Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume 80 1992

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TRANSACTIONS

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Contents

From the Editor

It was five years ago that I became editor of *Transactions*. It hardly seems that long, but my commitment of five years as editor is fulfilled, and this volume is my last. This has been a period of change in the activities of the Wisconsin Academy and in all its publications. But the great tradition of the Academy in providing a mechanism for collecting and preserving the creative, intellectual life of our state, and presenting that information to our citizens, has continued. It is a history in which the Academy justifiably takes pride, and it has been an honor to be associated, even for this short period, in the continuing process.

The changes in *Transactions* during the past five years were built on the groundwork established by previous editors, particularly Kathryn and Philip Whitford, whose dedication and work kept the journal alive. During my years as editor there have been a number of changes. Poetry and photography have been added as regular sections. In addition to regular issues, three special issues have been published: a history of the limnology program at UW–Madison (*Breaking New Waters*), a poetry anthology (*Wisconsin Poetry*), and a book on treaty rights (*Chippewa Treaty Rights*). There has also been started an occasional series that will result in at least two other publications. I am happy with these accomplishments, but they are not those of a single editor. Patricia Duyfhuizen and Bruce Taylor deserve much credit, and it is my pleasure to recognize their contributions and to thank them on behalf of all who have enjoyed the results of their work.

Bruce built the poetry section from an idea into one of the exciting places to sample the poetry of Wisconsin authors each year. It was Bruce who solicited and chose the poetry and then wrote the introduction to the special issue entitled *Wisconsin Poetry* (Vol. 79, No. 2), which has been extraordinarily well received. Bruce's poetry readings at the annual convention and around the state have done much to establish the Wisconsin Academy as one of the leaders in encouraging Wisconsin poets.

Our former Production Editor, Patricia Duyfhuizen, enabled us to expand our services to authors by increasing the level of professional scrutiny of the journal. Her advice, professional judgment, and dedication added immensely to the journal. And her work with student interns brought a level of professionalism that had not been available to previous editors.

When Patricia was unable to continue as Production Editor for this last volume under my editorship, *Transactions* was fortunate to find Jan Haywood to produce the current issue. Only those involved in publishing realize the seemingly unlimited number of mistakes possible in the process. The professional scrutiny and advice Jan has provided have continued the high quality of production our readers have come to expect. I am grateful to her for picking up the work on short notice and for doing so with good humor.

Virtually every piece of paper, telephone call, or message associated with *Transactions* for the past five years has been handled by Jan Kroll, a member of the Arts and Sciences staff at UW–Eau Claire. Perhaps only she and I realize her role in the success of this journal. She would, of course, dismiss it with "it's my job," but I know better and acknowledge her contributions with sincere gratitude.

The current volume of *Transactions* contains some absorbing articles. The lead essay is an examination of why a physician, licensed to practice medicine in two states and on the staff of two noted medical schools, would be denied a medical license by reciprocity or even an opportunity to sit for the examination to practice medicine in Wisconsin. Hania Ris' story is captivating. There are also the poetry section, an interview with Dresen Award–winning

photographer Mary North Allen, along with a selection of her photographs, and articles on subjects as diverse as the impact of the 1988 drought on Wisconsin dairy farmers, lake plants, natural land bridges, spring mosquitoes, and ancient Chinese wisdom. And there is even more for the reader to discover.

Bill Urbrock becomes the new editor with the publication of this volume. All further correspondence, articles, and proposals should be sent to him at the address on the inside front cover.

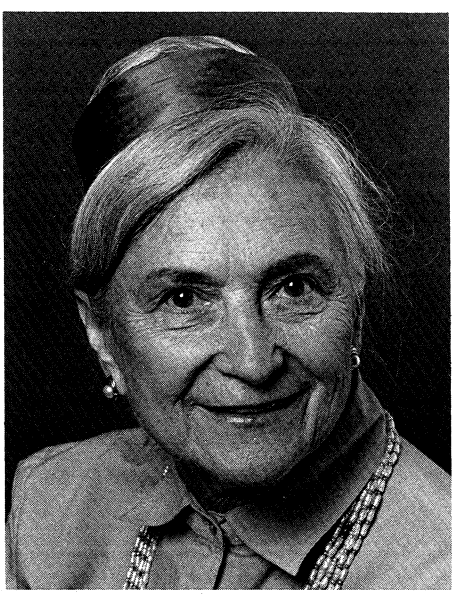
Carl N. Haywood
Editor, 1987–1992

The Ordeal of Being a Test Case: In Quest of the Right to Practice Medicine in Wisconsin

Hania W. Ris

When my husband Hans Ris accepted an appointment as Associate Professor in the Department of Zoology at the University of Wisconsin–Madison in 1948, I was intrigued. That was the year *Life* magazine (6 September) ran its famous cover story identifying Madison, Wisconsin, as America's best place to live. Although I had an interesting and prestigious position as a pediatrician in the Cornell Medical School Department of Pediatrics, I looked forward to the move with anticipation. After diligently studying the *Life* article, I became even more enthusiastic. I learned that Madison, with a population of 80,000, had three lovely lakes, that the streets were lined with elms and maples, that its many parks were maintained with a very ample city appropriation. Its "intelligent and alert populace" had a literacy rate of 98%, and 17% had attended college. The schools had an excellent reputation, pertinent information for a couple expecting their first child in March 1949. Babysitters were easily available because of a large student population. The city had many cultural groups. The university supported several "artists in residence" including a painter as well as musicians. Drama was provided by the Lunts, who lived nearby and usually opened their new plays in Madison. The article even referred to the importance of the Madison League of Women Voters and its influence on civic decisions.

At the time of the University of Wisconsin offer we were living in New York City. My husband, a biologist, had been working in the field of cytology (structure, function, and pathology of the cell) at the Rockefeller Institute for Medical Research. I was working with Dr. May Wilson at the Children's Cardiac Clinic of New York Hospital as a Fellow in Pediatrics as well as teaching on the staff of Cornell University Medical School.



Photograph by Michael Kienith

Hania Ris today

Hania W. Ris, M.D., has been a member of the Department of Pediatrics, UW–Madison Medical School, for thirty-five years. She is a peace activist and champion of women's rights, reproductive rights, the prevention of teenage pregnancy, quality day care, and national health insurance. She writes newspaper and magazine features, as well as scientific papers. An abstract painter, she has had several one-woman exhibits.

Before my departure I had to certify my medical documents. To my amazement and amusement, I was warned by the physician in charge that I was moving to a "socialist state"!

In order to learn something about Wisconsin state politics, I read about "Fighting Bob" La Follette and his Progressive Party, which lost to the Democrats after the Second World War. Although La Follette had been dead for twenty years, his ideas of social reforms, including care of the unemployed and the elderly, had left permanent marks on Wisconsin. It was the first state to pass a workmen's compensation law, in 1932, and to prohibit child labor. Its law became a prototype for other states. La Follette also promoted the idea that the state government should use the university as its first resource and the university in turn should exert its influence on the entire state.

All this information added to our conviction that Madison would be an interesting and stimulating place to live and to raise a family. My husband was especially urged to accept the position by a friend and colleague, Charles Leonard Huskins, Professor of Botany at the university. A Canadian, he had been Professor of Botany at McGill University in Montreal until he moved to Madison in 1945. He and his wife Margaret and their three children befriended us and offered their home when we arrived in Madison in June 1949 with our three-month-old son, Christopher. The Huskins lived in a spacious older house on Vilas Avenue near the Vilas Zoo. We stayed with them a fortnight, and we could not have had a warmer and more gracious welcome. The Huskins remained our friends and wise advisors until their deaths in 1953.

In July 1949 we moved to the University Houses, built by the Wisconsin Alumni Association the previous year for faculty and families, and later given to the state. A generous gesture, but the architecture left something to be desired. Imagine a kitchen with one drawer and minimal counter space! As an ardent admirer of Frank Lloyd Wright, a native son of Wisconsin, I could never understand why the "Williamsburg" style of architecture had been chosen. But taking into account the prevailing housing shortage, we were grateful.

After getting settled I was ready to continue my pediatric work. In preparation for the move to Wisconsin, I had had the application form for medical licensing in Wisconsin completed and certified by the Board of Medical Examiners of Maryland in June 1949 for the purpose of licensure by reciprocity. I had been granted a license to practice medicine by the Maryland Board of Examiners in 1941, after passing on the first attempt what was considered a very rigorous examination, and after I had worked and studied in this country for only one and a half years. I had obtained my New York license to practice medicine in 1942 through reciprocity—a standing agreement between two state boards of medical examiners. Wisconsin and Maryland also had a reciprocity agreement, and I expected to obtain a Wisconsin license in the same way. I was therefore totally unprepared for what followed.

I submitted my duly certified application and my curriculum vitae to the Wisconsin State Board of Medical Examiners (hereafter

The new Dr. Ris, circa 1937

referred to as the Board). My vitae outlined my experience:

> 1937—Graduation with Doctor of Medicine degree from the Medical School of the University of Zurich, Switzerland.
>
> 1937–39—Assistant in Pediatrics at the Children's Hospital of the University of Zurich.
>
> 1939–40—Year's internship in Baltimore.
>
> 1940–41 and 1943–49—A total of seven years at the Johns Hopkins Pediatrics Department, including one year of work with Dr. Helen Taussig, cardiologist, the originator of the world-famous operation which corrected the defects in the hearts of "blue babies."
>
> 1942–43—Resident in Pediatrics, Children's Hospital, and Instructor of Pediatrics, University of Cincinnati Medical School.
>
> 1948–49—Assistant Pediatrician, New York Hospital, and Fellow in Pediatrics, Cornell University Medical School.

All of these positions required teaching of medical students. My experience included clinical work in syphilis and diabetes, and I had conducted several Well Baby Clinics for the Baltimore City Health Department. I also included letters of recommendation from prominent physicians with whom I had worked.

Round I

To my amazement, on 15 July 1949 all of my credentials were returned to me with the following arbitrary denial: "The Board of Medical Examiners of the State of Wisconsin is not licensing foreign graduates at the present time. It is hoped that within the not too distant future we will be able to get reports on the foreign schools which might enable us to license graduates of some of them."

To my further dismay, I learned that the State Board, at a meeting held in 1937, had adopted a policy of refusing any qualifying examinations for graduates of foreign universities, with the exception of graduates from approved Canadian schools. This ruling coincided with the immigration to the United States of a number of physicians threatened by racial and political persecution in Germany and other parts of Europe. Critics suggested that the Board's 1937 ruling was self-serving, aimed at eliminating competition and creating a monopoly under the guise of protecting the health of Wisconsin citizens. Other states had passed similar measures.

Some in government questioned the Board's action. I learned that in 1948, Wisconsin Representative Ruth Doyle had proposed a bill requiring the Board to provide any applicant denied the right to take the examination with written notification of the reasons for denial. It also provided that the Board be subjected to judicial review of its decisions in the same manner as other state boards and commissions. The purpose was to provide the applicant with an orderly procedure through the courts. It was blocked by the successful lobbying of both the Board and the Wisconsin State Medical Society (hereafter referred to as the Medical Society).

There is indisputable evidence that the Board was making exceptions to the 1937 ruling, however. In reviewing the minutes of the Board in 1989, I discovered, to my surprise, that it had allowed Dr. Harry Leeb, an American-born graduate of the University of Bern Medical School, Switzerland, to obtain his license. Although denied that right on his first appearance before the Board on 11 January 1938, Dr. Leeb was granted licensure at the Board's subsequent meeting on 27 June–1 July 1938, during which Dr. Leeb's case was discussed "at length" by Mr. Resh of the attorney general's office. A resolution was adopted unanimously that since Dr. Leeb had received his medical education at the University of Bern prior to the adoption of the 1937 ruling, and because of the "mistaken assumption based upon correspondence with the Board that the Board would recognize such a school," Dr. Leeb was permitted to take the examination. This resolution also stipulated that the permission would not extend to other graduates of foreign medical schools.

Additionally, the *Milwaukee Journal,* 5 December 1948, reported that an American-born, Swiss-trained physician had been licensed within the previous three years by the

Board, after passing an examination given especially for him.

Ironically, there was a shortage of physicians at the time in Wisconsin, as frequently reported in the *Milwaukee Journal* and other newspapers. Indeed, prior to our move to Wisconsin, I had been contacted in January 1949 by Dr. Amy Hunter, Director of Maternal and Child Health, Wisconsin Department of Health, who offered me a position contingent on my obtaining a license. She had written me after hearing from Dr. Leona Baumgartner, Director of the New York City Health Department, that I would be available for employment.

I responded to the notification of my rejection by the State Board with a letter dated 8 August 1949, pointing out that I had graduated from the University of Zurich in 1937, *before the war,* that the medical school was considered one of the best on the European continent, that I had had ten years of experience in the United States teaching in three leading medical schools, including Johns Hopkins, and that I was certified in 1944 by the American Board of Pediatrics, a national professional organization that certifies competence in the field.

The Board did not keep me long in suspense. In its 12 August 1949 reply, it stated: "It is a definite policy of the Board . . . at this time to grant no licensure to graduates of foreign schools other than Canadian." Following the second refusal, I asked for the privilege of appearing before the Board at its 10 January 1950 meeting. It met regularly only twice a year, in January and July. Permission was granted.

My presentation was factual and legalistic. I emphasized that the University of Zurich, from which I had graduated, was comparable to the American schools with which I was familiar: Johns Hopkins, Cincinnati, and Cornell. All my records, European and American, were available for review. I pointed out that the Board had, in 1925, licensed Dr. Karl F. Schlaepfer, a graduate of the University of Zurich Medical School and an American citizen. (I had become an American citizen in 1944.) Dr. Schlaepfer was practicing at that time in Milwaukee, and his licensure showed that the Board had already accepted Zurich as a reputable school.

In addition, I stated that I had been advised that my credentials could be submitted by the proper authorities for evaluation by Dr. Helen Dwight Reid, Chief, European Section, Division of International Educational Relations, Federal Security Agency, Office of Education, Washington, D.C. Dr. Reid had also advised me as follows: "The fact that you have been accepted for postgraduate training in American institutions and licensed in two other states should be helpful in obtaining recognition, if the State can make any exception to its general regulation." I informed the Board that I had been considered for a position with the State of Wisconsin Board of Health which called for a person with my pediatric training. I added to my previously submitted letters of recommendation one from Dr. Helen Taussig, the world-renowned child cardiologist with whom I had worked at Johns Hopkins from 1940–41, testifying to my character and professional competence and the reputability of the University of Zurich Medical School.

To my continuing dismay and growing sense of unreality, I was once again denied the right to be admitted for examination for licensure to practice medicine in Wisconsin. The three and a half nonchalant lines in the Board's minutes hardly reflect the impact that this decision had on my life: "Dr. Hania Ris, graduate of the University of Zurich, Switzerland, in 1937, appeared. She answered questions asked by the Board members relative to her professional education and history, following which she was informed that her application was temporarily, at least, refused. Dr. Ris left the meeting."

Inner politics of Board and Medical Society

In the course of preparing for my 10 January 1950 meeting with the Board, I had been advised by a respected senior pediatrician, Dr. Horace Tenney of Madison, to consult

with two officers of the Medical Society. I found Mr. C. H. Crownhart, attorney and secretary of the Society, and Mr. Tom Doran, Society employee, both courteous and willing to advise. It was my impression that they were sympathetic to my plight and interested in my obtaining the license. As members of a professional organization dealing with the public, they appeared to be concerned about the image the Medical Society was projecting.

By contrast, the State Board was a legal body; its eight members (seven physicians and one osteopath) were appointed by the governor for a period of four years. I learned that Dr. C. A. Dawson, the powerful secretary of the Board and a homeopath, had run for the office of lieutenant governor. When Dawson was defeated, Governor Goodland appointed him to serve as secretary of the Board of Medical Examiners. The remaining seven members of the Board were appointed at Dr. Dawson's suggestion.

All the members of the Board, with the exception of the osteopath, were members of the Medical Society and active in its affairs. Since the Board and the Medical Society always presented a united front before the legislature in matters such as the Medical Practice Act, in the eyes of the public they were not differentiated. It is germane to note that the Medical Society had always been a conservative body, cautious in endorsing new ideas.

A letter from the past sheds light

In my recent search—some thirty-four years after my original request for licensure—for documentation indicating covert deliberation regarding my case, I found nothing other than my original application in my file or under various headings such as "Foreign Graduates," at the Historical Society Archives or in the office of the State Board. My written testimony presented to the Board, various documents submitted, the Board's correspondence with the Council of Medical Education of the American Medical Association (AMA) and with the University of Zurich Medical School, and the correspondence between my attorney and the Board cannot be found even at the office of the Board. But my file at the Medical Society (not available to the public) contained, among other informative documents, a letter by C. H. Crownhart, secretary of the Medical Society. This letter was sent to me in 1984 by courtesy of Mr. Earl Thayer, at the time secretary of the Medical Society. A consultation in 1989 with the attorney general's office revealed that it should have been part of the public documents of the State Board. It was either suppressed or overlooked, to my detriment.

Crownhart's letter of 23 November 1949 was addressed to Dr. H. H. Christofferson of Colby, Wisconsin, a member of the Board, a member of the Council of the Medical Society, and its president-elect. It was written six weeks before my 10 January 1950 hearing before the Board. Three and one-half pages, single-spaced, the letter was a legal attack on the Board's position against licensing foreign graduates in general, and its refusal to license me in particular.

Mr. Crownhart pointed out that he did not recall any instance in which there was a divergence of opinion between the Medical Society and the Board. When, in 1948, "Assemblywoman Ruth Doyle, along with other legislators interested in the problem of the foreign graduate, brought in a proposal to amend the law to make it easier for these people to qualify, the State Board and the State Society saw eye to eye on the effect of that bill. As a matter of fact the Secretary of the State Board and the Secretary of the State Medical Society appeared at the hearing and explained the problem." Both secretaries must have been very persuasive in defending the status quo; the bill did not pass.

However, Mr. Crownhart also pointed out in his letter that before the Board adopted the 1937 ruling against admitting graduates of foreign medical schools to examinations, the graduates of such schools could apply and their credentials would be verified. As a result, there were many foreign-educated physicians practicing in Wisconsin. Then Mr. Crownhart cited my case, emphasizing that

I had graduated from the University of Zurich in 1937 before the war, that I had had ten years of postgraduate training in this country in addition to teaching in three medical schools, and that I was accredited as a specialist by the American Board of Pediatrics and was a member of national medical societies. Furthermore, he noted that I was being considered for appointment in one of the state agencies on the basis of my credentials and recommendations.

"It is my feeling," Mr. Crownhart continued in his letter,

> that the odds are about even that this particular situation may ultimately result in wide public knowledge of her problem. . . . It seems to me that the public would feel that this woman was entitled to the examination. As a matter of fact they would feel that even if her school of graduation should have been inferior to American schools in the type of training offered, that her subsequent training as an intern and as a resident, and her acceptance on the teaching faculty of several schools would have overcome whatever deficiencies she might have had from her academic training.

Mr. Crownhart continued:

> I have read the Medical Practice Act many times. As I have told the Board I, as an attorney, fail to find in it authority under which the Board may adopt any blanket rule. The burden of proof is, undoubtedly, upon the applicant. I would not question that for one minute, but unless the Board considers the application and the applicant's qualifications and gives that individual an opportunity to fulfill the burden that is upon her or him, it seems to me that the Board has failed to follow the spirit or the letter of the law.

Unaware of this letter as I was for forty years, I could not have known at the time what an advocate I had—a competent attorney in an official position at the Medical Society who was cognizant of the political scene.

My case gains notoriety, or "Can't Examiners Examine?"

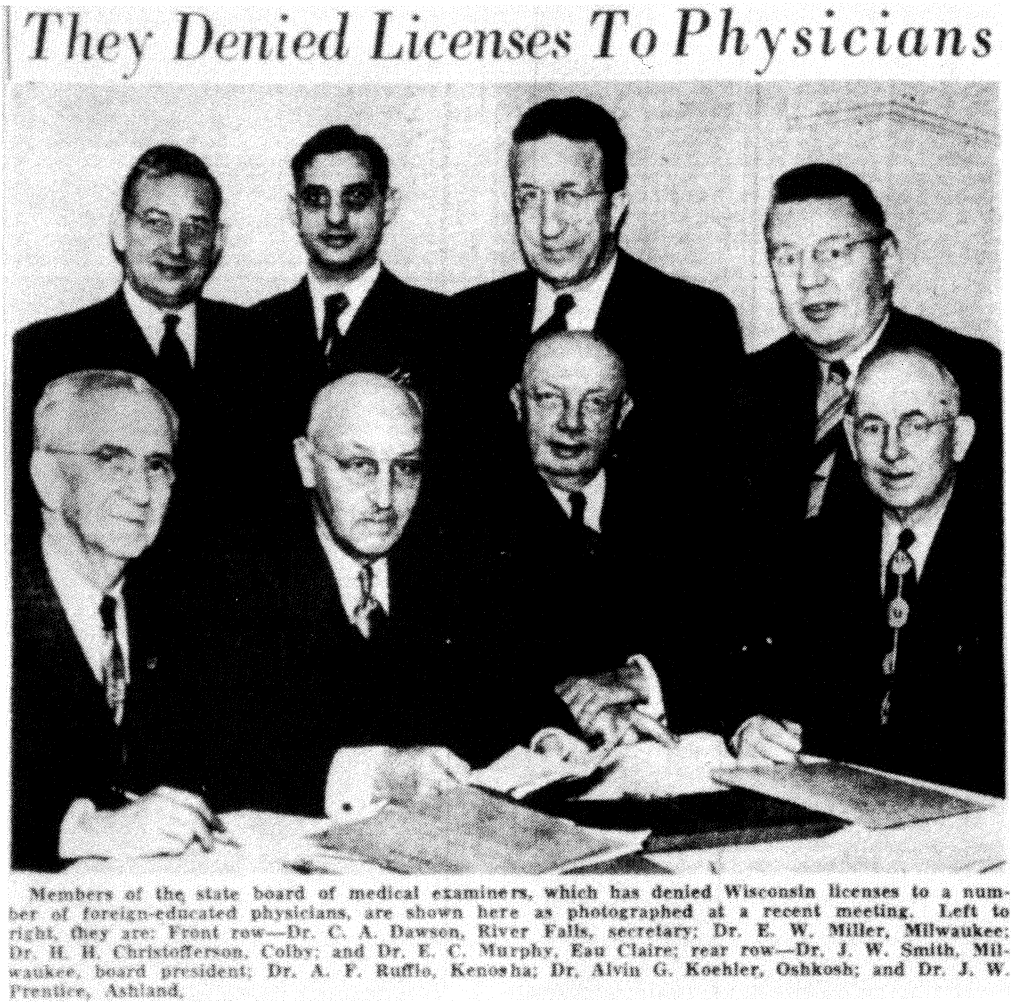
Indeed my 10 January 1950 appearance before the Board generated a great deal of publicity, accurately reported, and all of it critical of the Board. Europeans traditionally eschew publicity; I was crushed! I was to grow more accustomed to and more grateful for the press as my case was championed over the following year on the editorial pages of the *Capital Times,* the *Wisconsin State Journal,* the *Milwaukee Journal,* and the *Milwaukee Sentinel.* Headlines were often bluntly critical of the establishment: "The State Board of Medical Examiners Continues to Operate a Closed Shop," "Medical Monopoly Still Upheld," "The State Board of Medical Examiners Continues Its Stubborn Policy," and "Can't Examiners Examine?" It is hard to remember any other such instance when these four newspapers, with their otherwise divergent opinions, acted in such unison.

