POOR ORIGINAL

DOCKET NUMBER
PROD. & UTIL. FAC. 50-367

DEC 24 1980
Office of the Secretary
Docketing & Service
Branch

FINAL PANEL REPORT

"Effects of Dewatering on the Indiana Dunes National Lakeshore"

Submitted to

Indiana Dunes National Lakeshore
US Department of the Interior
National Park Service

Panel Members

Daniel Willard, Chairman
School of Public and
Environmental Affairs
Indiana University
Bloomington, IN 47405

James W. Geis
State University of New York
College of Environmental Science
and Forestry
Syracuse, NY 13210

Orie Loucks
The Institute of Ecology
Holcombe Research Institute
4600 Sunset Avenue
Indianapolis, IN 46208

Jerry Olson
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37830

November 26, 1980

DS03
50/1

8012300636

A

I. Introduction

A. Objectives

The objectives of this are to report on the available information base and provide an evaluation of the prospective effects on the Cowles Bog National Landmark area, and neighboring ecosystems, of up to a 1.6 drop in water levels upon completion of the current sealing of fly ash ponds and up to a 2.9 drop in water levels upon abatement of seepage plus the proposed increased pumpage from the confined sand aquifer underlying both the NIPSCO and Cowles Bog areas. In addition, the report is intended to summarize principles that could guide decisions related to resource protection if additional data were forthcoming, and to suggest guidance as to additional studies for providing such data.

B. Background

The Cowles Bog Wetland Complex (CBWC) includes the Cowles Bog National Natural Landmark and the surrounding Great Marsh within the Indiana Dunes National Lakeshore. It has been a subject of study, interpretation and scientific papers since the late 19th century (Cowles 1899, 1901; Lyon 1927, Kurz 1923, Olson 1951, Hendrickson and Wilcox 1979). Industrial development in the area during the past 20 years appears to have modified the hydrology and water chemistry of at least parts of the greater CBWC area (see Meyer and Tucci 1979, and related maps). Mineral Springs Road is one of a series of impacts which include ditching, farming, fire suppression and ash pond seepage. Portions have been used for a golf course and a residential development (Cook and Jackson 1978).

Increasingly persuasive evidence has accumulated recently supporting the viewpoint that the water regime of wetlands represents the single most important group of environmental variables defining the extent, species compositions, and stability of these systems (Gosselink and Turner 1978, Weller 1978, Geis 1979, Bedford and Loucks 1980). Small deviations in water regime, on the order of inches during some seasons, whether induced by natural processes or regulation, initiate disturbance and compositional change, but the course of the changes is difficult to predict (Willard 1978). These conclusions are supported by studies in shoreline wetlands along Lake Erie (McDonald 1955) and Lake Ontario (Geis and Kee 1977), and in shallow marshes in Wisconsin (Bedford and Loucks 1980). The changes in the wetlands are expressed as modifications in primary production and competitive dynamics, senescence and die-off of both dominants and rare species in the communities, and temporary niche filling or compositional displacement by aggressive species. Shifts in the vegetative surface as outlined above are tightly linked to other ecosystem functions and affect wetland values (Walker and Coupland 1967).

C. Importance of the Area

The Cowles Bog and surrounding marshes and dunes have long had high priority among proposals for expanded protection within Indiana Dunes (Olson 1958, Willard 1975). Public ownership now allows (and requires) a more critical analysis of the significance of contrasting sub-units within the National Landmark formally dedicated as "Cowles Bog" in 1966 (Reshkin et al. 1975, Hendrickson and Wilcox 1979).

The antiquity (indicated by tritium dating) of the ground water up-welling in the upmounded "spring mire" core area of the Landmark poses important questions for comparison and contrast with nutrient-rich fens and rain fed-bogs that are more studied in Europe than in North America. The spring-mire and the rest of the swamp and marsh complex (CBWC), like the neighboring dune savannas and prairie complex, will allow further tests and updating of general ecological principles introduced by Cowles (1899, 1901). Examples include the classic soil acidity studies by Kurz (1923), the bio-geomorphological work of Olson (1958) and reviews of early concepts of succession which once attracted students of natural ecosystems (Shelford 1913).

