

ECOLOGY

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ABSTRACTS

Present Status of *Taxodium Distichum* (L.) in Hovey Lake, Posey County, Indiana.

JOHN DAILEY, JAY CRAIG, KATHY WELBORN and THOMAS KOZEL, Indiana State University, Evansville, Evansville, Indiana 47712.—Hovey Lake, Posey County, Indiana, contains one of the northernmost stands of bald cypress, *Taxodium distichum* (L.) in North America. Few recent studies on the distribution and viability of *T. distichum* at the northern limits of its range are available. This work was begun to determine the distribution and viability of the trees at this limit. Three hundred and fifty nine of the several thousand trees in the 560 hectare lake were selected for study at random using the quadrat method. Core samples, for age determination, d.b.h., spatial distribution and density of the trees in the lake were recorded. These data were analyzed to determine the present status of the species and to allow comparisons with earlier work in the region.

The Fishes of Eagle, Stotts and Rattlesnake Creeks in Central Indiana.

W. L. FISHER, Water Resources Laboratory, University of Louisville, Louisville, Kentucky 40292, and J. R. GAMMON, Department of Zoology, DePauw University, Greencastle, Indiana 46135.—The fishes of three streams in central Indiana were sampled during the summers of 1978, 1979 and 1980 as part of a Model Implementation Program (MIP) sponsored by the U.S. Environmental Protection Agency and the Department of Agriculture. The goal of the project was to monitor the biota and water quality of two of the three streams in response to improved agricultural land-use practices within the watersheds. Rattlesnake Creek served as a control stream for the study.

One hundred individual collections were made from the three streams during the three-year period. The total number of fish collected during the study was 35,043 representing 11 families and fifty species. Of those fifty species, eight comprised 85% of the total number caught. These species were central stoneroller *Campostoma anomalum*, silverjaw minnow *Ericymba buccata*, striped shiner *Notropis chrysocephalus*, bluntnose minnow *Pimephales notatus*, creek chub *Semotilus atromaculatus*, white sucker *Catostomous commersoni*, johnny darter *Etheostoma nigrum*, and orangethroat darter *E. spectabile*. Mean summer standing crop values ranged from 33 to 320 kg/ha.

The collections at Eagle Creek yielded 37 species, seven of which comprised three-quarters of the total number of fish caught. Those seven species include all those listed above except the silverjaw minnow. Mean summer standing crop values ranged from 42-280 kg/ha.

Forty species of fish were taken from the sampling sites on Stotts Creek.

Eight species accounted for eighty percent of the total catch and include all those mentioned previously except the johnny darter. It is replaced on the list by sand shiner *Notropis stramineus*. Thirty-three to 242 kg/ha of fish represented the range of mean summer standing crop values for this stream.

Collections from two sites on Rattlesnake Creek produced 39 species of fish, the eight most common of which include all those initially mentioned except the white sucker. Northern hog sucker *Hypentilium nigricans* accounted for the eighth species on the list. The mean summer standing crop for the two sites ranged from 44 to 320 kg/ha.

A discussion of some of the factors which influenced the composition and abundance of fishes taken from the various sites is made.

Demographic Structure in *Peromyscus leucopus*. CHRIS KRUPP, MARK MINER and DAVID T. KROHNE, Department of Biology, Wabash College, Crawfordsville, Indiana 47933.—The spatial and temporal aspects of demographic structure have been studied for the past two years in a population of the white-footed deer mouse, *Peromyscus leucopus*, inhabiting an extensive tract of beech-maple forest in west-central Indiana. A massive live-trapping program samples from approximately 200 acres of habitat in which there are subtle but recognizable vegetation differences and topographic discontinuities. Trapping is sufficiently extensive and intensive to assess the extent of demographic subdivision within the 200 acre tract. Demographic differences between most portions of the study area are minor and not persistent in time. One successional area however, appears to be a dispersal sink. It accumulates animals from all other areas but these animals are unable to persist there for the winter. In the spring it is recolonized with mice from the areas surrounding it. These data suggest that an ecological "population" extends over as much as 200 acres but within such a population, smaller demographic units may exist which have distinct demographic patterns. Genetic subdivision of these populations will also be discussed.