During this period of publicity the Board cited cases in defense of its policies. Another physician, Dr. Ralph Smith, a graduate of Edinburg Medical School and formerly a professor in Canada, was denied a license to practice in Wisconsin. He was later found to be a drug addict.

Another case was that of a Dr. Dubin. In 1930 he had presented himself as a graduate *cum laude* of Maximilian University in Wurzberg, Germany. He was permitted to write the examination eight times, with failure each time. It was later discovered that he had never actually graduated from Maximilian University and that by a special dispensation he had been permitted to take an examination and present a doctoral thesis.

I was confronted with this case of forgery when I was referred by some prominent Wisconsin physicians to an administrator associated with the Wisconsin State Laboratory of Hygiene in the hope that he might intervene in my behalf. It was devastating for me to have this prominent administrator insinuate that my own veracity might be questionable.

In a similarly distressing encounter, a highly placed medical educator told me that academic medicine would be closed to me forever because of the publicity, that one does



From the Capital Times, *17 February 1950. Courtesy of the State Historical Society of Wisconsin.*

not go public with such complaints in the United States and especially in Wisconsin. I informed him that I myself had been perturbed by the publicity and explained that I had no control over it. He indicated doubt about this, and ironically an editorial critical of the Board appeared in the *Capital Times* the next evening.

I was not surprised that support for my plight was not coming from physicians in private practice, but this prejudiced treatment from physicians in academic medicine was unsettling. I was told that Dr. Amy Hunter, who had offered me the state position on the basis of my credentials, tried to intervene and for her efforts was rebuffed by her superior in the State Health Department. I grew desperate.

A confidential source within the Medical Society staff who began advising me about this time informed me that several physicians, members of the Medical Society, had gone to the Governor and asked him to intervene. But Dr. Dawson, secretary of the Board, had anticipated their move and presented my case to the Governor in a fashion that made him believe the Board would be breaking the law by granting me a license, an interpretation that distorted the law. I was also told that several physicians hoped I would

take my case to court. But none of them had the courage to protest the restrictive policy openly.

The biggest blow to my morale was a press release issued by the Medical Society unconditionally endorsing the Board's policy against licensing foreign graduates. In response to criticism by the media, the Medical Society, on 18 February 1950, issued a news release commending the State Board for acting in "good faith in the matter of reviewing qualifications of those educated in foreign countries." It complimented the State Board for being a moving factor in initiating a study of foreign medical schools by the AMA. At that time, thirty-eight schools had been approved, but Swiss schools had not as yet been evaluated. To counteract any suspicion of prejudice, the Medical Society added that the "Board consists of highly respected individuals, many of whose immediate forebears come from foreign countries."

If the State Board had done any "fence-building," of which it was accused, the news release continued, it had done so only "to protect the health of the people of this state . . . through the legislative and judicial processes." Yet this was the very process that had been described privately by Mr. Crownhart, the Medical Society's attorney, as a failure "to follow either the spirit or the letter of the law."

But the communique opened one door, namely, that the Board would "*continue* [emphasis added] in the future to receive applications from graduates of schools not as yet formally qualified." (Yet I had been denied this right when I had appeared before the Board in January 1950, only five weeks earlier.) The applicant would have the burden of proof to demonstrate that "he was trained under the same general conditions as are required of those attending the medical school of the University of Wisconsin."

This statement gave me some hope. Ironically, during that time many European and American medical academics were critical of the quality of institutions such as the University of Wisconsin Medical School. For instance, at Wisconsin the Department of Pediatrics was part of Internal Medicine and did not become independent until 1957. Similarly, the Department of Psychiatry did not become independent from the Department of Neurology until 1956. In contrast, the Department of Pediatrics of my medical school at the University of Zurich was headed by the world-renowned Professor Guido Fanconi. I had also been privileged to study under Professor W. R. Hess, Director of the Physiological Institute of the University of Zurich, who received the 1949 Nobel Prize in Medicine and whose work greatly enhanced physiologic and psychiatric thinking throughout the world. American physicians used to come to Zurich for postgraduate training and to work with such other famous department chairpersons as Professor Guido Miecher (dermatologist and venerealogist), Professor Hans Rudolf Schinz (roentgenologist), and Professor Otto Naegeli (hematologist). The departments of pediatrics in which I had trained in this country for ten years prior to seeking the Wisconsin medical license were also independent; the Department of Pediatrics at Johns Hopkins had been independent since 1914.

One other hopeful note in the Medical Society release was its endorsement of a proposal that the Board consider "such additional training as an applicant may have acquired since coming to this country." (The Board never acted on this endorsement in my case.)

In response to this press release, the *Milwaukee Journal* printed an editorial entitled "Whitewash for Doctors' Fence" on 20 February 1950. It attacked the policy of the Board in protecting its selfish professional interests: "Doctors of unquestioned ability and repute have been arbitrarily barred from examination in Wisconsin by a policy of the Board which was never imposed by the legislature, courts or public. Communities and institutions in need of those doctors have been denied them—by the Board and by nobody else."

Yet Mr. Crownhart, secretary of the Medical Society, defended the Board's actions in

a letter responding to this editorial which was published in the *Milwaukee Journal* and reproduced in the *Wisconsin Medical Journal,* March 1950. It seems impossible to reconcile this public statement with his letter sent to Dr. Christofferson in November 1949.

A steady source of encouragement

While battling what seemed a no-win situation, I contacted my former teacher and mentor, Dr. Edwards A. Park, recently retired and former chairman of the Department of Pediatrics of the Johns Hopkins Medical School. Though others helped, I am convinced that his tireless one and one-half year interventions with the AMA were crucial to my obtaining my license to practice medicine in Wisconsin.

Dr. Park, a nationally and internationally renowned pediatrician, became my steady source of encouragement. At age seventy-one he took it upon himself to fight my battle with youthful vigor. He wanted to know every detail of my dealings with the Board. I wrote lengthy letters to him to which he always responded promptly, frequently after consultation with individuals who he thought might help. This correspondence became a useful reference for documenting my case (and was recently accepted by the Johns Hopkins Medical Archives to broaden the profile of Dr. Park).

In his comforting letter to me after the Board's second refusal to recognize my application, Dr. Park wrote on 25 January 1950: "May I say that I was incensed at your treatment by the examining Board in Wisconsin. . . . I am sure you will receive your license, the examining Board will not dare refuse it after their exposure by the press. They will probably wait long enough to save their face." Dr. Park wrote me on 8 March 1950: "The whole affair makes me ashamed of my country and particularly ashamed of the medical profession." In a letter dated 22 March 1950 he informed me: "*Time* [magazine] has written that they will accept a letter from me on your case in Wisconsin." At the urging of Dr. Donald G. Anderson, secretary of the Council to the House of Delegates of the AMA, Dr. Park postponed sending this letter in order to allow Dr. Anderson to intervene in my behalf. On 11 April 1950 Dr. Park wrote to me again noting his request to Dr. Anderson and further explained, "I hesitate to take too open a part for the reason that I am anathema, having headed the protest against organized medicine. By some I am regarded as having communistic leanings."

Round II

In response to the Board's statement that it would accept new evidence from the applicants as to the reputability of their medical schools, I resubmitted my credentials on 5 April 1950 to Dr. Dawson, secretary of the Board. It included the enumeration of every lecture, every course and laboratory exercise, certified by the Zurich Medical School. I also sent a money order for fifty dollars to cover the reciprocity fee with Maryland, for which, as I was told by Dr. Dawson, I was to be eligible, once the reputability of the Zurich Medical School was established. I also asked him to consider my application at the forthcoming meeting on 19 April 1950.

I accompanied my application with a letter from Dr. Marion Sulzberger, an American-born U.S. citizen, a world-renowned dermatologist and allergist who was at the time professor and chairman of the Department of Dermatology and Syphilology at the Post-Graduate Medical School, New York University. He had graduated from the University of Zurich Medical School in 1926, just eleven years prior to my graduation. He had written several textbooks and more than a hundred articles and had contributed greatly to his fields of expertise. I could not have had a better testimony to the reputability of the University of Zurich Medical School. Indeed, some of my teachers were the same as those of Dr. Sulzberger. At the time I was a student, Dr. Sulzberger had returned to Zurich for postgraduate training. How could the Board ignore these facts?

Providing another written testimony was Professor Karl Meyer, a Swiss native and

Professor of Experimental Pathology at the University of California Medical Center–San Francisco.

My application, dated 5 April, was acknowledged by Dr. Dawson on 10 April 1950. His letter stated that although the one-day meeting of the Board on 19 April would have a heavy agenda, "I shall present your application in its entirety to the Board at that time." When I did not hear from Dr. Dawson within the following two weeks, I wrote him on 6 May to inquire about the action the Board had taken in my case. Dr. Dawson replied on 10 May saying that the matter of foreign graduates had not been considered. He added, "The fact of the matter is that no change in the policy regarding foreign graduates is possible at this time inasmuch as no addition has been made to the list of the approved schools issued by the AMA." This statement reversed the Board's alleged public change of policy that it would honor the right of the applicant to prove the reputability of the school of graduation. It became clear to me that the Board's intention was not only to stall but to deny me the license permanently.

Dr. Dawson also mentioned in his letter that the next meeting of the Board would be held in Milwaukee on 11–13 July 1950; if I wished to appear I should let the Board know, and they would notify me as to place and time of my appearance. On 17 May I wrote Dr. Dawson to confirm my interest, adding: "Undoubtedly, you have by now reviewed the standing of the Medical School of the University of Zurich in the prewar period [on the basis of documents I submitted]. . . . If there is any further evidence that you would like to have presented to prove that . . . the University of Zurich Medical School . . . provided training equivalent to the Medical School of the University of Wisconsin, I will make every effort to obtain such evidence."

I had been warned by my confidential source at the Medical Society that since Dr. Dawson withheld information and communication from other members of the Board, I should distribute a copy of each communication to every Board member. This was still a world without photocopy machines. If I did not advance my medical career during this interim, I certainly did advance my secretarial and paralegal skills.

The warning was not idle. I did not hear from Dr. Dawson until I wrote him again on 3 July, this time sending a copy to each member of the Board. The time constraint was nerve-wracking and intimidating. Had I missed the semiannual meeting, I would have had to wait another six months. Dr. Dawson responded with a letter dated 5 July 1950 giving me an appointment for 12 July at 2 P.M. at the Pfister Hotel in Milwaukee. There was no response to my inquiry as to whether the Board wished to have additional documents to prove the reputability of my medical school.

Approval of Swiss medical schools

By 1949, the year my fight for licensure began, the problem of licensing foreign graduates had assumed national and political dimensions. A report by the Council on Medical Education and Hospitals to the delegates of the AMA on 6 June 1949 recognized these dimensions: "In the past fifteen years more than 10,000 foreign trained physicians have migrated to the United States and it may be expected in the years ahead that at least 1,000 foreign medical graduates will be coming to this country annually." The Council recognized that the state licensure boards had no way by which to evaluate foreign medical schools, and consequently some excluded all foreign medical graduates, while others admitted all foreign graduates to their examination for licensure. (In 1949 only twelve state medical examining boards admitted foreign graduates to examinations for licensure.) The Council proposed that the House of Delegates empower it to evaluate foreign medical schools, which it did.

In preparing to appear before the Board I learned that on 24 June 1950 the Council on Medical Education and Hospitals of the AMA approved five Swiss medical schools, including that of the University of Zurich. Again my confidential source told me that Dr. Dawson would try to suppress this infor-

mation in order to prevent me from obtaining the license and to justify his original refusal.

I contacted Dr. Donald G. Anderson, Secretary of the AMA Council, and asked him to notify Dr. Dawson about the Council's decision. Dr. Anderson kindly obliged on 8 July by letter. On 7 July I received a wire from the Council of the AMA informing me of the Board's notification. Dr. Park's correspondence with Dr. Anderson on my behalf had paved the way to this unprecedented cooperation.

But there was a problem lurking in the Council decision. In its evaluation of the Swiss medical schools, the Council of the AMA had reviewed their status *after 1940,* at which time a new degree was introduced for non-Swiss citizens: *Akademische Zeugnis* or the *Certificat d'Etudes Médicales* (Certificate of Medical Studies). The only degree available to non-Swiss citizens like myself at the time of my graduation in 1937 had been the M.D. degree, which the Council of the AMA did not approve. The Council also approved a second degree, the Swiss Federal Diploma, for which only Swiss citizens were eligible. At the time of my study in Switzerland I was a Polish citizen, although I later became Swiss through marriage.

The AMA recommendation specified that the requirement for both approved degrees was at least eight semesters of study. I was in my tenth semester when I passed the examination for my M.D. degree and thereafter completed three additional semesters of postgraduate study. I took the same courses and lectures required of the Swiss students eligible for the Federal Diploma.

Immediately following my degree in 1937 I was granted a position as Assistant in Pediatrics at the Children's Hospital of the University of Zurich, working under the renowned pediatrician, Professor Guido Fanconi. I performed the same duties as my Swiss colleagues holding the Federal Diploma. I held this position for two years before coming to the United States in March 1939, and I had a statement from Professor Fanconi attesting to these facts. In spite of this evidence of my training, I surmised that the Board would use the AMA evaluation as a weapon against me. I did not err.

On the advice of my confidential source, I engaged a lawyer. My fortunate choice was James Doyle, who later became a federal judge and was married to Assemblywoman Ruth Doyle.

The date of my appearance before the Board on 12 July to defend my case was fast approaching. On 8 July an important letter was written by Dr. Kenneth McDonough, Associate Professor of Pediatrics, University of Wisconsin, to Dr. J. W. Smith, president of the Board:

> Dr. Ris has made rounds and attended staff meetings at the Wisconsin General Hospital in Madison during the past year. I have been impressed with her intelligence, her knowledge of medicine in general, and her understanding of pediatrics, the field in which she is particularly interested and for which she has excellent training. We also have the opportunity to know her professionally and believe that she will make a fine practitioner. She will render a valuable service to the community and state.

On the crucial day, I drove with my attorney to Milwaukee. I did not plan to have him appear with me at the meeting unless there was nothing further to lose. Dr. Park feared that having me represented by a lawyer might antagonize the Board. Members of the press representing major Wisconsin newspapers were also present.

I spoke and supplemented my oral presentation with two concise written statements. One addressed itself to the reputability of the University of Zurich Medical School and the other to the approval of the Swiss medical schools in general. I specifically explained why I could not possess the Certificate of Medical Studies. It seemed so simple. This particular degree was introduced in 1940, and I had graduated in 1937.

The Board at first denied knowledge of the AMA's approval of the University of Zurich Medical School. When I showed them the wire from the AMA stating that the Board

had been notified, its response was that the AMA's letter was not official, because the approval had not yet appeared in print in the *Journal of the American Medical Association.*

Though some members of the Board asked questions during my forty-five–minute appearance, the attorney for the Board, John W. Davison, questioned me most often. After the futile battle, I asked to be represented by my counsel. Davison agreed. Though the presence of James Doyle appeared not to antagonize the Board, it simply continued to stall. My attorney suggested that the Board should send my credentials for evaluation to the Council on Medical Education and Hospitals of the AMA and that the Board afford me opportunity to present my case personally to the Council. The Board appeared to accept this suggestion. When my attorney asked for a written confirmation of this agreement at the conclusion of the meeting, the Board's attorney stated that this request might anger the Board. There is no evidence that the Board ever sent my credentials to the AMA. This is no surprise since my attorney told me after the meeting that he had never seen such a disorganized state body as the Board of Medical Examiners. Most of the time, he observed, they did not seem to know what they were discussing.

The following are the "postmortem" minutes of the 11–13 July 1950 Board meeting as they relate to my case:

> The Dr. Hania Ris case was reviewed briefly by Mr. Davison, having been announced by the President as the first order of business. Dr. Ris had previously requested permission to attend the meeting, and she was admitted to it at this time. Mr. Spaulding of the *Milwaukee Journal,* and a reporter from the *Milwaukee Sentinel,* were also present. Dr. Ris made a short statement to the Board and answered several questions put to her by the members. Dr. Ris then requested that her attorney, Mr. James Doyle, Madison, be admitted to the meeting, and her request was granted. Mr. Doyle attempted to clarify Dr. Ris' position on the matter of recognition of Swiss schools, particularly the University of Zurich, and the matter of her diploma.
>
> The Board did not take any formal action on the matter of Dr. Ris' application, and indicated to her that nothing further could be done until a decision had been reached by the Council on Medical Education of the American Medical Association. Dr. Ris and Mr. Doyle left the meeting.

Following the meeting, Dr. J. W. Smith, Board president, spoke to me privately. He said he had tried to convince the members of the Board to grant me a license but they would not listen. He apparently wanted me to reassure him that he had been fair to me.

The Council on Medical Education and Hospitals of the AMA and the Executive Council of the Association of American Medical Colleges officially reported their approval of the University of Zurich Medical School on 14 July 1950, three days after my appearance at the Board meeting. My attorney, James Doyle, sent a written reminder on 25 July to Davison, the Board's attorney (as well as precautionary copies to all members of the Board), to send my credentials for evaluation to the AMA Council as per agreement. In the letter Mr. Doyle pointed out that the language of the AMA report of 14 July was almost identical to the language of the letter from Dr. Anderson of the AMA Council that had been in the possession of the Board at the 11 July meeting.

It was not certain that the Board would honor its agreement even after an article appeared in the *Milwaukee Journal* on 30 July 1950 stating that the Board intended to send my records to the Director of the Swiss Health Bureau for evaluation. The article added that the Board might consider it necessary to send my records to the AMA Council for interpretation after the Swiss director's reply had been received. In order to avoid further unnecessary delays, my attorney requested, in a 31 July 1950 letter, that the Board send my credentials simultaneously to Switzerland and the AMA Council. Mr. Doyle also asked to receive a copy of the letter the Board was to send to the Swiss Health Bureau and requested to be informed which of my records had been sent. There was no response to Mr.

Doyle's letters of 25 July and 31 July until he sent a written reminder on 7 August.

The Board's attorney responded on 9 August: "The case of Dr. Ris has been brought to the attention of the Director of the Swiss Health Bureau. To date none of the records has been sent to Switzerland. It may be necessary to do so in the future. At the present time I am not able to furnish you with a copy of the Swiss correspondence." We were at a loss to understand what objection there could be to our request to see the Board's correspondence with the Director of the Swiss Health Bureau. The disconcerting explanation was that the Board had not included my records, even though the basic controversy centered around the duration and character of my study.

The delays continued. On 17 November the Board requested a copy of the regulation sent me by the Dean of the University of Zurich Medical School, defining the eligibility for obtaining the Certificate of Medical Studies introduced in December 1940. "If I find it necessary to obtain this information from Switzerland," warned the Board's attorney, "it may take several weeks." I had, however, already submitted this six-page, single-spaced document in the original and with a translation at my 12 July 1950 appearance before the Board!

I learned not to underestimate the Board's creative stalling tactics. This same letter from the Board requested certified copies of my marriage license. Records from 20 November 1950 show that the Board's attorney requested the marriage certificate "in order to definitely establish the identity of the applicant." This request was made sixteen months after my original application for the license and after my two appearances before the Board! I found it insulting. My attorney was appalled.

The 1950 document spelling out why the Board needed my marriage license epitomized the Board's tortuous rationale against licensing me. It referred to a new course introduced by the Swiss Medical Schools in 1940 leading to a Certificate of Medical Studies, equivalent to the course leading to the Federal Diploma. Noted the Board's attorney: "Dr. Ris would have been eligible for this course had she been attending school at the time. The fact that she was not able to enroll in this course for the reason that it was not offered at the time can in no way be held against her, but neither can the Board be criticized because of her inability to do so." However ridiculous the reasons, it became clear that the Board hoped above all that its rationalizations would preserve its credibility with the public over this issue.

The reply of the Swiss Director of Health to questions submitted by the Board was necessarily general in nature, because the Board had not included my individual records despite our urging. Later, after I had sent the records myself and the Swiss director had reviewed them, he concluded that I had taken more courses, lectures, and clinics than required for admission to the examination for the degree of Doctor of Medicine; that, in fact, I had received the same training as Swiss citizens then received; and that I would have been admitted to examination for the Certificate of Medical Studies, if such examination had existed at the time.

Round III

News of the Board's refusal on 11 July to grant me the right to take an examination for licensure reached Dr. Park at his vacation cottage in Canada. In a letter dated 13 August this dignified and gentle human being expressed his profound outrage: "I am incensed over the action of the WI. Licensing B'd. . . . I have again written to Dr. Anderson [secretary of the AMA Council]. If this does no good I shall consider getting Dr. Weech and Levine to unite with me in some publicity. [Dr. Weech was chairperson of Pediatrics, University of Cincinnati Medical School, where I worked in 1942–43. Dr. Levine was chairperson of the Department of Pediatrics, Cornell University Medical School, where I worked in 1948–49.] I shall not give up. . . . I am filled with shame that you should be treated so."

My other champions, the Wisconsin press, meanwhile continued to advocate my licensure. In fact, the source of our information about the Board's contemplated action was often newspaper articles. An article of 6 October 1950 indicated that the Board said I would be notified of the meeting and permitted to present my case to the Board on 10 January 1951. I was glad to read this, since I had not been personally notified.

A *Capital Times* editorial on 9 October again defended my case: "Dr. Ris is a distinguished member of the profession . . . but here in Wisconsin the political fuddy-duddies who dominate the Board of Medical Examiners and whose competence is far inferior to that of Dr. Ris are allowed to sit in judgment of her case." Referring to the critical shortage of physicians, the editorial urged the passage of a bill introduced by U.S. Representative Andrew Biemiller of Wisconsin to provide federal aid to medical schools, a bill which it accused the AMA lobby of "knifing in Congress." This federal aid was deemed imperative by deans of the major medical schools "to insure even the barest minimum of doctors for future civilian and military needs," noted the *Capital Times*. President Harry Truman had termed the bill "the most vital health legislation before Congress" ("Washington Merry-Go-Round," syndicated column by Jack Anderson and Fred Blumenthal, *Capital Times,* 18 August 1950).

At the end of November I received a long letter from Dr. Park outlining a strategy to enlist the aid of Dr. Anderson of the AMA Council. Dr. Park intended to visit Dr. Anderson in Chicago and to "be guided of course by his advice, provided his advice appears to me in your interest and wise." He planned to seek Dr. Anderson's consent to send my credentials to the AMA Council for adjudication, and mailed him records of my educational qualifications and reports of the Board's action. In late December Dr. Park counseled me to write Dr. Anderson directly asking for the adjudication before the AMA Council, if the licensing Board would be willing to refer my records. Warning me not to mention his name, Dr. Park suggested that I try to secure a wise physician-advisor in Madison to guide me step by step so as to avoid political mistakes. No one was willing to take an open stand in what had become a controversial issue.

