WILDLIFE USE OF MITIGATED WETLANDS ON SURFACE MINED LANDS IN WESTERN PENNSYLVANIA [1]

by

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and

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Abstract. Twelve wetlands totaling 22.4 ha were constructed on 2 mine sites in western Pennsylvania to mitigate 6.6 ha destroyed by mining. A total of 24250 wetland plants and 14,000 trees and shrubs were planted on the 2 sites at a total cost of $17,068. Sixty species of birds representing 23 families and 18 feeding guilds, including 7 species of special concern in Pennsylvania, were observed using these wetlands during the first 2 years. Broods of wood ducks (Aix sponsa), Canada geese (Branta canadensis) and mallards (Anas platy-rhynchos) were observed on both mine sites. In addition, 17 species of mammals and 8 and 7 species of amphibians and reptiles, respectively, were observed using these wetlands. Based on these results, functional wetlands may be established on mined lands without added cost to the mine operator and their construction should be given prime consideration by the mine industry and regulatory agencies.

Additional key words: Wetland construction, cost involved, vegetation establishment wildlife use.

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Introduction

Wetlands are a declining resource in the middle Atlantic region of the United States (Tiner 1987) as well as elsewhere in North America. The reclamation of surface coal mines provide an opportunity to establish wetland communities without additional costs to the mine operator (Brenner 1987). For over 4 decades, wetlands have been developed on mine lands,

especially in the eastern (Brenner and Steiner 1987) and midwestern (Jones et al. 1985) regions of the United States. These wetlands provide habitat for a variety of wildlife species, including amphibians (brooks et al. 1985, Fowler et al, 1985), reptiles (Brooks et al. 1985), birds and mammals (Brenner and Mondok 1979, Sandusky 1978, Thompson 1984, Brenner and Sterner (1988), as well as their use for resting and feeding during migration (Brenner and Steiner 1987). Although wetlands and mine lands have been shown to be used extensively by wildlife, they are often left with little if any planning for their integration into the overall reclamation of the mine site.

Avian fauna has been suggested an index of habitat quality in natural wetland ecosystems (Cable et al. 1989, Glooschenko et al. 1988) and would also be applicable to man-made wetland habitats. The primary objective of this paper is to describe and discuss the evaluation of wetlands established on 2 mine sites in western Pennsylvania as to their value as wildlife habitats using birds as the primary indicator of habitat quality. For over a decade, I have advocated the development of wetlands on mine lands (Brenner 1973, 1983), including special areas designed for rare and endangered species (Brenner 1985, 1986). In this paper, the construction and establishment of wetlands on mine lands and their ultimate use by wildlife will be discussed.

Materials and Methods

Prior to the actual wetland construction, a 10-month planning and evaluation process was necessary to obtain the required permits and to complete the pre-mining surveys on the wetlands that would be impacted by mining. As an example of cooperation between the public and private sector, the project involved the Pennsylvania Department of Environmental Resources, the Pennsylvania Fish Commission, the Pennsylvania Game Commission, the U.S. Fish and Wildlife Service, the U.S. Soil Conservation Service, the U.S. Army Corps of Engineers, Lawrence County Conservation District, the Lawrence County Planning Commission, and the Western Pennsylvania Conservancy.

Approximately 22.4 ha (56 acres) of wetlands were established on 2 mine sites in northwestern Pennsylvania in 1987 as part of a mitigation and reclamation plan developed by Adobe Mining, Inc. On the site, hereafter referred to as the Guarnieri Mine, 7 palustrine wetlands and a deep water habitat totaling 19.2 ha were established on a 73.6 ha mine site to replace approximately 4.8 ha (4:1 ratio) of palustrine wetlands on an adjacent active mine. The palustrine wetlands consisted of a sedimentation pond converted to a wetland, a deep water habitat, and 6 other areas constructed during site reclamation. Water level control devices were installed on 64 of the palustrine wetlands, the sediment pond, and the deep water habitat for the management of aquatic vegetation. All water courses were diverted into the wetlands complex. Four of the 6 wetlands were designed with emergency spillways to allow flood waters to flow into the deep water habitat, which could then overflow into the sediment pond. This drained into a natural wetlands complex owned and managed by the Pennsylvania Game Commission. A 0.2 ha island was constructed in the center of the deep water habitat to provide additional waterfowl nesting habitat.

