HERPETOFAUNAL COMMUNITIES ON RECLAIMED COAL MINE SITES IN WESTERN KENTUCKY

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BERNARD ROTTMAN

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An Abstract
Presented to the
Graduate and Research Council of
Austin Peay State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

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by
Bernard Rottman
August 1983

ABSTRACT

Herpetofaunal communities were investigated on intensively reclaimed coal mine sites in Western Kentucky. Four general habitat types including grasslands, shrublands/ woodlands, shallow water depressions, and deep water impoundments were studied. Twenty-one herpetofaunal species representing 4 orders, 9 families, and 18 genera were encountered. The orders and number of species in each were Caudata (1), Salientia (7), Squamata (9), and Testudines (4). Salientians were the most common residents and included *Rana clamitans melanota*, the most widespread form, and *Rana catesbeiana*, the most abundant. *Sceloporous undulatus hyacinthinus* was the most abundant lizard even though limited in distribution. *Eumeces fasciatus* was present in all terrestrial habitats. *Coluber constrictor constrictor* was the most abundant and widespread serpent. *Pseudemys scripta elegans* and *Chrysemys picta marginata* were regularly observed in aquatic habitats. *Ambystoma texanum* was the only caudate species discovered. Species richness, diversity, and numbers of individuals were highest in the shallow water depression habitats, which were the most productive sites for herpetofauna. A substantial difference in the composition and structure of herpetofaunal communities was noted between habitat types of differing ages. Three periods of movement and high activity were

noted during the study period. The intensively reclaimed mine sites provided adequate habitats for several herpeto-faunal communities.

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LIST OF FIGURES

To the Graduate Council:

I am submitting herewith a Thesis written by Bernard Rottman entitled "Herpetofaunal Communities on Reclaimed Coal Mine Sites in Western Kentucky." I have examined the final copy of this paper for form and content, and I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Biology.

A. Floyd Scott
Major Professor

We have read this thesis and recommend its acceptance.

Edward Chester
Second Committee Member

R. H. McCoy
Third Committee Member

Accepted for the Graduate Council:

Dean of the Graduate School

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CHAPTER I

INTRODUCTION

The development of coal reserves plays a significant role in meeting energy requirements of this nation. However, lands affected as a result of this development undergo severe ecological stress. The concern that coal development should be carried out in an environmentally acceptable fashion is reflected in national legislation for the reclamation of mined lands. The Surface Mining Control and Reclamation Act of 1977 (PL 95-87) provides for the full consideration of environmental values and outlines responsibilities for the rehabilitation of these disturbed ecosystems.

The reclamation of mined lands in compliance with PL 95-87 is intended to expedite the recovery of these disturbed ecosystems. Although it is virtually impossible to immediately reconstruct an ecosystem to its predisturbed state (Brown, 1981), it can be restored to include all the main functional components of the undisturbed condition (Holgate, 1978). Ecological success (*i.e.*, the effective rehabilitation of these disturbed ecosystems) will depend on the variation in biotic and abiotic components and the environmental dynamics within the area (Van der Maarel, 1978). A thorough understanding of these components and their response to reclamation efforts will assist in the selection of optimum reclamation formats for the expedient rehabilitation of mined land ecosystems.

Although much research has been conducted on the recovery of mined land ecosystems, some components remain virtually unstudied. Studies involving the recovery of certain vertebrate populations and communities have increased dramatically in recent years. Allaire (1978), Crawford, *et al.* (1978), Curtis, *et al.* (1978), Wray II, *et al.* (1978), and Whitmore (1980a, 1980b) investigated various aspects of avian communities on reclaimed mined lands. Sly (1976), Hanson and Warnock (1978), Van Waggoner (1978), and Yearsley and Samuel (1980) studied mammalian recovery on these areas. Fish populations and communities were investigated by Gash and Bass (1973), Wilbert (1974), and Peltz and Maughan (1978). Little is known, however, concerning herpetofaunal communities on reclaimed mined lands.

Aquatic biota including herpetofauna were investigated in southeastern Ohio surface mine lakes and ponds by Riley (1960). Myers and Klimstra (1963) surveyed the herpetofauna of prelaw spoil banks in southern Illinois. Vertebrate communities including herpetofauna were evaluated in southern Indiana (Jones, 1967) and southern Illinois (Urbanek, 1976) on mined lands including prelaw spoil banks, reclaimed sites, and associated undisturbed areas.

The utilization of reclaimed mined lands by herpetofauna in southern Illinois was recorded by Pentecost and Stupka (1978). The breeding amphibia of reclaimed surface mine ponds in eastern Tennessee were identified by Turner and Fowler (1981).

Several of the aforementioned studies investigated herpetofaunal communities on mined lands and included areas which had received varying degrees of reclamation. The purpose of this investigation was to determine the community structure of herpetofauna on expansive reclaimed coal mine lands in Western Kentucky, where intensive grading and revegetation efforts had been carried out.

CHAPTER II

DESCRIPTION OF STUDY AREA

The study was conducted on portions of The Pittsburg & Midway Coal Mining Co.'s Paradise Mine properties in Muhlenberg County, Kentucky. This area lies within the Ohio River Hills and Lowlands Subsection of the Interior Low Plateau Province, Shawnee Hills Section (Quarterman and Powell, 1978).