In another letter from Dr. Park on 27 December, just two weeks prior to the Board's meeting on 10 January 1951, he indicated that he had written Dr. Anderson "that if the Board did not grant your request at their approaching meeting, . . . I could no longer restrain myself. . . . I should not be surprised if Dr. Anderson exerted some pressure on the Board, for he said to me over the telephone, 'Let's wait and see what they do on January 10.' . . . He expressed a belief that they would pass 'Hania' on that date . . . if they fail to pass Hania on that date, he [Dr. Anderson] would recommend some action."

Dr. Park also wrote of the possibility of seeking publicity to expose the Board's refusal to license me, perhaps consulting the *New York Times* or the *Washington Post*. In his strategy letter of 29 November, he had written: "It might be possible to create enough sentiment in Wisconsin so that the Board would be forced out." I do not think Dr. Park realized the political power of the Board.

Meanwhile, the communications between my attorney, James Doyle, and the Board's attorney, John W. Davison, accelerated. Between 12 July and 31 October there were seven such exchanges. In November they exchanged ten letters; in December thirteen, in addition to a number of telephone calls. There were always delays in Davison's answers to my attorney's letters, in spite of the fact that we were critically short of time. For instance, the letters from the Swiss authorities evaluating my credentials dated 15 August and addressed to the Board were not forwarded to us until 15 November, in spite of several earlier requests. And at this late juncture the Board asked me to translate the documents!

Another example of delay and harassment: On 29 November my attorney requested that the record of my two semesters (1942–43) in the Graduate School of the University of

Cincinnati, which was in the possession of the Board, should become part of my official record. Although the "record book" with entries constituted an "official transcript" as the term is commonly used, the Board's attorney now insisted that we obtain a certified copy of the official transcript from the university. We complied.

On 12 December my attorney reminded Davison that the Board now possessed two documents verifying that my studies at the University of Zurich had included more semesters and more courses than required for the Certificate of Medical Studies, which was now approved by the AMA Council. (These were from Dean F. Schwarz, of the University of Zurich Medical School, and from Dr. P. Vollenweider, Director of the Federal Health Department.) My courses of study would have entitled me to examination for the Certificate of Medical Studies had such a certificate been offered at the time I completed my studies. Furthermore, Mr. Doyle reminded the Board that I had taken the same medical courses as those taken by Swiss citizens then entitled to examination for the Federal license.

Mr. Doyle wrote: "I assume that any previous uncertainty has now been dispelled by the AMA Council's formal approval of the Medical School of the University of Zurich, coupled with the unequivocally favorable evaluation of Dr. Ris' credentials. . . . Dr. Ris will very much appreciate your early advice as to the time and place in January at which she will be expected to appear before the Board on her application for licensure by reciprocity."

But the Board was not yet willing to accept defeat. Davison stated in a 14 December reply that the two documents mentioned by my attorney were in the process of being translated. Translation was hardly the obstacle this implied. The records were, after all, in German, not Sanskrit, and were only two pages long.

Attorney Davison's letter continued: "It appears to me that the facts which you anticipate being included in the letters from [the University of Zurich] . . . could be very easily established by procuring from the University of Zurich the course of study required for a Certificate of Medical Studies and an official transcript of Dr. Ris's credits. If a comparison of these two documents reveals that she has taken all of the courses required for a certificate of medical studies, it would seem that that particular question would be definitely answered."

They were asking for documents they already had! They had possessed, since 1949, the official transcript of my credits and had had the official documents from Switzerland concerning courses required for the Certificate of Medical Studies since 11 July 1950.

Previously the Board had agreed it was willing to rely on the direct evaluation of the Swiss authorities. Apparently it had intended to honor this only if the result was detrimental to my record. Now the Board was proposing a different procedure and adopting new criteria less than a month before the meeting where my professional future was to be decided; I could not interpret this in any way other than that the Board had been acting in bad faith.

On 26 December the Board's attorney called my attorney to solicit his help in making a comparison of my courses with those required for the Certificate of Medical Studies. On 27 December Mr. Doyle made the comparison using two parallel columns. I came off with flying colors. Yet at this late date I still had not been granted permission to appear before the 10 January 1951 meeting of the Board.

On 27 December my attorney wrote a two-page letter to Dr. J. W. Smith, president of the Board (with copies to members of the Board and its Council), summarizing my one and a half year struggle for licensure. Mr. Doyle pointed out that I was entitled to be informed without delay whether the Board would grant me permission to appear at its upcoming meeting.

This was the last document in my own and attorney James Doyle's files of my case. What followed must have been transacted over the

telephone because of time constraints.

I was told I would be permitted to appear before the Board on 10 January 1951 to take the oral examination for licensure by reciprocity. Dr. Edwards Park, my advocate, awaited the outcome anxiously. Dr. Anderson of the AMA Council wired Dr. Park on 5 January:

> Your letter of January 3 just received. Have telephoned Dr. Christofferson, chairman of the Wisconsin Board, who assured me without reservation that Dr. Ris will receive exactly same type of oral examination as that given to all physicians seeking licensure in Wisconsin by reciprocity. Written examination was waived for her as it is for other candidates for reciprocity to spare unnecessary ordeal. I feel confident that Dr. Christofferson will insure Dr. Ris a fair examination. [signed:] Donald G. Anderson MD.

Round IV: I Am Finally Licensed

My appearance before the Board was summarized in the rather anticlimactic language of the 10 January 1951 minutes of the Board: "Dr. Hania Ris, applicant number 25, was ushered into the room. Dr. Ris' application has been reviewed again in the light of letters from the school from which Dr. Ris graduated, giving information that she had received the same education and had taken the same examination as those students who had received the accepted degree following which she left the room."

My name appeared later in the minutes among the list of candidates receiving the Wisconsin license by reciprocity. After one and a half years of painful negotiation with the State Board of Medical Examiners, I finally experienced one humane act. In mid-January 1951 I received a letter from Dr. C. A. Dawson (erroneously dated 13 January 1950 instead of 1951), stating: "Knowing you are naturally anxious as to the outcome of your examination, I am telling you confidentially that you were successful. . . . The list of all newly licensed physicians will be furnished shortly." The first congratulatory call came from Mrs. Edwin B. Fred (Rosa), the wife of the president of the university, who had kept in touch with me throughout the struggle. Her support was typical of the non-medical community.

It is ironic, however, that the State Board of Medical Examiners likely was not following the 1937 law when they denied me a license to practice medicine in Wisconsin. In a February 1991 Legislative Reference Bureau legal opinion, Mr. Barry J. Stern, legislative attorney, indicates the following:

> In my opinion, while the board appears to have had the authority under the 1937 law to adopt a policy of accepting an application for examination for licensure to practice medicine from any graduate of a foreign medical school that was classified in the American Medical Association (A.M.A.) rating, the board did not appear to have the authority under that law to accept an application from a foreign graduate *only* if the applicant was a graduate of one of the A.M.A. classified schools. On its face, the 1937 law, which required an applicant to have a diploma from a "reputable professional college approved and recognized by the board," would appear to have required the board to provide a foreign applicant who was a graduate of a school that was not classified by the A.M.A. with an opportunity to show that his or her school was reputable. [Personal correspondence, 4 February 1991]

Of course, the saga of my quest for licensure in Wisconsin does not end on the date of 10 January 1951. I paid a considerable price for being a test case, in addition to the price of being a woman challenging the medical establishment. I had many experiences as a *persona non grata;* one incident stands out.

While awaiting the decision of the Board, I attended clinical conferences held regularly at the University Hospital. At one conference, a prominent professor of gastroenterology approached me during a lecture and said: "You have to leave, you did not register." There were approximately forty participants in the room, which had a large capacity. I knew I was not displacing anybody by my presence, but I received a public rebuke because of my controversial status.

Four decades later, the professor's command still rings in my ears. However, at an Alumni Conference reception in 1981, some thirty years after the episode, the same professor, then approaching ninety years, came up to me, shook my hand and then kissed it (which was quite unusual for someone without a European background), and said, "I had to do what I have done." "I forgive you," I replied.

It is true that the struggle to be recognized for my professional credentials and expertise, to have the right to practice medicine in the state of Wisconsin, left some personal scars. But there were rewards in winning the battle, not just for me but for the many foreign physicians who followed.

Aftermath: The Status of Foreign Graduates

Since the conclusion of my personal battle, Wisconsin laws pertaining to foreign-educated applicants have been liberalized. The law of 1957 provided that if an applicant had graduated from a foreign medical school that was not approved or recognized by the Board, but had postgraduate training in this country substantially equivalent to training at the University of Wisconsin, the Board might admit the applicant to examination. However, this law allowed no more than twenty-five licenses a year to be granted under such conditions, and the ruling was to expire in 1961. After that date the fixed quota of foreign medical graduates who could be licensed each year was increased to fifty. In 1969 the Board started to rely selectively on examinations conducted by the Educational Council for Foreign Medical Graduates. Since 1970 Wisconsin law has governed the licensure of graduates of foreign medical schools under provisions similar to those of 1957 but without the limitation to fifty licenses annually.

In the opinion of Mr. Earl Thayer, who was employed by the Medical Society from 1947 to 1957 as public relations person, later serving as assistant secretary (1957–70) and as secretary of the Society (1970–87), my test case forced the Board to rethink and revise its policy and to accept the AMA Council's approval of some foreign medical schools. In the years 1930 to 1949, among active physicians in Wisconsin who were counted in a five-year period (Wisconsin Division of Health, Center for Health Statistics), the number of foreign graduates ranged between 6 (0.7%) and 44 (5.1%). Between 1950 and 1954 the number of foreign graduates increased to 140 (16.2%) (I was the first contributor to this increase), and in the years 1955–60 it increased to 218 (25.3%).

The Woman Question

What role, if any, did the fact that I was a woman play in the Board's attitude? I have never been sure. My perception, no doubt, was colored by almost a decade of earlier positive working experiences in friendly, congenial atmospheres where colleagues, professors, and administrators had gone out of their way to be helpful. The first time I experienced discrimination was when I came to Madison.

One authority is persuaded that being a woman and being aggressive were pivotal factors. Being aggressive was a positive trait in the world of men, but it was negative when applied to women. Mr. Earl Thayer, the Medical Society's respected secretary, recently told me that he had been appalled at the way the Board operated not only in my case but in general. He said I had been viewed as "aggressive" and the Board had hoped its tactics would discourage me.

The general lack of recognition and respect given to women in medicine was certainly a factor in my struggle to gain the right to practice medicine in Wisconsin, but perhaps it is illustrated even more clearly by a job offered to me in 1951 in Milwaukee. I was the mother of a fourteen-month-old infant at the time and had no private transportation, which prohibited my commuting. Nevertheless I was offered a position by the Bureau of Maternal and Child Health for the City of Milwaukee, which is about eighty miles from Madison. At first it was suggested that I hitch a ride daily with a truck driver at truck stops! Although I have never been conventional, I

rejected that idea. It was then suggested that I take a bus which left daily from Watertown, Wisconsin, at 6:30 A.M. and arrived in Milwaukee at 7:45 A.M. "In other words, it is only necessary for you to find transportation from Madison to Watertown [a distance of about thirty miles] to make your daily journey here possible." This kind of sacrifice was expected of a woman physician in the 1950s: a willingness to sacrifice her motherhood, her child, her personal life, for the privilege of having a position in the field of public health. These suggestions would have been less shocking and more amusing had they not come from a woman physician who was herself a promoter of maternal and child health.

Women have had to persevere in an arena and during times when medicine was considered male territory. Statistics bear this out. At the time I received my licensure, in 1951, there were 204 women physicians (5.5%) in Wisconsin, compared to 3,492 male physicians. In 1960 the percentage went down to 4.5% (3,833 males, 183 females). It has risen steadily since that time: 5.9% in 1978, 7.4% in 1980, and 9.9% in 1984, the last year for which statistics are available (Department of Health and Social Services, Center for Health Statistics).

But even today there are relatively few women in medical academia. In 1981 women constituted only 17% of all medical school faculty. Few women chair medical school departments, and few are in leadership positions in professional organizations. A case in point is the American Academy of Pediatrics, which was established in 1930, and now has a membership of 37,000 (25% of whom are women). Only in 1986 did a woman, Dr. Betty Lowe, become a member of the nine-person Executive Board. The Academy's first woman president, Dr. Antoinette Eaton, became vice-president and president-elect in 1989, by a majority vote of the Academy membership.

"Living the Good Life"

While public health medicine appealed to me, I turned to a much more reasonable and agreeable alternative. My family and I looked for a house in Madison that could lend itself to combining living quarters with a physician's office, where I could practice without outside pressures and spend as much time with each patient as necessary. We found such a house, surrounded by large trees, at 2306 Van Hise Avenue, across the street from West High School before its expansion. This work arrangement was rather unusual in Madison but quite common in the East. I would have preferred an academic position or an association with an obstetrician in an office, but this was unrealistic; I was still perceived as too controversial and too much a risk for close professional associations such as these.

Many of our friends, university teaching staff, people whom I came to respect and admire, entrusted me with their children. As a pediatrician, I later became a specialist in adolescent medicine, and then part-time medical director of a school for delinquent girls. I developed a comprehensive, multidisciplinary health program for the underprivileged young women, which led to clinical research in the field of sexually transmitted diseases and to the position of medical director of all Wisconsin state correctional institutions under the jurisdiction of the Department of Health and Social Services, Division of Health. Prevention of teenage pregnancy through sex education and the elimination of legal barriers to control of reproduction for teenagers and adults has been an important part of my activities.

Despite the dire predictions that I would be barred from academic medicine forever, since 1956 I have been a member of the University of Wisconsin Medical School faculty and am currently a Clinical Professor of Pediatrics. I have published a number of professional articles, mainly in the field of sexually transmitted diseases in young adults.

Of course, since *Life* magazine's 1948 article about "The Good Life in Madison, Wisconsin," many things have changed. Nevertheless, I have enjoyed my forty years as a Madison resident immensely and would still

contend that it is one of the best places in America to live. My fondness for Madison is probably even stronger because I had to fight for the right to make it my home, to be able to practice my profession without discrimination; I have always believed that is the right of every American citizen. My perseverance has been amply rewarded.

Acknowledgments

It should be obvious to the reader that I did not persevere without a great amount of encouragement and support. The press of Wisconsin championed my case with numerous articles, and without its airing of the issues my efforts would have been far more difficult. The late James Doyle, my attorney, exhibited incredible skill and patience in dealing with the machinations of the Board of Medical Examiners. He contributed greatly to bringing my case to a successful resolution.

I wish to reserve a special place to celebrate the late Dr. Edwards A. Park, physician, scientist, champion of medical care for the poor, early supporter of Medicare and Medicaid, and devoted friend. Dr. Park championed my cause out of his intense commitment to human decency, fairness, and justice. He was among the first to oppose the AMA's conservative policy regarding social health issues. In his teaching and by the example he set, he instilled in people the importance of the search for knowledge, the pursuit of truth, honesty, and high standards in all aspects of life. He published over a hundred articles, and until his death in 1969 at age ninety-one, his expertise was sought by authors of scientific publications. Much of the material needed to reconstruct the events described in this article came from the voluminous correspondence I had with Dr. Park, who obtained confidential information and advice from many individuals.

1988 Drought Impacts Among Wisconsin Dairy Farmers

John A. Cross

Abstract. *Drought such as occurred throughout the American Midwest during 1988 was an unusual experience for Wisconsin's farmers, who lost half their hay and corn crops. Dairy operators, who represent nearly half of the state's farmers, faced added hardships in maintaining their herds in face of feed shortages and rising feed prices. This paper reports the findings from a survey of Wisconsin dairy farmers concerning the drought impacts and the adoption of various drought mitigation measures. The consequences of the drought were most severely felt by farmers already experiencing a variety of economic stresses. Although three-quarters of the dairy farmers reported receiving federal drought assistance payments, 73% of these farmers would have survived without such relief. Farmers are pessimistic about future drought occurrences.*

Drought is a frequent and ever-present hazard for farmers tilling subhumid and semiarid lands and has been most studied within such environments (Hurt 1981; Rosenberg 1978; Saarinen 1966; and Warrick 1975). Although the rare drought events within normally humid environments have received less attention, the impacts of unusual drought occurrences can be highly significant and are worthy of study. This paper reviews the impacts of the 1988 summer drought upon dairy farmers in Wisconsin. At the time of the drought, 45% of Wisconsin's 81,000 farmers were engaged in dairying, leading the nation in milk production.

Drought conditions were felt throughout Wisconsin during the summer of 1988, when "43% of the area of the contiguous United States was in the severe or extreme drought category" (Trenberth, Branstator, and Arkin 1988). In Wisconsin the drought resulted in the loss of approximately half of the state's hay and corn (maize) crops. During the winter and spring of 1989 dairy farmers faced not only the consequences of these feed losses, but also the possibility of continuing drought conditions. This paper summarizes findings from a survey concerning the impacts of the 1988 drought at a time many dairy farmers would be expected to be experiencing hay and feed grain shortages resulting from the substantially diminished 1988 harvest. The 1988 drought provided an excellent opportunity to study drought impacts, mitigation, and perception among the population of a normally humid environment that has rarely had to deal with such a hazard.

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1988 Drought Conditions

Extreme drought conditions, as defined by the Palmer Index (Fig. 1), occurred in six of Wisconsin's nine agricultural reporting districts during the summer of 1988 (*Weekly Weather and Crop Bulletin* 1988). Precipitation from April through August 1988, as shown in Figure 2, was the lowest recorded in ninety-three years of records in both southwestern and southeastern Wisconsin, with three additional districts recording their second or third driest growing seasons. Rainfall was particularly deficient in May and June, with a Milwaukee weather station reporting a two-month total of 0.99 inch and Green Bay recording 0.73 inch—11.6% of normal (U.S. Department of Commerce 1988). Abnormally hot temperatures accompanied the drought, with six of Wisconsin's nine agricultural reporting districts reporting their highest June through August mean temperatures in records dating back to 1895 (U.S. Department of Commerce 1989b). Although a portion of eastern Wisconsin received substantial rainfall in August and September, over half of the state experienced an annual precipitation shortfall of at least six inches, with the southwestern corner of Wisconsin receiving fifteen inches below normal precipitation (Clark 1989a).

The 1988 corn harvest was 60% below the 1987 harvest, alfalfa hay was down 45%, other varieties of hay were off 44%, and oats were down 54% (Wisconsin Department of Administration 1989). Furthermore, because 1987 harvests had fallen from even greater 1986 harvests as a result of less severe drought conditions in 1987, the 1988 harvests of alfalfa hay and corn were 46% and 36%, respectively, of their 1986 harvests. Although the tonnage of corn silage harvested in 1988 was down only 2%, this was accomplished by a doubling of the harvested acreage, largely an effort to salvage wilted cornfields that had been planted for grain (Wisconsin Agricultural Statistics Service 1988 and 1989). Unfortunately, because of its lower protein content, the substitution of such corn silage for alfalfa without additional protein supplements reduced milk production (Howard and Shaver 1988).

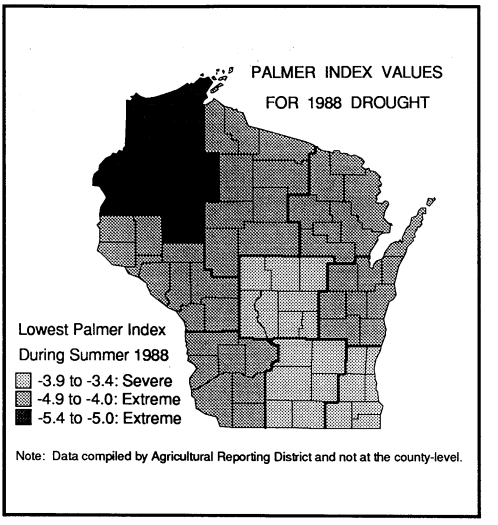

Figure 1

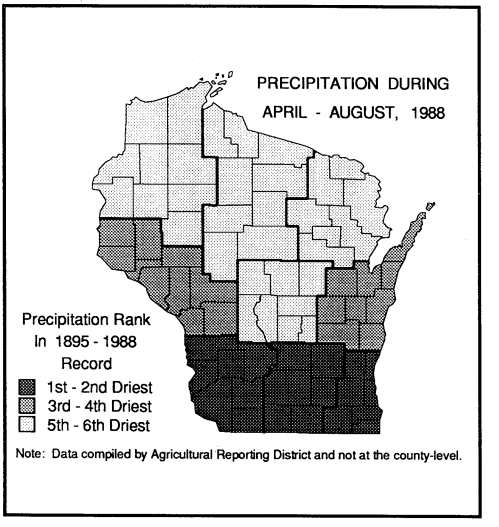

Figure 2

The dollar value of the 1988 hay harvest exceeded that of the 1987 harvest by 18.2% because of the shortage and rapidly escalating prices. Indeed, hay prices doubled or tripled, with the price of top-grade alfalfa hay reaching $250 per ton. Price increases failed to keep pace with lost production for other crops. For example, the cash value of the corn harvest was down by 48.9%, and the oat harvest

generated 25.5% less revenue than in 1987 (Wisconsin Agricultural Statistics Service 1988 and 1989). However, higher commodity prices were not advantageous to most Wisconsin dairy farmers. They normally consume their crop on their farms, and the higher prices simply translated into higher costs of feeding their herds to stay in business (Rodefeld 1988a).

Drought-induced crop losses were not uniformly distributed across Wisconsin, with the western and southern portions of the state reporting the greatest declines in production between 1987 and 1988 (Fig. 3). For example, in Polk County the 1988 corn crop was 17.8% of the 1987 harvest, and in Marathon County—the state's foremost milk producing county—the corn crop was only 24.5% of the previous year's harvest. Although the decline in alfalfa production (Fig. 4) was not as dramatic as the drop in the corn harvest, similar spatial patterns of crop losses were noted, with the greatest drought losses occurring in the north central, northwestern, and southernmost portions of Wisconsin.

Press reports during the winter and early spring of 1989 painted a bleak picture of conditions facing Wisconsin dairy operators. Large proportions of farmers had either exhausted their feed or were expected to do so before their next harvest. A Wisconsin Agricultural Statistics Service survey in early November 1988 determined that 14% of the state's livestock farmers (dairy, cattle, and hog) expected to have exhausted their hay by January, 42% by March, and 74% would be out of hay by May. Grain or grain concentrate supplies were expected to be similarly expended (*Wisconsin Farm Reporter* 9 November 1988). Wisconsin's hay stocks in December 1988 were down 3.9 million tons from December 1987 (Rodefeld 1988b). Replacement of this lost hay and haylage statewide was estimated to cost from $600 to $700 million, and replacement of corn stocks was estimated between $200 and $400 million (Wisconsin Department of Administration 1989).