On a second mine, the Edwards Mine, 3 palustrine wetlands totaling 3.2 ha were constructed to replace a 1.8 ha palustrine wetland (1.8:1 ratio) destroyed during mining of the site. As for the Guarnieri Mine, 1 wetland was a converted sedimentation basin and 2 were constructed

during reclamation. All water courses were diverted into these wetlands so that adequate water levels could be maintained. One 1.4 ha palustrine wetland was constructed with irregular shorelines along with 5 islands to increase the amount of edge, thereby providing additional feeding and nesting areas for waterfowl. On both mines, non-wetland areas were planted with trees and shrubs interspersed among the grassland (grasses and legumes) to provide additional habitats for upland wildlife species.

Two different procedures were used for the construction and establishment of wetlands on these sites. On the Guarnieri Mine, 2 wetland sites received soils and sediment material salvaged from natural palustrine wetlands that were destroyed by mining. Once the upper 60 cm of material was removed and stockpiled at the site, the lower clay and muck deposits were removed, transported, and spread in the newly constructed wetland. Within 5 working days, the construction and transportation phase of the project was completed and water was released into the sites. These areas did not receive supplemental planting of wetland species. This project was scheduled to be completed either in the late fall of 1985 or early spring 1986, but due to the excessive delays in the permitting process, it was not completed until late April 1986.

The remaining 6 wetlands received a total of 18,150 individual plants, comprising 10 different species, plus 23 kg of coontail (Ceratophyllum demersum) and 218 kg of grass and legume seeds. In addition, a total of 6,950 trees and shrubs representing 17 species were planted either adjacent to the wetlands or in upland areas, depending on site conditions.

Prior to mining on the Edwards Mine, soils and sediment were removed from a natural palustrine wetland and transported to a 1.4 ha wetland constructed on the same site. The same procedure was followed as at the Guarnieri Mine for the removal, storage and transportation of material between the natural and man-made system, except that scrapers rather than trucks were used to transport the material. Due to intermittent rainfall in the middle of August when this project was initiated, water from the active pit (pH 7.0-7.2) was pumped into the site as soon as all material was in place. The time lapse from the start of the project until there was sufficient water to maintain the system was approximately 10 days. A total of 6,100 individual wetland plants, 11 kg of coontail, plus 7,450 trees and shrubs and 314 kg of seeds representing 37 different species have been planted on the site. The total cost of the establishment of vegetation at this entire 3.2 ha wetland complex was $5,488 for material and $1,738 for labor. On both mines, the cost of construction, removal and transportation of wetland material were considered part of the overall mining and reclamation plan of these sites. The company indicated that the total cost of these wetland development was by current regulations.

To provide additional nesting sites for wildlife, 6 and 4 wood duck (Aix sponsa) and 17 and 7 blue bird (Sialia sialis) nest boxes were placed on the Guarnieri and Edwards Mines, respectively.

Vegetation and Wildlife Assessments

To assess the response of natural revegetation of wetland species on the Guarnieri Mine, 22m^2 quadrats were established on 5 wetlands, 3 received supplemental planting and 2 which received wetland soils and plant material from the adjacent mine site and 12m^2 quadrats

were established on the Edwards Mine. Each mine was visited at least once a week and the numbers of different species of wildlife observed were recorded. In addition, 15m small mammal snap trap transects with traps set at 3m intervals were established on each site. Trapping was conducted for 3 nights and animal capture rate was expressed as number of animals/100 trap nights.

