ECOLOGY

Chairman: Harold E. McReynolds
Bedford, Indiana 47421

Chairman-Elect: W. Herbert Senft
Muncie, Indiana 47304

ABSTRACTS

Terrestrial Ecology: A Review of the Present State of Knowledge. Robert P. McIntosh, University of Notre Dame.——The major facts of life in terrestrial ecology in recent decades have been exponential growth in the number of ecologists and great change in the nature of ecological studies variously described as "paradigm shifts", the "new ecology" or simply "revolution". A major impact was the development of systems ecology and large-scale studies of ecosystems in the International Biological Program (IBP). Although the halcyon days of the IBP are over, emerging ecosystem-level projects are still significant aspects of current terrestrial studies.

Another facet of the new ecology was the burgeoning of population ecology and ecological genetics and the efforts to integrate them as a basis for ecological theory. Theoretical mathematical ecology flourishes and strategy and tactics have become key words in some ecological studies, if not very explicit concepts.

There has been an upsurge of work on the coevolution of plants and animals including the chemical interactions between them and the role of animals in the evolution of plant secondary substances. Animal ecologists have reemphasized the community and extended descriptive and theoretical studies of community properties are apparent in the last decade. The problem of what controls community structure is much debated with competition reigning as the favorite of theoreticians, but no concensus evident.

Physiological ecology continues a long and distinguished tradition with striking studies of adaptations of plants and animals to environmental extremes and efforts to develop models of the energy relations of organisms.

A number of aspects of terrestrial ecology have expanded. Microbial ecology is developing new techniques in nature. Paleoecology has expanded into new areas and reinterpretation of Pleistocene events is underway. The establishment of the Organization of Tropical Studies (OTS) and the recognition of the importance of and tenuous status of tropical ecosystems has greatly expanded the effort to study the tropical regions before it simply is too late.

A Classification and Management Plan for Indiana Lakes. W. Herbert Senft II and Byron G. Torke, Ball State University, Muncie, Indiana. ——During the summer months of the years 1972-1977, over 450 lakes and reservoirs of the state of Indiana were sampled as part of the Indiana Lake Classification program. Various water quality parameters were measured to assess the trophic condition of each lake, and a composite eutrophication index was developed. The trophic information from this index and available lake morphometric data (lake area and mean depth) were used in cluster analysis to classify the lakes of the state into similar groups. Seven distinct major lake groups have been identified. Each group has been assigned management and restoration strategies based upon the similarities of the lakes in the group. This information is being used by the state of Indiana to formulate broad lake management policies.

A Proposed Stream Classification. J. R. GAMMON, Department of Zoology, DePauw University, Greencastle, Indiana 46135.——For several years midwestern streams and rivers have been studied by sequentially electrofishing 0.5 to 1.0 km long segments scattered throughout their lengths. Compositional differences make comparisons difficult, but community parameters have shown promise as evaluational tools. A composite index of well-being providing a single value reflective of both the abundance and diversity of fish in a collection was calculated as $I = 0.5 \text{ LnN} + 0.5 \text{ LnW} + \text{Shannon (no.)} + \text{Shannon (wt.)}$ where N = number of fish captured per km, W = the aggregate weight of fish captured per km, and the Shannon indices of diversity calculated using natural logarithms. Composite index values of 5.0 or lower are indicative of poor water quality and/or habitat. Fair water quality and/or habitat is indicated by I values of 5.0 to 6.5. Good environmental conditions are indicated by I values of 6.5 to 7.5, and excellent conditions by I values greater than 7.5.

Spatial Distribution of Resource Management Activities in Riparian Zones. H. E. MCREYNOLDS, U. S. Forest Service, Bedford, Indiana 47421. ——Both the National Forest Management Act of 1976 and the President's Executive Order 11990 direct the Forest Service to protect riparian zones on National Forest lands. Previous protective measures (if any) usually followed the buffer strip concept by restricting certain management activities (timber harvest and road building) within the buffer strip between a stream or lake. However, widths of buffer strips were arbitrarily assigned, and were not based on standardized environmental criteria. Further, the same spacing distance (i.e., width of the buffer strip) was assumed to apply identically to all management activities within this area of the riparian zone.

This present study is based on the premise that there *are* potentially different impacts on the riparian zone by different management activities. Strip mining and picnic sites have differential effects on the receiving waters which should be reflected in dissimilar spacing distances. In the formulation of this system, certain environmental criteria were judged to be of primary concern in determining the total impact on the stream or lake. I used three basic criteria to determine the sensitivity of the site to various management activities: soil erodibility, soil drainage, and water quality/use. In addition, slope of the land was judged to have a significant effect both on surface runoff and flooding.