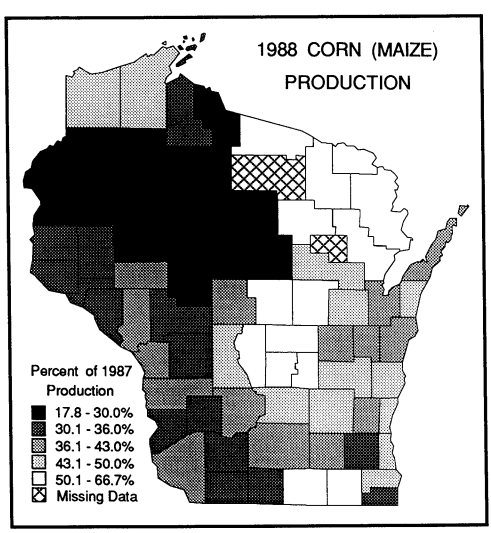

Figure 3

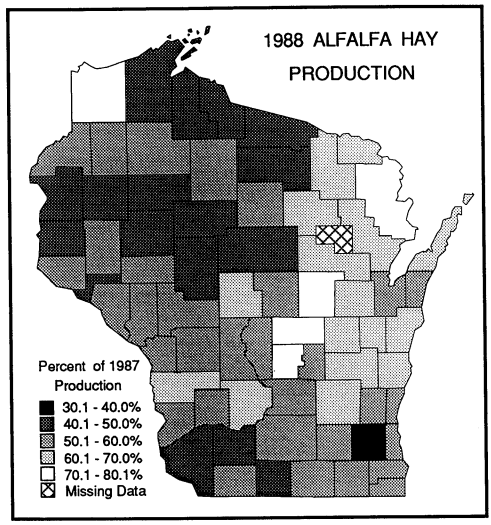

Figure 4

Weather conditions during the winter and spring of 1989 caused further concern at the same time dairy farmers were facing feed shortages. Freezing rains (rather than snow) during January 1989 had seriously damaged the alfalfa fields (Clark 1989b). Precipitation during the spring of 1989 was well below normal, with many areas by early May having received less precipitation since the beginning of the year than in 1988 (U.S. Department of Commerce 1989a). The 6 May

1989 Palmer Index (*Weekly Weather and Crop Bulletin* 1989) indicated that severe drought was occurring in southwestern Wisconsin, moderate drought was present in central Wisconsin, and mild drought was present in five of the state's other seven agricultural reporting districts.

Methodology

Concerns about how Wisconsin dairy farmers had managed to deal with the drought-induced hay and feed grain shortages during the winter and spring of 1988–89 and about these farmers' vulnerability to future stress—drought and otherwise—prompted the survey of Wisconsin dairy farmers that provided most of the data reported in this paper. An eight-page questionnaire was mailed on 4 May 1989 to 506 dairy operators throughout the state. The initial mailing of the questionnaire, accompanied by a cover letter and a business reply envelope, was followed six days later by a reminder post card. This card thanked participants and encouraged recipients to complete and return the survey. Farmers not responding to the initial survey were mailed a second copy of the questionnaire, a new cover letter, and a second business reply envelope on 24 May 1989. Completed surveys were received from 283 farmers, representing 57% of the eligible members of the sample who received the survey.

Farmers receiving this survey were selected by a stratified systematic sampling procedure from an early April 1989 Wisconsin Department of Agriculture listing of the 35,611 dairy operators whose herds had had the Brucellosis Ring Test, which is required quarterly for all commercial milk producers. The sampling was designed to select 1.2% of the dairy operators in the six largest agricultural reporting districts. In the remaining three districts, which would have fewer representatives, an additional 1–2% of the farmers were selected so that district-to-district comparisons could be made. In addition, a short survey was sent to agricultural extension agents throughout Wisconsin requesting data on their observations of farmers in their various counties.

Impacts of 1988 Drought

The 1988 drought had numerous impacts upon Wisconsin's dairy farmers, including substantial crop losses, losses of income, and shortages of hay and feed grains, together with a wide assortment of economic stresses (Table 1). Some even lost their farms.

Crop losses and feed purchases

Crop losses led to a cascade of drought impacts for Wisconsin's dairy farmers. The Wisconsin State Agricultural Stabilization and Conservation Service in late August 1988 es-

Table 1. Impacts of the 1988 drought

"Indicate to what degree (if any) you have experienced the following as a result of last summer's drought?"

Condition	*Strongly felt*	*Moderately felt*	*Slightly felt*	*Not felt*
	%	%	%	%
Decrease in gross farm income	27.0	29.2	23.2	20.6
Decrease in net farm income	39.1	27.8	20.3	12.8
Increase in farm indebtedness	19.6	18.1	23.1	39.2
Shortages in hay or alfalfa	49.8	24.3	13.9	12.0
Problems with corn toxicity	3.5	5.8	12.7	78.0
Bank foreclosure threat	3.5	4.3	6.7	85.5
Greater need of off-farm income	14.9	19.8	20.6	44.7
Sale of lands or farm equipment	3.5	6.9	6.9	82.7

timated statewide crop losses of 50% for both hay and corn (U.S. Department of Agriculture 1988). Crop yields for 1988, as reported by dairy farmers responding to my survey, were close to these estimates, with their hay/alfalfa harvest averaging 45% of normal and their corn crop averaging 50% of normal. When surveyed in May–June 1989, only 37% of the farmers indicated they had "sufficient feed grain supplies to last until the next harvest."

Purchases of hay or alfalfa hay had been made by 62% of the dairy operators between September 1988 and May 1989, and 72% had purchased feed grains. Statewide, 75.5% of Wisconsin's dairy operators reported making purchases of either hay or feed grains, with the proportion ranging from 68 to 83% of the farmers in the various agricultural reporting districts. In a normal year, over 40% of the surveyed farmers buy neither hay nor feed grains. Purchases of hay and feed grains during 1988–89 averaged $14,616, with a median purchase cost of $9,000. The mean cost of these purchases in a normal year averaged $6,733 with a median cost of $2,000. The greatest increase in hay and feed purchases was reported by dairy farmers in southwestern Wisconsin.

Changing feed, reducing herd size

Farmers also took a variety of other actions (Table 2) to mitigate the feed shortages. For example, 35% changed the type of feed given to their animals, 22% reduced the amount of feed, and 38% of the respondents reduced the size of their herds. Conversely, 27.8% of the survey respondents were able to increase their herd size.

Farmers most likely to reduce the size of their dairy herds were located in central Wisconsin (where over half took this action), as well as the southwestern, northeastern, and south central Wisconsin regions. With the exception of southwestern Wisconsin, which experienced the greatest precipitation deficits in 1988, districts where dairymen were less likely to purchase feed supplies were those most likely to have reductions in herd size. Farmers in east central, west central, and southeastern Wisconsin (42 to 50%) were most likely to change the type of feed given to their herds, while those in northeastern and south central Wisconsin were least likely (18 to 23%). Reduction of the amount of hay or feed grains fed to the dairy cows was reported by over 30% of the dairymen within central, southwestern, and southeastern Wisconsin, while fewer than 14% of the dairymen within

Table 2. Actions taken because of hay or feed grain shortages

Agricultural reporting district	*Percent of dairy farmers taking action*			
	Purchasing hay/feed	*Reducing herd size*	*Changing feed type*	*Reducing amount fed*
	%	%	%	%
Northwest Wisconsin	80	37	27	10
North central Wisconsin	83	28	31	14
Northeast Wisconsin	68	45	23	14
West central Wisconsin	69	36	44	19
Central Wisconsin	70	51	33	30
East central Wisconsin	79	29	50	24
Southwest Wisconsin	82	46	36	32
South central Wisconsin	70	44	18	22
Southeast Wisconsin	77	23	42	31
State total	75.5	37.5	34.9	21.9
Adjusted state total*	76.0	37.9	34.9	21.6

*Because Wisconsin's dairy farmers are not evenly distributed among the nine agricultural reporting districts, this total was calculated by weighting the responses from each district by the proportion of Wisconsin's dairy farms that operate in that district.

the northern third of the state put their herds on short rations.

Drop in farm income

Net farm income was down for the majority of the dairy farmers, yet for better than one in ten, income was above average. When asked an open-ended question, "Your net income (from all sources) for 1988 was about what percent of normal?" one-quarter of the farmers indicated 100% or more (Table 3). Dairy farmers reporting above normal income—with some reporting their best year ever—typically had substantial hay supplies carried over from 1987. Conversely, 11% reported net incomes of 50% or less of normal, with the mean net farm income being 84.5% of normal (median was 90%). These estimates are similar to those of the agricultural extension agents, who estimated that average income was 89% of normal. Although one out of seven of the agents estimated that the average farmer within his or her county earned a greater than normal income, in none of the agricultural reporting districts was the average net income (either mean or median), as reported by the farmers, greater than 90% of normal. The greatest departures from normal were reported by dairy farmers in central and southwestern Wisconsin.

Sixty-seven percent of the dairy farmers surveyed indicated that decreases in their net farm income were strongly or moderately felt, an even larger proportion than those farmers reporting decreases in gross farm income (56%, Table 1). Half of the farmers indicated that shortages in hay or alfalfa were "strongly felt," with an additional 24% claiming these shortages were "moderately felt." Nevertheless, increases in farm indebtedness as a result of the drought were strongly or moderately felt by only 38% of the farmers. Drought-induced bank foreclosure threat was strongly or moderately felt by 8% of the dairy farmers, and the sale of lands or farm equipment was similarly felt on 10% of the farms. Thirty-five percent of the farmers indicated that a "greater need of off-farm income" was strongly or moderately felt.

Table 3. Change in net farm income from normal during 1988

"Your net farm income (from all sources) for 1988 was about what percent of normal?"	%
0–50% of normal	10.7
51–75% of normal	19.1
76–89% of normal	16.8
90–99% of normal	29.0
100% of normal	13.7
101–200% of normal	10.7

Spatial differences in "strongly felt" impacts of the drought were noted (Table 4). Farmers in southwestern, central, and east central Wisconsin were most likely to report strongly felt shortages of hay or feed grains. Decreases in both gross and net farm income were most frequently reported in northeastern, central, and southeastern Wisconsin, all areas where dairy operators had faced above average economic stresses and declines in the previous decade (Cross 1989). Dairymen in the central Wisconsin region were significantly more likely to have strongly felt increases in farm indebtedness, while farmers in the north central, west central, and central agricultural reporting districts were most likely to have a greater need for off-farm income. Although these spatial patterns are not entirely consistent, farmers in central Wisconsin consistently reported above average levels of concern about all the potential drought impacts.

Drought-induced declines in both gross and net incomes, shortages of hay and feed grains, and increased indebtedness were experienced by a broad spectrum of Wisconsin dairy farmers. No differences in drought impacts were noted among the farmers based upon the age of the farmer, the number of years as farm operator, farm acreage, size of dairy herd, the farmer's land tenure status, or whether the farm was a grade A or grade B operation. On the other hand, the responses of the farmers to the shortages of hay and feed supplies were related to a number of these characteristics (Table 5). For example,

Table 4. Impacts of the 1988 drought in Wisconsin's agricultural reporting districts

Agricultural reporting district	*Percent of dairy farmers indicating that the condition was "strongly felt" as a result of the summer 1988 drought*				
	Shortage of hay/ alfalfa	*Decreased gross income*	*Decreased net income*	*Increased farm debt*	*Need of off-farm income*
	%	%	%	%	%
Northwest Wisconsin	43	29	37	18	8
North central Wisconsin	46	32	39	19	22
Northeast Wisconsin	38	41	54	19	14
West central Wisconsin	50	10	36	19	19
Central Wisconsin	64	39	47	32	21
East central Wisconsin	54	26	38	18	16
Southwest Wisconsin	65	21	28	21	14
South central Wisconsin	46	15	31	8	7
Southeast Wisconsin	33	37	44	21	4
State total	50.0	26.9	39.0	19.6	14.9
Adjusted state total*	51.1	24.7	37.2	18.8	15.2

*Because Wisconsin's dairy farmers are not evenly distributed among the nine agricultural reporting districts, this total was calculated by weighting the responses from each district by the proportion of Wisconsin's dairy farms that operate in that district.

Table 5. Significant relationships between dairy farmer characteristics and responses to drought-induced hay/feed shortages

Farmer characteristics	*Farmer responses*			
	Purchase hay/feed	*Reduce herd size*	*Change feed type*	*Reduce feed amount*
Age of farmer	.00977	NS*	.04195	.09128
Years of farm operation	.00387	NS	.01902	.01837
Farm acreage	NS	NS	NS	.03218
Farm ownership	NS	NS	NS	.06011
Herd size	.02114	.03078	NS	NS
Drop in net farm income	.06239	.00777	.05057	.07215
Off-farm income	.02173	.06594	NS	NS

*NS indicates chi-square not significant at .1000 significance level.

farmers most likely to have already purchased hay or feed grains as a result of the drought were the youngest, those with lower net incomes, those with the largest number of cows, and those with off-farm incomes.

Drought Relief

Wisconsin dairy farmers were asked to evaluate the importance of various factors in helping their farms financially survive the 1988 drought and its aftereffects. The two most important factors were government drought relief payments and increased milk support prices, cited as "very important" by 44 and 41% of the farmers, respectively. Personal savings were cited as "very important" by 26% of the dairy operators, bank credit by 22%, and off-farm income by 17%. Crop insurance payments were "very important" to only 8% of the surveyed farmers.

Several federal and state government programs provided assistance to Wisconsin farmers. Lands in the Conservation Reserve Program and Conservation Use (set-aside)

program were opened to both grazing and haying. State-owned lands and highway right-of-ways were opened to haying. Additional federal funds were authorized to purchase ground beef, assuring that dairy farmers who liquidated their herds could do so with a reasonable market for their cows. A scheduled drop in the federal milk support price was postponed, and support prices were increased. Property tax credits and a guaranteed loan program for farmers were approved by the state (Richards 1988; Wisconsin Department of Administration 1989). The largest relief program was provided by the U.S. Disaster Assistance Act of 1988, which authorized compensation to farmers with crop losses exceeding 35% of normal production. In general, farmers received no compensation for their first 35% of lost production, were compensated at 65% of the target price (approximately the pre-drought average market price) for the loss of 36 to 75% of their harvest, and 90% of the target price for the loss of 76 to 100% of production. Thus, the program did not "prevent farmers from experiencing substantial declines in their incomes" (Jones 1988).

Financial assistance through the Disaster Assistance (Drought Relief) Act was reported by 75% of the Wisconsin dairy farmers surveyed, a greater proportion than those who reported that this assistance was either "important" or "very important" in helping their farm financially survive the drought. Thirty-seven percent indicated that these drought relief payments were the primary source of funds for their hay and feed grain purchases. Thirty-five percent relied primarily upon their farm income (milk check) or withdrawal of funds from their savings to purchase hay or feed. Thirteen percent borrowed funds from banks or other financial institutions.

Seventy-three percent of the surveyed dairymen who received drought relief payments indicated that they would have been able to remain in the dairy business even without the aid. In contrast, Wisconsin agricultural extension agents estimated that without the drought relief payments only 9% of the dairy farmers would succumb. Dairymen in southeastern, south central, and west central Wisconsin expressed the greatest confidence that they would have survived without any drought relief payments. Conversely, dairy farmers in the central, east central, and north central agricultural reporting districts were least confident about their ability to have survived the drought without drought relief payments. In central Wisconsin only 53% felt they would have survived without the payments.

If we consider only those farmers who received drought relief payments, these payments were most significant in the survival of Grade B dairy farms, the farmers with off-farm income or employment, those farmers who reported that decreases in net farm income were moderately or strongly felt, and the farmers reporting the greatest hay and corn crop losses in 1988. Indeed, 41% of the dairy farmers receiving drought assistance who had lost over two-thirds of their hay/alfalfa crops doubted their ability to survive without those payments (Table 6).

Drought relief payments and other federal and state benefits, estimated at $565 million for Wisconsin farmers, covered approximately 37% of feed expenses and lost cash crop revenues of Wisconsin farmers. Thus, Wisconsin farmers (both dairy and crop) had estimated uncompensated losses averaging over $11,000 each (Wisconsin Department of Administration 1989). Since even a year before the drought 16% of all Wisconsin farms (a total of 12,800 farms) were considered by the U.S. Department of Agriculture to be experiencing "extreme financial stress," for many farmers such losses were unbearable. Furthermore, Rodefeld (1988) indicated, "Many farmers who survive the coming winter will have high levels of stress in future years because of their higher debt loads and tighter cash flows from this year's drought."

Loss of Dairy Farms

Statewide, an estimated 960 farmers had already terminated their dairy operations by

Table 6. 1988 hay/alfalfa crop loss and ability of drought relief recipients to survive without payments*

	Hay crop as percent of normal harvest		
	0–33%	*34–50%*	*51–100%*
Would survive without payment	41 (58.6%)	74 (77.9%)	40 (90.9%)
Would not survive/ doubtful without payment	29 (41.4%)	21 (22.1%)	4 (9.1%)
Totals	70 (100.0%)	95 (100.0%)	44 (100.0%)

*Chi-square = 16.010, 2 degrees of freedom, significance = .00033.

early May 1989 as a direct result of the 1988 drought, based upon estimates of county-level agricultural extension agents. Between March 1988 and March 1989 the total number of commercial herds in Wisconsin dropped by 1,351, a decline of 3.7% (Wisconsin Agricultural Statistics Service 1988 and 1989). Thus, the drought would appear to be the leading cause of herd losses. Between March 1989 and March 1990 Wisconsin lost another 1,768 dairy herds, a decline of 5%. However, to keep these losses in perspective, we should note that the number of dairy operations in Wisconsin fell by 9.8% (a total of 4,026 herds) between 1986 and 1988 (40% were participants in the Dairy Termination Program) and fell by 19.2% between 1982 and 1988 (Cross 1989). Although the annual loss between March 1988 and March 1989 was smaller than within the previous few years, many agricultural extension agents felt in May 1989 that it was still too early to determine the total number of casualties from the 1988 drought. Hence, many dairy farmers ceasing operations between 1989 and 1990 should also be considered victims of the drought.

The distribution of the losses of dairy farmers between 1988 and 1989 (Fig. 5) was similar to that over the previous half decade (Cross 1989), with a few notable exceptions. For example, above average declines were noted in several counties of northwestern Wisconsin and in central Wisconsin, simply continuing trends that existed before the drought. On the other hand, the above average losses during 1988–89 in several southwestern Wisconsin counties (notably Grant and Iowa) are in sharp contrast to their considerably below average declines between 1981 and 1988. Losses in dairy herds between 1989 and 1990 more closely parallel long-term pre-drought trends (Fig. 6), which saw the greatest declines in northern Wisconsin, parts of central Wisconsin, and near the Milwaukee metropolitan area in southeastern Wisconsin.

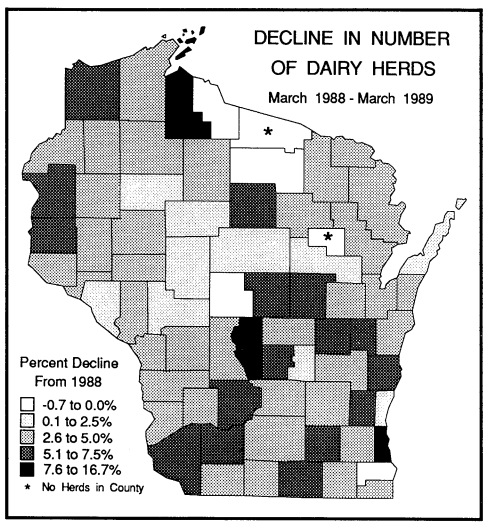

Figure 5

Vulnerability to continued drought stresses

A third of the dairy farmers surveyed indicated that, if there was a drought during

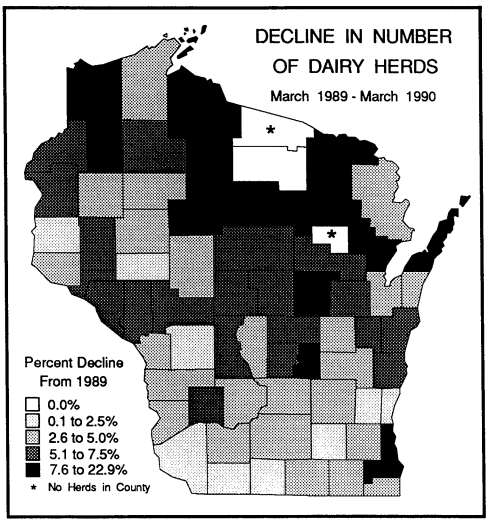

Figure 6

the summer of 1989, they would no longer be in business by the spring of 1990. (Although five of Wisconsin's nine agricultural reporting districts received less average district-wide precipitation in 1989 than in 1988, strategically spaced rainfall spared most crops [Naber 1990].) However, 7% of the surveyed farmers did not expect to still be in business the next year, even if rainfall amounts were normal during the summer of 1989. Furthermore, 29% of the dairy farmers affirmatively answered the question, "Would you like to sell your farm?" This was particularly prevalent throughout the northern third of Wisconsin, where 40% of the dairy farmers wished to sell. It should be noted the entire northern portion of the state saw the highest rates of farm abandonment over the past decade and the greatest participation rates in the Dairy Termination Program (Cross 1989).

Farmers who expressed the greatest concern about their vulnerability to continued drought were typically those with smaller than average farm acreages, with below average herd sizes, and with Grade B operations (Table 7). Thus, farmers most threatened by the drought were the same group the Wisconsin Dairy Task Force (1987) had identified even before the drought as having the bleakest chance of economic survival because they both lacked economies of scale and could not "afford relatively expensive new technologies." Strong statistical relationships were noted between the farmers' expectations that they could survive a 1989 drought and their crop losses (especially corn) in 1988 and the adequacy of their hay and feed grain supplies (Table 8). Those farmers who indicated they did not expect to still be in business—drought or no drought—by 1990 were generally the oldest, with the greatest number of years as farm operators, and with smaller than average herd sizes. However, those expecting to quit had suffered drought-

Table 7. Significant chi-square relationships between drought vulnerability of farmers and characteristics of farmers

Farmer characteristics	*Could survive drought in 1989*	*Could survive without drought relief payment**	*Wish to sell farm*
Age of farmer	NS†	NS	.01089
Years of farm operation	NS	NS	.08401
Farm acreage	.06472	NS	NS
Farm ownership	NS	NS	.039
Herd size	.00177	NS	NS
Herd grade (A/B)	.00881	NS	NS
Drop in net farm income	.01891	.00909	.07437
Off-farm income	.03370	NS	NS

*All respondents were asked this question, both those who had and those who had not received any drought relief payments.
†NS indicates chi-square not significant at .1000 significance level.

Table 8. Significant chi-square relationships between 1988 drought impacts and future vulnerability of dairy operations

Drought impacts from 1988	*Could survive drought in 1989*	*Could survive without drought relief payment*	*Wish to sell farm*
Hay crop losses	.06337	.00001	NS*
Corn crop losses	.00392	.00424	.00923
Adequacy of hay supplies	.00000	.00000	NS
Adequacy of feed supplies	.00084	.00164	.05057
Increased farm indebtedness	.00004	.00000	.06922
Feed/hay purchases	.09500	.00112	NS

*NS indicates chi-square not significant at .1000 significance level.

induced crop losses and feed and hay shortages that were no different than the remaining farmers.

Drought Mitigation for 1989

Many dairy farmers made no efforts to mitigate possible drought losses in 1989, although virtually all Wisconsin dairy farmers had suffered crop losses in 1988 and 70% expected a drier than normal 1989 growing season. Nevertheless, crop insurance coverage expanded, and nearly half the farmers took some action to reduce future drought losses.