General climatological characteristics for the area (as referenced by records taken at Paradise, Kentucky) include 117.8 cm of average annual rainfall and a mean annual temperature of 13.9°C (National Climatic Center, 1981). More specific climatic data, based on records kept over a 22 year period at nearby Greenville, Kentucky (U.S. Department of Agriculture, 1941), are as follows: January is the coldest month with an average temperature of 2.6°C and July is the hottest month with an average of 25.5°C. The duration of the growing season averages 191 days between the dates of the last (13 April) and first (21 October) killing frost. The wettest month is March with an average of 13.3 cm of precipitation, while February is the driest month with 7.7 cm. A summary of temperatures and precipitation occurring during the study at Paradise, Kentucky, which is located adjacent to the study area, appears in Table 1.

Table 1. Average monthly temperatures and total monthly precipitation occurring at Paradise, Kentucky from April 1982 to April 1983.

Date	Temperature (°C)*			Precipitation (cm)**
	Mean Daily Maximum	Mean Daily Minimun	Daily Mean	Monthly Total
April	16.1	6.5	11.0	8.9
May	27.1	15.0	20.8	15.8
June	26.2	15.7	21.1	5.0
July	30.4	20.8	25.2	15.3
August	28.2	18.4	23.0	9.0
September	24.6	14.6	19.3	13.9
October	21.1	9.6	14.8	ND***
November	14.5	4.4	9.4	10.1
December	11.1	3.2	7.2	ND
January	5.2	-1.9	1.6	5.9
February	8.7	-0.3	3.7	5.4
March	12.6	3.3	7.8	9.1
April	15.2	6.1	10.6	23.1

*Personal communication from Tennessee Valley Authority, Paradise, Kentucky.

**Personal communication from the Office of the State Climatologist, Bowling Green, Kentucky.

***ND = No data available.

Development of coal reserves on these properties began in 1952 and was completed in 1978. Surface mining, underground mining, coal processing, and support operations were conducted during this period. Mining operations included extraction of No. 12, No. 11, and No. 9 seams. Overburden characteristics for these respective coal seams exhibit typical Pennsylvanian lithology of the Carbondale and Lisman Formations (Hagan, 1963). Reclamation activities including grading and/or revegetation had been conducted on all disturbed areas.

The Paradise Mine properties include approximately 1930 ha of contiguous disturbed lands. Within this expanse approximately 417 ha of ungraded spoil banks were planted to trees and grasses. Revegetation and limited grading were conducted on 597 ha. Approximately 917 ha were intensively reclaimed by grading to gently rolling slopes, seeding with various grasses and legumes, and interspersing with tree plantings. Figure 1 depicts the configuration and interspersion of these various reclaimed areas.

The intensively reclaimed areas were subjectively divided into four general habitat types: grasslands, shrublands/woodlands, shallow water depressions, and deep water impoundments. These habitat types are further described below. Floristic components were identified by and nomenclaturally follow descriptions given by Fernald (1950).

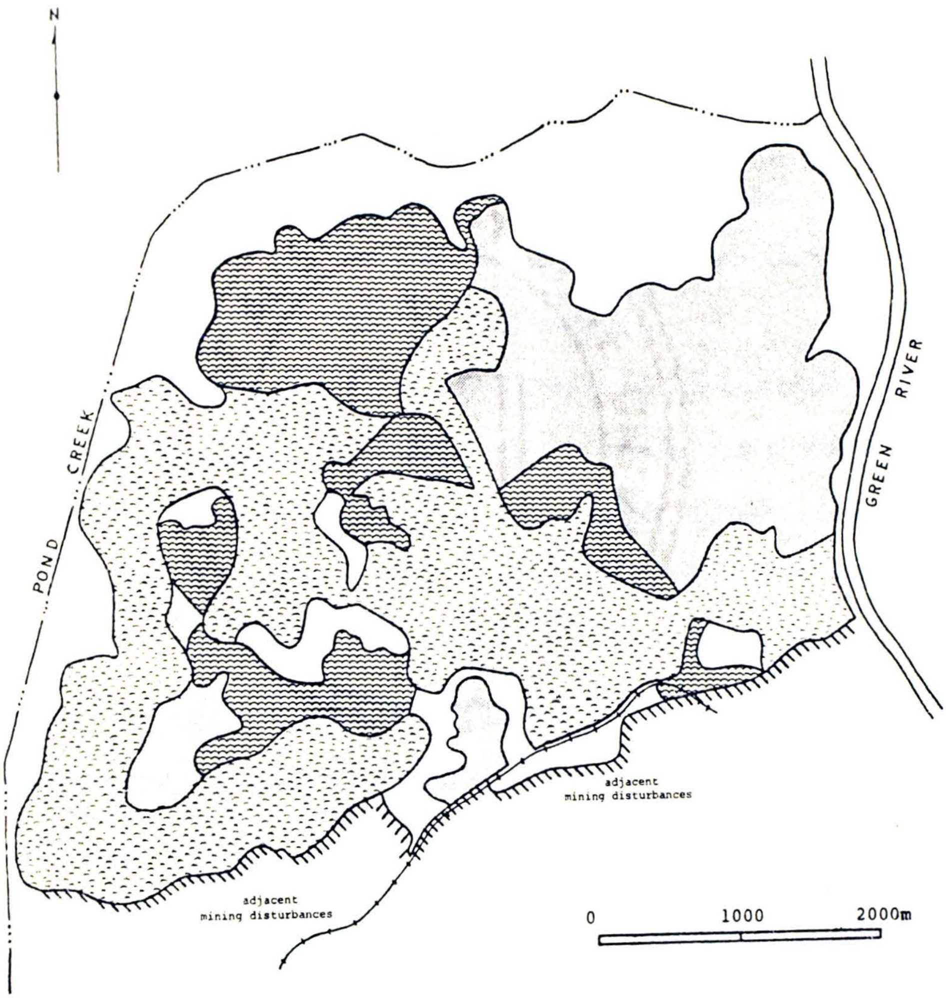

Figure 1. Reclaimed areas on the Paradise Mine properties. Reclaimed areas include: [revegetated, ungraded spoil banks symbol] revegetated, ungraded spoil banks, [revegetated with limited grading symbol] revegetated with limited grading, [intensively reclaimed symbol] intensively reclaimed.