A simple point system was assigned to each of the three criteria, and these were summed to give the sensitivity of the site. These site sensitivities were plotted against slope of the land on graphs for various management activities. With the calculated site sensitivity and the measured slope of the land, the graphs indicate the minimum spacing from the water body for various activities. Management activities were aggregated into Activity Groups which included: (A) Assorted; (B) Aerial treatments and timber harvest-related activities; (C) Harvest by various cutting methods; (D) Range practices; (E) Mineral extraction; (F) Refuse and sewage disposal; (G) Silvicultural treatments; (H) Fish and wildlife practices; (J) Outdoor recreation; (K) Transport of logs across streams. Spacing determinations can be made manually from the graphs, or by use of a computer program which was written for this spacing system.

The Indiana University Biological Station—Four Score and Five. PAUL McKELVEY, Indiana University, Purdue University at Indianapolis.——The first inland biological field station in the United States was established by the Indiana University Board of Trustees in November, 1894. Between June 25 and September 1, 1895, the first session was held at Turkey Lake (Lake Wawasee) in northern Indiana. The director, Carl H. Eigenmann, and his staff of eleven workers studied variation, analyzed the lake environment, and conducted informal courses in embryology, lake fauna, and general zoology.

In 1899, the Biological Station was moved to Winona Lake near Warsaw, Indiana. The variation studies ended abruptly in 1900 with the rediscovery of Mendel's principles of heredity. After that, researchers at the Station became primarily concerned with limnological investigations. Formal course offerings at the Station increased during the next few years until over one hundred students, both graduate and undergraduate, were present at several of the summer sessions. Fernandus Payne succeeded Eigenmann as director in 1910. He remained in that position until 1920 when Will Scott became director.

Under Scott's direction, cooperative research with the Indiana Division of Fish and Game was begun in 1922. This arrangement was expanded in 1939 after W. E. Ricker had become Station director following Scott's death, and continued with the appointment of David G. Frey as director in 1950. Much of the field research for the resulting Lake and Stream Survey was conducted at the Biological Station. The cooperative program ended in 1953.

With an increasing emphasis on research and declining enrollments in Station courses, the formal instructional program was discontinued in 1938. The Station became a summer research center for graduate students and faculty. Later, following the winterization of one of the laboratory buildings, aquatic studies were encouraged throughout the year. Research has remained the primary function of the Station to date. However, some undergraduate field work has been conducted at the Station during the past few years.

The Biological Station was moved from Winona Lake to Crooked Lake, near Columbia City, Indiana, during the early 1960's. A laboratory building was constructed, and six mobile homes were purchased to be used as faculty and student housing. No instructional facility was built. In 1975, the operational responsibility for the Biological Station was transferred from Indiana University at Bloomington to Indiana University-Purdue University at Fort Wayne (IUPUFW). Since that time, IUPUFW has utilized the Station primarily for undergraduate student field studies and for faculty research. The future of the Biological Station is uncertain.

Pre- and Post-Treatment Results of Aquatic Herbicide Application at Purdue Wildlife Area. DEBORAH S. TORREY and CHARLES M. KIRKPATRICK, Department of Forestry, Purdue University, West Lafayette, Indiana 47907.——It was believed that excessive growth of submerged aquatic vegetation may have been detrimental to waterfowl use of Purdue Wildlife Area ponds located six miles west of West Lafayette, Indiana. This uncontrolled growth had possibly resulted in certain waterfowl species not being able to dive to obtain particular foods and was progressively filling in the sections of open water that were essential to attract waterfowl in general. Due to the concern over the amounts of submerged aquatic vegetation present, and in an attempt to preserve waterfowl habitat and increase waterfowl use of the area, aquatic herbicide was applied to the West Pond in June 1977. An untreated area, Otterbein Lake, was also used for comparison with the waterfowl observed during the study.

The application of Aquathol herbicides divided the study into a pre-treatment period and a post-treatment period. The pre-treatment period began in October 1976 and continued through May 1977. During this time, observations were made of waterfowl using the West Pond concurrent with the fall and spring migrations. Two plant collections were made from random plots and invertebrate populations were sampled. Muskrat houses were sampled for materials used in their construction. Similar studies were made after treatment during the fall of 1977 and waterfowl observations continued through the spring of 1978.