Crop insurance

Crop insurance to cover drought losses had been obtained by only 8% of the surveyed dairy farmers in 1988, although 36% had obtained insurance to cover hail losses. For their 1989 crop season, 51% of the dairy farmers reported that they either had or would obtain crop insurance to cover drought losses. Such a low figure is surprising because multi-peril crop insurance was required of drought relief recipients who lost at least 65% of their crops as a condition for receiving their payments (U.S. Public Law 100-387, Section 207). Nevertheless, 16% of the surveyed farmers whose hay and corn crops were both under 35% of normal—but who still had received drought assistance—had not purchased drought (or multi-peril) insurance. Furthermore, several other respondents obtained only minimal crop insurance coverage because of its cost. Although the legal requirements mandating multi-peril insurance in exchange for drought assistance did not receive universal compliance, dairy operators with the largest crop losses (whether or not they received financial assistance) were significantly more likely to obtain drought insurance for the next year.

Crop planting

The 1988 drought prompted 42% of the dairy farmers to make changes in their crop planting plans for 1989. Farmers in northwestern, north central, and east central Wisconsin were significantly more likely to report these changes. Numerous changes in cultivation techniques and crops were undertaken, although only a few farmers mentioned changes in plowing/planting dates, reduced tillage, or fertilizer and herbicide usage.

Farmers with the greatest acreages were most likely to report making changes in their crop planting plans for 1989. Likewise, younger and middle-aged farmers were significantly more likely to report making changes than the older farmers (those over sixty years of age). On the other hand, the land tenure status of the farmers, the size of the farmer's dairy herd, and whether the herd was a Grade A or Grade B operation were not statistically related to crop planting changes. The decision to make changes in crop planting plans was significantly related to both the farmers' perceptions of the likelihood of drought during the summer of 1989 and their perception

that drought possibilities are a problem in Wisconsin.

The prominence of hay/alfalfa, corn, and oat production on Wisconsin dairy farms remains unchanged following the drought. Ninety-five percent of the surveyed farmers reported planting corn in 1988, and 94% intended to grow corn in 1989. Similar proportions produced hay and/or alfalfa. Oats were cultivated on 73% of the dairy farms in 1988, the same proportion that planned to grow oats in 1989. However, a slightly greater amount of crop diversification was planned for 1989, and the proportion of farms producing many of the lesser grown crops increased. For example, dairy farmers planting sudan grass increased from 9.6% in 1988 to 13.3% in 1989 and sorghum from 5.2% to 7.3%.

Irrigation is a rarity on Wisconsin dairy farms. Only 3.2% of the surveyed farmers had irrigation systems in place before 1988, with an additional 1.4% installing systems during 1988. Only two (of the 283 farmers responding to the survey) planned to install an irrigation system during 1989. Statewide, only 250 of Wisconsin's 81,000 farms installed emergency surface water irrigation systems during the summer of 1988 (Wisconsin Department of Administration 1989).

Conclusions

The drought of 1988 has provided us with a unique opportunity to study drought perceptions and drought mitigation among farmers who have rarely dealt with this hazard. Drought is but one of many conditions that threaten the livelihood of Wisconsin dairy farmers. When asked to evaluate drought and a variety of other problems, farmers more frequently mentioned everyday economic concerns as being major problems than any natural hazard, including drought, hail, and flood. Indeed, milk support prices were considered a major problem by 53% of the farmers, property taxes by 51%, and drought by 36%. Only 9% of the farmers ranked drought possibilities as the single most important problem facing dairy farmers in their Wisconsin county, compared with 45% who cited either milk support prices or wholesale milk prices.

The final toll of the 1988 drought upon Wisconsin's dairy farmers will take years to tally fully. However, between March 1988 and March 1990 Wisconsin lost 3,119 dairy operations, an 8.4% decline. The economic stresses caused by the drought-induced diminished feed stocks and high hay and feed grain prices were somewhat mitigated by increased milk production per cow, rapidly escalating milk prices, and drought relief payments. The greatest stresses of drought did not necessarily occur in those areas experiencing the greatest meteorological drought or crop losses, but in areas where farmers were already under economic stress, and thus lacking in the resilience to respond successfully to another threat. In this respect, Wisconsin dairy farmers are no different from farmers in Mexico, where Liverman (1990) made similar observations. For many Wisconsin dairy farmers, high debt loads remain, only increased by the stresses of the drought.

Wisconsin dairy farmers are generally pessimistic about the possibility of future droughts. Another drought, as severe as the 1988 drought, is expected within ten years by nearly half of the farmers surveyed (Cross 1990). If predictions of climatologists about climatic warming because of the Greenhouse Effect are accurate (Schneider 1989), Wisconsin farmers must learn to deal with an increasingly capricious environment. Although the Greenhouse Effect cannot be blamed for an individual drought such as that during 1988, "the greenhouse effect may tilt the balance such that conditions for droughts and heat waves are more likely" (Trenberth, Branstator, and Arkin, 1988). We should remember what we have learned from this drought experience, which nationally was overshadowed only by the droughts of the 1930s and 1950s. Indeed, we should not forget the advice of Miewald, who wrote after another drought, "If we learn nothing from the current drought, then it may be said that

the worst impact is no real impact at all'' (1978).

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Distribution, Abundance, Larval Habitats, and Phenology of Spring *Aedes* Mosquitoes in Wisconsin (Diptera: Culicidae)

Jeffrey W. Gilardi and William L. Hilsenhoff

Abstract. *In 1988 10,651 larval and 1,612 adult* Aedes *were collected in nine representative areas of Wisconsin during the spring and early summer; an additional 3,146 larvae were collected during the spring in 1989 and 1990. From these collections and previous studies we determined the distribution, relative abundance, larval habitats, and probable phenology of the twenty-three species of* Aedes *that breed in water from melting snow and early spring rainfall.* Aedes decticus *and* A. euedes *were collected for the first time in Wisconsin. Adult longevity and flight ranges were also studied.*

In May and June Aedes stimulans *was the predominant mosquito biting humans in central and southern Wisconsin, while* A. communis *and* A. punctor *were the most important pests in the north. Adults of* A. vexans *were late spring pests in most areas in 1988 but were absent in 1989 and restricted to west central Wisconsin in 1990. Adults of* A. canadensis, A. excrucians, A. fitchii, *and* A. provocans *were minor pests in most areas of the state but were abundant locally. Adults of* A. cinereus *were troublesome biters in woodland areas throughout Wisconsin.*

Almost every year in May and June mosquitoes become a nuisance in wooded areas throughout Wisconsin. This problem is created by females of twenty-three species of *Aedes* that breed in temporarily flooded areas, which have resulted from snowmelt and early spring rains. The mosquito nuisance is especially severe after heavy snowmelt and/or heavy rains. Adults of these spring *Aedes* mosquitoes have a limited flight range and tend to remain in areas near larval development sites. Most are relatively short-lived, and after June, mosquitoes that have emerged in spring are rarely a nuisance.

Fifty-three species of mosquitoes are known from Wisconsin; twenty-eight of them are *Aedes*. All adult mosquitoes probably feed on floral nectar and other plant liquids (Grimstad 1973), but only females take blood meals. Females of some species feed on reptiles and amphibians, others prefer birds, but those of at least forty species, including all *Aedes*, readily attack humans and other mammals. This study was undertaken to determine the distribution, relative abundance, larval habitats, and nuisance potential of each species of *Aedes* that emerges during the spring and to summarize previous studies of these species in Wisconsin.

Larvae of all *Aedes* in Wisconsin develop in areas that are temporarily inundated with water, ranging from small cavities, holes, and depressions to marshes, ponds, bogs, and swamps. They also develop in fluctuating margins and intermittent shallow areas of more permanent habitats. Areas included in this

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study fall into six categories: (1) marshes, primarily open areas vegetated with cattails (*Typha*) and/or sedges and rushes (*Carex, Eleocharis, Scirpus*) and associated plants; (2) *Sphagnum* bogs and swamps, usually with leatherleaf (*Chamaedaphne calyculata*), tamarack (*Larix laricina*), and/or black spruce (*Picea mariana*), and with water often limited to isolated pockets; (3) woodland pools surrounded by coniferous and/or deciduous trees, with a layer of leaf litter, and without aquatic vegetation; (4) drainage ditches without associated aquatic vegetation; (5) grassland pools surrounded by non-woody vegetation and without aquatic vegetation; and (6) temporary to semipermanent ponds with aquatic vegetation.

Species of *Aedes* in Wisconsin can be divided into two groups, both of which overwinter as eggs. The first group has a single generation each year, with eggs entering an obligatory diapause that is terminated by exposure to several weeks of cold winter temperatures. In Wisconsin this group includes *A. abserratus, A. aurifer, A. communis, A. decticus, A. diantaeus, A. euedes, A. excrucians, A. fitchii, A. flavescens, A. grossbecki, A. implicatus, A. intrudens, A. provocans, A. punctor, A riparius,* and *A. stimulans*. Hatching of eggs is related to flooding from snowmelt and rain and also to warming in March and early April; it may be delayed in heavily shaded areas and in habitats that remain relatively cold.

The second group consists of species whose eggs also hatch in the spring, but these species are capable of having additional broods throughout the warm months of the year. Additional eggs hatch each time the habitat is reflooded after it has become dry. This group includes *A. atropalpus, A. campestris, A. canadensis, A. cinereus, A. dorsalis, A. hendersoni, A. nigromaculis, A. spencerii, A. sticticus, A. triseriatus, A. trivittatus,* and *A. vexans*. Some of these species may have only one brood in some northern locations. *Aedes nigromaculis* (Ludlow, 1907) and *A. trivittatus* (Coquillett, 1902) were not studied because their larvae develop in late spring or summer. Also not studied were *A. hendersoni* Cockerall, 1918 and *A. triseriatus* (Say, 1823), which breed in tree holes and artificial containers, and *A. atropalpus* (Coquillett, 1902), which develops in rock pools.

While several studies of mosquitoes have been carried out in Wisconsin, the relative abundance, statewide distribution, and larval habitats of species of spring *Aedes* have remained poorly known. Dickenson's monograph (1944) provided the first account of Wisconsin mosquitoes, listing thirty-eight species. It was followed by Allen's summary (1950) of Wisconsin mosquito studies and his preliminary survey of species in the University of Wisconsin–Madison Arboretum. He documented the only statewide survey of adult mosquitoes, which was conducted in twenty-three counties by the Wisconsin State Board of Health in 1941; univoltine species of *Aedes* were poorly represented in this survey because many counties were sampled only in mid or late summer. More recently, Siverly and DeFoliart studied larvae (1968a) and adults (1968b) in northeastern Wisconsin, significantly contributing to our knowledge of spring *Aedes*. A study by Porter and Gojmerac (1970) identified *A. stimulans* as the most important pest in Point Beach State Forest, Manitowoc County, and another study (Gojmerac and Porter 1969) compared pest species of Point Beach State Forest with those of Wyalusing State Park, Grant County, where *A. communis* group species and *A. vexans* predominated. Amin and Hageman (1974) identified *A. stimulans* and *A. vexans* as important springtime pests in southeastern Wisconsin. Other studies that included county records or other information pertinent to this study were carried out by Ryckman (1952), Patel (1959), Thompson (1964), Thompson and Dicke (1965), Thompson and DeFoliart (1966), Loor and DeFoliart (1970), Wright and DeFoliart (1970), Wright et al. (1970), Grimstad (1973), and Kardatzke (1979).

The bionomics of mosquitoes, including almost all species of *Aedes*, was summarized by Carpenter and LaCasse (1955) for North America and by Wood, Dang, and Ellis (1979)

for Canada. Several previous studies in Wisconsin also provided ecological information, especially those by Siverly and DeFoliart (1968a, 1968b). Additional information on larval ecology in nearby states and provinces appeared in Owen (1937), Barr (1958), and Price (1963) for Minnesota; Knight and Wonio (1969) for Iowa; Ross (1947) for Illinois; Matheson (1924), Irwin (1942), Obrecht (1949, 1967), Beadle (1963), and Wilmot, Henderson, and Allen (1987) for Michigan; Christensen and Harmston (1944) and Siverly (1959) for Indiana; Venard and Mead (1953) for Ohio; and Beckel and Atwood (1959) and Steward and McWade (1960) for Ontario. In our "Account of Wisconsin Species," which follows, these references are not cited unless the information differs from our findings.

Methods and Materials

Study areas

Larval and adult *Aedes* populations were surveyed in nine approximately 24-mile-square areas defined by Billmyer (1971) in conjunction with a survey of Wisconsin stoneflies (Fig. 1). These areas were selected as representative of Wisconsin based on topography, geology, soil types, vegetation, and climate. Study areas were located as follows:

Northern: North of T47N, R4–7W in Bayfield and Ashland counties.
Northwestern: T37–40N, R15–18W in Burnett and Polk counties.
Northeastern: T36–39N, R15–18E in Florence, Forest, and Marinette counties.
North central: T33–36N, R2–5E in Lincoln, Oneida, Price, and Taylor counties.
West central: T23–26N, R11–14W in Buffalo, Dunn, and Pepin counties.
East central: T15–18N, R19–22E in Calumet, Fond du Lac, Manitowoc, and Sheboygan counties.
Central: T16–19N, R7–10E in Adams, Marquette, and Waushara counties.
Southwestern: T9–12N, R1E–3W in Crawford, Richland, and Vernon counties.
Southeastern: T2–5N, R14–17E in Jefferson, Rock, Walworth, and Waukesha counties.

Larval collections

Using a long-handled 350-ml dipper, Gilardi collected mosquito larvae from twenty to thirty sites in each study area on two dates between 4 April and 19 May 1988 (Gilardi 1990). The first set of collections was made when most larvae were early instars. The second set was made just prior to, or coinciding with, the first appearance of adults. Larvae were not present in all localities when the first collections were made, and many sites had dried up before they were sampled again. Five dips were taken from each site on each collection date. Each dip was taken from a different area within the site because numbers and species composition may vary with location (Service 1976). Because larvae submerge when disturbed, they were allowed one minute to return to the surface following a disturbance of the habitat (Hocking 1953) before each sample was collected. Larvae were reared to the fourth instar and pupae were reared to adults to facilitate species identifications.

Ten sites in each area were selected for additional larvae collections by Hilsenhoff in 1989 and 1990. Collections were made just prior to first emergence in 1989 (18 April–10 May) and somewhat after first emergence in 1990 (25 April–8 May), with ten dippers of larvae or a maximum of fifty larvae being collected from each site. Identifications of larvae and adults were based on keys and descriptions by Barr (1958) and Wood, Dang, and Ellis (1979). Voucher specimens are in the University of Wisconsin Insect Collection.

Adult collections

Gilardi (1990) also collected adult mosquitoes with an aspirator during the daytime from 6 June to 21 July 1988 as they attempted to feed. Although the propensity to feed in daylight varies among species, effective biting responses were obtained by collecting in heavily vegetated areas where mosquitoes rest during the day, and by disturbing vegetation before obtaining samples. Two sets of collections were taken. The first

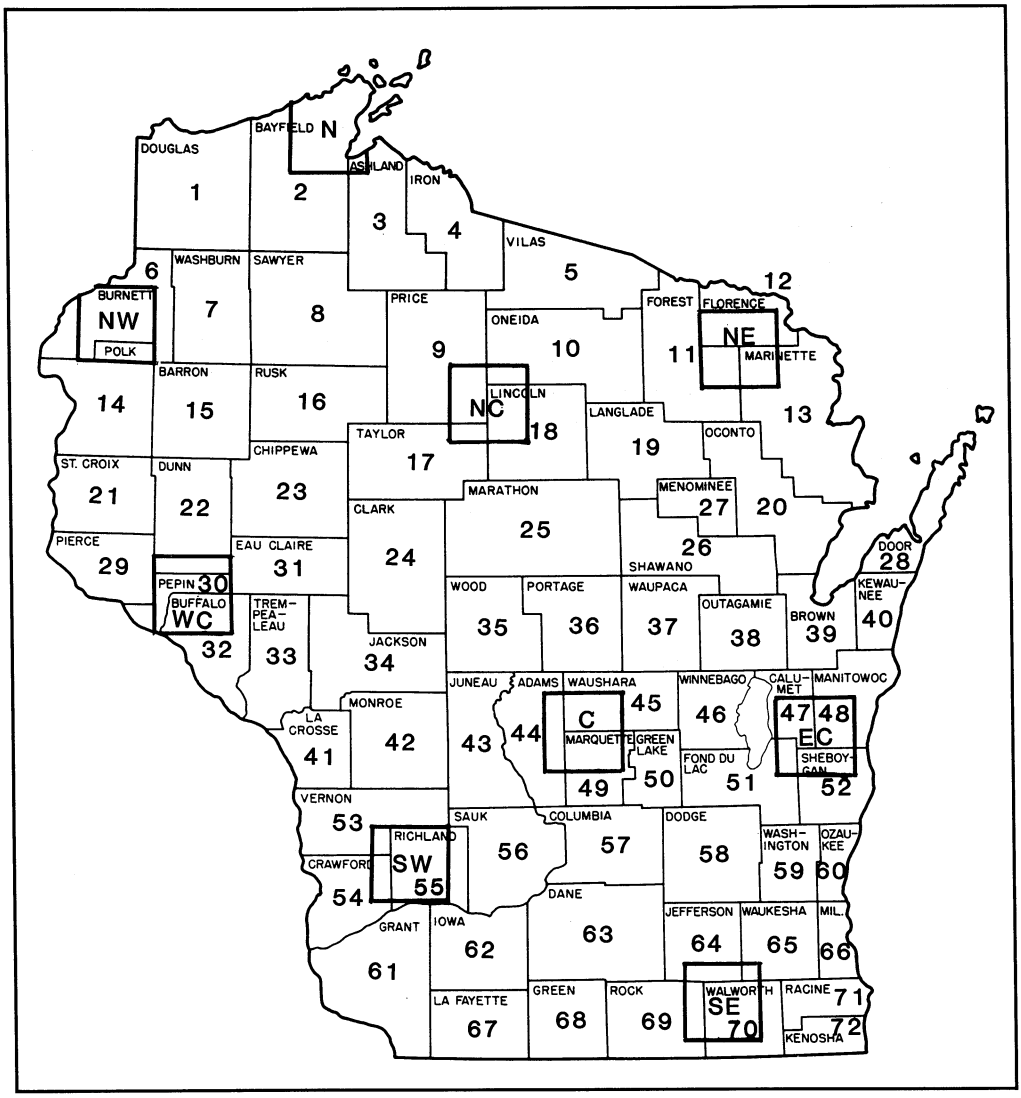

Figure 1. *Nine approximately 24-mile-square study areas selected to be representative of Wisconsin (Billmyer 1971), with a number for each county.*

set approximated peak adult populations. The second was obtained five to six weeks later. Collections were made for a ten-minute period at ten previously identified breeding sites within each study area and also at locations one to five miles from all known breeding areas. Mosquitoes were collected from all areas of the body that could be reached with an aspirator; the head and back were protected with a repellent.

Because female adults of several species of *Aedes* cannot be readily identified after more than a few days of flight, some were often identified only to species group. Two groups are typically recognized for species in this region. The *A. stimulans* group includes the following band-legged species: *A. euedes, A. excrucians, A. fitchii, A. flavescens, A. riparius,* and *A. stimulans*. The *A. communis* group includes the following black-legged species: *A. abserratus, A. cinereus, A. communis, A. decticus, A. diantaeus, A. implicatus, A. intrudens, A. provocans, A. punctor,* and *A. sticticus*.

Results and Discussion

Weather

Prior to the study period in 1988, precipitation ranged from near normal to more than 40% below normal. An early thaw occurred and was followed by cold temperatures, which may have affected the larvae of some species. Kardatzke (1979) determined that larvae of *A. abserratus, A. communis, A. diantaeus, A. provocans,* and *A. punctor* may appear during early thaws in northern Wisconsin and Michigan but subsequently become vulnerable to refreezing. James (1962) documented mortality of *A. provocans* larvae trapped in ice following a thaw in Ontario.

The 1988 study period was characterized by unusually warm temperatures and the onset of a record drought. Small or shallow breeding areas remained dry, and an unusually large proportion of habitats dried before larval development was completed. The spring of 1989 was very dry, and some sites that had been sampled in 1988 contained no water. Very warm temperatures and melting snow in mid-March of 1990 caused an early hatch of *Aedes* larvae, but unseasonably cold temperatures followed, retarding larval development. The onset of very warm weather during the last ten days of April accelerated development and caused rapid pupation and emergence of mosquitoes in most study areas. As a result, larvae of early emerging species were missed or underrepresented at some sites. Except for the northeastern study area, which remained very dry, water levels in 1990 were similar to those in late April of 1988.

Collections

A total of 10,651 larvae and 1,612 adults were collected in 1988, representing twenty of the twenty-three species of spring *Aedes* known to occur in snowmelt habitats in Wisconsin. Included were the first collections of *A. euedes* within the state. The 1988 collections are summarized in Tables 1 and 2. Larval collections from ten selected sites in each area numbered 1,546 in 1989 and 1,600 in 1990, which compares to 1,658 (total adjusted for differences in collecting procedures) from the same sites in 1988 (Table 3). The 1989 samples included the first records of *A. decticus* in Wisconsin.

Species distributions

Crossing the state diagonally is a region of climatic and ecological transition that is reflected in a tension zone of varying width between two major floral regions, the Northern Hardwood-conifer province and the Oak-prairie Province (Curtis 1959). *Aedes communis, A. decticus, A. diantaeus, A. euedes, A. implicatus,* and *A. intrudens* are boreal in Wisconsin, and the southern limit of their range apparently parallels this floral tension zone. Ranges of *A. aurifer, A. canadensis, A. cinereus, A.dorsalis, A. fitchii, A. flavescens, A. sticticus, A. stimulans,* and *A. vexans* encompass the entire state. *Aedes abserratus, A. campestris, A. excrucians, A. provocans, A. punctor, A. riparius,* and *A. spencerii* are probably also present throughout Wisconsin, but may reach their southern limit in southern Wisconsin or northern Illinois. *Aedes campestris, A. provocans,* and *A. riparius* have not been reported from Illinois. *Aedes grossbecki* is represented in Wisconsin by a single specimen from Dane County, which probably represents the northwestern limit of its range.