The CBNNL combines a number of ecosystems and communities in a scientifically significant array. The combination of physical and biotic communities offer many opportunities for study and public interpretation. The value of CBNNL is heightened because it is already in public hands. Given the importance of the site historically and scientifically, human interference should be kept to a minimum.

II. The Implications of Water Regime Interventions

A. The Links to Ground Water

The several reports available to the panel show convincingly that the current prevailing water regime at CBNNL is controlled largely by a ground water system which originates off the site, and to a much lesser degree by precipitation and surface flows within the surface watershed. The designation "spring mire" has been suggested for the upmounded central area of the CBWC in recognition of this relationship (Hendrickson and Wilcox 1979 unpublished) and we endorse that usage. A description of the ground water system, including its hydraulic characteristics, component aquifer and non-water bearing units, and lateral variations in stratigraphy is provided in Meyer and Tucci (1979) and Gillies and Lapham (1980). The linkage of the ground water system to surface waters in CBNNL and the Great Marsh has been noted in these and other reports. The linkage is demonstrated by the hydrogeologic "unit one" peizometer level which are at or near the organic matter surface in the Great Marsh. These observations, reinforced by the Meyer and Tucci study (1979) strongly suggest that changes in the ground water system will have an immediate and significant effect on the surface water at the CBWC, and particularly in the CBNNL.

Generally we accept the hypotheses that the spring mire is dependent on "unit three" water under hydrostatic pressure. Pumping at the proposed Bailly Generating Station will affect primarily unit three. Thus, we conclude the pumping will affect the spring mire area. On the other hand, the Great Marsh depends primarily on unit one water. Sealing the fly ash ponds will affect unit one water levels in varying degrees, and therefore will affect the Great Marsh to the largest extent on the west. To this extent the pumping at the construction pit, and the sealing of fly ash ponds can have separate effects.

B. Seasonal and Annual Variation

As already pointed out, a recurring annual pattern in water regime is essential for maintaining wetland communities. Sedge meadows, for example, will change quickly in response to stabilized water levels, evolving to shrub communities, if dried, and conversely into open marsh and water if the water level is kept high (Curtis 1959, van der Valk and Davis 1979). Wetland forests respond similiarly, but more slowly (Johnson et al 1976).

Other wetlands, such as prairie ponds, adapt to alternating wet and dry years by maintaining seed banks which allow the community alternative strategies, depending on the season (van der Valk and

Davis). While the foregoing authors discuss several possible outcomes of water regime changes in sedge meadows, there is very little information in the literature concerning the effects of such changes on spring-mires. Kukla (1965) hypothesizes that the area of a spring mire is related to the upward force and the volume of water in the artesian spring beneath the mire. However, the vegetation of Kukla's area was mostly Sphagnum and thus somewhat different from CBNNL.

To summarize to this point, we conclude that the proposed changes in water regime will affect the Great Marsh ecological community, although the magnitude of the changes in response to the predicted ground water change are unquantifiable at this time. There is no literature on prospective changes in spring mires similiar to the one in the CBNNL.

The USGS studies (Meyer and Tucci 1979, Gillies and Lapham 1980). do not, as yet, provide either the background for, or projections of the prospective changes in seasonal or annual water regime. Because it is the departure from these patterns that foretell changes to wetlands, future monitoring and modelling must establish baselines for water levels, departures from baselines, and water chemical conditions associated with the mixing of surface vs ground water sources in the upper layers of the marsh.