Results from the two periods indicate that the herbicide had an effect on the aquatic vegetation, waterfowl, and aquatic invertebrates. The vegetation showed the most dramatic and predictable response to the herbicide by the absence of submerged vegetation in the fall 1977 plant collection. The waterfowl observations indicated that although there was no increase in the number of diving ducks, these species appeared to dive more and increased their time at the area after the herbicide application. The number of dabbling waterfowl declined post-treatment, apparently due to the substantial reduction of aquatic vegetation. Aquatic invertebrates typically found in the submergent vegetation exhibited a decline in weight, number, and species. A decrease was also noted in the benthic invertebrates, although the decline was not as great as among the plant-dwelling species. Studies of muskrat house composition suggest muskrats were not affected by the reduction of submerged aquatic vegetation; and these animals do not appear to be dependent on a particular plant or group of plants, at least for building materials for houses. There are indications that aquatic herbicide may be an effective tool for preserving waterfowl habitat in that it inhibits the natural plant succession that would eventually replace the aquatic environment.

Mixed Cropping of Beans and Tomatoes *Ekpo Ossom.* B. J. HANKINS and C. L. RHYKERD, Agronomy Department, Purdue University, West Lafayette, Indiana 47907.——Mixed cropping, the practice of growing two or more crops together, is an often-practiced cultural method used in tropical agricultural regions. This is especially true of subsistence farmers. One of the more common examples of mixed cropping is the growing of edible beans in corn.

As a rule, the major reason for growing two crops together is that one of the crops is a legume. The legume, if properly inoculated, can provide nitrogen (N) for itself and possibly some for the non-legume crop such as corn. The cost of N fertilizer in developing countries prohibits its use by many farmers, especially subsistence farmers.

A greenhouse experiment was conducted to study the production of Rutgers tomatoes (*Lycopersicon esculentum* Mill.) grown in association with Bountiful bush greenbeans (*Phaseolus vulgaris* L.) or Amsoy soybeans (*Glycine max* (L.) Merrill) with that of tomatoes grown alone with and without N fertilizer. The population of the legume was 0, 1, or 3 plants per pot. After the plants were harvested, the pots were seeded to sudangrass (*Sorghum bicolor* (L.) Moench) to determine whether there was residual N in the soil from the N fertilizer applied or from the N fixed by the rhizobia growing in the nodules of the legumes.

The data obtained in the experiment were extremely interesting since soybeans appeared to have a very beneficial effect on tomato production while bush greenbeans seemed to have an antagonistic effect. The amount of growth and color of the sudangrass following the harvesting of the tomatoes, soybeans, and greenbeans strongly suggested that N was added to the soil by legumes, especially soybeans. Additional research is to be conducted to evaluate other legumes at varying populations relative to their effect on the growth of tomatoes.

Size-Class and Age-Class Structure in an Aspen-White Pine Successional System. EDWIN R. SQUIERS. Department of Biology, Taylor University, Upland, IN and AuSable Trails Institute of Environmental Studies, Mancelona, MI.——Size-class and age-class data were used to study the developmental dynamics of an aspen-white pine successional ecosystem in Kalkaska County, Michigan. Data from random and non-random samples revealed a significant positive relationship between size and age among the white pines while no such relationship exists for the aspens. The results confirm the danger of assuming a relationship between the size of trees and their age. Information relating to intraspecific competition, reproductive strategy, and the pattern of past disturbances is used to develop a hypothetical explanation of the observed pattern.

Competition and Spatial Patterning in an Aspen-White Pine Successional System. EDWIN R. SQUIERS and JANE E. KLOSTERMAN, Department of Biology, Taylor University, Upland, IN and AuSable Trails Institute of Environmental Studies, Mancelona, MI.——Competition and spatial patterning were studied in an aspen-white pine successional system in Kalkaska County, Michigan. Density, diameter, and distance measures were recorded for tree species on two 40-meter square grids composed of 64 quadrats each 5 x 5 meters. Regression analysis of nearest neighbor distance and tree diameter provided an index of competition and several indices of dispersion were used to assess pattern. The results suggest that interspecific competition with established aspen clones may lead to regular spacing among the invading white pines.

