

Evaluating Wildlife Response to Vegetation Restoration on Reclaimed Mine Lands in Southwestern Virginia

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Environmental and land use studies are frequently conducted on reclaimed coal mines, but limited work has been done to determine the response of wildlife populations to these reclamation efforts. Land use typically changes following the mining process, and post-mining habitat and land-use may be strikingly different from their former composition. Changes in vegetative cover, vegetation type and composition, soil properties, and topography can provide different resources for wildlife than those previously available. There are opportunities to “improve” habitat, or at least provide substrates or topography that may be lacking in adjacent areas, if planned properly ahead of time (Scott and Zimmerman 1984).

Wildlife are often displaced from their native environments after mining, and may not return without the appropriate conditions necessary for their survival. Disturbances to wildlife during a mining operation include more than just excavation at the mine site. Impacts can be widespread and affect areas adjacent to and removed from the mine site. Other disturbances affecting wildlife and their habitat include the construction and use of temporary road systems and heavy machinery, noise, erosion, changes in topography and landforms, loss of native vegetation and cover, and sometimes environmental health concerns. Habitat complexity is often reduced following mining or other disturbances, causing a shift in the composition of wildlife communities such as birds (Wray et al. 1982). For example, a mature forest will support different species and abundances of birds than an open shrubland or managed pasture.

This project focused on studying avian and amphibian communities on reclaimed mine sites. Birds are generally one of the earliest species to visit a site following reclamation due to their mobility and active search for suitable habitat (Brändle et al. 2003). Although many studies have been conducted with birds on reclaimed sites, most have focused on the response of a single avian species (Balcerzak and Wood 2003, Bajema et al. 2001) or assemblage, such as grassland birds (Ingold 2002, Scott et al. 2002, Wray et al. 1982, Whitmore and Hall 1978). Amphibians are an ecologically sensitive group, frequently serving as important early indicators of poor environmental quality (Hyde and Simons 2001). Because amphibians are preyed upon by a variety of other species, they are believed to play an essential role in the cycling of nutrients into the food chain. Often these organisms are considered to be indicators of forest biodiversity (Welsh and Droege 2001), which illustrates the importance of understanding and considering anthropogenic impacts upon this species group. In the past 20 years, there have been substantial amphibian declines due to habitat disturbance and other anthropogenic influences (Alford and Richards 1999, Beebee and Griffiths 2005). Because of strong site fidelity and limited dispersal capacity, even small disturbances that result in fragmentation could isolate amphibians from important breeding or foraging habitat necessary for survival (Krishnamurthy 2003). Even though amphibian species that inhabit the coal-producing regions of North America have not shown signs of imminent danger, by understanding the habitat designs that impact these species, we can apply these findings to species in other geographic locations (Lacki et al. 1992).

The purpose of this study was to monitor wildlife use on mined sites of varying ages since disturbance and post-mining land uses at two locations in southwestern Virginia. Bird, salamander, and frog communities were sampled to gain an understanding of site use and species

composition. This information was compared with wildlife communities on nearby mature reference forests to better understand the impacts of mining and reclamation.

Objectives

1. To determine avian and amphibian community composition of different age classes of reclaimed mine lands that have been restored to wildlife habitat and forest post-mining land uses.
2. Compare avian and amphibian communities of reclaimed wildlife habitat and forest communities to: (1) reference forests that have not been recently disturbed by mining or harvesting, and (2) forests that are regenerating after recent harvest.
3. Compare the structure and composition of reference forests to that of forests established on reclaimed sites, and compare the response of selected wildlife species to habitat patterns on reference and reclaimed sites.
4. Develop guidelines that can be used to suggest standards for reclaiming sites with forests that will meet avian and amphibian objectives.