Grassland habitats were dominated by tall fescue (*Festuca elatior*), sericea (*Lespedeza cuneata*), switchgrass (*Panicum virgatum*), and sweetclovers (*Melilotus* spp.). Alfalfa (*Medicago sativa*), red clover (*Trifolium pratense*), weeping lovegrass (*Eragrostis curvula*), smartweeds (*Polygonum* spp.), milkweeds (*Asclepias* spp.), and horseweed (*Erigeron canadensis*) were present, but of lesser importance.

Black locust (*Robinia pseudoacacia*) dominated the shrubland/woodland habitats. These sites were comprised of numerous dead or damaged black locust trees, due to recent infestations of the locust borer (*Megacyllene robiniae*). Maximum tree height was less than 15 m. Numerous black locust root sprouts up to a height of 2 m were present. Important herbaceous ground cover included sweetclover, tall fescue, switchgrass, broomsedge (*Andropogon virginicus*), goldenrods (*Solidago* spp.), sericea, and black locust root sprouts.

Shallow water-filled depressions varied in depths up to 2 m. During dry periods, these ponds receded, exposing mudflats around a central pool. The vegetation was dominated by emergent and moist soil species along the banks and in the shallow and ephemeral areas. Common species included common cattail (*Typha latifolia*), bullrushes (*Scirpus* spp.), barnyard grass (*Echinochloa crusgalli*), various sedges (*Carex* spp.), tall fescue, sweetclovers, cottonwood (*Populus deltoides*), and black willow (*Salix nigra*).

Deep water impoundments consisted of final pits or ramps with water depths ranging to 25 m. Banks of impoundments supported vegetation similar to that around the shallow water depressions. However, steep slopes above and below the pool elevation narrowed the zone for these emergent and moist soil plant communities.

CHAPTER III

METHODS AND MATERIALS

Data Collection Techniques

Only areas that had received intensive reclamation efforts were investigated in this study. Eight study sites, two from each of the four habitat types, were selected. The sites within each habitat type were disturbed in different years; thus each site supported communities of differing age. Table 2 presents the years in which each site was disturbed. Reclamation activities were conducted over the ensuing two-three year period. The eight sites were intensively sampled for a one-year period to determine the type and extent of herpetofaunal utilization.

Since the four habitat types represented both aquatic and terrestrial environments, different sampling techniques were required. Shallow water depressions were considered as both aquatic and terrestrial, and sampled accordingly.

Trap arrays described by Campbell and Christman (1982) were installed at each of the grassland, shrubland/woodland, and shallow water depression sites. These trap arrays were a combination of drift fences, pitfall traps, and double-ended funnel traps. Drift fences were 7.6 m long and arranged in a plus-shaped pattern with a 15 m central separation. Pitfall traps were constructed from

Table 2. Years of mining for respective sample sites.

Habitat and Site	Year of Mining
Grassland	
Site 1	1978
Site 2	1972
Shrubland/Woodland	
Site 1	1971
Site 2	1969
Shallow Water Depressions	
Site 1	1976
Site 2	1965
Deep Water Impoundments	
Site 1	1978
Site 2	1969

19 l plastic buckets and placed on each end of the four individual drift fences. Double-ended funnel traps were placed against both sides of the drift fences at their midpoints. The pitfall traps were covered with an elevated board and other boards were placed over funnel traps to provide shade and protect the traps from rain and debris. Figure 6 depicts the trap array system.

Trap arrays were installed during the second week of April 1982. Trapping began on 18 April 1982 and arrays were checked weekly through 4 December 1982. From 4 December 1982 through 19 February 1983, trap arrays were checked when weather conditions were considered conducive to periods of herpetofaunal activity. Trap arrays were monitored weekly from 20 February 1983 through 16 April 1983. All specimens captured were permanently removed from the study area.

Seining operations were conducted in the shallow water depressions and the deep water impoundments. Three passes were made at each site with a 1.2 x 9.1 m, 6.35 mm mesh seine. Seining was carried out monthly from April 1982 through October 1982, and March 1983 through April 1983.

In addition to trapping and seining, general observations, random investigations, and opportunistic collecting were also conducted.