Distribution of Barrens Vegetation in Harrison and Washington Counties, Indiana. JAMES KEITH, Indiana Department of Natural Resources, Indianapolis, Indiana 46204.——Distribution of barrens vegetation and surrounding forest composition in south-central Indiana was determined from the examination of photocopies of original land surveys (1805-1807) contained in the Archives of the Indiana State Library. Data were recorded on work sheets containing a 6x6 grid corresponding to each Congressional Township, and included the following:

1) Size (dbh), distance and species of witness trees
2) Surveyor's additional notes on vegetation and understory composition
3) Surveyor's notes on landforms, soils and geologic features.

Survey notes from Crawford, Harrison, Floyd, Washington, Orange, Lawrence, Jackson and Monroe Counties were examined. Only two counties, Harrison and Washington, possessed barrens of any size. Barrens occurrence was easily determined from the surveyor's narratives. Barrens areas were outlined on base maps for Harrison and Washington Counties. Discussion is primarily concerned with the Harrison County barrens.

Barrens in both counties occur predominantly in areas of sinkhole topography on soils of the Baxter-Crider Association. A change in either topography or soil type usually resulted in a change to forest vegetation.

North of Indian Creek in Harrison County, the barrens occupied about 60% of the area underlain by the Baxter-Crider Association. South of Indian Creek, the barrens occupied less than 25% of the area underlain by these soils. Both areas have sinkhole topography.

The barrens were closely associated with Oak-Hickory forest. However, immediately east of the major streams of Harrison County (Indian Creek, Buck Creek), the forest composition is mixed, with beech and sugar maple becoming dominant in some areas.

The available evidence suggests that the patterns of barrens and forest vegetation in Harrison County occurred as a result of past fires. This hypothesis is discussed.

Population Studies of Indiana Cavernicolous Ostracods *(Ostracoda: Entocytheridae)*. H. H. HOBBS III, Department of Biology, Wittenberg University, Springfield, Ohio 45501.——Four species of entocytherid ostracods are associated with Indiana cave crayfishes: *Dactylocythere* *susanae* Hobbs, *Donnaldsoncythere donnaldsonensis* (Klie), *Sagittocythere barri* (Hart and Hobbs), and *Uncinocythere xania* (Hart and Hobbs). The following crayfishes serve as hosts to the ectocommensal ostracods: *Orconectes inermis inermis* Cope, *Orconectes inermis testii* (Hay) (both troglobites), *Cambarus (Eribicambarus) laevis* Faxon (troglophile), and *Orconectes propinquus* (Girard) (trogloxene). *S. barri* was host specific to the troglobitic crayfishes, *Dn. donnaldsonensis* and *Dt. susanae* host specific to *C. laevis*, and *Un. xania* demonstrated a host preference for *C. laevis* and O. *propinquus*. There was relatively little interchange of ostracod species between the troglobitic crayfishes and the others, indicating a high degree of host specificity. *C. laevis* hosted significantly larger populations of ostracods than *O. i. inermis* and *O. i. testii*.

Maximum size of an ostracod population was limited by the size of the host and relatively unaffected by the length of the intermolt period. Sexes and various instar stages of ostracods were selective for microhabitats on crayfishes (eye-antennae, gnathal, sternal-leg basal, and abdomen). Numerous other symbionts were associated with crayfish exoskeletons, placing possible pressures on ostracods in competition for food and space.

Influence of Nutrient Concentrations on the Spatial Distribution of *Pithophora oedogonia* (Chlorophyceae) in Surrey Lake, Indiana. D. F. SPENCER and C. A. LEMBI, Department of Botany & Plant Pathology, Purdue University, West Lafayette, IN 47907.——Although filamentous algae may contribute significantly to the total productivity of some aquatic ecosystems, there exists relatively little information on the role played by environmental factors in regulating their temporal and spatial distribution. Observations made at Surrey Lake, Indiana suggested that *P. oedogonia* biomass was more abundant in the shallow area near the stream inflow than in the deeper portion of the lake. Measurements of NO_3-N and PO_4-P concentrations along a transect clearly suggested a gradient in NO_3-N but not PO_4-P concentration. The results of batch culture studies and tissue analysis of field-collected *P. oedogonia* suggested that NO_3-N concentrations in the water column were important in determining the distribution of this species.

Notes on the Biology of the Yellow Perch in Indiana Waters of Lake Michigan in the 1970's. T. S. MCCOMISH, Department of Biology, Ball State University, Muncie, Indiana 47306.——Selected aspects of the life history of the yellow perch *(Perca flavescens)* were investigated from 1970 to 1978 in the Indiana waters of Lake Michigan. Young-of-the-year (YOY) perch ate primarily cladocera and copepods (zooplankton) and chironomid larvae (zoobenthos). Larger perch ($\geqslant$ age I) ate mainly chironomid larvae (zoobenthos) and alewife *(Alosa pseudoharengus)* eggs and YOY (fish). Both YOY and larger perch fed at or near the bottom.

