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THE NATURAL FOREST COMMUNITIES OF IOWA: A RESOURCE IN TROUBLE

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Abstract

Based on the original United States Land Office survey, it has been estimated that 18 percent of the total state land area was once covered by forest. Today, less than 4 percent of the Iowa landscape remains in forest. In essence, Iowa's forest lands have a value underrated and misunderstood by most of its citizens. Threatened with exhaustion of our natural forest heritage, it is imperative that the citizens of this state awaken at last to the necessity of protecting what is left. The appreciation, conservation, restoration and wise management of our remaining forest resource must play a critical role within all future planning at state, county and local decision-making levels.

Iowa Landscape Change

What is now the state of Iowa was first surveyed between March 1832 and August 1859. Based on this original United States Land Office survey, it has been estimated that 29,412,580 acres (82 percent) of the total state land area were covered by tall grass prairie at that time, with the remaining 6,680,926 acres (18 percent) in forest (Davidson 1961). The rich soils that developed under the prairie landscape have been converted to agronomic croplands which feed the world. Today, fewer than 2,942 acres (.01 percent) of the Iowa landscape remain in prairie. The state forest resource has likewise decreased. In 1954, a United States Forest Service survey estimated that the forested landscape of Iowa totaled only around 2,620,000 acres, or about 7 percent of the state. This represents a 61 percent decrease in forest area in less than 100 years. In 1974, another Forest Service survey revealed the total area had shrunk to 1,458,700 acres, or about 4 percent of the state's total land area (Essex 1975). Since the previous survey in 1954, forest areas declined by 1,136,000 acres, or 44 percent in this 20-year period. Since early settlement, much of our original forest heritage has been cut, cleared or grazed, leaving only remnants. A comparison of forest in Iowa at the time of settlement (Fig. 1) and at present (Fig. 2) illustrates this dramatic reduction in acreage. Our forest resources continue to be diluted and jeopardized by commercial, residential, recreational and agricultural development pressures. Projected demand threatens the health and survivability of our remaining forest resource.

The remnants of Iowa's forest persist at quarry spoils, along some fence rows, lining creek beds, in wooded pastures, in savanna-like landscapes or in the complex woodlands of the river corridors. The forest areas of Iowa offer a multitude of values, ranging from vegetation diversity, wildlife habitat, soil erosion control and water quality protection to the recreational, historical, educational, aesthetic and spiritual.

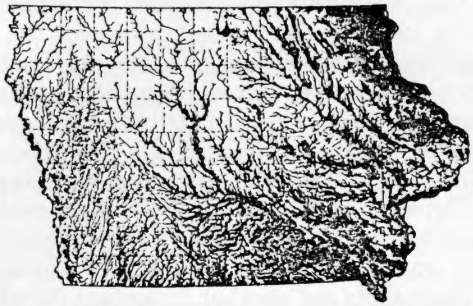

Fig. 1 *Presettlement forest in Iowa reconstructed from original land survey conducted from 1832-1859, as presented in Shimek, B. 1948; p. 12, The plant geography of Iowa.* Univ. Iowa Stud. Nat. Hist. *18(4): 1-178.*

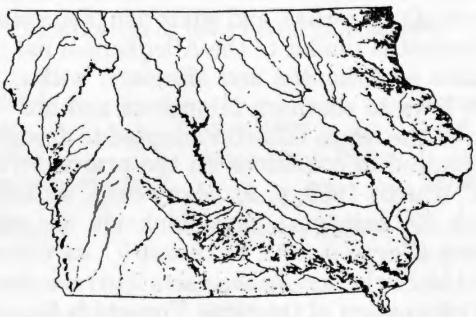

Fig. 2 *Present forest in Iowa redrawn from remote-sensing, satelite photography gathered data as presented in Land-Use in Iowa, Miscellaneous Map Series 5, Iowa Geological Survey, 1976.*

Vegetation Diversity Value

The mid-continental climate of North America supports a transitional landscape from Alberta, Canada to Texas (Dyas 1972, Küchler 1964, Braun 1950, Oosting 1956) between the deciduous forests to the east and the grasslands to the west. Within this climatic belt presettlement gallery forest in Iowa occupied the valleys and fire protected slopes (Bowles 1971) and followed the major rivers in eastern and southern parts of the state. Groves of bur oak (*Quercus macrocarpa*) and mixed groves intermingled with tall-grass prairie along the forest edge forming the "savanna" (a transitional floristic region where forests are a component but where their density is so low that the grasslands become the actual dominants of the region) landscape characteristic of this region.