Vegetational Changes at the Grants (NM) Volcanic Area after 37 years; A Photocomparison. ALTON A. LINDSEY, Purdue University, West Lafayette, Indiana 47907.—In 1944-48 many photos were taken of biological and geological features of the Grants (NM) Lava Bed, and published in Ecological Monographs, Ecology, etc. Most of these sites were rephotographed in May-June, 1981, under sponsorship of the U.S. Bureau of Land Management, which plans official wilderness status for this 320-square-mile area on the continental divide. There have been noteworthy natural and man-made changes in the 37-year interval. In ice caves in lava tubes a striking recession of the ice mass has occurred, in one case opening widely to access a cavern completely obstructed earlier by an ice plug holding up a meltwater pond supporting a variety of microscopic plants and animals. Potsherds, thick charcoal deposits, and animal and human bones within the cavern depths indicate Indian occupancy, probably during the 900-1300 AD thermal period. Photopairs of ancient, stunted ponderosa pines and pinyons in lava cracks and cinder-cone substrates usually show no detectable growth has taken place since 1948, and even a net loss of biomass in many individuals. Instances of either reproduction or death were very rare. One 230-year-old ponderosa pine, 7 ft. tall, had required 92 years to produce each average inch of diameter growth in wood of the lower trunk. On the windy west or exposed slope of one cinder cone, sizable patches of pine forest have been destroyed by undermining and slippage of ash on the steep slope. In sheltered lava niches, relatively rapid growth of *Parmelia* lichen has drastically eroded the surface of lava rock. Some slight expansion of lichen patches of open surface sites, and

the conspicuous increase of trembling aspen at higher elevations, suggest favorable overall growth conditions. Largely man-made changes are conspicuous in the disruption of sinkhole ponds and marshes, natural wells, and deep pits along new Interstate 40 and the Santa Fe tracks just west of McCarty's village. Highway construction where scientific features and rarities, some not known elsewhere in the world, had existed in the Forties has completely destroyed (e.g., the only satisfactory place for observing the optical effect or reflection phenomenon in undisturbed surface bloom of the minute alga *Chlorella*, the stratified myxophycal crust on submerged lava, and the subterranean colony of *Asplenium trichomanes*) or severely damaged (e.g., the emerald green pond bottoms, the red sulfur bacteria forming grossly conspicuous expanses on pond bottoms, and the habitat for the stonewort alga, *Chara*). All these lava bed sites would have easily been spared by placing I-40 alongside the old Rt. 66 to the south side instead of the north. Former population of bats in dry caves have been decimated by disturbance in central parts of the flow, the only part where they were known of, but overall other forms of wildlife seems to have increased. The 396 photos and descriptive report on them are stored at the BLM office at Socorro NM.

Availability of Lipid-Soluble Vitamins in Freshwater Ecosystems: Contributions from Plant Decomposition and Algal Secretion. J. R. LITTON, JR., Department of Biology, Saint Mary's College, Notre Dame, Indiana 46556.—During the 1977-80 period estimates of the contributions of lipids from decomposing plant material and algal excretion to the total lipid fraction (particulate and dissolved) in freshwater Vermont and New Hampshire ecosystems were made. A detailed component of this study was a determination of lipid-soluble vitamins, and their pro-vitamins—compounds of potential significance in the life cycles of herbivores—that were made available in the water column. Fresh samples of mixed phytoplankton, mixed filamentous algae, *Typha*, mixed leaf litter, *Lemna*, *Potamogeton*, and cultured algae (*Zygnema* and *Chlorella*), treated variously, were allowed to decompose in jars of distilled water under aerobic conditions over a 40 day period. The contents of each jar was monitored regularly over this period and the lipid-soluble vitamin concentrations in the water determined. In general, these compounds were both rapidly released into the dissolved fraction and subsequently quickly decomposed by the decomposing plant material. They were more gradually released into the particulate organic fraction and their concentrations remained more stable for the duration of the experiments. These results are correlated with levels of these vitamins detected in the late summer in natural water samples from northern New England.