Conant's (1975) field guide was employed to identify adult herpetofuana. Tadpoles and larval salamanders

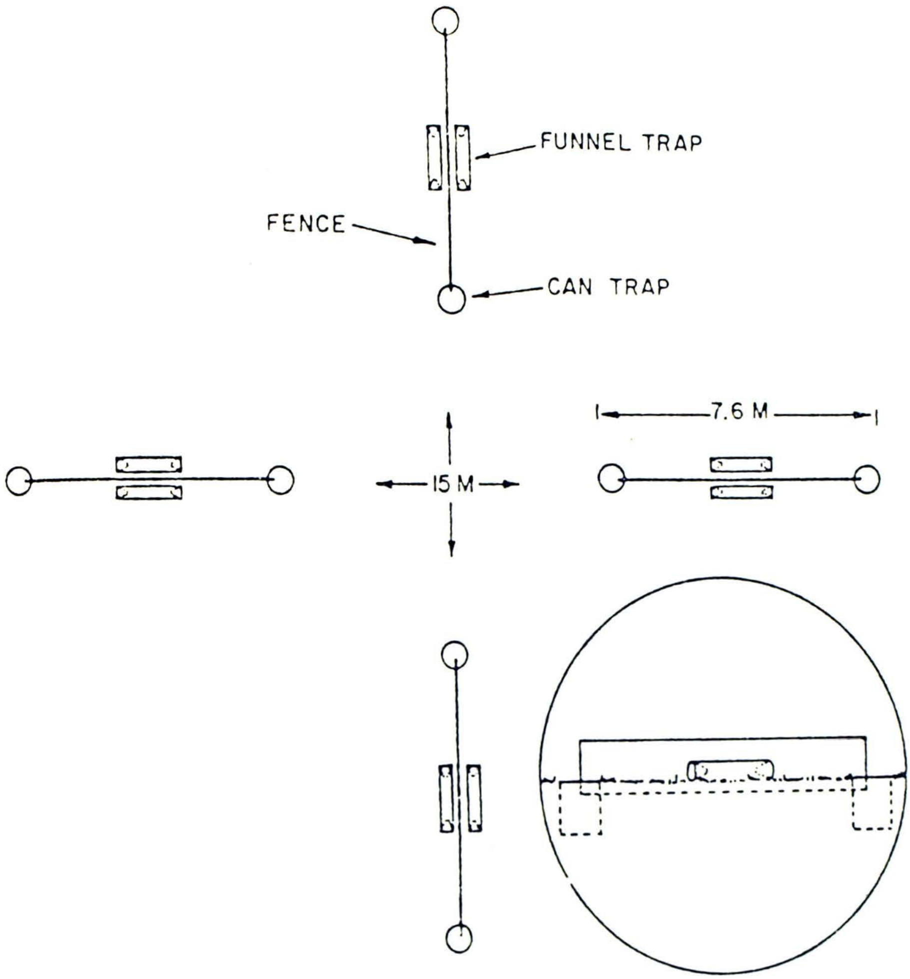

Figure 2. Trap array system (from Campbell and Christman, 1982).

were identified using the keys of Altig (1970) and Brandon (1961), respectively. Subspecies were investigated using Zweifel (1963 *et seq.*). Nomenclature follows Collins, *et al.* (1982). Representative specimens were preserved as suggested by Pisani (1973), and deposited in the Austin Peay State University Museum of Zoology.

Data Analysis Techniques

The nature and arrangement of component species within habitat types are important aspects of community ecology. Species composition was recorded for the entire study area and for each study site. Relative species abundance, species richness, and species diversity, were determined within each habitat type. Temporal patterns were analyzed by species, and the similarity of communities between different age habitats was investigated.

Relative abundance of each species was calculated for each study site. These determinations involved calculating the percentage of individuals of a species over the total number of individuals of all species from each study site. Species richness was set as the number of species per sample site.

Species diversity is a function of the number of species present and the relative balance in numbers of individuals among those species. The Shannon and Weaver (1949) Function calculates species diversity based on information theory, relating the amount of uncertainty in predicting interspecific encounters. In ecological terms, the amount of uncertainty relates to diversity (Pielou, 1969). The value of this measure is its description of a theoretical relationship between species and individuals. Certain interpretations from the Shannon and Weaver Function are untenable, especially when sampling is nonrandom (Lloyd and Ghelardi, 1964; Pielou, 1966). However, the Shannon and Weaver Function is useful as an overall average of species diversity, irrespective of whether it measures uncertainty of encounter for any individual in the community (Lloyd, *et al.*, 1968). Species diversity was calculated according to Shannon and Weaver (1949) using the Base 2 logarithm as follows:

$$H' = -\sum P_i \log P_i$$

where H' = diversity

P_i = decimal fraction of total individuals belonging to the $_i$th species

The index of community similarity (IS) described by Smith (1974) was calculated for habitat types of various ages as:

$$IS = \frac{2C}{A + B}$$

where A = number of species in community 1

B = number of species in community 2

C = number of species in communities 1 and 2

Temporal patterns were analyzed by comparing trapping, seining, and random observation records to determine movement and activity patterns of individual species.

Data collection techniques involved separate sampling procedures for aquatic and terrestrial habitats. Since these sampling procedures were different, valid direct comparisons between community structure in aquatic and terrestrial habitats were not possible. Comparisons of such findings were restricted to habitats sampled with similar techniques.

CHAPTER IV

RESULTS AND DISCUSSION

Twenty-one herpetofaunal species were found on the study area. Eight amphibian species were collected or observed, including members of three families and six genera. Reptiles were represented by thirteen species from six families and twelve genera. These herpetofauna are presented in Table 3.

A single salamander species was detected. Two smallmouth salamanders were taken, one juvenile and one adult. Both individuals were collected at a shallow water depression. The juvenile specimen was captured in the early summer of 1982 during a drying period when the water level was dropping. The adult specimen was collected in late February of 1983. These collections indicate that reproduction was occurring at the site.