The state of Iowa lies within the transition between five great floristic provinces (Curtis 1959), each of which influences the composition and current geographical distribution of Iowa forests. In the northeast part of the state relict species of the Boreal Element are found. These species are outliers from forests whose distribution extends from Alaska through the northern Great Lakes Region to Maine with a narrow extension down the Appalachian Mountains at high elevations. Included in the Boreal Element are balsam fir (*Abies balsamea*), eastern white pine (*Pinus strobus*), paper birch (*Betula papyrifera*) and yellow birch (*B. lutea*), and quaking aspen (*Populus tremuloides*). The flora of Eastern Iowa represents yet another important floristic element influence, the Alleghenian. These species represent the westernmost range limits of the great deciduous forests to the east, which extend from the Great Smoky Mountains of the southern Appalachians up to the White Mountains of New England and westward to the Mississippi River. Tree species include sugar (*Acer saccharum*) and black maple (*A. nigrum*), American linden (*Tilia americana*), white (*Quercus alba*) and northern red oak (*Q. borealis*), and white ash (*Fraxinus americana*). A third forest element is similar to the Alleghenian but is centered in the Ozark Mountains of Arkansas and Missouri, with a range extending north through Iowa to southern Minnesota and into Wisconsin. "This Ozarkian flora on the whole is better adapted to drought conditions and is thus better suited to conditions on the prairie forest border of the mid-continent" (Curtis 1959, p. 9). Many oaks, including bur (*Q. macrocarpa*), black (*Q. velutina*), and chinkapin (*Q. muhlenbergi*); hickories, shagbark (*Carya ovata*), bitternut (*C. cordiformis*) and pignut (*C. glabra*) and black cherry (*Prunus serotina*) are characteristic trees. The optimum expression of Ozarkian Forests is found in the southern 1/3 of the state.

The Coastal Plain Floristic Element greatly influences the character of the state's lowland forests. This floristic province ranges from New Jersey to Texas along the Atlantic Coastal Plains and extends northward up the Mississippi River Valley and into Iowa on alluvial land along all the rivers of the state. Dominant species include river birch (*Betula nigra*), American planetree (*Platanus occidentalis*), pin (*Q. palustris*) and swamp white oak (*Q. bicolor*), eastern poplar (*Populus deltoides*), silver maple (*Acer saccharinum*) and common boxelder (*A. negundo*), black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica lanceolata*), common hackberry (*Celtis occidentalis*), black walnut (*Juglans nigra*), and common honeylocust (*Gleditsia triacanthos*).

The Prairie Element for the most part extends in an uneven band from the prairie provinces of central Alberta, Saskatchewan and southwest Manitoba, south through the plains states to Texas, and is bounded on the west by the Rocky Mountains, extending eastward through Iowa into Illinois and Indiana. Groves of fire resistant bur oaks (*Quercus macrocarpa*) and broad expansive grasslands characterized by big bluestem (*Andropogon gerardi*) and little bluestem (*A. scoparius*), switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*),

prairie cordgrass (*Spartina pectinata*), sideoats grama (*Bouteloa curtipendula*), prairie dropseed (*Sporobolus hetrolepis*), and many other grass species dominate the northern and western landscape regions of the state and extend along the ridges and upland flats between stream valleys into southern and eastern Iowa.