C. Fly Ash Settling Pond effects on Unit 1 Water and the Great Marsh.

During the middle 1960's the Northern Indiana Public Service Company installed a series of fly ash settling ponds on the north side of its properties (see Meyer and Tucci F16.15 and other reports for physical setting). These ponds are designed with earthen dikes and water levels with a head of approximately 8 feet above pre-1980 water levels in ponds just outside the dikes. Sealing has since lowered the pond levels. Cross-sectional data continuing 1000 feet north of the ponds indicate an additional drop of 4 feet in the water level of the interdunal ponds. Analysis of the unconfined surface water levels of Unit one (the uppermost aquifer in both the industrial area and the National Lakeshore) indicates modification of this aquifer by approximately three feet at the west end of CBWC. This evidence provides partial confirmation of the USGS's projection of a 1.6 ft. drop in ground water in the Great Marsh near the CBNNL (three feet at the west end of the surrounding wetland) as a result of sealing the fly ash ponds.

These projected decreases in water level are judged here to represent the magnitude of an earlier water level increase in the wetlands following introduction of the fly ash pond seepage (2 million gals./day, total, some portion of which follows the drainage system to the east). Since organic materials tend to separate and partially float upward with increases in water level, no obvious differential between the level of the new water surface and the organic sub-strate would be evident either in the late 1960's or at present. Personal observations (Loucks) show that reconsolidation of such materials takes place gradually, but no information is available on rates of vegetation response. The reconsolidation probably can be expected during the first two growing seasons after abatement, depending on weather conditions.

Numerous studies have shown that the principal effects of elevated water levels similiar to those which appear to have taken place in the 1960's are to weaken the short, mat-forming grass, sedge and composite populations, and induce invasion by weedy, widely dispersed aquatics such as *Typha* and *Phragmites* (Bedford 1978, Bedford and Loucks 1980). Several reports indicate the CBWC (specifically the Great Marsh) was dominated by sedges as late as the 1950's (Wilhelm 1978). Sedge/grass mats were described by Cressy (1928) at locations now dominated by cat-tail (Hendrickson and Wilcox 1979). These observations, supplemented by evidence that is recognizable on aerial photography available from 1938 through the 1950's and 1960's to the present, support a conclusion that the most dramatic changes in the vegetation of the CBWC were induced by the seepage from the fly ash ponds. While we know of few studies on the recovery of biological systems following abatement of flooding, we believe that height and vigor of the Typha/Phragmites mat could be reduced by nutrient limitation (due to reduced surface flows) in 5 to 10 years. Studies of long-term recovery in prairies suggests that the principal visual and structural components of the sedge meadows could be restored in 50 years, but, in the prairie, recovery of the uncommon species takes longer.

On the other hand, a reduction in water level, coupled with fire control, can lead to the spread of shrubs, such as the Spiraea tomentosa, Betula pumila, Cornus stolonifera and Salix spp., although the species response differs depending on pH and depth of organic soil. These shrubs normally have deeper root systems than the sedge-mat species allowing increased competition under more fully aerated conditions. Alnus increases its competitive advantage in partially aerated organic soils by nitrogen fixing.

One interesting feature of the present vegetation is the difference in wetland species composition between the tamarack and "ellipse" areas north of the spring-mire, and the wetlands to the south of the spring-mire. The area in the "ellipse" appears to have been significantly isolated from seasonal surface water inputs, (see, for example, the pH of 5.0 reported by Kurz in the 1920's for what appears to be this area). Recent data collected at the ellipse (Hendrickson and Wilcox 1979) do not show any appreciable surface chemical differences, although small populations of the acid-loving plants still survive in the "ellipse" area. Careful monitoring of surface water characteristics in this area during the growing season as abatement from fly ash pond seepage proceeds should indicate the potential for future vegetation recovery.

As mentioned earlier, the sealing of the fly ash pond can be expected to reduce the three foot head in unit one water on the west end of the CBWC. This reduction in gradient should reduce the surface flows of water from west to east over the marsh. The reduction in flow will allow the central portions of the Great Marsh to become more ombrotrophic and perhaps acidic. This, we believe, was its state before 1965, although the absence of fire may have influenced the trends by allowing the spread of Typha and shrubs.