Laboratory cultures of *Zygnema* and *Chlorella* were monitored over a four week period to determine whether these same lipid-soluble compounds were also available from algal secretion. Cell-free supernatants from these cultures were examined over this period for the presence of these compounds or their precursors. Regular and intensive log-phase samples showed appreciable concentrations of vitamin E (α -tocopherol) in the supernatant. Secretation of lipid material may be an additional source of lipid-soluble compounds in freshwater.

Differential Responses of Male and Female Mallard Ducks to Decoys. K. MARK LOYD, Ball State University, Muncie, Indiana 47306.—Mallard duck responses to decoys were studied during November and December, 1980, at Muscatatuck National Wildlife Refuge. Field tests employing three variations in mallard decoy sex ratios (50:50, 0:100, 100:0) of males and females were utilized. The number of ducks responding to these decoys was compared to those of the local population. Results

suggest that neither male nor female mallards responded out of proportion to their occurrence in the local population. Comparisons of responses between male and female mallards to decoy location, decoy sex ratios, and approach to decoys indicated no statistical differences. However, all mallards showed a preference for an open water decoy location and for a mixed sex decoy group.

Additions of the Flora of Spencer County, Indiana. WILLIAM E. MCCLAIN, Division of Forest Resources and Natural Heritage, Illinois Department of Conservation, Springfield, Illinois 62706.—A floristic study was conducted on an industrial site near Rockport in Spencer County, Indiana. As a result of this investigation, 92 vascular plant species not previously known from Spencer County are reported. Including the plants reported here, the vascular flora of Spencer County totals 667 species, including 16 ferns or fern allies, 1 gymnosperm, 472 dicots and 180 monocots. A significant distribution record is reported for *Orobanche ludoviciana* Nutt., and *Gerardia fasciculata* Ell. and *Anoda cristata* (L.) Schlecht. are new to Indiana.

Additions of the Flora of Sullivan County, Indiana. WILLIAM E. MCCLAIN, Division of Forest Resources and Natural Heritage, Illinois Department of Conservation, Springfield, Illinois 62706.—A floristic study was made of an industrial site located west of Fairbanks in Sullivan County, Indiana. As a result of this investigation, 188 species of vascular plants not previously known from Sullivan County are reported. This increases the vascular flora known from Sullivan County to 721 species, including 15 ferns or fern allies, 1 gymnosperm, 201 monocots, and 504 dicots. New distribution records are reported for *Naias minor* All., *Juncus secundus* Beauv., *Spiranthes ovalis* Lindl., and *Liparis loeselii* (L.) Rich.

An Economic Evaluation of Four Fishing Ponds in the Hoosier National Forest. H. E. McREYNOLDS, U. S. Forest Service, Bedford, Indiana 47421.—For the past 4 years, the U. S. Fish and Wildlife Service, under a tripartite agreement with the Forest Service and Indiana Department of Natural Resources, has been surveying and renovating small fishing ponds in the Hoosier National Forest. Although use and harvest of larger impoundments on the Forest have been assessed, the small ponds had no creel census until 1980.

In 1980, the Hoosier National Forest contracted with Ball State University to conduct a creel census of 4 selected fishing ponds. Criteria for selection of these study ponds were (1) that the two ponds of each pair would be in the same general locality (to minimize travel costs and time), and (2) that (of each pair of ponds) one would have easy access, and the other more difficult access.

Anglers at the 4 ponds were interviewed during 1980 (April 19-October 20) and a variety of use, harvest, and preference data were collected. These data provided an opportunity to measure the economic value of these ponds. Several conclusions can be drawn from the economic data, the basic one being that this pond fishing resource is monetarily competitive with other Forest resources.

The Degree of Likeness of Interbasin and Intrabasin Fish Faunas as Measured by Similarity Coefficients. H. E. McREYNOLDS, U. S. Forest Service, Bedford, Indiana 47421.—The implicit assumption has been that the greater the geographic proximity of stream basins, the greater the likelihood that their fish faunas will be more alike. This thesis has been generally based on untested logic rather than formalized investigation and controlled comparisons.