The predominant forest communities of Iowa (Table 1) and their representative species (Table 2) have been delimited subjectively based upon extensive research (Hightshoe, 1979, 1980) and by personal field observation and the observations and records of my respected colleagues over a period of many years. Correlation and support for these observations has been substantiated in part by the local and regional records and writings of past professionals and laypersons with expertise and interest in this area. The list of contributing authorities is too long to include here. However, major contributions are cited (see notes). The forest areas of Iowa have been classed according to moisture gradient segments (the most limiting factor affecting geographic distribution of

Table 1

Classification of Iowa Forest Communities

Gradient Segment	Habitat Type	Association	Literature Cited
wet	lowland riparian successional	Willow-Maple-Poplar	(1) (5) (6) (8) (14) (17) (19) (20)
	lowland alluvial flats	Oak-Birch-Planetree	(5) (6) (8) (10) (12) (13) (14) (17)
wet-mesic	lowland mixed floodplain	Maple-Hackberry-Elm-Ash	(5) (6) (8) (10) (12) (13) (14) (17) (19)
mesic	upland mesic climax	Maple-Linden	(3) (4) (5) (6) (8) (9) (13) (14) (15) (16) (19)
mesic-dry	upland mesic-dry climax	Oak-Linden	(1) (2) (4) (17) (19)
	upland mesic-dry successional	Aspen	(8) (13) (19)
	upland mesic-dry northern forest	Pine-Fir-Birch	(5) (6) (8) (12) (13) (14) (19) (20)
dry	upland dry climax	Oak-Hickory	(1) (3) (4) (6) (8) (9) (10) (13) (14) (15) (16) (18) (19)
	upland dry savanna	Oak Savanna	(1) (5) (6) (8) (13) (14) (15) (17) (19)
	upland dry successional	Cedar Glade	(6) (8) (11) (13) (14) (19) (20)
		Mixed Shrub	(1) (2) (9) (14)

forest communities), *i.e.* five segments from wet to dry. Each of these in turn is divided according to habitat type, and then further divided into associations, named for the dominant canopy species. The botanic nomenclature presented in tables 1 and 2 are according to *Standardized Plant Names, Third Edition,* presented by the American Joint Committee on Horticultural Nomenclature.

Educational Value

The plant community in the field is so full of complexities of traits and histories, of responses under different circumstances, that the procedures for becoming acquainted with this structure and for determining its importance to man are difficult and challenging.

There is much that we can learn through association with natural forest environments. As we gain an understanding of these environments we will come to respect the role that our natural forest communities play upon the landscape which enriches our daily lives.

Recreational Value

Our forest landscapes, with their variety of wildlife, topography, geology, water, scenery and plant resources, are popular settings for many of our recreational activities. Compatable uses include hiking, fishing, controlled hunting, wildlife observation and nature education, to name a few.

If the availability of gasoline and petroleum supplies becomes increasingly limited and consumer costs continue to rise at a rapid inflationary pace, then leisure time recreation demand will shift from interstate to greatly increased "in"-state visitation of natural areas. Peak weekend vacation use is projected to increase greatly, resulting in a potential "crisis" in local recreation demand. It is not that existing parks and recreation areas cannot hold all who come, but that after a certain saturation point the health and survivability of the natural area becomes jeopardized. The human recreation experience itself is greatly diminished. Heavy use of popular natural areas has already caused irreparable damage to vegetation, wildlife, water and rock resources. The acquisition of additional state and county areas will be necessary in order to disperse user traffic over a wider area of quality recreation opportunity, while restricting access to more delicate, unique areas.

Aesthetic and Spiritual Value

It takes more than towns and railroads and cornfields to make the state of Iowa a pleasant place in which to live. It is the natural places of beauty which offer aesthetic, physical and, in the broad sense, religious value. As a "civilized" people, we need the economic material form of artificial landscapes. But as a "cultured" people, we also need the spiritual form of the natural landscapes.

Table 2

Representative Tree Species of Iowa Forest Communities

Community/ Association	Dominant Species	Associate Species
Willow-Maple-Poplar	Sandbar Willow (Salix interior) Black Willow (Salix nigra) Common Boxelder (Acer negundo) Silver Maple (Acer saccharinum) Eastern Poplar (Populus deltoides)	Peachleaf Willow (Salix amygdaloides) other willows (Salix spp.)
Oak-Birch-Planetree	Pin Oak (Quercus palustris) Swamp White Oak (Quercus bicolor) River Birch (Betula nigra) American Planetree (Platanus occidentalis)	as above but add: Pecan Hickory (Carya illinoensis)
Maple-Hackberry-Elm-Ash	Silver Maple (Acer saccharinum) Common Hackberry (Celtis occidentalis) American Elm (Ulmus americana) Slippery Elm (Ulmus fulva) Green Ash (Fraxinus pennsylvanica lanceolata)	Bitternut Hickory (Carya cordiformis) Eastern Black Walnut (Juglans nigra) Bur Oak (Quercus macrocarpa) Common Honeylocust (Gleditsia triacanthos) Kentucky Coffeetree (Gymnocladus dioicus) Blue Ash (Fraxinus quadrangulata), southeast Mockernut Hickory (Carya tomentosa), southeast Ohio Buckeye (Aesculus glabra), southeast Shingle Oak (Quercus imbricaria), southeast
Maple-Linden	Black Maple (Acer nigrum) Sugar Maple (Acer saccharum) American Linden (Tilia americana)	American Elm (Ulmus americana) Slippery Elm (Ulmus fulva) Bitternut Hickory (Carya cordiformis)