Geology and soil type also influence the distribution of mosquitoes. Two sections in the Central Lowlands Geomorphic Province of the United States are represented in Wisconsin (Hole 1976), the Wisconsin Driftless Section in the southwestern part of the state, and the Great Lakes Section elsewhere. Mosquito breeding was confined primarily to floodplain marshes and pools in the Wisconsin Driftless Section (southwestern and west central study areas), which limited somewhat the diversity of species collected. Larval habitats were more varied and numerous in the Great Lakes Section (all other study areas). Paleozoic bedrock is present in nearly all areas except a southern extension of the Canadian Shield into the northern third of the state.Certain northern species of *Aedes* were

Table 1. Larvae and collection sites (in parentheses) for species of *Aedes* collected from nine 24-mile-square areas of Wisconsin in the spring of 1988

Species	*Northern*	*North-western*	*North central*	*North-eastern*	*West central*	*Central*	*East central*	*South-western*	*South-eastern*	*Total*
abserratus	1 (1)	31 (6)	37 (14)	20 (7)	2 (1)	23 (4)	2 (2)	1 (1)	6 (2)	123 (38)
aurifer	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)
canadensis	40 (6)	16 (4)	48 (6)	14 (6)	94 (4)	39 (4)	20 (4)	280 (9)	28 (5)	579 (48)
cinereus	14 (7)	73 (18)	106 (14)	12 (7)	44 (7)	12 (6)	28 (10)	5 (1)	32 (8)	326 (78)
communis	5 (2)	0 (0)	0 (0)	162 (11)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	167 (13)
diantaeus	1 (1)	0 (0)	5 (1)	10 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	16 (6)
euedes	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	1 (1)	5 (3)	0 (0)	0 (0)	7 (5)
excrucians	22 (4)	13 (7)	61 (11)	73 (15)	24 (7)	399 (14)	62 (16)	53 (10)	20 (5)	727 (89)
fitchii	1 (1)	3 (2)	4 (3)	30 (4)	7 (3)	71 (5)	2 (2)	7 (5)	4 (3)	129 (28)
flavescens	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	0 (0)	1 (1)	3 (3)
implicatus	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
intrudens	0 (0)	4 (3)	1 (1)	30 (7)	1 (1)	2 (1)	0 (0)	0 (0)	0 (0)	38 (13)
provocans	33 (9)	41 (6)	65 (13)	337 (17)	48 (8)	347 (19)	39 (9)	37 (4)	37 (5)	984 (90)
punctor	1 (1)	3 (3)	29 (10)	118 (11)	1 (1)	10 (2)	1 (1)	3 (1)	4 (1)	170 (31)
riparius	0 (0)	2 (2)	4 (2)	2 (1)	0 (0)	2 (2)	0 (0)	0 (0)	1 (1)	11 (8)
spencerii	3 (2)	2 (2)	2 (1)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	9 (6)
sticticus	1 (1)	1 (1)	5 (2)	1 (1)	14 (3)	1 (1)	2 (1)	3 (2)	0 (0)	28 (12)
stimulans	5 (1)	45 (1)	1 (1)	22 (9)	633 (13)	2,510 (18)	397 (18)	344 (12)	533 (15)	4,490 (88)
vexans	1,006 (7)	1,365 (23)	23 (4)	2 (2)	239 (10)	11 (7)	12 (3)	16 (5)	168 (8)	2,842 (69)
Totals	1,134 (21)	1,599 (30)	391 (30)	836 (28)	1,108 (20)	3,429 (27)	570 (24)	749 (21)	835 (25)	10,651 (226)

Table 2. Adults and collection sites (in parentheses) for species of *Aedes* collected at known breeding sites in nine 24-mile-square areas of Wisconsin in 1988

Species	*Northern*	*North-western*	*North central*	*North-eastern*	*West central*	*Central*	*East central*	*South-western*	*South-eastern*	*Total*
abserratus	0 (0)	0 (0)	6 (2)	0 (0)	0 (0)	3 (1)	0 (0)	1 (1)	12 (2)	22 (6)
aurifer	5 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (1)
campestris	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
canadensis	0 (0)	0 (0)	7 (2)	2 (1)	0 (0)	6 (3)	7 (4)	1 (1)	2 (1)	25 (12)
cinereus	28 (5)	34 (5)	80 (6)	9 (3)	88 (6)	54 (5)	233 (9)	11 (3)	46 (6)	583 (48)
communis group	0 (0)	1 (1)	13 (3)	4 (2)	0 (0)	0 (0)	21 (7)	0 (0)	0 (0)	39 (13)
excrucians	6 (1)	1 (1)	1 (1)	4 (1)	0 (0)	2 (2)	20 (9)	0 (0)	6 (4)	40 (19)
fitchii	2 (1)	0 (0)	4 (2)	11 (2)	1 (1)	11 (5)	53 (9)	0 (0)	7 (3)	89 (23)
provocans	85 (8)	0 (0)	119 (5)	12 (4)	2 (1)	24 (6)	6 (3)	0 (0)	0 (0)	248 (27)
stimulans group	3 (2)	1 (1)	3 (2)	2 (2)	27 (5)	152 (10)	235 (10)	43 (5)	33 (6)	499 (43)
vexans	2 (2)	13 (6)	0 (0)	0 (0)	33 (4)	10 (6)	0 (0)	1 (1)	2 (2)	61 (21)
Totals	132 (10)	50 (10)	233 (10)	44 (10)	151 (10)	262 (10)	575 (10)	57 (10)	108 (10)	1,612 (90)

associated with the latter area (Wood, Dang, and Ellis 1979).

Larval phenology

Based on larval collections and rearing, the order of appearance of fourth instar larvae approximated the following sequence: (1) *A. spencerii;* (2) *A. implicatus, A. intrudens, A. provocans;* (3) *A. communis, A. diantaeus, A. punctor, A. sticticus, A. stimulans;* (4) *A. abserratus, A. aurifer, A. excrucians, A. euedes, A. flavescens;* (5) *A. canadensis, A. fitchii, A. riparius;* (6) *A. cinereus, A. vexans*. Larval development of most species was synchronized, with nearly all members of a given species entering the fourth instar within a week or less in the same region. Exceptions were *A. cinereus* and *A. vexans,* which often had staggered emergence periods.

The central sandy uplands and plains, and northern loamy uplands and plains, respond quickly to seasonal warming (Hole 1976). Larval development in these regions was considerably advanced relative to development on other soils.

Adult dispersal

Aedes canadensis, A. cinereus, A. excrucians, A. fitchii, A. provocans, A. stimulans, and *A. vexans* were frequently collected within two miles of known breeding sites. Collections at greater distances did not occur for *A. excrucians* and were infrequent for the other six species. These observations are similar to reports of *Aedes* flight ranges by Jenkins and Hassett (1951), Neilsen (1957), Burst (1980), Washino (1984), and Joslyn and Fish (1986), although many workers have cited much greater flight ranges for *A. vexans* during the summer. Horsfall et al. (1973) indicated that dispersal varies with environmental conditions and may be thwarted in *A. vexans* populations that emerge in the spring before evening temperatures are conducive to flight.

Table 3. Larvae of each species of *Aedes* collected from ten selected sites in each of nine 24-mile-square study areas in 1988, 1989, and 1990

Species	*Year*	*N*	*NW*	*NC*	*NE*	*WC*	*C*	*EC*	*SW*	*SE*	*Total*
abserratus	1988	1	13	5	4	0	9	1	1	0	34
	1989	3	23	35	6	0	0	2	0	0	69
	1990	5	18	58	42	0	0	0	0	0	123
aurifer	1988	0	0	0	0	0	0	0	0	1	1
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
canadensis	1988	23	8	24	1	0	3	0	44	0	103
	1989	0	2	41	0	0	0	0	0	0	43
	1990	61	0	22	0	0	0	18	7	0	108
cinereus	1988	7	28	2	6	7	0	7	5	1	63
	1989	3	44	9	7	3	1	1	0	0	68
	1990	43	19	66	0	3	0	5	0	1	137
communis	1988	2	0	0	51	0	0	0	0	0	53
	1989	100	0	19	58	0	0	0	0	0	177
	1990	9	0	0	9	0	0	0	0	0	18
decticus	1988	0	0	0	0	0	0	0	0	0	0
	1989	0	0	4	2	0	0	0	0	0	6
	1990	0	0	0	0	0	0	0	0	0	0
diantaeus	1988	1	0	5	5	0	0	0	0	0	11
	1989	3	0	3	0	0	0	0	0	0	6
	1990	6	0	0	5	0	0	0	0	0	11
euedes	1988	0	0	0	0	0	0	1	0	0	1
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	1	0	0	6	0	0	7
excrucians	1988	17	4	27	33	17	66	23	15	11	213
	1989	64	7	7	61	4	10	8	4	1	166
	1990	131	84	18	19	0	36	27	2	0	317
fitchii	1988	1	1	1	0	4	50	1	2	0	60
	1989	5	0	0	4	0	20	7	1	2	39
	1990	11	13	4	9	2	18	18	0	0	75
flavescens	1988	0	0	0	0	0	1	0	0	1	2
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
implicatus	1988	1	0	0	0	0	0	0	0	0	1
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
intrudens	1988	0	0	1	2	0	2	0	0	0	5
	1989	4	0	0	0	0	1	0	0	0	5
	1990	0	0	0	0	0	0	0	0	0	0
provocans	1988	16	18	31	38	28	76	12	2	18	239
	1989	88	7	64	132	0	48	0	0	0	339
	1990	24	28	30	39	0	24	0	0	0	145
punctor	1988	1	0	7	5	0	8	0	3	0	24
	1989	10	0	20	12	0	0	0	0	0	42
	1990	4	1	70	65	0	0	0	0	0	140

Continued on next page

Table 3—*Continued*

Species	*Year*	*N*	*NW*	*NC*	*NE*	*WC*	*C*	*EC*	*SW*	*SE*	*Total*
riparius	1988	0	1	0	0	0	1	0	0	0	2
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
spencerii	1988	1	0	2	0	0	0	0	0	0	3
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
sticticus	1988	0	0	0	0	3	0	0	0	0	3
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	0	0	0	0	0	0
stimulans	1988	5	0	1	18	152	201	94	55	51	577
	1989	27	0	0	5	87	210	167	22	68	586
	1990	14	8	0	0	23	157	112	84	58	456
vexans	1988	0	210	20	0	15	1	9	7	1	263
	1989	0	0	0	0	0	0	0	0	0	0
	1990	0	0	0	0	61	1	0	1	0	63
Totals	1988	76	283	126	163	226	418	148	134	84	1,658
	1989	307	83	202	287	94	290	185	27	71	1,546
	1990	308	171	268	189	89	236	186	94	59	1,600

Adult longevity

Because drought prevented additional broods of multivoltine spring *Aedes* in 1988, this study provided an unusual opportunity to identify persistent components of spring populations. The second set of adult collections yielded *A. aurifer, A. campestris, A. cinereus, A. stimulans* group, and *A. vexans*. *Aedes stimulans* group adults are frequently reported to persist into August and occasionally September. Carpenter and Nielsen (1965) reported a seventy-two–day biting period for *A. campestris,* and Horsfall et al. (1973) concluded that the typical lifespan of spring generation *A. vexans* females is about seventy-two days. At the opposite extreme, the nuisance potential of *A. provocans* was offset by its brief adult lifespan. Adult collections of this species were primarily a measure of how recently it had emerged in a given area. Wood, Dang, and Ellis (1979) noted that adults of this early species were seldom seen in Canada after other spring *Aedes* had emerged.

Account of Wisconsin species

***Aedes abserratus* (Felt and Young, 1904)** = *Aedes implacabilis* of authors before 1954, except Walker, 1848. County records (Fig. 1): 2, 6, 9, 11–13, 18, 32, 45, 48,* 49, 51, 52, 55, 63,* 64, 65,* 69. (Asterisks indicate published records only.)

Aedes abserratus was fairly common statewide. Larvae were almost always associated with *Sphagnum* in swamps, bogs, shrubby marshes, and woodland pools. Larvae developed in essentially the same habitats occupied by *A. punctor,* but *A. abserratus* larvae were more prevalent in sandy regions, and *A. punctor* larvae were more prevalent in and around *Sphagnum* bogs. Other researchers also noted the association of larvae with *Sphagnum* among shrubs or trees.

***Aedes aurifer* (Coquillett, 1903).** County records (Fig. 1): 2, 13,* 17,* 18,* 35,* 43,* 46,* 51,* 52,* 57,* 61,* 63,* 70.

This statewide species is apparently rare in early spring breeding sites in Wisconsin. In 1988 a single larva was collected from a large, open cattail pond in the southeastern study area, and five adults were collected near a small woodland lake in the northern study area. Other studies in Wisconsin resulted in the collection of a limited number of specimens. Breeding sites reported from

nearby states and provinces include permanent and semipermanent bodies of water, cranberry bogs, river-overflow areas, woodland pools, and roadside habitats, with larvae frequently being collected away from shoreline areas.

Aedes campestris **Dyar and Knab, 1907.** County records (Fig. 1): 2, 52,* 63.*

Aedes campestris is apparently rare in Wisconsin in the spring; it may occur more commonly in the summer. A single adult was collected in the northern study area from a row of trees surrounded by open farmland. This species was found during three surveys in Dane County and was represented by only three specimens in the State Board of Health General Survey (Allen 1950). Elsewhere in the United States and Canada, it was usually found in open areas; larvae were reported to develop in alkaline prairie pools, especially those with a high organic content.

Aedes canadensis **(Theobald, 1901).** County records (Fig. 1): 2, 5,* 6, 9, 11–13, 17,* 18, 22, 30, 34,* 35,* 37,* 45,* 46,* 48,* 49, 52, 55, 56 (unpublished), 57,* 58,* 63,* 64, 69, 70, 71,* 72.*

This species was fairly common statewide. Larvae were most abundant in woodland seepage pools in the south and boggy areas in the north but also occurred in sedge-cattail marshes. Many researchers in nearby states to the south of Wisconsin noted that woodland pools, especially those associated with streams, are a preferred habitat. Others in northern states and provinces noted an association with *Sphagnum*.

The limited number of adults that were collected may be attributed to the wide range of hosts that are attractive to this species. Limited biting activity was also noted in Wisconsin by DeFoliart (1967), and Carpenter and LaCasse (1955) observed that this species is seldom a pest in the eastern half of its range, even when present in considerable numbers. Several authors have noted that adults often feed on turtles (Crans 1964; Hayes 1965; Nolan, Moussa, and Hayes 1965; DeFoliart 1967; Crans and Rockel 1968). Nevertheless, adults are known to readily attack humans, and they may be an important pest in some areas of Wisconsin, most notably in woodland seepage areas.

Aedes cinereus **Meigen, 1818.** County records (Fig. 1): 1,* 2, 4,* 5,* 6, 7,* 9, 11–14, 17,* 18, 19,* 22, 23,* 30, 32, 34,* 35–37,* 39,* 41,* 43,* 44, 45,* 48,* 49, 51, 52, 55, 57,* 58,* 61–63,* 64, 65, 66,* 69, 70, 71,* 72.*

Larvae were fairly common in a wide variety of habitats but were mostly found in sedge and cattail marshes or in bogs. They were especially common in the northern, northwestern, and north central study areas. Often several instars were present at the same time, indicating a staggered emergence. The wide variety of larval habitats was noted previously in Wisconsin and by many workers in nearby states and provinces.

Adults attacked readily throughout the day in woodlands, where they were often encountered in considerable numbers. This species was identified as a pest throughout Wisconsin in the State Board of Health General Survey (Allen 1950); it was the second most numerous species biting humans in Iowa County (Loor and DeFoliart 1970).

Aedes communis **(De Geer, 1776).** County records (Fig. 1): 2, 5,* 9, 11–13, 18, 35,* 48,* 63,* 72.*

This boreal species is an important pest of the Canadian Shield. Larvae were collected only in the northern, north central, and northeastern study areas, where they were the predominant or only species in certain sites. They occurred only within soils of loamy uplands and plains. Here they were found in vernal ponds, mostly in woodlands and partially shaded areas, and along margins of swamps and leatherleaf bogs. Larvae were especially common in 1989; they were much less common in 1988 and 1990. Rapid drying of habitats in 1988 and possible emergence before completion of sampling in 1990 may have contributed to lower numbers of larvae in these years. Siverly and DeFoliart reported this to be the most numerous species in larval collections from Forest County (1968a), and the second most abundant spring mosquito

in adult collections from five northeastern counties (1968b). Workers in nearby states and provinces reported *A. communis* larvae from habitats similar to those described above and also noted that they often occur exclusively or nearly so in large numbers. Irwin (1942) found that larvae were particularly abundant in rapidly drying pools and shallow habitats in central Michigan; Gjullin et al. (1961) indicated that adults frequently emerged just before larval habitats in Alaska had dried.

Aedes decticus **Howard, Dyar, and Knab, 1917.** County records (Fig. 1): 12, 18.

In 1989 six larvae were collected in northeastern Wisconsin from two sites that contained *Sphagnum*. They represent the first records of this species for the state. Four larvae were found in an open leatherleaf bog; the other two were collected from a spruce-tamarack swamp. In the western Great Lakes region other studies associated larvae of this relatively rare species with *Sphagnum*.

Aedes diantaeus **Howard, Dyar, and Knab, 1917.** County records (Fig. 1): 2, 8,* 9, 11,* 12, 13, 18.

This boreal species occurred uncommonly in northern Wisconsin. Larvae were collected from margins of swamps or from pools in alder (*Alnus*) thickets and were usually associated with *Sphagnum* and alders and almost always with larvae of *A. punctor*. Siverly and DeFoliart (1968a) identified a productive breeding site in Forest County where larvae occurred in stump holes "formed by cedar and hemlock windthrow." They also obtained modest numbers of adults from five northeastern counties (1968b). Prior to their study this species was represented in Wisconsin by a single adult from Sawyer County (Smith 1952). Other studies in our region associated larvae with *Sphagnum* pools and alders or woodland pools.

Aedes dorsalis **(Meigen, 1830).** County records (Fig. 1): 19,* 63,* 64,* 72.*

Aedes dorsalis adults may emerge later than those of most species of spring *Aedes* in Wisconsin, where they have usually been collected in small numbers, mostly during the summer. No specimens were collected in this study. In other states and provinces larvae of this species were reported to occur in alkaline and saline pools and also in ponds that are rich in organic matter. Outside of the prairie region larvae were usually associated with industrial wastes.

Aedes euedes **Howard, Dyar, and Knab, 1917 =** *Aedes barri* Rueger, 1958. County records (Fig. 1): 11, 13, 49, 51, 52.

Aedes euedes larvae were found only in the northeastern, central, and east central study areas, where they were uncommon. Seven were collected in 1988 and seven more in 1990. These are the only records of this species from Wisconsin. Larvae were collected in association with cattail marshes containing scattered ash trees (*Fraxinus*) or from rather open pools adjacent to woodlands. Wood, Dang, and Ellis (1979) associated larvae with large open marshes having dense accumulations of decomposing sedges and cattails. Wilmot, Henderson, and Allen (1987) reported larvae from several woodland pools in Michigan, while Price (1963) found larvae in nearly all habitats he sampled in northern Minnesota.

Aedes excrucians **(Walker, 1856).** County records (Fig. 1): 2, 4,* 6, 7,* 9, 11–14, 18, 28,* 30, 39,* 41,* 42,* 44, 45, 48,* 49, 51, 52, 55, 57,* 58,* 63,* 64, 65, 66,* 68,* 69, 70, 71,* 72.*

Aedes excrucians larvae were common in all study areas and occurred in more different sites and habitats than larvae of any other species. They were almost always found in association with larvae of other species and usually were not the dominant species. The relatively ubiquitous larvae were most common in marshes and margins of swamps. It was the most abundant larva that Siverly and DeFoliart (1968a) collected in Lincoln County, where it occurred in unshaded grassy pools and ditches. In nearby states and provinces all researchers reported larvae from a variety of habitats.

Aedes fitchii **(Felt and Young, 1904).** County records (Fig. 1): 2, 4,* 5,* 6, 7,* 9, 11–14, 18, 19,* 22,* 28,* 30, 35,* 37–39,* 43,* 44, 45, 48,* 49, 51, 52, 55, 57,* 58,*

63,* 64, 65, 66,* 69, 70, 71.*

Larvae of *A. fitchii* were fairly common statewide. They were almost always associated with larvae of *A. excrucians* and/or *A. stimulans* and were never the dominant species in collections. Larvae were most common in marshes but also occurred in drainage ditches, woodland pools, and margins of swamps and bogs. Siverly and DeFoliart (1968a) reported that *A. fitchii* larvae occurred in a wider range of habitats than *A. excrucians* in northeastern Wisconsin. Other researchers in our region found that larvae inhabited mostly marshes and rarely were associated with *Sphagnum*.

Although *A. excrucians* outnumbered *A. fitchii* in larval collections, the opposite was true in adult collections. This may be partially attributed to the greater propensity of *A. fitchii* to invade woodlands, where biting counts were made. In addition, since adults of *A. fitchii* emerge later than those of *A. excrucians,* they would have experienced less mortality prior to the collection of adults in June and July.

***Aedes flavescens* (Müller, 1764).** County records (Fig. 1): 2,* 5,* 32, 43,* 49, 60,* 63,* 65,* 69, 72.*

This species was rare in our study. It was reported to be sporadic over most of its range and common only in prairies (Wood, Dang, and Ellis 1979). Three larvae were collected in the southern half of the state, one from a woodland pool, another from a cattail pond, and the third from a glacial kettle. Siverly and DeFoliart (1968b) collected a single adult from northeastern Wisconsin. In other areas of the western Great Lakes region larvae were associated with grassland pools and marshes, cattail ponds, and by Irwin (1942) with woodland pools.

***Aedes grossbecki* Dyar and Knab, 1906.** County record (Fig. 1): 63.*

Aedes grossbecki is represented in Wisconsin by a single adult from the University of Wisconsin–Madison Arboretum (Thompson and DeFoliart 1966). This southern woodland species was reported to be common in southern Illinois and rare northward (Ross 1947; Ross and Horsfall 1965).

***Aedes implicatus* Vockeroth, 1954 =** *Aedes impiger* of authors before 1954, except Walker, 1848. County records (Fig. 1): 2, 9 (unpublished), 11,* 48.*

Aedes implicatus is apparently a rare boreal species in Wisconsin. In the northern study area a single adult was reared from a pupa that was collected from a marsh that contained willows and was next to a stream. Siverly and DeFoliart, who first reported this species in Wisconsin, obtained a single larva from a coniferous woodland stump hole in Forest County and one adult nearby (1968a); they also collected one adult from an unspecified location in northeastern Wisconsin (1968b). Porter and Gojmerac (1970) reported small numbers of adults emerging from woodland pools in Point Beach State Forest, Manitowoc County. In Colorado, Smith (1965) found larvae in "small shallow pools left by receding streams and shaded by willow thickets"; Wood, Dang, and Ellis (1979) obtained large numbers of larvae from a similar habitat in Ontario. Other workers found larvae mostly in temporary woodland habitats and *Sphagnum* bogs.

***Aedes intrudens* Dyar, 1919.** County records (Fig. 1): 2, 5,* 6, 9 (unpublished), 11–13, 18, 28,* 30, 44, 48,* 49, 63,* 72.*

Larvae were rare, but those that were collected were found in all types of habitats except ditches. The varied larval habitat was also noted by other researchers in our region, with *Sphagnum* bogs and woodland pools the most frequently mentioned habitats.

***Aedes provocans* (Walker, 1848) =** *Aedes trichurus* (Dyar, 1904). County records (Fig. 1): 2, 6, 9, 11–14, 18, 30, 32, 44, 45, 49, 51, 52, 55, 64, 70.

Aedes provocans larvae were very common in all study areas. Although they were collected most frequently from marshes and woodland pools, larvae were rather common in all types of habitats that were sampled, especially open, temporary sites such as grassy ditches and grassland pools. In northeastern

Wisconsin, Siverly and DeFoliart (1968a) associated larvae with grassy pools. The varied nature of the larval habitat was also reported in studies in nearby states and provinces.

***Aedes punctor* (Kirby, 1837).** County records (Fig. 1): 2, 5,* 6, 9, 11–13, 18, 30, 35, 45,* 48,* 49, 52, 55, 57,* 65,* 69.