D. Pumping of Unit Three Water and the Spring Mire Response

The additional drawdown of approximately 1.5 feet due to pumpage and dewatering of Unit three also is likely to result in compression of the organic layers, particularly in and around the "spring mire". However, the drawdown of the spring mire surface probably will not be of the same magnitude as the projected change in hydrostatic head. This further drying seems likely to be sufficient to induce increases in shrub populations. At this time there is insufficient information on the coupling between Unit one and Unit three to say where, or for how long, biologically significant water stress will influence the more sensitive spring mire species and/or stimulate shrubs. The rewatering following the proposed two growing seasons of pumpage (and during which most species probably would begin rooting at slightly greater depth) seems likely to affect the CBNNL as much or more than the drawdown because it could take place faster.

The USGS reports (Meyer and Tucci 1979, Gillies and Lapham 1980), and our independent observations are consistent with the conclusion that even modest changes in water pressure and local surface regimes are significant ecologically. Changes in waters rising through organic bog deposits are clearly important for the physical and chemical landscape, as well as for the biotic inhabitants, regardless of details of the mechanics of the aquifer. We have received the summary of the D'Appolonia study and find it is generally consistent with the USGS studies, although differing in the magnitude of predicted change. We leave the resolution of the differences between the two USGS reports and the D'Appolonia study to further research.

The paucity of literature on spring mire ecosystems, coupled with lack of seasonal data on the ground water, weakens our ability to predict detailed consequences of construction dewatering on the spring mire. However, we confirmed the USGS and NPS observation of a hydrostatic head slightly above the organic surface in the White Cedar area of the spring mire. The possibility of this head being lowered to any level at or below the existing level of water in the mounded peat should be of considerable concern to ecosystem stability here. Conversely, should the reduction in head under the spring mire would allow it to settle, the vegetation around the edges would become more strongly influenced by Unit or water and assume the character of the surrounding Great Marsh. The hydrostatic head is the physical basis that maintains the existence of this peculiar and interesting feature the CBNNL. Reduction in the head before the is a workable mitigation program would constitute a negligent management practice. Furthermore, it is not clear what mitigative measures, if any, would ameliorate the impacts to be transmitted via the ground water system

III. Conclusions

A. General

1. The fly ash pond seal and the construction dewatering are largely separate impacts, with separate consequences within the Cowles Bog Wetland Complex.

B. The Great Marsh Area of the CBWC

1. The sealing of the fly ash pond will influence the surface water regime at CBWC, lowering the water level, reducing the gradient and slowing the west to east unit one flow.

2. The vegetation should slowly return to its pre-1965 condition of sedge meadow, or become a shrub-carr depending on whether or not it can be burned periodically.

3. The sites in the ellipse to the north of the spring mire, where acid-loving species still survive, would possibly return to a condition principally governed by precipitation inputs gradually reducing the dominance of Typha.

C. The Effect of Construction Dewatering on the Spring Mire

1. Construction dewatering will reduce the hydrostatic head in the spring mire and lower the ground water level there.

2. Changes in the ground water system due to construction dewatering are expected to result in gradual compaction of the peat and seasonal drying. These changes will occur irregularly over time, affecting competitive dynamics and stability of the plant populations making up the spring mire.

3. Because of changes in plant community composition and in the rooting depth of component plants during the dewatering period, the cessation of dewatering after 18 months is likely to produce effects of at least equal significance. The longer the dewatering continues the greater the likelihood of a significant change toward mesic conditions. Further, the greater the compositional change following dewatering, the more significant the additional compositional adjustment when pumping is stopped.
4. There is little literature available on the structure and functioning of spring mires. Therefore we cannot predict with confidence the magnitude and ecological importance of prospective changes. However, the spring mire community is likely to become more mesic, (i.e. more dominated by shrubs) as a result of the dewatering process.