Table 2: Representative Tree Species of Iowa Forest Communities (Cont.)

		Butternut (Juglans cinerea) White Ash (Fraxinus americana) Northern Red Oak (Quercus borealis)
Oak-Linden	Black Oak (Quercus velutina) Bur Oak (Quercus macrocarpa) White Oak (Quercus alba) Northern Red Oak (Quercus borealis) American Linden (Tilia americana)	American Elm (Ulmus americana) Slippery Elm (Ulmus fulva) Bitternut Hickory (Carya cordiformis) Shagbark Hickory (Carya ovata)
Pine-Fir-Birch	Eastern White Pine (Pinus strobus) Balsam Fir (Abies balsamea) Paper Birch (Betula papyrifera) Yellow Birch (Betula lutea)	Northern Red Oak (Quercus borealis) Northern Pin Oak (Quercus ellipsoidalis) Sugar Maple (Acer saccharum) Bigtooth Aspen (Populus grandidentata) Quaking Aspen (Populus tremuloides)
Aspen	Bigtooth Aspen (Populus grandidentata) Quaking Aspen (Populus tremuloides)	Black Cherry (Prunus serotina) American Elm (Ulmus americana) White Ash (Fraxinus americana) Black Ash (Fraxinus nigra)
Oak-Hickory	Northern Red Oak (Quercus borealis) Black Oak (Quercus velutina) White Oak (Quercus alba) Bitternut Hickory (Carya cordiformis)	American Elm (Ulmus americana) Pignut Hickory (Carya glabra), southeast Common Persimmon (Diospyros virginiana) rare, south-central Ohio Buckeye (Aesculus glabra), southeast

Table 2: Representative Tree Species of Iowa Forest Communities (Cont.)

Oak Savanna	Bur Oak (Quercus macrocarpa)	Northern Pin Oak (Quercus ellipsoidalis) north Black Cherry (Prunus serotina) White Oak (Quercus alba), east 2/3 Common Hackberry (Celtis occidentalis), northwest Quaking Aspen (Populus tremuloides), north Black Oak (Quercus velutina), south-central Green Ash (Fraxinus pennsylvanica lanceolata), northwest
Cedar Glade	Eastern Red Cedar (Juniperus virginiana)	Common Juniper (Juniperus communis), northeast Common Honeylocust (Gleditsia triacanthos) Mixed Shrub (See below) Paper Birch (Betula papyrifera), northeast
Mixed Shrub	American Filbert (Corylus americana) American Plum (Prunus americana) Common Pricklyash (Zanthoxylem americanum) Prairie Crabapple (Malus ioensis) Gray Dogwood (Cornus racemosa) Hawthorn spp. (Crataegus) Western Snowberry (Symphoricarpos occidentalis), west Sumac spp. (Rhus) Vibrunum spp. (Viburnum) Common Chokecherry (Prunus virginiana) Raspberry spp. (Rubus) Gooseberry spp. (Ribes) Rose spp. (Rosa)	Tree emergents include: Eastern Red Cedar (Juniperus virginiana) Common Honeylocust (Gleditsia triacanthos) American Elm (Ulmus americana) Eastern Black Walnut (Juglans nigra) Common Hackberry (Celtis occidentalis) Bur Oak (Quercus macrocarpa)

It becomes obvious that a high planning and management priority must be assigned to our remnant forests. It is only this small proportion of the state that can provide suitable environment for our flora, fauna, recreation, and aesthetic and spiritual needs. Unfortunately, the very attributes that make these areas suitable and attractive for these uses are the same attributes that attract nonconforming uses. Major development pressures include the location of utility and highway corridors through woodland, commercial and private timber harvest, large reservoir impoundments, urban and industrial expansion, suburban residential expansion, surface mining of gravel, coal, limestone and gypsum resources, and the conversion of woodland for agricultural rowcrops and pasturage.