Results and Discussions

Response of Wetland Vegetation

On both mines, there was good survival and growth of vegetation on both the relocated wetlands as well as those receiving supplemental plantings of wetland species. Of the 833 individual plants found on the quadrats 752 or 90% were volunteer species. In open water areas Nitella spp. and Lemna minor had a density of approximately 15/cm^2, respectively. Nineteen of the 24 species identified on these wetlands were the result of volunteer invasions and/or from seeds or root stocks present in the material transported from the adjacent mine site. The number of species/m^2 and the density of plants/m2 on those wetlands that received the transplanted wetland material was similar to those receiving supplemental plantings. Between 8 and 13 different species occurred on the individual quadrats receiving supplemental plantings compared to the 8 or 9 species that occurred on the transplanted sites. The average number of plants was 36 (32-41) and 38 (23-53) individuals/m2 for areas that received supplemental plantings and those that received wetland soils, respectively. The similar number of species and density of vegetation on wetlands with supplemental plantings compared with those that received only wetland soils indicate that both procedures may be used to establish productive wetlands of mine sites. The principal species occurring on all wetlands on the Guarnieri Mine included Echinocloa muricata, Eleocharis obtusa, Bidens frondosa, Pancium capillare and Polygonum sagittatum (Table 3). Sensitive fern Onoclea sensibilis), skunk cabbage Symplocarpus foetidus), along with rushes (Juncus ssp.) and sedges (Carex ssp.) were observed on the transplanted wetlands, but did not occur on the randomly selected quadrats. Throughout the transplanted wetlands, numerous dogwoods (Cornus spp.), black willow (Salix nigra), and buttonbush (Cephalanthus occidentalis) were observed sprouting from root stocks present in the soil. On the wetlands that received supplemental plantings of wetland species, the species in the shallow and intermediate depth zone became established within 2 months of planting and those in the deep zone became established the following spring.

On the Edwards Mine, the response of vegetation on the site that received the transplanted material was not as rapid as it was on the Guarnieri Mine. Natural revegetation of wetland plants did not occur until the following spring and summer months. However, the response of those species that did regenerate naturally as well as the supplemental species in the shallow water zone showed excellent survival and growth.

In contrast to the Guarnier Mine, only 9 species were present on the 5 quadrats and of those 2 species, Trifoloim pratense and Trifolium repens, probably invaded from adjacent upland areas. A total of 127 individual plants were found on this wetland, and of these, 40% were volunteers. Between 4 and 6 species were on the individual quadrats and the average density was 25 (22-29) individuals/m^2 .

This wetland has a dense grass and legume cover immediately adjacent to the relocated wetland. Dense cover along with elevated water levels over the transplanted wetland materials could be factors in the reduction in the number of volunteer species that invaded this wetland.

Table 1. Species of birds, feeding guilds, populations, breeding status, and abundance of avian species observed on constructed wetlands on two surface coal mine sites in western Pennsylvania.

SPECIES	A Guilds	B State Population Status	C Regional Breeding Status	D Abundance Guarnieri	Edwards
Ciconiiformes					
Great Blue Heron (Ardea herodias)	249	V	*	4	3
Green-backed Heron (Butoides striatus)	249	C	*	4	3
Anseriformes					
Tundra Swan (Cygnus colombianus)	340	C	M	1	
Canada Goose (Branta canadensis)	340	C	*	4	4
Mallard (Anas platyrhynchos)	340	C	*	4	4
Black Duck (Anas rubripes)	340	C	*	3	
Blue-winged Teal (Anas discors)	340	C	*	3	2
Green-winged Teal (Anas crecca)	340	C	*	3	1
Gadwall (Anas strepera)	340	C	*	1	
Wood duck (Aix sponsa)	340	C	*	3	3
Ring-necked Duck (Athya collaris)	348	C	M	2	
Greater Scaup (Athya marila)	348	C	M	1	
Bufflehead (Bucephala albeola)	348	C	M	1	
Ruddy Duck (Oxyura jamaicensis)	348	C	M	1	
Hooded Merganser (Lophodytes cucullatus)	248	C	*	1	
Podicioediformes					
Pied-billed Grebe (Podilymbus podiceps)	248	C	*	2	
Falconiformes					
Red-tailed Hawk (Buteo jamaicensis)	257	C	*	4	
American Kestrel (Falco sparverius)	257	C	*	4	
Northern Harrier (Circus syaneus)	257	V	*	4	2
Osprey (Pandion haliaetus)	247	Exp.	**	1	
Galliformes					
Ringnecked Pheasant (Phasianus colchicus)	123	C	*	1	1
Gruiformes					
American Coot (Fulica americana)	248	C	*	2	
King Rail (Rallus elegans)	261	E	**	2	
Charadriiformes					
Herring Gull (Larus argentatus)	349	C	M		3
Killdeer (Charadrius vociferus)	223	C	*	4	4
Spotted Sandpiper (Actitus macularia)	261	C	*	3	2
Upland Sandpiper (Bartramia longicauda)	223	T	*	1	
American Woodcock (Philohela minor)	221	C	*	1	1
Willet (Catoptrophorus semipalmatus)	261	C	*	1	
Greater Yellowlegs (Tringa melanoleuca)	261	C	M	3	3
Lesser Yellowlegs (Tronga flavipes)	261	C	M		1
Columbiformes					
Morning Dove (Zenaida macroura)	123	C	*	3	3
Strigiformes					
Great Horned Owl (Bubo virginianus)	237	C	*	4	