Overview of Methods

- Field work was conducted in 2007 and 2008 at the Powell River Project (PRP) in Wise County, Virginia, and also on the Public Access Lands for Sportsmen (PALS) property owned and managed by The Forestland Group, LLC in Dickenson County.
- We sampled in 6 cover types: pre-SMCRA (mined prior to the Surface Mining Control and Reclamation Act, 1977), early successional, mid-successional, managed pastureland, reference, and recently harvested reference (Table 1, Figure 1).
- Bird point count surveys consisted of tallying all bird species and counting individuals during a 5 minute survey period. Each of 102 sampling points was visited 10 times over the course of 2 breeding seasons (May-July). All surveys were conducted between 6 and 9 AM on clear mornings with minimal winds.
- Bird presence was related to habitat characteristics on the ground, and to cover type data from Virginia Base Mapping Program (VBMP) aerial photography using logistic regression modeling.
- Two methods were used to sample salamander populations from May-August:
 - A series of wooden coverboards to act as artificial cover structures that provide habitat for salamanders.
 - Time constrained (20 minutes) night searches during rainy, humid evenings when salamanders would be actively foraging and generally visible on the surface.
- Frogs were sampled at water bodies on wet summer evenings using frog call survey methods from the North American Amphibian Monitoring Program (NAAMP 2009).

Table 1. Sampling point distribution across study areas (Powell River Project [PRP] and Public Access Lands for Sportsmen [PALS]) and land use classifications.

Land use classification	Number of sampling points		
	PALS	PRP	TOTAL
Early successional reclaimed (~5-12 years)	9	10	19
Mid-successional reclaimed (~13-25 years)	4	7	11
Harvested (1990-2005)	5	2	7
Managed pastureland	13	3	16
Pre-SMCRA (~30-60 years)	27	6	33
Mature forest (~65-100 years)	8	8	16
TOTAL	66	36	102

Figure 1. Representative photos of general cover type categories that were sampled. Photos were all taken at the PALS site.

A. Early successional



B. Mid-successional



C. Harvested



E. Pre-SMCRA



D. Managed pastureland



F. Mature forest



Summary of Results

Birds

Because distinct groups or guilds were identified through cluster analyses of habitat characteristics (Carrozzino 2009), habitat appears to be a good descriptor of relationships within the bird community on the study areas. These guilds that respond similarly to habitat characteristics can be managed as a group rather than trying to focus on individual species.

Mature forest species, such as Northern parula and wood thrush, responded to characteristics of undisturbed habitat, such as canopy cover and canopy height. Early successional species, such as American goldfinch and prairie warbler, required more open areas with scattered vegetation and small trees. Forest generalists (e.g., scarlet tanager and hooded warbler) and shrubland generalists (e.g. blue-winged warbler and yellow-breasted chat) were loosely associated with characteristics similar to those of the mature forest species and early successional, respectively. However, discrete or specific habitat characteristics were more difficult to identify, indicating a more “generalist” approach to habitat selection by these species.

Table 2. Representative bird species identified as part of four guilds during cluster analysis.

A=abundant; relative abundance > or = 0.4 birds observed per station per visit

C= common; relative abundance 0.2 - 0.399 birds observed per station per visit

R= regular; relative abundance 0.1 – 0.199 birds observed per station per visit

U= uncommon; relative abundance 0.01 – 0.099 birds observed per station per visit

+ = incidental; relative abundance < 0.01 birds observed per station per visit

	Early successional	Mid successional	Harvested	Pasture	Pre- SMCRA	Mature forest
Early successional guild						
Common yellowthroat	C	U		U	U	+
Eastern meadowlark	U	U		U		
Grasshopper sparrow	U	U		U		
Field sparrow	A	C		A	U	U
Prairie warbler	A	U	U	R		U
Mature forest guild						
Blue-headed vireo	+				U	R
Black-throated green warbler		U	U		R	U
Northern parula					U	U
Ovenbird		U	C		U	C
Wood thrush	U	U	R	U	U	R
Shrubland generalists						
American robin	U	U	U	U	U	+
Indigo bunting	A	A	A	A	A	C
Northern cardinal	R	R	R	R	C	R
White-eyed vireo	U	U	R		U	U
Yellow-breasted chat	A	C	A	R	U	R

Table 2. (continued)

	Early successional	Mid successional	Harvested	Pasture	Pre- SMCRA	Mature forest
Forest generalists						
Blue jay	+	U	U	U	R	U
Carolina chickadee	U	U	U	U	C	R
Dark-eyed junco					U	
Mourning dove	U	U	C	U	U	U
Scarlet tanager	+	U	R		U	R

Amphibians

Six species of salamanders were observed using cover objects and actively foraging on the surface. The species captured most frequently were red-spotted newt (39 captures) and slimy salamander (18 captures). Fifteen salamanders were found under cover boards, and all other observations were made incidentally or during night searches. Most salamanders were found in mature forest (42 captures) and on pre-SMCRA (21 captures) sites, with only one individual found in pine cover on a mid-successional reclaimed site (Table 3).