Concern for the survivability of a richly diverse woodland fabric was expressed by professionals, students and laypersons during the formative period of the state parks and preserves movement. In 1919, Dr. Robert I. Cratty, a respected botanist, wrote:

> So large a proportion of our state is suitable for cultivation that our native flora is being rapidly swept away, and while many of the species may survive along the roadsides, in hilly and stony locations, and along the streamside, others which are local or rare must eventually disappear entirely.

Aldo Leopold, who pioneered the development and understanding of the need for a man-land ethic where, because of his power, man bears the responsibility of maintaining the environment in the best interest of the life community, draws this conclusion in his book, *A Sand County Almanac:*

> To sum up: We have asked the farmer to do what he conveniently could to save his soil, and he has done just that, and only that. The exclusion of cows from woods and steep slopes is not convenient and is not done. Moreover, some things are being done that are at least dubious as conservation practices; for example, marshy stream bottoms are being drained to relieve the pressure on wornout uplands. The upshot is that woods, marshes, and natural streams, together with their respective faunas and floras, are headed toward utlimate elimination.
>
> It cannot be right, in the ecological sense, for a farmer to drain the last marsh, graze the last woods, or slash the last grove in his community, because in doing so he evicts a fauna, flora, and a landscape whose membership in the community is older than his own, and is equally entitled to respect.

The principles of sound land-use management based upon land capabilities dictates generally that residential, commercial and agricultural development locate outside of the immediate forest corridor area. We must learn to facilitate maximum use within the limits of the resource, in order to assure future generations that the resource will be available for their stewardship. In economic terms the value of one acre

of Iowa forested land (Iowa ranks 41st in the nation in total forest area) must represent 10 or 20 times the value of that same acre if it occurred in a state containing a large proportion of forest. In essence, Iowa's forest lands have a value that is underrated and misunderstood by most of its citizens. In a time of material and energy crises, the erroneous concept that food, water, soil, lumber and fuel are inexhaustible and that local supplies are plentiful is still a dominant feature in the thinking of many Iowans. The appreciation, conservation, restoration, and wise management of our remaining forest resource must play a critical role within all future planning at state, county and municipal decision-making levels.

Forest Conservation

Threatened with exhaustion of our natural forest heritage, it is imperative that the citizens of this state at last awaken to the necessity of protecting what is left. In the 1970s, concern over the protection of natural environment qualities has aroused "the conscience of the whole country from sleep." In this time of energy and environmental crisis, our incentive to protect all that we can has never been clearer, nor the opportunity to do so more favorable. We still maintain an advantage over more ancient cultures. We can protect as many remaining examples of our original forest communities as possible. But time is running out.

In 125 years of agricultural development we have lost over 50 percent of our topsoil resource. Today, over 10 tons of topsoil per acre are lost annually to wind and water erosion. Legislative proposals to conserve the remaining soil resource are now being considered. However, in the same 125 year period our forest resource has decreased by an alarming 75 percent! Yet no significant public or private endorsement to protect the remaining woodlands has been introduced in the state legislature.

Forest Restoration

Not only must our remaining forest lands be protected, but replacement plantings should be encouraged in areas thinned or denuded by development. The proportions and accommodations which ensured the stability of existing forest community arrangements have been greatly disrupted. Much of our present woodland has a life expectancy of only one generation because the seedling habitat beneath the canopy (ground herbaceous, woody shrub and understory) has been significantly modified or eliminated due to grazing pressures by domestic animals and by the replacement of the forest floor with lawns in residential areas. In these areas only the parent canopy remains. The natural regeneration of these woodlands has largely been ignored. Is it possible for man to rebuild these disturbed harmonies from their nakedness and restore the ancient fertility and healthfulness which took nature centuries to create?