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Mallard (Anas platyrhynchos)	340	C	*	4	4
Black Duck (Anas rubripes)	340	C	*	3	
Blue-winged Teal (Anas discors)	340	C	*	3	2
Green-winged Teal (Anas crecca)	340	C	*	3	1
Gadwall (Anas strepera)	340	C	*	1	
Wood duck (Aix sponsa)	340	C	*	3	3
Ring-necked Duck (Athya collaris)	348	C	M	2	
Greater Scaup (Athya marila)	348	C	M	1	
Bufflehead (Bucephala albeola)	348	C	M	1	
Ruddy Duck (Oxyura jamaicensis)	348	C	M	1	
Hooded Merganser (Lophodytes cucullatus)	248	C	*	1	
Podicioediformes					
Pied-billed Grebe (Podilymbus podiceps)	248	C	*	2	
Falconiformes					
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American Kestrel (Falco sparverius)	257	C	*	4	
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American Woodcock (Philohela minor)	221	C	*	1	1
Willet (Catoptrophorus semipalmatus)	261	C	*	1	
Greater Yellowlegs (Tringa melanoleuca)	261	C	M	3	3
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Columbiformes					
Morning Dove (Zenaida macroura)	123	C	*	3	3
Strigiformes					
Great Horned Owl (Bubo virginianus)	237	C	*	4	

Short-eared Owl (*Asio flammeus*)	237	E	**	2	
Coraciiformes					
Belted Kingfisher (*Ceryle alcyon*)	248	C	*	3	
Piciformes					
Yellow Shafted Flicker (*Colaptes auratus*)	211	C	*	3	1
Downy Woodpecker (*Picoideus pubescens*)	211	C	*	2	
Hairy Woodpecker (*Picoideus villosus*)	211	C	*	3	1
Passeriformes					
Horned Lark (*Eremophila aipestris*)	223	C	*		3
Tree Swallow (*Tridoprocne bicolor*)	237	C	*	4	4
Barn Swallow (*Hirundo rustica*)	237	C	*	1	1
American Crow (*Corvus brachyrhynchos*)	334	C	*	4	4
Blue Jay (*Cyanocitta cristata*)	334	C	*	4	3
Black Capped Chickadee (*Parvus atricapillus*)	323	C	*	2	2
American Robin (*Turdus migratorius*)	323	C	*	4	4
Chestnut-sided Warbler (*Dendroica pensylvanica*)	234	C	*	1	
Ruby-crowned Kinglet (*Regulis calendula*)	232	C	M	1	
Red-winged Blackbird (*Agelaius phoeniceus*)	334	C	*	4	4
Common Grackle (*Quiscalus quiscula*)	323	C	*	3	3
Eastern Meadow Lark (*Sturnella magna*)	323	C	*	4	4
Bobolink (*Dolichonyx oryzivorus*)	234	C	*	3	1
Slate-colored Junco (*Junco hyemalis*)	334	C	*	3	4
Cardinal (*Cardinalis cardinalis*)	134	C	*	1	4
Rufous Sided Towhee (*Pipilo erythrophthalmus*)	323	C	*	1	
Chipping Sparrow (*Spizella passerina*)	334	C	*	2	2
Tree Sparrow (*Spizella arborea*)	237	C	*	3	1
Vesper Sparrow (*Pooecetes gramineus*)	334	V	*	2	1
Song Sparrow (*Melospiza melodia*)	334	C	*	3	4
Swamp Sparrow (*Melospiza georgiana*)	334	C	*	4	3
Savannah Sparrow (*Passerculus sandwichensis*)	334	C	*	1	1

Species names after American Orintnologist's Union (1983).