Salientians are common residents in mine site habitats (Riley, 1960; Myers and Klimstra, 1963; Jones, 1967; and Urbanek, 1976). Seven salientian species were recorded on the study area. The three ranid species, as well as Blanchard's cricket frog, were frequently encountered throughout the study area. Northern spring peepers and upland chorus frogs were abundant in wet areas during the spring breeding season of 1983. Fowler's toads were

Table 3. Herpetofauna recorded on reclaimed coal mine sites at the Paradise Mine properties in Muhlenberg County, Kentucky.

Class	Species	Common Name
Amphibia		
	Ambystoma texanum	Smallmouth Salamander
	Bufo woodhousii fowleri	Fowler's Toad
	Acris crepitans blanchardi	Blanchard's Cricket Frog
	Hyla crucifer crucifer	Northern Spring Peeper
	Pseudacris triseriata feriarum	Upland Chorus Frog
	Rana catesbeiana	Bullfrog
	Rana clamitans melanota	Green Frog
	Rana sphenocephala	Southern Leopard Frog
Reptilia		
	Sceloporus undulatus hyacinthinus	Northern Fence Lizard
	Eumeces fasciatus	Five-lined Skink
	Scincella lateralis	Ground Skink
	Coluber constrictor constrictor	Northern Black Racer
	*Elaphe obsoleta**	Rat Snake
	Heterodon platyrhinos	Eastern Hognose Snake
	Lampropeltis getulus niger	Black Kingsnake
	Nerodia erythrogaster neglecta	Copperbelly Water Snake
	Nerodia sipedon sipedon	Northern Water Snake
	Chelydra serpentina serpentina	Common Snapping Turtle
	Sternotherus odoratus	Stinkpot
	Chrysemys picta marginata	Midland Painted Turtle
	Pseudemys scripta elegans	Red-eared Slider

*Dorsal pattern suggests an intergrade between *E. o. obsoleta* and *E. o. spiloides*.

sporadically encountered over the study area. Tadpoles of bullfrogs, green frogs, and southern leopard frogs were collected, and calling individuals and/or chorusing populations of all anuran species listed in Table 3 were heard.

Three lizard species were found. Northern fence lizards were abundant throughout, but exhibited what appeared to be a nonrandom clumped distribution pattern. Dry, sandy, open areas with moderate ground cover and structures for climbing such as trees, shrubs, or rocks appeared to be the preferred sites. Dense populations of these lizards were often seen in such habitats, despite the fact they were collected in only one site sampled by trap arrays. Five-lined skinks and ground skinks were also present on the study area, the former in moderate numbers, but the latter only sparingly.

Snakes were frequently seen in terrestrial habitats. Northern black racers were observed on numerous occasions and were the most common serpent. Both adults and juveniles were collected. Subspecies identity was verified by an examination of the hemipenes of adult males. One rat snake, collected opportunistically in a shrubland/ woodland habitat, appeared to be an intergrade between the black and gray subspecies. Eastern hognose snakes in both dark and patterned phases were occasionally observed throughout the study area. One adult copperbelly water snake was opportunistically collected along the bank of a deep water impoundment, and one juvenile northern water snake was taken adjacent to a shallow water depression.

Red-eared sliders were regularly observed and collected in shallow water depressions and deep water impoundments. Midland painted turtles appeared to inhabit only deeper bodies of water, and only those water bodies with sufficient structures to provide adequate basking sites. Where suitable habitat existed, these turtles were observed regularly. One large adult common snapping turtle was collected in late April, 1982 as it moved toward a shallow water depression. A population of stinkpots was encountered in the late spring of 1982 at one of the deep water impoundments, but this species was not observed otherwise.

The qualitative results of sampling habitats by seining and the trap array system are presented in Table 4. Green frogs were the most ubiquitous herptiles on the study area, but bullfrogs were most abundant. Riley (1960) noted that green frogs were the most common species in mine site habitats in Ohio. Blanchard's cricket frog, although noted by Myers and Klimstra (1963) as the most abundant frog on mine sites in southern Illinois, was most abundant only in association with shallow water depressions on this study area. Ranid species, as well as Blanchard's cricket frog, were commonly encountered and were the most abundant herpetofauna.

Table 4. Herpetofauna collected in reclaimed coal mine site habitats by seining and the trap array system. Habitat types include: grassland (G), shrubland/woodland (S/W), shallow water depression (SWD), and deep water impoundment (DWI).

Species	Trap Array						Seine			
	G		S/W		SWD		SWD		DWI	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Ambystoma texanum	-	-	-	-	-	x	-	-	-	-
Bufo woodhousii fowleri	x	-	-	x	x	x	-	-	-	-
Acris crepitans blanchardi	-	-	-	-	x	x	x	x	-	x
Pseudacris triseriata feriarum	-	-	-	-	x	x	x	-	-	x
Rana catesbeiana	x	x	-	-	x	x	x	x	x	x
Rana clamitans melanota	-	x	-	x	x	x	x	x	-	x
Rana sphenocephala	-	-	x	x	x	-	x	x	x	x
Sceloporus undulatus hyacinthinus	-	-	x	-	-	-	-	-	-	-
Eumeces fasciatus	-	x	-	x	-	x	-	-	-	-
Scincella lateralis	-	-	-	-	-	x	-	-	-	-
Coluber constrictor constrictor	x	x	-	-	-	-	-	-	-	-
Heterodon platyrhinos	-	-	-	x	-	-	-	-	-	-
Lampropeltis getulus niger	-	-	-	x	-	-	-	-	-	-
Nerodia sipedon sipedon	-	-	-	-	x	-	-	-	-	-
Chelydra serpentina serpentina	-	-	-	-	-	x	-	-	-	-
Sternotherus odoratus	-	-	-	-	-	-	-	-	x	-
Chrysemys picta marginata	-	-	-	-	-	-	-	-	x	x
Pseudemys scripta elegans	-	-	-	x	-	x	x	x	-	x