The restoration of whole forest communities is our contemporary challenge. Using our knowledge of the different kinds of original forest

communities as models, it may be possible to match the most adaptable forest community with the physical resources of the restoration site. At best, such a manmade forest could only hope to emulate the visually healthful appearance of already existing forest models. Our natural forest communities are so overwhelmingly complex that only symbolic restoration is possible. Well-planned restoration efforts on a large scale could reconnect our fragmented corridor woodlands, reestablishing wildlife travel corridors and expanding suitable habitat.

Conservation/Restoration Programs

The state of Iowa could make the first significant national contributions by developing public and private participatory programs in forest conservation/restoration areas. Three such programs exhibit great potential if supported by Iowans. The Fruit Tree and Forest Reservations Program (Chapter 161 of the Iowa Code) offers property owners a significant tax exemption for maintaining timbered acreages. Qualifying woodlands must maintain a minimum prescribed stand density and be protected from domestic livestock grazing pressures. This little-known program could extend protection to existing natural forest environments with greatest biological diversity. The Iowa Conservation Commission is in the process of submitting preliminary study recommendations (as charged by the 1979 Iowa State Legislature) aimed at protecting the remaining quality wetlands of the state. This Protected Water Areas Program is designed to protect designated sensitive water areas and adjacent landscape from noncompatable land-use development. Such a program, if supported by the citizens of Iowa could protect forested river corridors throughout the state. In January, 1980, Iowa Governor Robert D. Ray announced the formulation of the Plant Iowa Program. This program encourages the planting of native trees and shrubs throughout the state by communities, individuals, schools and counties. The planting of thousands of plants indigenous to the Iowa landscape as individuals or as groups in naturalistic community assemblages is a primary mission of the program, a program all Iowans can take part in.

The reestablishment of an acceptable balance between the two most broadly characteristic distinctions of Iowa's landscape, woodland and plowland, is admittedly a utopian goal. The following message presented by Harriet S. Kellogg in 1919 to the citizens of Iowa embraces our contemporary challenge and aspirations for the future of our forested landscapes:

> A natural woodland carpeted with a mosaic of wild flowers appeals to each individual according to his inherent traits of character. One estimates it in terms of cord-wood and acres; another banishes all utilitarian ideas, seeing it only as a most glorious heritage to be preserved that future generations may also enjoy its beauty, while the third correctly imagines a golden mean where in both the utilitarian and the man of sentiment may be satisfied.

Notes for Tables 1 and 2

(1) Aikman, J.M. 1927. *Distribution and Structure of the Forests of Eastern Nebraska.* University of Nebraska PhD Thesis. Lincoln, Nebraska.

(2) Aikman, J.M. and Gilly, C.L. 1948. A Comparison of the Forest Floras along the Des Moines and Missouri Rivers. *Proc. Iowa Acad. of Sci.*, 55:53-73.

(3) Aikman, J.M. and Smelser, A.W. 1938. The Structure and Environment of Forest Communities in Central Iowa. *Ecology*, 19:141-150.

(4) Braun, E. Lucy. 1950. *Deciduous Forests of Eastern North America.* Philadelphia: The Blakiston Company.

(5) Conard, Henry S. 1952. The Vegetation of Iowa. *Studies in Natural History*, 19:1-66.

(6) Curtis, John T. 1959. *The Vegetation of Wisconsin.* Madison: University of Wisconsin Press.

(7) Davidson, Robert A. 1960. Plant Communities of Southeastern Iowa. *Proc. Iowa Acad. Sci.*, 67:162-188.

(8) Dyas, Robert W. *Unpublished notes and records.* Iowa State University, Ames, Iowa.

(9) Eilers, Lawrence J. 1974. The Flora of Brush Creek Canyon State Preserve. *Proc. Iowa Acad. Sci.*, 81:150-157.

(10) Getty, Russell E. 1951. *Forest Composition, Volume, and Growth in Johnson County, Iowa.* Iowa State College, M.S. Thesis. Ames, Iowa.

(11) Graff, Dolores I. 1969. *Distribution Pattern of Eastern Red-Cedar, Juniperus virginiana L.*, in Iowa. Iowa State University Ph.D. Thesis. Ames, Iowa.