A Feeding guilds are characterized by a 3-digit (ABC) number where; A = primary food habits (1) granivore, (2) carnivore (e.g., insectivore, piscivore), or (3) omnivore; B = foraging stratus (1) bark, (2) ground, (3) foliage, (4) water, (5) ground and air, or (6) mud; and C = foraging behavior (0) dip, (1) probe, (2) bark glean, (3) ground glean, (4) foliage glean, (5) sally, (6) friut or buds, (7) sustained flight, (8) dive, or (9) hunt (modified from Willson 1974).

B Classification based on Gill (19d5), V = vulnerable; T = threatened; E = endangered; C = common (unclassified).

C Based on Leberman (1988), *Breeding species; ** Probable breeder, M = Migrant.

D 4 = observed 75-100% visits; 3 = observed 50-75% of visits; 2 = observed 25-30% of visits; 1 = observed 25% or less of visits.

Table 2. Comparison of total number of species, feeding guilds, population status, breeding status and abundance of avian fauna observed on constructed wetlands on two mine sites compared with those observed on natural wetland prior to their removal.

LOCATION	TOTAL SPECIES	TOTAL FEEDING GUILDS	POPULATION STATUS C	V	T	E	TOTAL POINTS	BREEDING STATUS *	**	M	ABUNDANCE 1	2	3	4
Guarnieri	57	18	50	3	1	3	1550	47	3	7	17	9	15	16
Edwards	37	14	34	3	-	-	640	35	-	2	11	6	10	10
Total	60	19	53	3	1	3	2190	48	3	9	-	-	-	-
Private Mining	19	11	18	1	-	-	280	19	-	-	1	1	2	15

Classification same as that used in Table 1. C = 10 points, V = 100 points, T = 150 points, E = 200 points.

To provide additional nesting sites for wildlife, 6 and 4 **wood duck (Aix** sponsa) and 17 and 7 blue bird (Sialia sialis) nest boxes were placed on the Guarnieri and Edwards Mines, respectively.

Vegetation and Wildlife Assessments

To assess the response of natural revegetation of wetland species on the Guarnieri Mine, 22 m^2 quadrats were established on 5 wetlands, 3 received supplemental planting and 2 which received wetland soils and plant material from the adjacent mine site and 12 m^2 quadrats were established on the Edwards Mine. Each mine was visited at least once a week and the numbers of different species of wildlife observed were recorded. In addition, 15m small mammal snap trap transects with traps set at 3m intervals were established on each site. Trapping was conducted for 3 nights and animal capture rate was expressed as number of animals/100 trap nights.

Results and Discussions

Response of Wetland Vegetation

On both mines, there was good survival and growth of vegetation on both the relocated wetlands as well as those receiving supplemental plantings of wetland species. Of the 833 individual plants found on the quadrats 752 or 90% were volunteer species. In open water areas Nitella spp. and Lemna minor had a density of approximately 15/cm^2 respectively. Nineteen of the 24 species identified on these wetlands were the result of volunteer invasions and/or from seeds or root stocks present in the material transported from the adjacent mine site. The number of species/m^2 and the density of plants/ m^2 on those wetlands that received the transplanted wetland material was similar to those receiving supplemental plantings. Between 8 and 13 different species occurred on the individual quadrats receiving supplemental plantings compared to the 8 or 9 species that occurred on the transplanted sites. The average number of plants was 36 (32-41) and 38 (23-53) individuals/m^2 for areas that received supplemental plantings and those that received wetland soils, respectively. The

similar number of species and density of vegetation on wetlands with supplemental plantings compared with those that received only wetland soils indicate that both procedures may be used to establish productive wetlands of mine sites. The principal species occurring on all wetlands on the Guarnieri Mine included Echinocloa muricata, Eleocharis obtusa, Bidens frondosa Pancium capillare and Polygonum sagittatum (Table 3). Sensitive-fern (Onoclea sensibilis.),skunk cabbage (Symplocarpus foetidus),along with rushes (Juncus ssp.) and sedges (Carex ssp.) were observed on the transplanted wetlands, but did not occur on the randomly selected quadrats. Throughout the transplanted wetlands, numerous dogwoods (Cornus spp.), black willow (Salix nigra), and buttonbush (Cephalanthus occidentalis) were observed sprouting from root stocks present in the soil. On the wetlands that received supplemental plantings of wetland species, the species in the shallow and intermediate depth zones became established within 2 months of planting and those in the deep zone become established the following spring.