Myers and Klimstra (1963), Jones (1967), and Urbanek (1976) reported substantial populations of northern fence lizards in mine site habitats. Northern fence lizards dominated the shrubland/woodland habitat Site 1, since this site exhibited preferred habitat features. Although this was the only quantitative sample of northern fence lizards, numerous random sightings and the evident clumping distribution pattern of populations indicated a significant presence in reclaimed mine site habitats. Five-lined skinks were well represented in terrestrial habitats, but were not present in large numbers. Myers and Klimstra (1963) reported similar findings, while Jones (1967) and Urbanek (1976) did not encounter these skinks on the mine sites they studied. A single ground skink was found during the study period at a shallow water depression.

Northern black racers were sampled quantitatively only in grassland habitats where they were very abundant. These snakes were randomly observed, however, throughout the study area in all terrestrial habitats. Myers and Klimstra (1963), Jones (1967), and Urbanek (1976) also found northern black racers to be the most common terrestrial serpent. Other snakes and turtles were well represented in aquatic and terrestrial habitats, depending on the species habitat affinity. Table 5 presents relative abundance of species collected from seining and trap array systems.

Table 5. Relative abundance (percent) of herpetofauna in reclaimed coal mine site habitats based on seining and trap capture data. Habitat types include: grassland (G), shrubland/woodland (S/W), shallow water depression (SWD), and deep water impoundment (DWI).

Species	Trap Array						Seine			
	G		S/W		SWD		SWD		DWI	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Ambystoma texanum	-	-	-	-	-	15.38	-	-	-	-
Bufo woodhousii fowleri	33.33	-	-	12.50	10.00	7.69	-	-	-	-
Acris crepitans blanchardi	-	-	-	-	30.00	15.38	21.05	11.11	-	4.65
Pseudacris triseriata feriarum	-	-	-	-	20.00	7.69	10.53	-	-	2.33
Rana catesbeiana	33.33	33.33	-	-	10.00	15.38	36.84	25.93	33.33	4.65
Rana clamitans melanota	-	16.66	-	12.50	10.00	7.69	10.53	14.81	-	4.65
Rana sphenocephala	-	-	14.29	25.00	10.00	-	10.53	33.33	11.11	76.74*
Sceloporus undulatus hyacinthinus	-	-	85.71	-	-	-	-	-	-	-
Eumeces fasciatus	-	16.66	-	12.50	-	7.69	-	-	-	-
Scincella lateralis	-	-	-	-	-	7.69	-	-	-	-
Coluber constrictor constrictor	33.33	33.33	-	-	-	-	-	-	-	-
Heterodon platyrhinos	-	-	-	12.50	-	-	-	-	-	-
Lampropeltis getulus niger	-	-	-	12.50	-	-	-	-	-	-
Nerodia sipedon sipedon	-	-	-	-	10.00	-	-	-	-	-
Chelydra serpentina serpentina	-	-	-	-	-	7.69	-	-	-	-
Sternotherus odoratus	-	-	-	-	-	-	-	-	44.44	-
Chrysemys picta marginata	-	-	-	-	-	-	-	-	11.11	2.33
Pseudemys scripta elegans	-	-	-	12.50	-	7.69	10.53	14.81	-	4.65

Grasslands exhibited the lowest species richness, diversity, and numbers of individuals present of the three habitat types sampled with the trap array system. Shallow water depressions had the highest herpetofaunal utilization using the same sampling format. The relatively high density of northern fence lizards in shrubland/woodland Site 1 may have accounted for its low species richness and diversity, as compared to shrubland/woodland Site 2, where none of these lizards was found. This suggests some form of interspecific dominance by northern fence lizards over other small terrestrial herpetofauna, expecially on sites where the densities of northern fence lizards are high. Herpetofaunal communities in older terrestrial habitats exhibited markedly higher species richness, diversity, and numbers of individuals. In aquatic habitats, species richness and species diversity were higher in younger shallow water depressions. However, data from the trap array system indicated five species present at the older site that seining operations did not recover. One seine pass in the older deep water impoundment yielded 33 southern leopard frog tadpoles, which affected species diversity calculations. Data collected from seining indicated the number of individuals in older habitats to be higher. The shallow water depressions were the most productive habitats for herpetofauna in terms of species and individuals. Table 6 presents these findings on community structure.

The index of community similarity, based on all species captured at each sample site using each sampling method, was calculated for the habitat types of differing ages. These findings are presented in Table 7. Grassland habitats and shallow water depressions sampled by the trap array system and deep water impoundments all showed moderate differentiation between old and young habitat sites. The shrubland/woodland habitat exhibited a great dissimilarity due to the dominance of northern fence lizards. Shallow water depressions sampled by seining showed great similarity, but as mentioned previously, this sampling method did not recover five species identified by the trap array system. A noteworthy difference in community similarity between varying age sites within habitat types was apparent.