Length x weight relationships for perch from 1976 to 1978 were similar comparing males for each of the years and for females in each of the three years. Body x scale length relationships were linear and highly correlated in each year. The mean estimated length at scale formation was 39 mm. Growth by year was summarized and females grew faster than males after age I. All males were sexually mature by age II (150 to 160 mm) while females were not all mature until age IV (230 to 240 mm). Commercial harvest in Indiana waters results in high mortality of age III and IV fish and therefore numbers of age V and older fish is greatly reduced compared to nearby Michigan waters (New Buffalo) where commercial harvest is restricted.

What Determines the Species Composition of Larval Amphibian Pond Communities in South Central Indiana? CRAIG E. NELSON, Indiana University, Bloomington, Indiana 47405.——This contribution addresses the question: what determines which amphibian species breed successfully at ponds in the vicinity of Bloomington, Indiana. Published and unpublished data and speculation are combined to suggest the following hypotheses. 1). Differences in temporal stability among ponds explain most of the variation in aquatic vertebrate predators present in early spring. In order from most to least stable, the dominant aquatic predators are fish, adult newts *(Notopthalmus viridescens)* and the fall-breeding marbled salamander *(Ambystoma opacum)*. The least stable ponds typically lack aquatic vertebrate predators in early spring. 2). These early spring aquatic vertebrate predators are in turn the primary determinant of the breeding success of spring breeding amphibians in the ponds, with success for most species strongly but inversely correlated with predator density. 3). Some species are relatively immune to predation. Eggs and larvae of green frogs *(Rana clamitans)* and bull frogs *(Rana catesbeiana)* are distasteful to both adult newts and larval marbled salamanders. Larval spring peepers *(Hyla crucifer)* seem to be protected by alternative means. 4). Although habitat selection and competition are apparently less important than stability and predation, they presumably explain partial complementary in the local distributions of some related species. Moreover, the breeding success of the spring peeper in some ponds apparently increases when other species are decimated by salamanders, suggesting that it may be more strongly influenced by competition than by salamander predation. Finally, it is worth emphasizing that two groups of invertebrate predators, leeches and caddis fly larvae, which are often important elsewhere were never observed feeding on amphibia eggs in the Bloomington area.

Factors Regulating the Abundance of *Volvox aureus* in a Small Borrow Pit Pond. ROBERT A. HUNCHBERGER and W. HERBERT SENFT, Biology Dept., Ball State University, Muncie, IN 47306.——A detailed limnological study of Clark's Borrow Pit Pond (SW¼ Sec. 30 T22N R9E, Delaware County, Ind.) was conducted from the spring of 1978 through the fall of 1979 to ascertain what factors regulate the abundance of *Volvox aureus*, a major phytoplanktor of the pond. This algal species often dominates the spring and sometimes fall phytoplankton blooms that occur annually, but disappears from the plankton throughout the remainder of the year.

Laboratory growth experiments suggest that the spring peak of *V. aureus* (10^5 colonies/ml in 1978) is most likely induced by the high nutrient levels in the pond (total P = 4.5 umoles/1; $NH_3 + NO_3 = 28.0$ umoles/1) and warming temperatures. Competition from other algal species is reduced at this time by the presence of the zooplanktor *Daphnia ambigua* which effectively grazes all but the *V. aureus* colonies. Decreased nutrient levels in the summer months (total P = 1.0 umoles/1; $NH_3 + NO_3 = 4.0$ umoles/1) restrict the abundance of *V. aureus*, and other algal species (notably blue-greens) dominate. Two of these species, *Oscillatoria ornata* and *Microcystis aeuruginosa*, were shown to exhibit no allelopathic influences on the growth of *V. aureus*. However, experiments suggested a possible growth inhibition of *V. aureus* by the large macrophyte populations in the pond. Increasing nutrient levels in the fall sometimes induce a second *V. aureus* bloom, but this declines rapidly as the water temperature drops below 10°C. We conclude that the abundance of *V. aureus* in Clark's Pond is influenced mainly by abiotic factors (nutrient availability and water temperature) and only to a lesser degree by biotic factors (grazing and competition).