Larvae of *A. punctor,* an important pest of the boreal forest, were common in the north central and northeastern study areas and uncommon elsewhere. They were the most numerous larvae in the northeastern study area, and also in the study by Siverly and DeFoliart (1968a) in northeastern Wisconsin. Among species we commonly collected, *A. abserratus* and *A. punctor* were most often coincident in larval habitats; *A. punctor* larvae appeared in more than three-fourths of the sites known to be inhabited by larvae of *A. abserratus*. During a seven-year study in Minnesota, Price (1963) observed that *A. punctor* larvae occurred in all habitats that had yielded *A. abserratus* larvae. While larvae were collected from a variety of habitats, they most frequently occurred in *Sphagnum* bogs and, to a lesser extent, in woodland pools with *Sphagnum*. Most researchers in nearby states and provinces mentioned that larvae were associated with *Sphagnum* and shrubs or trees. The exception was Steward and McWade (1960), who found larvae in Ontario in virtually all types of standing water, most commonly in woodland pools.

***Aedes riparius* Dyar and Knab, 1907.** County records (Fig. 1): 6, 9, 12, 28,* 43,* 45, 49, 51,* 63,* 64, 65.*

Aedes riparius is apparently rare in Wisconsin. Only four specimens were found in the State Board of Health survey (Allen 1950). Larvae were collected in small numbers from several habitats but most frequently were found in marshes. Researchers in nearby states and provinces also collected larvae mostly from marshes that frequently contained some scattered trees or shrubs, or had trees along their margins.

***Aedes spencerii* (Theobald, 1901).** County records (Fig. 1): 2, 5,* 6, 9, 12, 13,* 32,* 51,* 52,* 58,* 63,* 69.*

Aedes spencerii is apparently uncommon in Wisconsin. A few pupae were collected in northern areas during the first set of larval collections in 1988; in 1989 and 1990 adults had probably emerged before larval collections were made. All pupae were collected from open habitats, including grassland pools, a sedge marsh, a *Sphagnum* bog, and a small pond. In adjacent states larvae were reported from grassland pools, marshes, and bogs. Wood, Dang, and Ellis (1979) indicated that this species has been underrepresented or overlooked in several studies because of its early appearance, noting that pupae were present when larvae of other spring *Aedes* were about half grown.

***Aedes sticticus* (Meigen, 1838).** County records (Fig. 1): 2, 6, 11, 18, 30, 32, 35,* 42,* 48,* 49, 52, 55, 67.*

Larvae develop throughout the state primarily in floodwater pools along streams. Although rare in this study because of the drought in 1988, *A. sticticus* larvae may become exceptionally numerous near streams after unusually heavy snowmelt and/or rain. It was identified as a pest in Manitowoc County (Porter and Gojmerac 1970). Adults were collected in considerable numbers in Wood County (Wright et al. 1970) and in five northeastern counties (Siverly and DeFoliart 1968b).

Cook, Bodine, and Wermerskirchen (1974) studied the biology of this species in the Twin Cities area just west of Wisconsin. Eggs were laid along the periphery of flooded areas and accumulated in river floodplains and bottomlands during intervals between extensive floods. They remained viable for several years under drought conditions and hatched after flooding. In Canada, Wood, Dang, and Ellis (1979) observed that *A. sticticus* populations are almost always associated with *A. vexans,* but that the converse is seldom true "because *A. vexans* develops in summer rainpools after local flooding, whereas *A. sticticus* requires extensive flooding, which only follows widespread excessive precipitation."

***Aedes stimulans* (Walker, 1848).** County

records (Fig. 1): 2, 4,* 5,* 6, 11–14, 18, 19,* 22, 28,* 30, 32, 37,* 39,* 44, 45, 47, 48,* 49, 51–53, 55, 57–59,* 61,* 63,* 64, 65, 66,* 69, 70, 72.*

Larvae of *A. stimulans,* the most numerous species in this study, were found in a variety of habitats but were collected most frequently and in largest numbers from marshes, temporary ponds, and woodland seepage pools, including river valley sites. Some ditches and grassy pools near marshes also harbored large populations. In other studies larvae were most often associated with woodland pools. In Minnesota, however, Owen (1937) mentioned grassland pools as a preferred larval habitat, while Price (1963) observed that they prefer marshes but often occur elsewhere.

Adults were the most important nuisance in central and southern Wisconsin in May and early June, but they were uncommon in much of the north. Siverly and DeFoliart (1968a) noted a virtual absence of this species in northeastern counties. A similar pattern is evident in other studies in this region. Wood, Dang, and Ellis (1979) associated large populations south of the Ottawa area with paleozoic sediments, and the general scarcity northward with the Precambrian Shield, implicating acidity as a possible limiting factor. The largest collection of larvae from the four northern study areas in 1988 (outnumbering all other northern collections combined) was taken from a site in the northwestern study area that is not on the Precambrian Shield.

***Aedes vexans* (Meigen, 1830).** County records (Fig. 1): 2, 5,* 6, 9, 11, 13, 14, 17,* 18, 22, 29,* 30, 32,* 34,* 35,* 37–39,* 41,* 42,* 44, 46,* 47, 48,* 49, 50,* 51, 52, 53,* 54,* 55, 56–58,* 61–63,* 64, 65–68,* 69, 70, 71,* 72.*

Aedes vexans, the most important pest mosquito during the summer and fall in most areas of Wisconsin, was a variable component of spring populations. It was the second most abundant species in larval collections in 1988, larvae were absent in 1989, and larvae were numerous only in the west central study area in 1990. This was probably the result of more extensive flooding of habitats by early spring rains in 1988. Adults, however, were found in small numbers in 1988 because many habitats dried before larval development was completed. Larvae were collected from all types of habitats, but more than 85% were found in marshes and grassland pools, and only about 1% were from woodland pools and *Sphagnum* bogs. Shallow, open, grassy depressions were identified as primary breeding areas by workers in nearby states and provinces. However, Horsfall et al. (1973) and Wood, Dang, and Ellis (1979) observed that woodland habitats can also harbor large populations.

Larvae were collected most frequently and in largest numbers within areas containing sandy or loamy soils, which corroborates findings in other states (Horsfall et al. 1973). Siverly and DeFoliart collected substantial numbers of larvae (1968a) and adults (1968b) in parts of a five-county area in northeastern Wisconsin that were dominated by such soils. Horsfall et al. (1973) indicated that this species is very local or absent in northern Michigan wherever black-legged species such as *A. communis* and *A. punctor* are abundant. A predominance of *A. communis* group species and scarcity of *A. vexans* were evident in most larval collections by Siverly and DeFoliart (1968a).

Possible additional species

***Aedes pionips* Dyar, 1919.** This univoltine northern species was reported from Itasca State Park, Minnesota (Barr 1958; Price 1963), Isle Royale, Michigan (Cassani and Newson 1980); and Ontario (Wood, Dang, and Ellis 1979). It was reported to be common in the boreal forest region and rare or local southward.

***Aedes pullatus* (Coquillett, 1904).** Earlier reports of *A. pullatus* from Michigan by Irwin (1942) were questioned by Barr (1958) and Wood, Dang, and Ellis (1979), and because of their distance from established records and an apparent lack of more recent material, they were discounted by Darsie and Ward (1981). However, based on unpublished data of Wagner and Newson from 1971,

Cassani and Newson (1980) reported *A. pullatus* from six counties in the northern half of Michigan. Other records show an unusual disjunct distribution of this univoltine species in northwestern and northeastern North America, which may be a result of glacial history (Wood, Dang, and Ellis 1979).

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Symbolism in the Cave of Montesinos

James T. Abraham

The episode of the Cave of Montesinos in *Don Quixote* has become one of the most analyzed and interpreted incidents in modern literary history. Most critics agree that it is the crucial moment in the work because, as Gethin Hughes states, "We witness the confrontation of two worlds in Don Quixote's mind—the chivalric and the real" (112). The novel takes a different direction after Don Quixote resurfaces and tells the story of his "grande adventura de la cueva de Montesinos." This is the only adventure that Don Quixote faces alone, so it gives us the best opportunity to study his psychological state. By analyzing the dream, we can better understand Don Quixote's madness. This paper discusses the symbols and their meanings in the dream and the significance of the dream itself.

Sigmund Freud wrote in his book, *The Interpretation of Dreams,* that all dreams have meaning. The meaning of a dream can be interpreted through the symbols that appear in the dream itself. The incident in the Cave of Montesinos is rich in symbolization. In the dreamwork Don Quixote descends into a legendary cave and encounters a beautiful landscape and crystal palace. He meets several famous characters, all demonstrating bizarre behavior. Upon seeing his enchanted mistress, the knight is elated but confused by her actions. Finally Don Quixote ascends back into the "real" world only to find his friends criticizing the cave, the adventure, and Don Quixote himself. Analyzing dreams and their significance is part of the psychoanalytic process developed by Freud around the turn of the century. Psychologists today still use the guidelines set down by Freud to analyze dreams. The ideas presented in this paper suggest possible explanations for the dream and even Quixote's madness by using psychoanalytical theories.

The first symbol we encounter is the cave itself. Don Quixote is familiar with the legend surrounding the cave and insists on stopping at it on his way to Barcelona. He wants to descend into the cavern and see "si eran verdaderas las maravillas que de ella se decían por todos aquellos contornos (if they were true, the wonders that were spoken of the cave in those parts)" (Cervantes, *Don Quixote,* 435). Before entering the cave, Don Quixote must chop his way through thick brush to find the entrance and fend off bats, owls, and other nocturnal birds. Quixote has intense drive and needs to experience what the cave holds. He is not afraid of his destiny and is, in this case, actively pursuing his future.

The cave itself is "a maternal symbol that excites curiosity" (Becker, 149). It is a positive symbol because caves were often used as oracles. In the pastoral novel of Spain, the cave was the entrance to the underworld. According to Frederik de Armas, caverns were "the source of power of magicians, wisdom of prophets and inspiration of poets" (Armas, 337). They were used to communicate with the dead. Carl Jung believed the cave represents the unconscious. Cervantes did not use caves in his pastoral novels because of

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their demonic connotations but reversed his fear in *Don Quixote* and *La cueva de Salamanca*.[1] The use of a cave by Cervantes signals something very important. In this case, the cave symbolizes a mystical realm in the unconscious mind of Don Quixote where he can come in contact with the souls of his fallen brethren and chivalric heroes from an age regrettably now past.

This magical place where knights live is known to Alonso Quijano only through the books of chivalry that have driven him mad. The old man's love and belief in the Age of Chivalry, yet total lack of experience in it, mirror in reverse his adventures. In the novels of chivalry, the aspiring knight learned of rules and codes of conduct to be followed by all in order to establish order amidst chaos. But *El Caballero de la Triste Figura,* upon putting on armor and accepting the charge of knighthood, has come to learn that being a knight is not an easy endeavor. He is battered and trampled, disgraced and dishonored. Needing rest and a return to the code of chivalry, Quixote sets out on a pilgrimage to the cave of Montesinos. But the cave is much more than just another place to explore. He seeks in the maternal symbol a return to his novels, to security, to the womb. This is evident when Don Quixote resurfaces and begins to tell his story. Sancho, solidly fixed in the "real" world of the novel, calls the cave a pit. Don Quixote becomes enraged and demands that Sancho and the scholar not call it a pit. With great emotion, he chastises them saying, "Dios os lo perdone, amigos; que me habéis quitado de la más sabrosa y agradable vida y vista que ningún humano ha visto ni pasado (God forgive you friends because you have taken me from the most pleasurable life that any human has seen or experienced)" (Cervantes, *Don Quixote,* 438). On the surface Quixote may be defending the honor of his mother since the cave is a maternal symbol. However, I believe he is really defending his entire chivalric world and the fact that it exists. No part of his "world" may be put into question because it is founded on such unsteady ground that it could easily be toppled.

Deeper into the symbolism, we can look at the bell that Don Quixote forgets to put on. The bell is a symbol of reality and his link to the world outside the cave. It is proof that he is moving in the flesh and blood world of reality. If he had been wearing the bell, Sancho and the scholar would surely have yanked him back into reality when it stopped making a sound, thus ending any possible adventure. Without it, however, the knight is free to roam in the unknown and experience all the "maravillas" of the cave. He is free to step out of reality and explore the world of fantasy.

Another symbol that is part of the old knight's entrance into the cavern is the rope used to lower him. Becker states that a rope represents the sexual act (84). The smooth walls of the cave represent erect bodies according to Freud (109). Therefore, Don Quixote's descent by means of a rope, past the smooth walls of the cave, symbolizes what Don Quixote knows little about—sex. The effect is to emphasize the fact that Don Quixote is breaking new ground with respect to the world of his heroes and his own sexuality.

Once inside the cave, Don Quixote sees a beautiful place that only nature could create. He is not sure whether he is asleep or awake but soon convinces himself that he has all his faculties. Could the knight be in paradise? I believe so, at least the paradise that the knight Don Quixote de la Mancha has envisioned. The beautiful landscape emphasizes the idyllic nature of the dream. In this ideal land, Quixote spies a crystal castle. Crystal represents the self (Becker, 154), and here Don Quixote is looking into a mirror. He sees himself as a majestic, strong, and royal personage equal to his ideals. He has created in his mind the perfect reincarnation of himself and his beliefs.

Soon after creating his heaven, Quixote meets its first inhabitant, the old Montesinos. The knight describes Montesinos as "vestido

con un capuz de bayeta morada, que por el suelo le arrastraba, ceñíale la cabeza una gorra milanesa negra, y la barba, canísima, le pasaba de la cintura (He was clad in a long mourning cloak of purple baize, which trailed upon the ground; over his shoulders and breast he wore a kind of collegiate tippet of green satin, his hoary beard reaching below his girdle)'' (Cervantes, *Don Quixote,* 439). Is this the image of God in Don Quixote's mind? Not exactly. Becker says kings or queens represent parents (85); Montesinos represents Don Quixote's father. Quixote further proves this when he says, ''El continente, el paso, la gravedad y la anchísima presencia, cada cosa de por sí y todas juntas, me suspendieron y admiraron (His mien, his gait, his gravity, and his goodly presence each singly and conjointly filled me with surprise and admiration)'' (Cervantes, *Don Quixote,* 439). Just as a child respects his parents, Don Quixote looks up to Montesinos and respects him.

Montesinos has been analyzed by many critics, and all have found different things about him strange. He is a figure from medieval Spanish ballads in the region of La Mancha. Carrol B. Johnson, in his book, *Madness and Lust,* remarks that although Montesinos is dressed in a scholarly way, he does not know all the answers. He does not know how to disenchant all the people in the cave or whether he used a ''daga'' (dagger) or a ''puñal buido'' (dirk) to take out his friend Durandarte's heart. Even more startling to Quixote is the fact that Montesinos is not familiar with the beautiful Dulcinea (163). Johnson interprets these uncertainties as Don Quixote's own or, much more likely, as those of his father (163). Just as a rebellious teenager believes that his parents do not know what is best, Don Quixote questions Montesinos.

A theme discussed by E. C. Riley is the absurdity of Montesinos. The picture given us of Montesinos does not fit the image of a great knight. He is holding a rosary with beads the size of chestnuts and ostrich eggs. He does not evoke awe or fear as a great knight of his time would, but rather appears ridiculous. Further highlighting the absurdity of Montesinos is the fact that his best friend, Durandarte, was to have had a heart that weighed two pounds.[2] Riley writes, ''These ridiculous details puncture the fabric of his (Don Quixote's) chivalric vision'' (142). He believes these elements are meant to mock Don Quixote and his principles (142). They emphasize the ridiculous nature of the dream and the old knight himself.

Soon after meeting Montesinos, Don Quixote asks the old man if the legend surrounding the removal of his best friend's heart is true. Montesinos answers ''yes,'' and the fact that there is a question about the dagger leaves us to wonder about its significance. The knife is a masculine symbol. The appearance of a masculine element within the womb causes much fear in Don Quixote. Johnson believes the dagger symbolizes Quixote's fear of castration and the castrating female (167). This symbol is a manifestation of his inability to interact with women and probably stems from an unresolved problem in the Oedipal stage of his childhood (Johnson, 167).

Next, Don Quixote meets the zombie Durandarte. Named for Roland's sword, he is Don Quixote's image of the ideal knight. Johnson believes Durandarte is identifiable to Don Quixote because they are both knights and both have hairy, bony hands that show great strength. Don Quixote identifies with him but is afraid when he realizes that Durandarte is no longer a powerful knight. Because Durandarte and a sword are so closely related, Johnson associates Durandarte to the phallus through symbolization (164). The fact that Durandarte is a ''sword-phallus rendered useless by bloody mutilation'' (Johnson, 164) points to impotency. Because Durandarte and Quixote are essentially the same, Durandarte's impotency points to fears of impotency in Don Quixote. Johnson goes as far as to say that this element of impotency ''bring[s] together some of the most pervasive

themes of Don Quixote's psychic life, with some of the most deep-seated fears about himself and his manhood'' (164).

The first female character that the knight encounters is the noble woman, Belerma. Quixote describes Belerma as clad in black, with a slightly up-turned nose and a large mouth with colored lips. Johnson sees three different themes in the character of Belerma. First, he believes that she represents all the older women in Quixote's life—his mother, his grandmother, and others (165). The allusions to the age and sensuality of Belerma are signs of an Oedipal attraction in the knight's past. Next, there is a relationship between Belerma and Dulcinea since Belerma is to Durandarte what Dulcinea is to Don Quixote, mainly the object of courtly love (164). Belerma, according to Johnson, represents the reason for his dysfunction, something from his childhood that has forced him to create Dulcinea (167). Finally, because they both have bad teeth and are sexually inoperative,[3] Don Quixote and Belerma are identifiable as one (Johnson, 168). Belerma was a legendary beauty, but when Don Quixote sees her he is disappointed and disillusioned. Hughes sees the symbolism and applies it to Dulcinea. She believes that it means if Belerma can be made ugly, through enchantment, so too can his beautiful Dulcinea (110). It is important to remember that Don Quixote's picture of the enchanted Dulcinea is the ugly maid Sancho pointed out to him. The image of ugliness through enchantment bolsters Quixote's belief in the existence of an enchanted world and its need for his help.

Separately, each of these people has major significance. Is there any significance to the three being together? Johnson believes there is. He states, ''All three of the chivalric characters are projections of different aspects of our hero himself'' (167). This idea fits with Freud's theory of condensation; that is, many unrelated elements may come together in a dream. All share nearly the same age and the fact that their lives are at a standstill (Johnson, 167). The three inhabitants of the cave are sentenced to live forever in legend, while Don Quixote, although still part of the ''real'' world, takes time out from the continuing action above ground to join them in fantasy below ground. By joining the three characters into one, we complete the psychic picture of the bent knight. Montesinos, according to Johnson, projects a number of intellectual insecurities. Durandarte projects Quixote's fear of castration and impotence, and Belerma reflects his fear of aging (167). Throughout the dream, Quixote is analyzing himself and struggling with questions that run deep into his psyche.

Finally, Don Quixote comes face to face with the ''incarnation of his chivalric world'' (Hughes, 109), Dulcinea. She is with two other damsels and runs away at the sight of the great knight. One of the damsels soon comes back and asks if Don Quixote might lend Dulcinea six *reales*. He has only four, but gives them to her anyway. Johnson believes the money represents Dulcinea's sexual needs and Quixote's prowess (158). The fact that he is unable to give her the total of six *reales* once again symbolizes his fears of impotency and capability of loving his mistress. Hughes believes the monetary aspect destroys Don Quixote and his chivalric world (112). The money is not part of the chivalric code and thus proves that this world cannot and does not exist. It is this event that later (on his deathbed) permits Don Quixote to accept Sanson Carasco and the priest. Dulcinea's simple request for money shows him that his ideals are fantasy, and he cannot survive in the current age of realism.

By looking at the entire episode of the Cave of Montesinos, we can get a good look at Don Quixote's psychological state. Perhaps the best picture comes not from a psychoanalyst, but from one of Spain's great authors, Miguel de Unamuno. Donald Palmer, in his article entitled, ''Unamuno, Freud and the Case of Alonso Quijano,'' points to Unamuno's book *Vida de Don Quijote y Sancho*[4] as the first psychoanalytical account of Don Quixote (243). In fact, Unamuno and Freud were contemporaries, and Unamuno's book was published while Freud was doing

his major work on psychoanalysis. In the book, Unamuno discusses sublimation. Freud defines sublimation as "the sexual trend abandoning its aim of obtaining a component of reproductive pleasure and taking on another which is related genetically to the abandoned one but is itself no longer sexual" (Brill, 179). Palmer reports that Unamuno believed Quixote repressed his amorous feelings for his teenage maid and, after letting the repression boil for twelve years, finally went mad. Claiming that aspects of higher culture come from sublimations of repressed instinctual drives (Brill, 215), Freud does not condemn this sublimation as evil but calls it "a triumph of spirituality over the senses" (Brill, 217). Quixote's quest for the pure, the noble, and the chivalric is the outcome of his sublimation of amorous feelings. His need to contact past heroes is just another manifestation of his repressed desires. Although hiding a dark secret, he retains his honor and dignity (at least in his own eyes). Johnson agrees with this idea, stating that Don Quixote has repressed his feelings for his niece from "just below conscious to deep unconscious level" (156).

Another plausible explanation for the dreamwork in Don Quixote's dream is the theory of wish fulfillment. Freud writes: "A dream is a (disguised) fulfillment of a (suppressed or repressed) wish" (Brill, 57). Quixote has been struggling with the enchantment of his damsel since Book I, Chapter 10, when Sancho invented her. Hughes believes the dream allows him to solve the problem of Dulcinea's enchantment (108) through wish fulfillment. Don Quixote's wish for a land where the laws of chivalry are upheld and adventure involving his damsel is obvious in the dream. He identifies with all the people in the dream world, and his supreme chivalric act would be to disenchant all its inhabitants. This theory rationalizes the dream as merely an escape into fantasy land for the gallant knight, thus having no psychological value other than to manifest his aspirations.

The final explanation for this episode is that it is a look into the psyche of Cervantes himself. Becker states, "The work of art and, even more, dreams in works of art have been considered as confessions of the artist's unconscious personality, his affective conflicts and especially his sexual complexes" (103). He outlines how dreams may be used in literature. First, the author may use the dream explicitly to further the main theme in the work. Second, he may use the dream implicitly as an invisible support system for the structure of the work. Applying this theory to *Don Quixote,* we might say Cervantes uses Don Quixote's lunacy explicitly to satirize the Chivalric Age. The dream, once again, reinforces the madness of the old knight and the absurdity of the Chivalric novel. Implicitly, however, the dream creates a picture of the reasons for Don Quixote's madness. It subtly shows us that Don Quixote is not just mad but that there are concrete reasons for his condition. He has suppressed his amorous desires for all the women he has ever known and now must deal with all the repercussions. He struggles relentlessly against tremendous obstacles. It is sad that Don Quixote will never know love, but it is noble that he will fight until death to keep the hope for it alive.

Endnotes

[1]Miguel de Cervantes, "La cueva de Salamanca," in *Entremeses de Miguel de Cervantes Saavedra,* ed. Adolfo Bonilla y San Martín (Madrid: Asociación de la Librería de España, 1963).

[2]The legend of the day stated that the size of a man's heart is directly proportional to his bravery.

[3]Belerma was postmenopausal and Don Quixote impotent.

