wilcoxon) to compare the median co-occurrence of the species in these two categories for our umbrella species.

Table 1. Nineteen Y2Y broad habitat cover types.

Broad habitat cover types	
Alpine/tundra	Moist Douglas-fir/mixed/grand fir
Aspen	Northern shrubfields
Cedar/hemlock	Sagebrush steppe
Coniferous riparian	Spruce/tamarack bog
Deciduous riparian	Subalpine spruce/fir
Dry ponderosa pine/Douglas-fir mix	Subboreal mixed wood (spruce/pine/aspen)
Grassland	Subboreal spruce
Lakes	Whitebark pine
Lodgepole pine	Willow riparian
Marsh	

Results

The final 20 umbrella species (Table 2) were wide-ranging and fairly abundant, and had detections that were well distributed throughout the species' range. Species that represented a habitat cover type provided from 67.0 to 100% overlap in range coverage with other Y2Y conservation priority species with the same primary habitat, and had good geographic overlap with species in their clusters. The exception was the grasshopper sparrow (*Ammodramus savannarum*), which provided poor coverage to the wide-ranging Swainson's hawk (*Buteo swainsoni*). Our umbrella species had stronger associations with the species in their clusters and with the same primary habitat usage compared to other bird species ($P = 0.006145 \pm 0.000361$ SE; 95% CI, 0.005437 to 0.006852).

Conclusions

In conclusion, our final group of 20 umbrella species represented the broad habitat cover types and satisfied the range overlap requirements needed to act as effective umbrella species for

Y2Y's conservation priority species. We found that cluster analysis grouped species successfully and clearly showed which bird species are represented by each umbrella species.

Table 2. Common and scientific names and associated broad habitat cover types of the 20 umbrella bird species.

Umbrella bird species	*Broad habitat cover types*[*]
American dipper (*Cinclus mexicanus*)	**Coniferous riparian** specialist
American tree sparrow (*Spizella arborea*)	**Northern shrubfields, alpine/tundra**
American wigeon (*Anas americana*)	**Marsh**, lakes
Blackpoll warbler (*Dendroica striata*)	**Subboreal spruce**, spruce/tamarack bog, marsh, subalpine spruce/fir
Brewer's sparrow (*Spizella breweri*)	**Sagebrush steppe** specialist
Brown creeper (*Certhia americana*)	**Cedar/hemlock, subalpine spruce/fir**, lodgepole pine, moist Douglas-fir/mixed/grand fir
Cassin's vireo (*Vireo cassinii*)	**Moist Douglas-fir/mixed/grand fir**, lodgepole pine, aspen
Clark's nutcracker (*Nucifraga columbiana*)	**Whitebark pine**, subalpine spruce/fir, dry ponderosa pine/Douglas-fir mix
Common loon (*Gavia immer*)	**Lakes** specialist
Golden eagle (*Aquila chrysaetos*)	**Subalpine spruce/fir, grassland**, alpine/tundra
Grasshopper sparrow (*Ammodramus savannarum*)	**Grassland** specialist
Gray-crowned rosy-finch (*Leucosticte tephrocotis*)	**Alpine/tundra** specialist
Lewis's woodpecker (*Melanerpes lewis*)	**Dry ponderosa pine/Douglas-fir mix**, deciduous riparian
Long-billed curlew (*Numenius americanus*)	**Grassland**, sagebrush steppe
Spotted sandpiper (*Actitis macularia*)	**Deciduous riparian**, lakes, coniferous riparian
Ruffed grouse (*Bonasa umbellus*)	**Aspen**, deciduous riparian, willow riparian, subboreal mixed wood
Veery (*Catharus fuscescens*)	**Deciduous riparian**, aspen
White-crowned sparrow (*Zonotrichia leucophrys*)	**Subalpine spruce/fir**, alpine/tundra, northern shrubfields
Wilson's warbler (*Wilsonia pusilla*)	**Spruce/tamarack bog, deciduous riparian, willow riparian**, northern shrubfields
Yellow warbler (*Dendroica petechia*)	**Willow riparian, deciduous riparian**, marsh, subboreal mixed wood

[*]Primary habitat is indicated in bold.

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