On the Edwards Mine, the response of vegetation on the site that received the transplanted material was not as rapid as it was on the Guarnieri Mine. Natural revegetation of wetland plants did not occur until the following spring and summer months. However, the response of those species that did regenerate naturally as well as the supplemental species in the shallow water zone showed excellent survival and growth.

Wildlife Use

Sixty species of birds (Table 1) representing 23 families, including 7 species of birds of special concern in Pennsylvania (Genoways and Brenner 1985) were observed using these wetlands and adjacent uplands on both mine sites during the first 2 years. Of these, 57 species representing 18 feeding guilds were observed on the Edwards Mine (Table 2). Three of the 7 species of special concern were listed as endangered species and included the King Rail (Rallus elegans), the osprey (Pandion haliaetus) and the short-eared owl (Asia flammeus). According to Gill (1985), the osprey is considered to be an extirpated species in western Pennsylvania. Leberman (1988) indicated that it might be an occasional breeder, but confirmed osprey nesting had not been documented in western Pennsylvania and only reintroduced individuals have bred in eastern Pennsylvania. Five broods of Canada geese (Branta canadensis), and 3 mallard (Anas platyrhnchos) broods were observed in both years using the Guarnieri Mine. Two and 4 wood duck broods (Aix sponsa) were observed using this wetland complex the first and second year, respectively. On separate visits during the summer months between 100 and 300 Canada geese and flocks of over 100 ducks, including mallards, black ducks (Anas rubripes), blue-winged teal (Anas discors), green-winged teal (Anas crecca), and wood ducks were observed feeding on these wetlands and adjacent upland areas. In addition, approximately 20 spotted sandpipers (Actitic macularia), 3 great blue herons (Ardea herodias), and 2 green-backed herons (Butorides striatus) were observed on each visit feeding along the shoreline and the shallow areas of this wetland complex. Two and 4 of the 6 wood duck nesting boxes were used by nesting females producing 16 and 30 fledglings the first and second year, respectively. Thirteen of the 17 bluebird boxes were used by tree swallows (Tridoprocne bi-color) the first year and all boxes were used by nesting tree swallows the second year, producing 66 and 88 fledglings, respectively. In addition 2 of the wood duck nesting boxes were occupied by nesting American Kestrels (Falco sparverius).

The use of wetlands on the Edwards Mine by avian fauna was not as great as the Guarnieri

site. A total of 37 different species representing 14 different guilds were observed using this wetland during the year. Of these 3 were listed as vulnerable species by Gill (1985) and are therefore considered as species of special concern in Pennsylvania. The first year, a Canada goose nesting on one of the islands and the second year, 3 broods of Canada geese along with 3 mallard broods were produced on these wetlands. In the first year, 4 of the 7 bluebird boxes were used by nesting tree swallows. In the second year all 7 of these boxes were occupied by nesting tree swallows producing 23 and 35 fledglings, respectively. In addition to the wetland species, 3 breeding pairs of bobolinks (Dolichonyx oryzivorus), a species of special concern in Pennsylvania, were observed nesting on surrounding grasslands on both sites.

Based on the total number of species and the amount of points assigned as to whether the species were common in Pennsylvania or a species of special concern, the avian fauna on the Guarnieri Mine (Table 2). The avian fauna used at both mines, however, was greater than the 19 species observed using the wetlands that were destroyed during mining and the northern harrier (Circus syaneus) was the only species of special concern observed on these sites. The number of total points accumulated by the avian fauna use of the wetlands destroyed by mining was 240 which was considerably less than that accumulated by the avian fauna using either of the 2 mitigated wetland systems.

These wetlands were also used by diverse mammalian species (17) used the wetlands on the Guarnieri Mine site and 10 used the Edwards Mine site (Table 3). Based on a snap trap transects on both mine sites, the total number of small mammals/100 trap nights was 19 on the Guarnieri site and 45 per 100 trap nights on the Edwards site. The 3 species trapped on both mine sites included the meadow mole (Microtus pennsylvanicus), the white-footed deer mouse (Peromyscus leucopus), and the short-tailed shrew (Blarina brevicauda) (Table 4). The greater number of captures on the Edwards Mine was probably due to the dense grass and legume cover which surrounded the wetland complex. The number of captures on both wetland complexes, however, either equaled or exceeded that present on the wetlands that were removed during mining (Table 4).