D. Mitigation

1. Because of the anticipated time-lag between the dewatering at the NIPSCO plant and measured hydrologic responses at the spring mire, there could be significant ecological effects at the spring mire before hydrological recovery if pumping were to be stopped. Further, the detection of influence of ground water pumping on surface waters at CBWC is hindered by the absence of an appropriate water-level baseline and the capacity to predict the control of ground water on the surface water regime. Thus, monitoring at the CBNNL provides little protection from the potential effects of the unit three dewaterin
2. A more appropriate monitoring strategy would be to establish as many peizometers as may be necessary and surface water-level guages in reasonable proximity to the construction site. Detection of change in the quantity or quality of ground and surface water at these

locations will permit an early opportunity for anticipating ground water responses at the National Landmark and will suggest appropriate actions based on the monitoring and modelling.

E. Further Studies*

1. We suggest the establishment of a comprehensive monitoring system which includes observations of ground and surface waters at several locations and at several levels within the hydrologic system. It should include water level and quality measures, with observations as often as needed to document seasonal changes.
2. Background monitoring stations for both the water regime and plant communities should be established throughout the Indiana Dunes National Lakeshore. Because a classic "control" area is impossible, observation stations should be frequently replicated in similiar communities.
3. As part of the IDNL research program, baseline measurements of the populations of selected threatened species should be established, along with measurement of chemical microhabitat properties, so that responses after 10 to 20 years will be fully documented. Species with high rating coefficients in Wilhelm (1978) would be good candidates for such studies.

IV. Recommendation

Although the information base is limited, the possibility of significant irreversible ecological damage to the spring mire area is large enough that the proposed construction dewatering should be postponed until further studies are completed.

---

*No panel member had an opportunity to review the proposal for continuing studies and therefore cannot comment on their adequacy.

Literature Cited

Bedford, B. L. 1978. Alteration in the Growth and Phenology of Wetland Plants as Indicators of Environmental Change. Proceedings of the Fourth Joint Conference on Sensing Env. Poll., Amer. Chem. Soc. Washington D.C. pp. 170-174

Bedford, B. L. and O. Loucks. 1980. Changes in the Structures, Function, and Stability of a Wetland Ecosystem Following a Sustained Perturbation. Wisconsin Power Plant Impact Study Progress Report. Water Research Center University of Wisconsin.

Cook, G. S. and R. S. Jackson. 1978. The Bailey Area of Porter County Indiana. Robert Jackson and Associates: Evanston, Illinois.

Cowles, H. C. 1899. Ecological Relations of the Vegetation on Sand Dunes of Lake Michigan. Botanical Gazette. 27:95-117, 167-202, 281-308, 361-388.

Cowles, H. C. 1901. The Physiographic Ecology of Chicago & Vicinity; A Study of the Origin, Development, and Classification of Plant Societies. Botanical Gazette. 31:3, pp. 145-182.

Cressy, G. B. 1928. Indiana Sand Dunes and Shoreline. The University of Chicago Press: Chicago, Illinois.

Curtis, J. T. 1956. A Prairie Continuum in Wisconsin. Ecology 36:556-558.

Curtis, J. T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press: Madison, Wisconsin.

D'Appolonia. Preliminary Review, Soil Parameters Used in USGS Report 78-138. Bailey Generating Station, Nuclear 1, Baileytown, Indiana. May 1980.

Geis, J. W. and J. L. Kee. 1977. Coastal Wetlands Along Lake Ontario and the St. Lawrence River in Jefferson County, New York. SUNY College Environ. Sci. For., Syracuse, New York. p. 130.

Gillies and Lapham. 1980. Reassessment of the Effects of Construction Dewatering on Ground-Water Levels in the Cowles Unit, Indiana Dunes National Lakeshore, Indiana. Supplement to Geological Survey Water-Resources Investigations 78-138.