Collections and sightings of all herpetofauna were organized to identify activity patterns during the study period. A summary of these findings is presented in Figure 7. Three periods of substantial movement by herpetofauna were recorded. These periods were 24 April 1982 through 12 June 1982, 21 August 1982 through 2 October 1982, and 27 February 1983 through 13 March 1983. The spring movement period of 1982 far exceeded any other period of activity, both in numbers of species and numbers of individuals. Both amphibians and reptiles were active

Table 6. Structure of herpetofaunal communities within reclaimed coal mine site habitats at the Paradise Mine properties in Muhlenberg County, Kentucky.

Sample Method	Habitat and Site	Species Richness	Number of Individuals	Species Diversity
Trap Array	Grassland			
	Site 1	3	3	1.5850
	Site 2	4	6	1.9171
	Shrubland/Woodland			
	Site 1	2	7	0.5917
	Site 2	7	8	2.7499
	Shallow Water Depression			
	Site 1	7	10	2.6464
	Site 2	10	13	3.2389
Seine	Shallow Water Depression			
	Site 1	6	19	2.3715
	Site 2	5	27	2.2016
	Deep Water Impoundment			
	Site 1	4	9	1.7527
	Site 2	7	43*	1.3688

*Includes 33 *Rana sphenocephala* tadpoles.

Table 7. Similarity of herpetofaunal communities within reclaimed coal mine site habitats of different ages.

Sample Method	Habitat	IS
Trap Array	Grassland	0.5714
	Shrubland/Woodland	0.2500
	Shallow Water Depression	0.5882
Seine	Shallow Water Depression	0.9091
	Deep Water Impoundment	0.5454

Figure 3. Herpetofauna recorded in reclaimed mine site habitats, by month, from 18 April 1982 through 16 April 1983. Darkened areas indicate months during which each species was observed active.

during this period. The late winter 1983 movement period involved early spring breeding amphibians emerging from hibernation. A variety of herpetofauna was involved in the late summer 1982 movement period. During the months of December 1982 and January 1983, no herpetofaunal activity was recorded. Other than the middle of the 1982 - 1983 winter, the more common herpetofauna were active to varying degrees throughout the study period.

CHAPTER V

SUMMARY AND CONCLUSIONS

Herpetofaunal communities were investigated on intensively reclaimed coal mine sites at the Paradise Mine in Muhlenberg County, Kentucky. The four general habitat types studied included grasslands, shrublands/woodlands, shallow water depressions, and deep water impoundments.

Twenty-one species representing four orders, nine families and eighteen genera were identified. Smallmouth salamanders were the only caudate species discovered. Green frogs were the most widely distributed salientian encountered, although bullfrogs were most numerous. Overall, three species of ranids and Blanchard's cricket frog were the most abundant herpetofauna present. Five-lined skinks were present in all terrestrial habitats, but northern fence lizards were the most numerous lizard. Northern black racers were the most abundant and commonly encountered serpent. Red-eared sliders and midland painted turtles were regularly observed in aquatic habitats. Species richness, diversity, and numbers of individuals were highest in the shallow water depression habitats and lowest in grasslands. A substantial difference in herpetofaunal communities was noted between habitat types of different ages. Periods of greatest movement and highest activity occurred in late winter, spring, and late summer.

The intensively reclaimed coal mine sites examined in this study provided adequate habitats for several different herpetofaunal communities. Aquatic and terrestrial forms were present throughout the study area, and appeared to be well established. Species composition and community structure varied widely between habitats and sites. This is thought to reflect the variety of reclamation formats utilized in the rehabilitation of these disturbed areas. Water resources, especially shallow water depressions, were of major importance to herpetofaunal communities on these areas.

LITERATURE CITED

Allaire, P. N. 1978. Reclaimed surface mines: new potential for some North American birds. Am. Birds 32(1):3-5.

Altig, R. 1970. A key to the tadpoles of the continental United States and Canada. Herpetologica 26(2):180-207.

Brandon, R. A. 1961. A comparison of the larvae of five northeastern species of *Ambystoma* (Amphibia, Caudata). Copeia 1961 (4):377-383.

Brown, L. F. 1981. Brown "Topsoil accelerates reclamation". Coal Industry News 5(33):10,14.

Campbell, H. W., and S. P. Christman. 1982. Field techniques for herpetofaunal community analysis. In N. J. Scott (ed.), Herpetofaunal Communities. FWS - Wildlife Research Report 13. Department of Interior, Washington, DC. p. 193-200.

Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. 2nd ed. Houghton Mifflin Co., Boston, MA. 429 p.

Collins, J. T., R. Conant, J. E. Huheey, J. L. Knight, E. M. Rundquist and H. M. Smith. 1982. Standard common and current scientific names of North American amphibians and reptiles. Herpetological Circular No. 12. Society for the Study of Amphibians and Reptiles. 28 p.

Crawford, H. S., D. M. Hardy, and W. A. Abler. 1978. A survey of bird use of strip mined areas in southern West Virginia. In D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States. FWS/OBS - 78/81. Department of Interior, Washington, DC. p. 241-246.

Curtis, R. L., D. K. Fowler, C. H. Nicholson, and L. F. Adkisson. 1978. Breeding bird populations on three contour surface mines reclaimed under different intensities and types of treatment. In D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States. FWS/OBS - 78/81. Department of

Interior, Washington, DC. p. 369-375.

Fernald, M. L. 1950. Gray's manual of botany. 2nd ed. Van Nostrant Reinhold Co., New York, NY. 1632 p.

Gash, S. L., and J. C. Bass. 1973. Age, growth, and population structures of fishes from acid and alkaline strip-mine lakes in southeast Kansas. Trans. Kansas Acad. Sci. 76(1):39-50.