(12) Hagge, Harold P. 1969. *Flora of Northeastern Iowa and Southwestern Wisconsin.* Iowa State College M.S. Thesis. Ames, Iowa.

(13) Küchler, A.W. 1964. *Potential Natural Vegetation of the Conterminous United States.* American Geographical Society Special Publication No. 36. New York: American Geographical Society.

(14) Landers, Roger Q. Jr. *Unpublished notes and records.* Iowa State University, Ames, Iowa.

(15) Neimann, David A. and Landers, Roger Q., Jr. 1974. Forest Communities in Woodman Hollow State Preserve, Iowa. *Proc. Iowa Acad. Sci.*, 81:176-184.

(16) Oosting, Henry J. 1956. *The Study of Plant Communities.* 2nd Ed. San Francisco, Cal.: W.H. Freeman and Co.

(17) Pammel. L.H., MacDonald, G.B. and Clark, H.B. The Native and Cultivated Forest Trees and Shrubs of the Missouri River Basin. *Proc. Iowa Acad. Sci.*, 22:23-56.

(18) Sanders, Dana R. 1969. *Structure and Pattern of the Herbaceous Understory of Decidous Forests in Central Iowa.* Iowa State University Ph.D. Thesis. Ames, Iowa.

(19) Society of American Foresters, Committee on Forest Types. 1954. *Forest Cover Types of North America (Exclusive of Mexico).* Washington, D.C.: Society of American Foresters.

(20) Thorne, Robert F. 1964. *Relict Nature of the Flora of White Pine Hollow Forest Reserve, Dubuque County, Iowa.* State University of Iowa Studies in Natural History, 20:1-35.

Selected References

Aikman, John M. 1927. *Distribution and Structure of the Forests of Eastern Nebraska*, Unpub. Ph.D. Thesis, University of Nebraska, Lincoln, Nebraska.

Aikman, John M. and Smelser, A.W. 1938. The Structure and Environment of Forest Communities in Central Iowa, *Ecology*, 19:141-150.

Boot, D.H. 1918, Plant Studies in Lyon County, Iowa. *IA. Acad. of Science* 24 (1917): 393-414.

Bowles, J.B. 1971. *Distribution and Biogeography of Mammals of Iowa.* Unpublished PH.D. Thesis, University of Kansas, Lawrence.

Braun, E. Lucy, 1950. *Deciduous Forests of Eastern North America.* Philadelphia: The Blakiston Company.

Carter, Jack Lee, 1960. *The Flora of Northwestern Iowa.* Unpublished PH.D. Thesis, State University of Iowa Botany Library, Iowa City, Iowa.

Conrad, Henry S. 1952. The Vegetation of Iowa. *State University of Iowa Studies in Natural History*, V. 19 (4):1-166.

Curtis, John T. 1959. *The Vegetation of Wisconsin.* University of Wisconsin Press, Madison, Wisconsin, 657 pp.

Davidson, Robert A. 1957. *The Flora of Southeastern Iowa.* Unpub. PH.D. Thesis, State University of Iowa Botany Library, Iowa City, Iowa.

Davidson, Robert R. 1961. Comparisons of the Iowa Forest Resource in 1832 and 1954. *Iowa State Journal of Science* 36 (2): 133-136.

Diehl, William A. 1915. The Flora of The Ledges Region of Boone County, Iowa. *Proc. Iowa Acad. of Science*, V. 22.

Dyas, Robert W. 1972. *The Spirit of The Savanna.* Traveling Photographic Exhibit, Iowa State University, Ames, Iowa.

Essex, Burton L. 1974. *Forest Area in Iowa Counties. Research note NC-195*, North Central Forest Experiment Station, Forest Service - U.S. Dept. of Agriculture, St. Paul, Minnesota.

Fay, Marcus Joseph, 1953. *The Flora of Southwestern Iowa.* Unpublished PH.D. Thesis, State University of Iowa Botany Library, Iowa City, Iowa.

Getty, Russell E. 1951. *Forest Composition, Volume, and Growth in Johnson County*, Iowa. Iowa State College, M.S. Thesis, Ames, Iowa.

Graf, Dolores, I. 1969. *Distribution Pattern of Eastern Red Cedar, Juniperus Virginiana* in Iowa. Iowa State University PH.D. Thesis, Ames, Iowa.