Gosselink, J. G. and R. E. Turner. 1978. The Roll of Hydrology in Freshwater Wetland Ecosystems. Pages 63-78 in R. E. Good, D. F. Whigham and R. L. Simpson, eds. Freshwater Wetlands. Ecological Processes and Management Potential. Academic Press, New York.

Hendrickson, W. H. and D. A. Wilcox. 1979. Relationship Between Some Physical Properties and the Vegetation Found in Cowles Bog National Landmark, Indiana. Second Conference on Scientific Research in the National Parks: Proceedings 26-30. November, 1979.

Johnson, W. C., R. L. Burgers, and W. R. Keamever. 1976. Forest Overstory Vegetation and Environment on the Missouri River Floodplain of North Dakota. Ecol. Mang. 46(11), 56-89.

Kurz, H. 1923. Hydrogen Ion Concentration in Relation to Ecological Factors . Botanical Gazette, pp. 76, 1-29.

Kukla, S. T. 1965. The Development of Spring Bogs in the Region of N. E. Poland (Eng. Summary I. Polska). Zeszyty Probelmowe Post. Akad Nauk Roln. Warsawa. 57, 481-495.

Lyon, M. W., Jr. 1927. List of Flowering Plants and Ferns in the Dunes Stat Park and Vicinity, Porter County, Indiana: American Midl. Nat. Vol. 10, pp. 245-295.

McDonald, M. E. 1955. Causes and Effects of a Die-off of Emergent Vegetatio J. Wildlife Manager 19:24-35.

Meyer, W., and P. Tucci. January 1979. Effects of Seepage From Fly Ash Settling Ponds and Construction Dewatering on Groundwater Levels in the Cowles Unit, Indiana, Dunes National Lakeshore, Indiana U. S. Geological Survey. Water-Resources Investigations. 78-138.

Olson, J. S. 1951. Indiana Sand Dunes Preservation. Friends of our Nature, Landscape, and Indiana Department of Conservation, Division of State Parks. Mimeo p. 5.

Olson, J. S. 1958. Rates of Successions and Soil Damages on Southern Lake Michigan Sand Dunes. Botanical Gazette. 119:125-170.

Reshkin, M., H. Feldman, W. E. Kiefer, and C. H. Krekeler. 1975. Basic Ecosystem Studies of the Indiana Dunes National Lakeshore: Indiana University Northwest. pp. 1-1 to 6-22.

Shelford, V. E. 1913. Animal Communities in Temperate America. University of Chicago Press, Chicago.

Van der Valk, A. G. and C. B. Davis. 1979. A Reconstruction of the Recent Vegetational History of a Prairae Marsh, Eagle Lake Erie, From its seed bank. Agrac. Bot. 6:29-51.

Walker, B. H. and R. T. Coupland. 1967. An Analysis of Vegetation-Environm Relationships in Saskatchewan Sloughs. Cam. J. of Bot 46:509-522.

Weller, H. W. 1978. Management of Freshwater Marshes for Wildlife. pp. 267 in R. E. Good, D. F. Whigham, and R. L. Simpson, eds. Freshwater Wetla Ecological Process and Management Potential. Academic Press. New York.

Wilhelm, G. S. 1978. Kane County Natural Area Survey. Kane County Urban Development Division: Geneva, Illinois.

Willard, B.E. 1975. What Indiana Dunes Mean to Ecology. Special Paper Presented to the Annual Meeting of the Save the Dunes Council, Beverly Shores, Indiana. November 2, 1975. Mimeo. p. 13.

Willard, D.E. 1978. Natural Instability & Baseline Studies. Proc. Fourth Conference on Sensing Environmental Pollutants. ACS. New Orleans. pp. 74-77.

Erratum Citation Below

Geis, J. W. 1979. Shoreline Processes Affecting the Distribution of Wetland Habitat. SUNY College of Environmental Science and Forestry. Syracuse, New York. p. 529.