Hagan, W. W. 1963. Coal reserves in portions of Butler, Edmonson, Grayson, Muhlenberg, Ohio, and Warren Counties, Kentucky. Information Circular No. 1. Kentucky Geological Survey. Lexington, KY. 29 p.

Hanson, L. P., and J. E. Warnock. 1978. Response of two species of *Peromyscus* to vegetation succession on land strip mined for coal. Am. Midl. Nat. 100(2): 416-423.

Holgate, M. W. 1978. Conclusions. In M. W. Holgate and M. J. Woodman, (eds.), The breakdown and restoration of ecosystems. Plenum Press, New York, NY. pp. 475-478.

Jones, G. S. 1967. Vertebrate ecology of a strip-mined area in southern Indiana. M. S. Thesis, Purdue Univ., West Lafayette, IN. 158 p.

Lloyd, M., and R. J. Gelardi. 1964. A table for calculating the "equiability" component of species diversity. J. Anim. Ecol. 33(2):217-225.

_____, J. H. Zar, and J. R. Karr. 1968. On the calculation of information - theoretical measures of diversity. Am. Midl. Nat. 79(2):257-272.

Myers, C. W., and W. D. Klimstra. 1963. Amphibians and reptiles of an ecologically disturbed (strip-mined) area in southern Illinois. Am. Midl. Nat. 70(1): 126-132.

National Climatic Center. 1981. Climatological data, annual summary. Environmental Data and Information Service, Department of Commerce, Asheville, NC. 76(13):1-13.

Peltz, L. R., and O. E. Maughan. 1978. Analysis of fish populations and selected physical and chemical parameters of five strip mine ponds in Wise County, Virginia with implications for management. In

D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States. FWS/OBS - 78/81. Department of Interior, Washington, DC. p. 171-176.

Pentecost, E. D., and R. C. Stupka. 1978. Wildlife investigations at a coal refuse reclamation site in southern Illinois. In D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States, Addendum. FWS/OBS - 78/81A. Department of Interior, Washington, DC. p. 107-118.

Pielou, E. C. 1966. The measurement of diversity in different types of biological collections. J. Theoret. Biol. 13:131-144.

_____. 1969. An introduction to mathematical ecology. Wiley-Interscience, New York, NY. 286 p.

Pisani, G. R. 1973. A guide to preservation techniques for amphibians and reptiles. Herpetological Circular No. 1. Society for the Study of Amphibians and Reptiles. 22 p.

Quarterman, E., and R. L. Powell. 1978. Potential ecological/geological natural landmarks of the Interior Low Plateau. National Park Service, Washington, DC. 739 p.

Riley, C. V. 1960. The ecology of water areas associated with coal strip-mined lands in Ohio. Ohio J. Sci. 60(2):106-121.

Shannon, C. E., and W. Weaver. 1949. A mathmatical theory of communication. Univ. Illinois Press, Urbana, IL. 117 p.

Sly, G. R. 1976. Small mammal succession on strip-mined land in Vigo County, Indiana. Am. Midl. Nat. 95(2): 257-267.

Smith, R. L. 1974. Ecology and field biology. Harper and Row, Publishers, New York, NY. 850 p.

Turner, L. J., and D. K. Fowler. 1981. Utilization of surface mine ponds in east Tennessee by breeding amphibians. FWS/OBS - 81/08. Department of Interior, Washington, DC. 13 p.

U. S. Department of Agriculture. 1941. Climate and man. Department of Agriculture, Washington, DC. 1248 p.

Urbanek, R. P. 1976. Vertebrate and floral diversity on strip-mined land in Williamson and Saline Counties, Illinois. M. A. Thesis, Southern Illinois Univ., Carbondale, IL. 94 p.

Van der Maarel, E. 1978. Ecological principles for physical planning. In M. W. Holgate and M. J. Woodman, (eds.) The breakdown and restoration of ecosystems. Plenum Press, New York, NY. p. 413-449.

Van Waggoner, K. 1978. The effects of lignite mining and reclamation on small mammal populations in Texas. In D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States. FWS/OBS - 78/81. Department of Interior, Washington, DC. p. 256-266.

Whitmore, R. C. 1980a. Reclaimed surface mines as avian habitat islands in the eastern forest. Am. Birds 34(1):13-14.

_____. 1980b. Temporal variation in the selected habitats of a guild of grassland sparrows. Wilson Bull. 91(4): 592-598.

Wilbert, D. L. 1974. Limnological and fisheries investigations of twelve strip mine lakes in southeast Kansas. M. S. Thesis, Kansas State College of Pittsburg, Pittsburg, KS. 130 p.

Wray II, T., P. B. Wackenhut, and R. C. Whitmore. 1978. The reproductive biology of passerine birds breeding on reclaimed surface mines in northern West Virginia. In D. E. Samuel, J. R. Stauffer, C. H. Hocutt, and W. T. Mason, (eds.), Surface Mining and Fish/Wildlife Needs in the Eastern United States. FWS/OBS - 78/81. Department of Interior, Washington, DC. p. 333-334.

Yearsley, E. F., and D. E. Samuel. 1980. Use of reclaimed surface mines by foxes in West Virginia. J. Wildl. Manage. 44(3): 729-734.

Zweifel, R. G., Ed. 1963 *et seq*. Catalogue of american amphibians and reptiles. American Society of Ichthyologists and Herpetologists.