It appears that similarity analysis could be applied to fish fauna data of stream basins with varying degrees of proximity. Interbasin similarity gradients could be

determined. Additionally, use of similarity coefficients could aid in determining the degree of likeness of the fish faunas of different tributaries within the same basin (intra-basin similarities). Results indicate that the seemingly logical assumptions of the past (correlated similarity-proximity gradients) are not conclusively supported by similarity analysis, especially in interbasin comparisons.

Seasonal Succession and Productivity of Phytoplankton in Lake of the Woods and Lake Waubee. CRAIG A. NELSON, and W. HERBERT SENFT II, Department of Biology, Ball State University, Muncie, Indiana 47306.—Phytoplankton population dynamics of Lake of the Woods and Lake Waubee were studied over a twelve month period commencing in October, 1980.

Both lakes exhibited similar, well-defined patterns of seasonal succession. Following the autumnal overturn the phytoplankton community was dominated by the diatom *Stephanodiscus niagarae* and the green algae *Ankistrodesmus falcatus*. During the early winter months, *Oscillatoria* spp. and *Ankistrodesmus falcatus* dominated the phytoplankton communities of both lakes. In late winter, *Asterionella formosa*, *Stephanodiscus tenuis*, *Cryptomonas* spp., and *Dinobryon sociale* became the dominant species. During spring overturn, the phytoplankton community once again exhibited a diatom pulse consisting primarily of *Asterionella formosa*, *Stephanodiscus niagarae*, and *Stephanodiscus tenuis*. This pulse, however, was more pronounced in Lake of the Woods. In Lake Waubee, *Cryptomonas* spp. and *Dinobryon sociale* replaced the diatoms as dominant phytoplankters. Upon stratification and throughout the summer months, *Oscillatoria* spp. were the dominant algal species in both lakes.

Primary productivity measurements indicate that both lakes are quite productive and can be classified as eutrophic. Lake of the Woods with maximum production values of ca 640 mg C/m³/h appears to be approximately twice as productive as Lake Waubee (ca 265 mg C/m³/h). Results of algal assay experiments indicate that both lakes are phosphorus limited. Phosphorus additions to the lake water stimulated algal growth while the lake water control (no nutrient addition) did not.

Phosphorus Content of Bottom Sediments from Lake of the Woods and Lake Waubee. KENNETH ROBERTS, W. HERBERT SENFT II, and BYRON G. TORKE, Department of Biology, Ball State University, Muncie, Indiana 47306.—The phosphorus content of bottom sediments from 17 locations in Lake of the Woods and 18 locations in Lake Waubee was determined. Samples were collected using scuba, and both shallow water and deep water areas were surveyed. Total phosphorus concentrations in sediment interstitial waters ranged from 493 to 3363 $\mu\text{g l}^{-1}$ in Lake of the Woods and from 90 to 3159 $\mu\text{g l}^{-1}$ in Lake Waubee. Acid-nonlabile sediment bound phosphorus ranged from 94 to 1053 $\mu\text{g (g dry weight)}^{-1}$ in Lake of the Woods and from 67 to 1687 $\mu\text{g (g dry weight)}^{-1}$ in Lake Waubee.

Zooplankton Populations of Lake of the Woods and Lake Waubee. BARRY SALERNO and BYRON G. TORKE, Department of Biology, Ball State University, Muncie, Indiana 47306.—Zooplankton populations of Lake of the Woods and Lake Waubee were sampled over a six month period beginning in March, 1981. Vertical sample hauls were collected at a deep and shallow station in each lake using a #20 mesh plankton net. During the spring months, the rotifer *Keratella cochlearis* dominated the zooplankton community of both lakes. *Keratella cochlearis* maintained dominance during the summer in Lake of the Woods. In Lake Waubee, however, *Kellicottia longispina* and *Conochilus* sp. increased as the summer progressed. In both lakes, rotifers composed a significant portion of the zooplankton community.