Hartley, Thomas G. 1962. *The Flora of The Driftless Area.* Unpub. PH.D. Thesis, State University of Iowa Botany Library, Iowa City, Iowa.

Hightshoe, Gary L. 1978. *Native Trees For Urban and Rural America, A Planting Design Manual For Environmental Designers.* Iowa State University Research Foundation, Ames, Iowa 375 pp.

Hightshoe, Gary L. 1979. *Classification and Development of Interpretive Keys For Forest Community Analysis In Land Use Planning For Iowa Using Low Altitude Aerial Photography.* Unpublished work in cooperation with the Iowa State University Agriculture and Home Economics Experiment Station, Ames, Iowa.

Hightshoe, Gary L. 1980. *The Natural Forest Communities of Iowa, A Resource in Trouble.* Traveling Photographic Exhibit. Iowa State University, Ames, Iowa.

Küchler, A.W. 1964. *The Potential Natural Vegetation of The Conterminous United States.* American Geographical Society Special Publications No. 36. New York: American Geographical Society.

Niemann, David A. 1971. *Classification and Ordination of The Vegetation of Woodman Hollow,* Iowa. Unpublished MS Thesis, Iowa State University, Ames, IA.

Pammel, L.H. 1902. Preliminary Notes on The Flora of Western Iowa (especially from the physiographical standpoint). *Proc. Iowa Acad. of Science* 9:152-180.

Pammel, L.H., G.B. McDonald and H.B. Clark, 1915. The Native and Cultivated Trees and Shrubs of The Missouri River Basin. *Proc. Iowa Acad. of Science* 22:23-59.

Sanders, Dana Roy, 1969. *Structure and Pattern of The Herbaceous Understory of Deciduous Forests in Central Iowa.* Unpublished PH.D. Thesis, Iowa State University, Ames, Iowa.

Shimek, B. 1899. The distribution of forest trees in Iowa. *Proc. Iowa Academy of Science* 7:47-59.
Shimek, B. 1899. Flora of Lyon County. Iowa. *Geol. Survey, Annual Report.* 10:157-184.
Shimek, B. 1915, The Plant Geography of the Lake Okoboji Region. *State University of Iowa Laboratories of Natural History, Bul. 7* (2):3-69.
Shimek, B. 1948. The plant geography of Iowa. *State University of Iowa Studies in Natural History* 18 (4).
Society of American Foresters, Committee on Forest Types. 1954. *Forest Cover Types of North American (Exclusive of Mexico).* Washington, D.C.: Society of American Foresters.
Thorne, Robert F. 1955. The Flora of Johnson County, Iowa. *IA. Academy of Science* V. 62:155-198.
Thornton, P.L. and J.T. Morgan, 1959. *The Forest resources of Iowa.* Central States Forest Experiment Station Release 22, Columbus, Ohio.
Van Bruggen, Theodore, 1958. *The Flora of Southcentral Iowa.* Unpub. PH.D. Thesis, State University of Iowa Botany Library, Iowa City, Iowa.

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Math Plus Science Equals Engineering

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Algebra and geometry are essential courses for all high school students (Sells, 1980). An understanding of these subjects is essential to a multitude of occupations, whether the student is college bound or not.

Pre-college science education and mathematics education should reflect societal concerns with ecology, energy and other social problems. Engineering is one of the main occupations that offers solutions for a vast number of human problems. The engineer of today and tomorrow is faced with a broad range of problems which require a sound science and mathematics background for their solution.

Reference

Sells, L.W. 1980. Mathematics: The Invisible Filter. *Engineering Education* January Issue. p.26.

Babies Cry

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Most girls have intercourse before marriage and 96 percent of girls are sexually active before they seek contraceptive information. One girl in 10 is a mother before her 18th birthday, and the death rate of babies born to mothers under 15 years of age is more than twice the rate for babies born to mothers ages 20-24. Less than half of those who become mothers at ages 13-15 graduate from high school. The average age at which girls can conceive has dropped from 15½ to 14½. School-age children need counseling and special education programs to guide them through this critical time in their lives.

Reference

Nye, F.I. 1978. *School-age Parenthood* (PM798). Iowa State University Extension Service, Ames, Iowa 50011.