A total of 8 and 5 species of amphibians were observed using the Edwards and Guarnieri sites, respectively (Table 5). Of these, the most common species included the green frog (Rana clamitans) and the red spotted newt (Notophthalmus viridescens). On the Guarnieri mine, the leopard frog (Rana pipiens)and the pickerel frog (Rana palustris) were found in large numbers on those wetlands that were completely surrounded by grasslands. Snakes were the most prevalent reptiles on both mine sites with the eastern garter snake (Thamnophis sirtalis), black racer (Coluber constrictor), and water snake (Nerodia sipedon)being the most common species encountered during site visits.

Table 3. Species of mammals observed using constructed wetlands on two surface coal mine sites in western Pennsylvania.

MAMMALS	GUARNIERI	EDWARDS
Virginia Opossum (Didelphis virginianus)	X	X
Star-nosed Mole (Condylura cristata)	X	X
Masked Shrew (Sorex cinereus)	X	X
Short-tailed Shrew (Blarina brevicauda)	X	X
White-footed Deer Mouse (Peromyscus leucopus)	X	X
Eastern Chipmunk (Tamias striatus)	X	
Meadow Jumping Mouse (Zapus hudsonius)	X	X
Meadow Vole (Microtus pennsylvanicus)	X	X
Muskrat (Ondatra zibethicus)	X	
Woodchuck (Marmota monax)	X	
Eastern Cottontail Rabbit (Sylvilagus floridanus)	X	X
Raccoon (Procyon lotor)	X	
Long-tailed Weasel (Mustela frenata)	X	
Mink (Mustela vison)	X	
Red Fox (Vulpes vulpes)	X	X
Grey Fox (Urocyon cinereoargenteus)	X	X
White-tailed Deer (Odocoileus virginianus)	X	X
TOTAL	17	10

Classification based on Jones et al. 1982.

Table 4. Comparison of the number of small mammals trapped on constructed wetlands on two mine sites in western Pennsylvania compared with those removed during mining.

LOCATION	Microtus pennsylvanicus	N/100 Trap Nights	Peromyscus leucopus	Blarina brevicauda
Guarnieri	11.3±		2.5±	5.0-
Edwards	25.0±		10.0±	10.0-
Wetlands removed during mining	4.0±		3.0±	5.0-

Table 5. Species of amphibians and reptiles observed using constructed wetlands on two surface coal mine sites in western Pennsylvania.

	GUARNIERI	EDWARDS
AMPHIBIANS		
American Toad (Bufo americanus)	X	X
Fowler's Toad (Bufo woodhousei fowleri)	X	X
Green Frog (Rana clamitans)	X	X
Leopard Frog (Rana pipiens)	X	
Pickerel Frog (Rana palustris)	X	
Wood Frog (Rana sylvatica)	X	
Spring Peeper (Hyla crucifer)	X	X
Red-spotted Newt (Notophthalmus viridescens)	X	X
TOTAL	8	5
REPTILES		
Black Rat Snake (Elophe obsoleta)	X	X
Eastern Garter Snake (Thamnophilis sirtalis)	X	X
Eastern Milk Snake (Lampropeltis dollata)	X	X
Black Racer (Coluber constrictor)	X	X
WaterSnake (Nerodia sipedon)	X	X
Painted Turtle (Chrysemys picta)	X	X
Snapping Turtle (Chelydra serpentina)	X	
TOTAL	7	6

Classification after McCoy (1982).

in Pennsylvania. Spec. Publ. No. 14, Carnegie Mus. Nat. Hist. Pittsburgh, PA.

Summary

Based on these results, it is apparent that wetlands can be constructed and mitigated on mine lands which will have value for wildlife as well as providing other functions including sediment and erosion control (Brenner 1987).

The similarity in the number of species and the density of vegetation on wetlands with supplemental planting compared with those that received only wetland soils indicate that both procedures may be used to establish productive wetlands on mine sites. But if the objectives is to develop a wetland with identical species composition as the one being mined, then the removal and transportation of wetland soils to the constructed wetland would be the preferred procedure. Regardless of the procedure, the cost of wetland establishment is approximately the same as if the land is returned to AOC as required by current regulations. The rapid establishment of vegetation on these sites as well as the multiple use by wildlife indicates that the construction of wetlands on mine sites should be given increased consideration by both the coal industry and the regulatory agencies alike.

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