Growth and Abundance of Aquatic Macrophytes in Lake of the Woods and Lake Waubee. W. HERBERT SENFT II, TRACY DUNN, and BYRON G. TORKE, Department of Biology, Ball State University, Muncie, Indiana 47306.—Aquatic plants of Lake of the Woods and Lake Waubee were sampled from May through August, 1981. Species diversity was low in both lakes. The dominant species in Lake of the Woods was Eurasian mil-foil *Myriophyllum spicatum*, and it reached maximum densities of 183 g dry weight m^{-2} during peak abundance in early July. The macrophyte flora of Lake Waubee was more diverse and included *Potamogeton crispus*, *Potamogeton pectinatus*, *Ceratophyllum demersum* and the ubiquitous *Myriophyllum spicatum*. Biomass densities reached 359 g dry weight m^{-2} during peak abundance. By late July, macrophyte biomass began to decline in both lakes.

Management and Restoration Strategies for Lake of the Woods and Lake Waubee. W. HERBERT SENFT II and BYRON G. TORKE, Department of Biology, Ball State University, Muncie, Indiana 47306.—Following detailed limnological surveys, water management and restoration plans have been developed to improve the water quality of Lake of the Woods and Lake Waubee. Management strategies for Lake of the Woods currently focus upon two restoration alternatives. Macrophyte harvesting has been suggested to help increase the recreational usage of the lake. Sewage diversion of cottage owners' septic fields is proposed to divert a large phosphorus input to the lake. Restoration plans for Lake Waubee focus upon controlling streamflow nutrient input by the construction of holding ponds for nutrient absorption and/or precipitation. Chemical sediment treatment may also be used to prevent internal phosphorus recycling.

Diagnostic-Feasibility Studies of Lake of the Woods and Lake Waubee. W. HERBERT SENFT II, BYRON G. TORKE, PAUL GLANDER, ROBERT HUNCHBERGER and KENNETH ROBERTS, Department of Biology, Ball State University, Muncie, Indiana 47306.—Two public lakes in Indiana—Lake of the Woods, Marshall County, and Lake Waubee, Kosciusko County—have been the focus of intensive limnological studies over the past year. Sponsored by the Clean Lakes Program of the Environmental Protection Agency, these diagnostic-feasibility studies have focused on identifying and quantifying the major nutrient sources of each lake. Extensive tributary and in-lake sampling was begun in November, 1980, and continued through August, 1981. Information from this sampling effort has been used to develop a management and restoration plan for each lake.

Hydrologic and Nutrient Budgets for Lake of the Woods and Lake Waubee. W. HERBERT SENFT II, BYRON G. TORKE, PAUL GLANDER, ROBERT HUNCHBERGER, and KENNETH ROBERTS, Department of Biology, Ball State University, Muncie, Indiana 47306.—Hydrologic and nutrient budgets have been formulated for Lake of the Woods, Marshall County, and Lake Waubee, Kosciusko County. Lake of the Woods has a volume of $7.848 \times 10^6 m^3$ and a residence time, T_w of 1.17 years. The measured areal phosphorus and nitrogen loadings to Lake of the Woods are $0.616 g m^{-2} y^{-1}$ and $49.66 g m^{-2} y^{-1}$, respectively. Lake Waubee has a volume of $6.017 \times 10^6 m^3$ and a residence time, T_w , of 0.72 years. The measured areal phosphorus and nitrogen loadings to Lake Waubee are $0.770 g m^{-2} y^{-1}$ and $106.4 g m^{-2} y^{-1}$. Streamflow inputs of nutrients are the dominant external sources for both lakes. Septic input is minimal for Lake Waubee, but contributes 22% of the external phosphorus loading to Lake of the Woods. In addition, Lake of the Woods appears to have substantial internal phosphorus loading from the sediments.

The Influence of Fly Ash on the Lake Charles East Zooplankton Community.

DAVID F. SPENCER, Indiana University-Purdue University, Indianapolis, Indiana 46205, HUNG YIU YEUNG, and RICHARD W. GREENE, University of Notre Dame, Notre Dame, Indiana 46556.—The zooplankton community in Lake Charles East, Indiana, was sampled from June, 1974 through September, 1977 as part of a lake restoration study. About 1.8×10^4 kg of lime and 1.8×10^6 kg of ponded fly ash were added to the lake during May through August, 1975 to precipitate phosphate and seal the sediments. Twenty six zooplankton taxa were observed in samples during the study period. Annual mean species number (5.2-11.3) and annual mean species diversity (H, 0.9-1.3) were highest in 1976, the first year after treatment. By the second post-treatment year these variables had returned to pre-treatment levels. Prior to treatment Cladocera were dominant during fall and early winter (Sept.-Dec. 1974), with Copepoda dominant in late winter and spring (Jan.-May 1975). After treatment Cladocera were dominant throughout the fall and winter (Nov. 1975-May 1976). Copepoda were again dominant in August 1976. The short term effect of the treatment appeared to be termination of the latter part of the copepod annual cycle through elimination of aestivating copepodites in the summer.