We identified 8 frog species during frog call surveys or when encountered while on site for other work (Table 4). Spring peepers were heard most frequently near water bodies and calling from wet highwalls. We often heard spring peepers in full chorus, where calls are constant, continuous, and overlapping. We also frequently heard bullfrogs and green frogs at a lower call intensity (i.e. individual calls could be distinguished).

Table 3. Salamander species encountered from May-August in 2007 and May-September 2008. Four cover types were searched: early successional reclaimed, mid-successional reclaimed, pre-SMCRA, and mature forest.

Species	Cover type	Total # of captures
Longtail salamander	Pre-SMCRA	4
	Mature forest	1
Northern red salamander	Pre-SMCRA	1
Red-spotted newt	Mid-successional reclaimed	1
	Pre-SMCRA	10
	Mature forest	28
Northern slimy salamander	Pre-SMCRA	5
	Mature forest	13
Southern two-lined salamander	Pre-SMCRA	1
Spotted salamander	Mature forest	0 ^a

Table 4. Frog species identified at PRP from May-July 2007 and 2008.

Species	Both years	2007 only	2008 only
American toad	E ^a		
Bullfrog	1 ^b		
Fowler's toad		1, 2	
Gray treefrog		E	
Green frog	1, 2		
Pickerel frog			1, 2, 3
Spring peeper	1, 2, 3		
Upland chorus frog		2, 3	

^a“E” indicates that the species was encountered on site and not heard during call surveys.

^bIndicates the North American Amphibian Monitoring Program call intensity score:

1= Individuals can be counted; there is space between calls.

2= calls of individuals can be distinguished by there is some overlapping of calls.

3= full chorus, calls are constant, continuous, and overlapping.

Conclusions

From our research, it is clear that a diversity of bird species can use reclaimed sites and the surrounding habitat during the breeding season. By identifying important habitat variables, we can customize the reclamation processes to fit the management goals for the property. For example, if managers are provided with information indicating that some Neotropical migrants prefer areas with conifers and small woody stems (e.g. common yellowthroat), these habitat characteristics can be provided or encouraged on reclaimed sites to attract the desired species. This type of active management will be particularly important to provide habitat for species of concern, such as the golden-winged warbler.

The methods developed in this study could be used to assess wildlife communities on reclaimed sites in other parts of the Appalachian region, and are adaptable to evaluating other forms of disturbed wildlife habitat. Long-term monitoring of these wildlife communities, along with vegetation and environmental considerations, will serve to further describe the restoration of reclaimed coal mines in Appalachia.

Although this work serves as a significant step to understanding wildlife use on reclaimed surface mines, data collected represent visual and auditory observations and do not include any information about reproductive success or survival. Without this important demographic information, we cannot fully relate the presence or density of species to the habitat quality on these sites (Van Horne 1983, Vickery et al. 1992). The cumulative value of these sites to birds will be best reflected by knowledge of reproductive success linked to population estimates. We plan to initiate a follow-up study to focus on avian survival and reproduction beginning in the spring of 2010.

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Appendix Key:

- A=abundant; relative abundance ≥ 0.4 birds observed per station per visit
C= common; relative abundance 0.2 - 0.399 birds observed per station per visit
R= regular; relative abundance 0.1 - 0.199 birds observed per station per visit
U= uncommon; relative abundance 0.01 - 0.099 birds observed per station per visit
+ = incidental; relative abundance < 0.01 birds observed per station per visit

Appendix. Relative abundance of 80 species observed at PRP and PALS in southwestern Virginia in 2007 and 2008, calculated as the number of observations per point per visit. A star (*) identifies a bird observed in 2007 only; a dagger (†) identifies birds observed in 2008 only.