Time of Disturbance as a Factor in the Species Composition of a First Year Indiana Oldfield.

EDWIN R. SQUIERS, Department of Biology and Environmental Science, Taylor University, Upland, Indiana 46989.—The effect of the date of fallowing on the community structure of a first year oldfield was studied on a series of replicate 7 x 7 meter square subplots in each of six plots in a randomized complete block design at the Taylor University Field Research Area. Every two weeks from the first of May to mid-July 1980 a set of six subplots, one from each plot, was tilled to a depth of 20 cm. Density and cover data were collected for each plant species from 15 randomly located quadrats (0.5 x 0.5 meters square) in each treated subplot at the peak of the growing season. Two-way analysis of variance was used to assess the relative differences within and between replicate subplots and within and between treatments. The results indicated little or no significant difference between identically treated subplots and highly significant differences between treatments. Major shifts in community dominance were generated by altering the time of disturbance by as little as two weeks. The study lends support to the argument that the community structure of early successional systems is heavily dependent on an interaction between the time of last soil disturbance and the dormancy patterns of the species represented in the seed pool.

Bacteriological Analysis of Water Quality in Lake Waubee and Lake of the Woods, Indiana.

CARL E. WARNES, W. HERBERT SENFT II, and BYRON G. TORKE, Department of Biology, Ball State University, Muncie, Indiana 47306.—Bacterial analyses of these two lakes in northern Indiana were conducted over a 5 month period spanning the warmer months of 1981. Membrane filtration techniques were used to determine levels of total coliform, fecal coliforms, fecal streptococci, and *Aeromonas hydrophila* in water and selected sites in the two lakes. The standard plate count technique was employed to determine the total bacterial counts in the water. Samples were taken concurrently with water analyzed for other biological, chemical and physical parameters. Both seasonal and site variations were noted in both lakes. Higher counts were observed in July in both lakes with Lake of the Woods showing higher counts in most instances. On numerous samples greater than 100 fecal coliforms were determined in 100 ml samples. The fecal coliform—fecal streptococci ratios were usually around 0.3 and rarely over a value of 1.0. Deep water samples gave values in acceptable range for recreational use while

tributary samples proved to contain levels of these indicator bacteria showing a very poor level of water quality.

Diurnal Variations in Surface Water Dissolved Oxygen Content and Sediment Oxygen Demand of a Northwest Indiana Stream. RICHARD L. WHITMAN, Department of Biology, Indiana University Northwest, Gary, Indiana 46408.—Forty-eight hour diurnal dissolved oxygen, temperature, and pH analyses were performed monthly at a minimum of 4 stations in Salt Creek, Porter County, Indiana from July through September, 1980. Twenty-four hour diurnal analyses were similarly performed at 5 stations in April, 1981. Triplicate sediment samples at 8 stations, from creek km 5.6 to 39.1, were analyzed for oxygen uptake (by Gilson respirometry), organic content and texture. Nitrate-nitrogen, ammonia-nitrogen, total phosphorus, total suspended solids, specific conductance, pH and dissolved oxygen of surface waters were concurrently obtained.

Diurnal oxygen and sediment oxygen demand analyses suggest that oxygen depletion is greatest at creek km 15.0, or 4.3 km below Valparaiso Combined Sewage Overflow (CSO). Sediment oxygen demand is greatest just below Valparaiso CSO. Short periods of rains experienced during July and September diurnals reveal a plume of low oxygen arising below the Valparaiso CSO station and reaching anoxic conditions at the 15 km oxygen sag point. Dissolved oxygen contents were higher below and above this point. Nutrient content of Salt Creek waters were generally lowest above Valparaiso, rose sharply just downstream of the CSO, and gradually declined thereafter.