Species	Land use classification					
	Early Successional	Mid-successional	Harvested	Pasture	Pre-SMCRA	Reference
	n=19	n=11	n=7	n=16	n=33	n=16
Acadian flycatcher *						+
American crow	U	R	U	U	U	U
American goldfinch	C	R	C	A	R	U
American kestrel *					U	
American robin *	U	U	U	U	U	+
American woodcock *					U	+
Barn swallow				U		
Black-and-white warbler	U	U	R	U	A	C
Black-billed cuckoo †	U				+	
Blackburnian warbler †						+
Black-capped chickadee				U	U	U
Black-throated blue warbler	U	U			U	U
Black-throated green warbler		U	U		R	U
Blue jay	+	U	U	U	R	U
Blue-gray gnatcatcher	U				U	
Blue-headed vireo	+				U	R
Blue-winged warbler	C	R	R	U	R	U
Brown thrasher	U	U		U		
Brown-headed cowbird	U	+	R	U		+
Carolina chickadee	U	U	U	U	C	R
Carolina wren	R	C	C	U	C	R
Cedar waxwing †	U		U	U	U	U
Cerulean warbler *		U	U			U
Chestnut-sided warbler †		+	U			U

Appendix. (continued)

Land use classification

Species	Land use classification					
	Early Successional n=19	Mid-successional n=11	Harvested n=7	Pasture n=16	Pre-SMCRA n=33	Reference n=16
Chimney swift †				U		
Chipping sparrow	U	U	U	R	R	U
Cliff swallow †				+		
Common grackle *				+		+
Common raven †		+				
Common yellowthroat	C	U		U	U	+
Cooper's hawk *		U	U			
Dark-eyed junco †					U	
Downy woodpecker	U	U	U	U	U	U
Eastern bluebird	+	+		U		
Eastern meadowlark	U	U		U		
Eastern phoebe	U		U		U	
Eastern towhee	A	A	A	A	C	R
Eastern wood-pewee			U	+	+	U
European starling	+			C		
Field sparrow	A	C		A	U	U
Golden-winged warbler	U			+	+	+
Grasshopper sparrow	U	U		C		
Gray catbird	U	U	U		+	U
Hairy woodpecker				+	+	U
Hooded warbler	R	C	A	U	C	A
Indigo bunting	A	A	A	A	A	C
Kentucky warbler			U		+	+
Killdeer *	+					
Magnolia warbler *						U
Mourning dove	U	U	C	U	U	U
Northern bobwhite	U	U		U	U	
Northern cardinal	R	R	R	R	C	R

Appendix. (continued)

Species	Land use classification					
	Early Successional	Mid-successional	Harvested	Pasture	Pre-SMCRA	Reference
	n=19	n=11	n=7	n=16	n=33	n=16
Northern mockingbird*	U	+	U	+	+	
Northern parula					U	U
Ovenbird		U	C		U	C
Pileated woodpecker	+	U		U	U	U
Pine warbler	+	+			+	
Prairie warbler	A	U	U	R		U
Red-bellied woodpecker	+		U			
Red-eyed vireo	R	C	C	U	A	A
Red-headed woodpecker †					+	
Red-shouldered hawk*				+		
Red-tailed hawk						+
Red-winged blackbird	U	+		U	U	
Rough-winged swallow †	U					
Ruby-throated hummingbird	+		U	U	+	+
Scarlet tanager	+	U	R		U	R
Song sparrow	U	U		U		
Swainson's warbler †		+			+	U
Tree swallow	U			U		
Tufted titmouse	U	R	U	U	R	R
Veery †						+
White-breasted nuthatch			U		+	U
White-eyed vireo	U	U	R		U	U
Wild turkey		U		U	+	U
Wood thrush	U	U	R	U	U	R
Worm-eating warbler	U				+	
Yellow-billed cuckoo	U	U	U		U	U
Yellow-breasted chat	A	C	A	R	U	R
Yellow-throated vireo †					+	