[4]Miguel de Unamuno, *Vida de Don Quixote y Sancho Según Miguel de Cervantes Saavedra, Explicada y Comentada por Miguel de Unamuno* (Madrid: Renacimiento, 1928).

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The Distribution of Franklin's Ground Squirrel in Wisconsin and Illinois

Timothy L. Lewis and Orrin J. Rongstad

Abstract. *Eastern populations of Franklin's ground squirrel* (Spermophilus franklinii) *have declined in the past two decades. We studied the current range of this squirrel in Wisconsin and Illinois to determine whether a reduction in range accompanied the population decline. We contacted 236 biologists in Wisconsin and Illinois by mail and telephone to determine the extent of recent sightings. We found a range extension in northwestern Wisconsin but a range reduction in southwestern Wisconsin and northwestern Illinois. Several possible explanations for the range reduction are discussed.*

A growing body of evidence indicates that in recent years the number of Franklin's ground squirrels has declined at the eastern extent of its range (Van Petten and Schramm 1972; Panzer 1986; Johnson 1988). We studied the distribution of this squirrel in Wisconsin and Illinois to determine its current range.

In Indiana Franklin's ground squirrel was listed as a "species of special concern" (Panzer 1986). Recent trapping work in Indiana indicated a substantial reduction in the ground squirrel's distribution (Johnson 1988). At least two reintroductions of Franklin's ground squirrel in Illinois have succeeded in countering this decline (Van Petten and Schramm 1972; Panzer 1986). In Wisconsin the squirrel is currently managed by the Bureau of Endangered Resources.

Franklin's ground squirrel is reclusive, hibernating from late September until April each year (Sowls 1948; Panzer 1986), and is strictly diurnal. Thus it may spend 90% of its life below ground (Sowls 1948). Its habitat is native prairie, brushy borderlands, fence rows bordering cropland and railroad tracks, or marshland edges (Cory 1912; Sowls 1948; Jackson 1961).

This squirrel's natural range was almost exclusively in the tall- and mid-grass prairie region (Hall 1981; Hall and Kelson 1956). The general range of the squirrel has not changed much in recent times, although De Vos (1964) reported a slight range extension along the Indiana-Michigan border, and Anderson (1947) reported a range extension in Manitoba. De Vos (1964) attributed the extension along the Indiana-Michigan border to human-influenced disturbances. Smith (1957) attributed the Manitoba extension to climatic changes.

The Franklin's ground squirrel has probably always been an uncommon species in Wisconsin and Illinois. The squirrel is more abundant farther west in Minnesota, the Dakotas, and north into the plains of Canada. Wildlife biologists in the eastern range of the squirrel feel that the abundance of the ground squirrel has declined during the past twenty years. This survey was conducted to deter-

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mine whether there have been any changes in the ranges found in Wisconsin and Illinois.

Methods

We identified wildlife biologists and state park naturalists as the people most likely to be familiar with the Franklin's ground squirrel. In October 1986 we surveyed each biologist by mail and by follow-up telephone interview about recent and past ground squirrel sightings. In the past, sightings were often recorded because of the squirrel's destructive role as a nest predator (Sowls 1948; Sargeant et al. 1987). Each biologist was asked to report any Franklin ground squirrel sightings made in the past ten years.

In Wisconsin we contacted all 68 Department of Natural Resources wildlife biologists and managers, as well as 4 U.S. Fish and Wildlife biologists at Horicon National Wildlife Refuge. In Illinois we contacted 22 of 25 wildlife managers and all 6 natural heritage biologists. In addition, we wrote to each state park supervisor or naturalist at Wisconsin's 61 state parks and recreation areas, the Illinois Department of Conservation's 71 state parks and recreation areas, and 4 forest preserve districts. A sample of nonrespondents was made to determine nonresponse bias.

Information on Franklin's ground squirrel was also solicited from the general public through wildlife managers, radio programs, and personal contacts in areas where Franklin's ground squirrels were previously found. Most such sightings reported by the public were other small mammals; however, several sightings were later confirmed by personal observation. Each potential sighting location in Wisconsin was visited and livetrapping attempted at five locations.

Results

We received 70 responses from 126 biologists (many responded jointly) of the 236 biologists originally surveyed. Follow-up telephone calls to 15 nonrespondents indicated nonresponse was due to lack of sightings to report.

Wisconsin

The Franklin's ground squirrel was reported in 14 of 72 counties in Wisconsin. There were 35 sightings reported for 28 locations (Fig. 1). Concentrations of squirrels

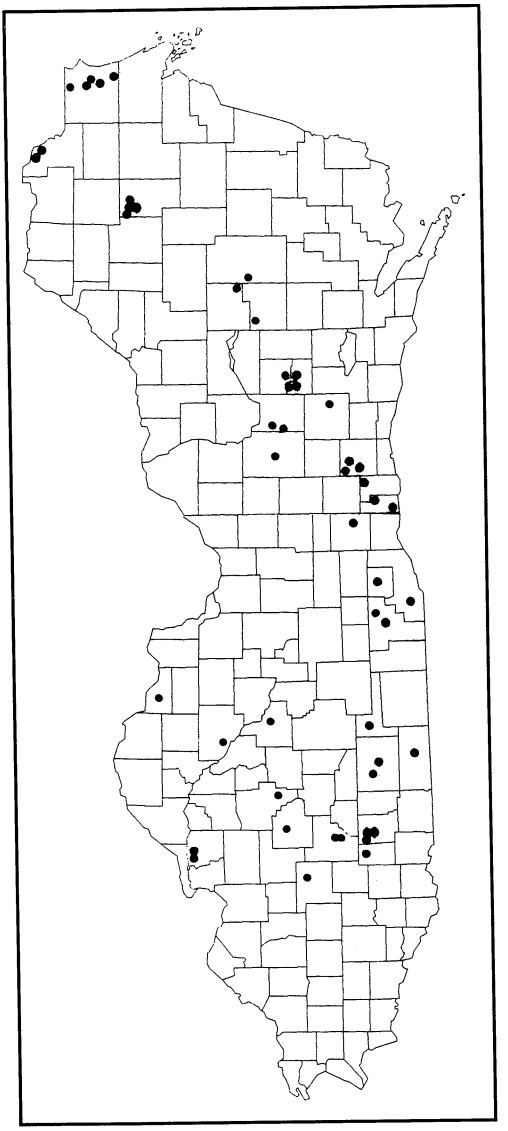

Fig. 1. *The reported locations of Franklin's ground squirrel sightings by Illinois and Wisconsin biologists for 1985 and 1986. Note the lack of sightings in the unglaciated southwest portion of Wisconsin and northwest Illinois.*

were found in Douglas, Burnett, and Rusk counties in northwest Wisconsin, and in Waukesha, Racine, and Kenosha counties in southeastern Wisconsin, as well as thinner groupings in between in an area ranging from Marathon County to Dodge County. In addition, one Franklin's ground squirrel was observed during trapping near Horicon National Wildlife Refuge, and two were collected in northwestern Douglas County.

Illinois

Franklin's ground squirrels were reported in 22 locations in 16 of 102 counties in Illinois (Fig. 1). Squirrels were reported in the northeast in Cook, DuPage, and Will counties. All other sightings were in a band of central counties from Henderson and Green counties to Ford, Vermilion, Coles, and Champaign counties. Squirrel range in Illinois showed no new extensions; no sightings were reported in northwestern Illinois, contiguous to an area of southwestern Wisconsin where there were no squirrels.

Discussion

Wisconsin

Cory (1912) listed the range of Franklin's ground squirrel in Wisconsin as southern and western Wisconsin. His map (Fig. 2A) depicted the range from Burnett County southeast to Walworth County, west of Lake Michigan on the Illinois border. No specific sightings were listed.

Hall and Kelson (1956) drew the range line closer to Lake Michigan in the southeast, including Racine and Kenosha counties, south of Milwaukee (Fig. 2B). They listed only one specific sighting in Wisconsin, at Lake Delavan, and relied on sightings in Minnesota and Illinois to place the range line in Wisconsin.

Jackson (1961), dealing specifically with Wisconsin mammals, as had Cory (1912), listed 32 sightings and museum specimens dating from pre-1900 to 1960. Jackson's range for the Franklin's ground squirrel (Fig. 2C) is the most accurate to that date,

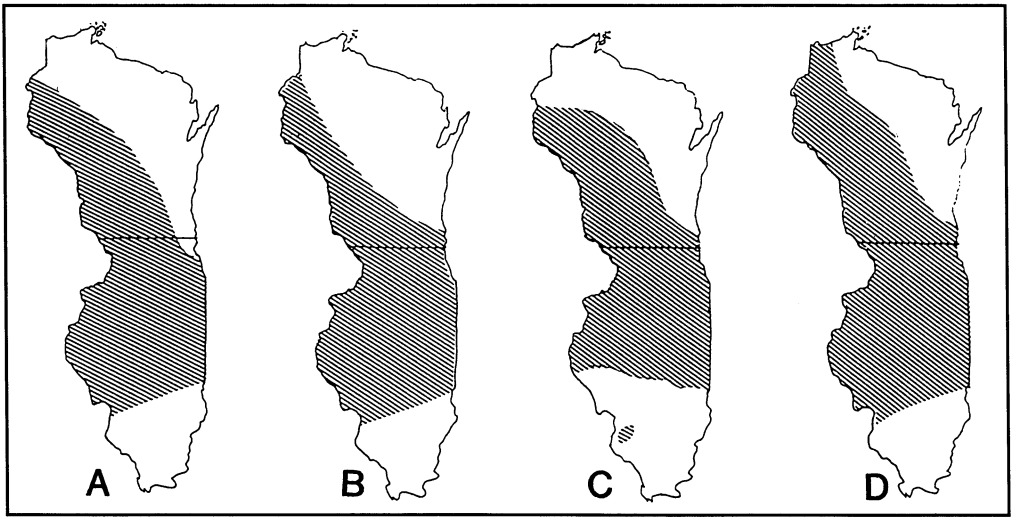

Fig. 2. *The historical distribution of the Franklin's ground squirrel in Illinois and Wisconsin. Figure A shows the early distribution in both states according to Cory (1912). Figure B shows the distribution according to Hall and Kelson (1956). Figure C gives the Illinois distribution of Hoffmeister and Mohr (1957) and the Wisconsin distribution after Jackson (1961). Figure D shows the most recent range estimates for both states as given by Hall (1981).*

based upon museum specimens and sightings from authorities. He confirmed the range described by Hall and Kelson (1956) in Racine and Kenosha counties with actual records and moved the northwest range more southerly to Polk County, just south of Burnett County.

Hall (1981) revised the 1956 range map in Wisconsin (Hall and Kelson 1956) in light of Jackson's 1961 work and one additional sighting in Hibbing, Minnesota, and one in Duluth. Using no records from Wisconsin, Hall estimated the range to extend north in northwest Wisconsin into Douglas County (Fig. 2D). We found five Franklin's ground squirrels, including two livetrapped, for Douglas County, verifying Hall's 1981 range estimate. All of the Wisconsin ranges listed are close to the tension zone described by Curtis (1959).

Illinois

Cory (1912) placed the range of the Franklin's ground squirrel in Illinois as the entire northern two-thirds of the state except Lake County in the far northeast (Fig. 2A). His southern line ran from Madison to Clark counties.

Hall and Kelson (1956) established the range 80 km farther south based on one sighting in St. Clair County (Fig. 2B). They also included one sighting in Lake County in the northeast. Hall (1981) did not modify his earlier range map (Hall and Kelson 1956) after twenty-five years (Fig. 2D).

Hoffmeister and Mohr (1957) were more conservative with their range line (Fig. 2C). Their line of known locations was farther north from Adams County to Vermilion County, with a disjunct population in St. Clair County.

Our results tended to follow a line from Madison County to Clark County in the south, though sightings were reported from St. Clair County. There were no sightings in northwest Illinois contiguous with the area in southwestern Wisconsin that had no recent Franklin's ground squirrel sightings.

Changes in distribution

It appears from our distributional data that Franklin's ground squirrels have a relatively stable range in Wisconsin and Illinois. However, we found no sightings in southwestern Wisconsin or northwestern Illinois, where a few squirrels had previously been reported (Jackson 1961).

Illinois naturalists familiar with Franklin's ground squirrel think it has declined over the past thirty years, although precise data are lacking. Jim Grude of the McHenry County Conservation Department attempted to trap ground squirrels in the county but found none during the summers of 1986 or 1987 (pers. com.). Van Petten and Schramm (1972) wrote twenty years ago of the "increasing rarity" of Franklin's ground squirrel in Illinois. Many of the responses to our survey also included comments suggesting the loss of squirrels, or at least the perception of loss from decreased frequencies of sightings. In order to counter the decline in Illinois, Van Petten and Schramm (1972) in Knox County and Panzer (1986) at the Markham Prairie have with some success attempted reintroduction into the former range.

There are several reasons that the Franklin's ground squirrel may no longer be found in southwestern Wisconsin. The squirrels may never have been common in the unglaciated portions of Wisconsin and Illinois. This area is covered by a thin layer of unconsolidated material less than fifty feet thick, and often only inches thick. Erosion can be severe and could create a problem with burrow construction.

Land-use changes seem to be a primary candidate for causing a decline, as suspected in places in Minnesota as early as 1892 (Herrick). Sowls (1948) related a comment from C.C. Furniss that the squirrel "appears to be retreating before the advance of agriculture." Van Petten and Schramm (1972) blamed cultivation, mowing, and grazing for the decline of Franklin's ground squirrel. However, Cory (1912) felt the squirrel was not greatly affected by the cultivation of land.

The general loss of prairie habitat alone may not be entirely responsible for the decline. The Franklin's ground squirrel is often locally abundant while nearby areas have none (Jackson 1961). Recent trappings in the plains of Canada by A. Sargeant revealed small concentrations of the squirrel isolated by large areas without them, despite apparently homogeneous habitats (pers. com.).

Isolation of these "islands" could easily lead to long-term numerical declines. Newmark (1987) found that over 40% of all species of lagomorph, carnivore, and artiodactyl (12 species) found in western national parks have become extinct. The loss of park species was attributed to the loss of mammals on adjacent lands, isolating the park populations. The populations within the park were smaller, less stable, and isolated from potential recolonizers. Habitat fragmentation in agricultural areas could similarly isolate ground squirrel populations.

Another factor contributing to a decline may be that the populations are cyclic. Erlien and Tester (1984) noted a ten-year cyclic population pattern in Franklin's ground squirrel that they linked to predator shifts during cyclic lows in the snowshoe hare population. Sowls (1948) noted a six-year cycle at Delta, Manitoba, that he attributed to climate, infertility, and disease. Normal cyclic declines in fragmented populations could eliminate some populations even though habitat is suitable, and the isolation would prevent reoccupation, leading to a general decline. However, the apparent decline in Franklin's ground squirrels at the eastern extent of the range has been noted for more than twenty years, and farther south than other cyclic populations. There seems to be no macroclimatic change that could exclude the squirrels from the area, as they are found farther south in Illinois, farther north into Canada, farther east into Indiana, and farther west into Illinois, Iowa, and the Dakotas.

Further work on site-specific changes in habitat should be done to examine changes over time in areas that may have lost or gained Franklin's ground squirrels. Also necessary are studies of reproductive success and survivorship.

Acknowledgments

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That Eyes May Be Free: Mary North Allen Talks with *Transactions* Editor Carl Haywood

In 1990 the Wisconsin Academy of Sciences, Arts, and Letters established the Dresen Award in memory of David Dresen, longtime photographer with the University of Wisconsin Photo Media Center.

Mary North Allen was the first recipient, and the award was presented at the Academy's annual meeting held at UW–Platteville. Looking at the photographs, I was intrigued with the question, "What are Mary North Allen and her work about?" After the awards luncheon I sought her out to talk about the possibility of publishing some of her photographs in *Transactions,* perhaps with an interview regarding her work and her view of photography. A year later we met for the interview at the Academy meeting at UW–Superior. I thought it would be a relatively easy assignment, but that was before I knew Mary North Allen. After talking to her for hours, listening to the tapes, and reading transcriptions, I found the results complex and subtle. Months of correspondence have followed, with telephone discussions for clarifications, and Mary has put her answers in writing, but the answer to my question remains elusive. As with so many things, the interview published here does not do justice to the complexity and richness of one of Wisconsin's remarkable people. The purpose will have been served if the reader comes to see the beauty in both the person and her work. What started out as an assignment has become a joy, and it is my hope to share that with our readers.

Transactions: When we talk about "photography," what idea or definition comes to mind?

MNA: On a simple level photography is a way of making pictures by bringing light together with a light-sensitive surface. A camera is a light-tight box containing a device for holding film. Opposite the film is a hole through which the light can pass. For opening and closing the hole a cork would do or a piece of electrician's tape. All the stuff you pay so much money for is there to let you control exactly how the light will enter the camera and impinge upon the film. But most people buy cameras with automatic controls to coordinate the various actions. Some of us prefer to do our own coordinating.

The light entering your camera is, of course, not pure light. What enters the camera is light that is reflected from the surfaces in front of the camera. The configuration of light and shadow which impinges on the film is thus a reflection of the *surface appearance* of what's in front of the camera. But surface appearance changes every hour of the day, every time a cloud passes, every season of the year.

Although the camera is often figuratively described as an "eye," it cannot see the way a person sees. The purpose of photography, in most cases, is that you want to share with somebody your *interest* in what you are seeing. The camera is just a box. It has no way of knowing about your interests.

Transactions: In our discussions you have often used the words "seeing" and "vision." Do these have special meaning in your approach to photography?

MNA: Vision is more than reception of raw data, more than identification, more than seeing enough to avoid bumping into things. Vision is a thought process, interrelated with all of mind's activity, with all our formal and experiential learning, and with all the baggage, both essential and superfluous, that we all carry. A configuration of various intensities and wave lengths of light impinging upon the retina of our eyes generates nerve impulses that travel the optic nerve to enter an intricate network of thousands of brain cells. Herein lies the intuitive part of the visual

process—what the photographer depends upon.

I believe that each person's vision is as unique to that particular person as his or her voice. We recognize the voice of a friend whom we haven't seen for years. But how can any of us know our friend's vision—or our own vision—unless we communicate it in some way? And my way is to make something—to create a photograph.

Transactions: Have you always had this sense of seeing or did something in your background develop it?

MNA: I am one of those who can't draw, or so I always thought. When I was a child in rural New York State, there was no art taught in the local schools. Nor was there music, except for a singing class, for which the teacher screened us in first grade. He determined that roughly half of the pupils were listeners, not singers. Through twelve grades we sat while others sang.

We lived on a farm and I played in the woods. I waded in a clear, clean, sparkling brook. In my trusty oatmeal carton I collected flowers and pretty stones, twigs of interesting shape, colored leaves, hemlock cones, wild strawberries and blackberries and raspberries (a patch of white raspberries grew by the remains of an old stone wall where trees met the upper field) and beechnuts, if I could get them ahead of the squirrels. When I lugged my treasures home, my mother didn't scold about the holes in the knees of my stockings or my hair ribbon tattered with briars. Instead, she admired my precious findings and listened to my tales of adventure. It was imaginative, inventive play.

After public schools I majored in biology at Mills College, then washed laboratory glassware at Hopkins Marine Station, where I marvelled at intertidal fauna and studied microbiology. Biology appealed to me as a new way of seeing the living earth I felt so close to.

In 1946 I came to Wisconsin with my husband, who was for thirty years professor of botony at the University in Madison. We raised three children on a farm near Mt. Horeb. I had long been interested in photography and in the 1960s decided to study it seriously. I entered the UW–Department of Art, where I was fortunate to work with George Gambsky, who taught photography and who himself had been a student of Minor White.

In biology I had been asked, "On the basis of what observations do you draw your conclusions?" There was some important difference in the seeing I was now learning to practice. I was engaged in yet another kind of learning, another mode of thinking new to me. Gambsky was reminding us that making a photograph is sending a message. "Don't you think you ought to know what sort of messages you are sending?" We would sit in class, in long, concentrated silence, looking at our own and each other's prints, before anybody spoke up.

The photographer has to grasp what Cartier-Bresson called the "precise moment," when all elements of your picture come together, and this can only be done intuitively. Only later, when studying prints, can you assess the message content.

In 1971 I hung my first one-person show. I was already past fifty, but I had finally found the right work for me. I was elated to discover that there is such a thing as grasping a concept aesthetically, that image-making opens a whole new approach to understanding. Above all, I had the joyful feeling that some part of me that had been totally neglected was coming to life. I'm still learning, along with my students, many of whom have experienced a similar liberation themselves.

Only after several more decades did it dawn on me that the driving question of my life has been to make sense of the dilemmas of being human, the paradoxes that have been puzzling me as long as I can remember, and that this is the stuff of art—all the arts. The arts are of and for all of us, and in simpler eras they played essential roles in daily living.

It is photography as an art form that particularly interests me. There are countless other applications of photography, from X ray

to remote sensing to advertising, about which I know very little.

For ten years I taught photography with the UW–Extension, which for much of that time had one of the best photography programs in the country, with more than a dozen instructors under the direction of Tom McInvaille. In 1985, after Tom had left and the peak of that excellence had passed, I resigned to found CAMERA WORKS, making my home into an independent center for photographic study.

In the CAMERA WORKS program beginners do an intensive eight-week sequence of structured assignments that enable them to see with their own eyes how the technical adjustments they have made influence their images. The basic building block of photography is the one-stop difference in exposure. Making a series of photographs of the same subject with a one-stop difference, they see how change in the intensity of light looks and how it alters relationships between the objects in the picture. At one end of the series, detail in the shadows is more visible; at the other end, detail in the highlights. Often there are several acceptable possibilities, and the photographer must make a choice: What will be revealed, what will remain hidden?

From experiments with light, students go on to learn about depth of field as they work on problems of making a two-dimensional picture out of the three-dimensional world. Finally they work on problems of making a still photograph out of the hustle and bustle of a world endlessly in motion.

Encouraged to be aware of the design elements all around them, and to see with their own eyes, students apply the discipline of the photographic craft to whatever they see in their daily lives. They begin to discover new worlds on their own doorsteps. Sometimes in class we all spark each other. We stretch ourselves. We outdo ourselves, and we're all amazed at the photographs that emerge.

CAMERA WORKS has been enormously successful as a pedagogical experiment. I found that I love teaching, and I've come to see teaching as inseparable from learning. Take the problems of teaching depth of field. It is hard to find words for speaking of relationships in space, as distinct from the measurement of distance. There was the hockey coach still mystified after two class sessions. Well, I venture, sometimes he must be watching just one player, and other times he must watch the movements of several. How does he get just one in focus for one picture, and then for another picture get several players in focus all at once? Right away he sees the problem, and I have a new way of presenting it.

I tell a family story to illustrate the complexities of thinking spacially. Many years ago we took our children to Niagara Falls. Here we are standing at the top of the cliff. I am getting nervous at the height, wanting to get away before somebody falls. Suddenly the four-year-old, all excited, is pointing to the boatload of people at the bottom of the falls. "Look at all the little people!" he exclaims.

A small child, in the habit of looking up at adults towering above him, has found some adult-type people who are the size of his little fingernail—what a discovery! Somewhere along the line we learn to use that illusion of diminished size as a measure of distance. But we are not aware we ever learned it until a child shows us.

Vision is not a simple mirroring of the world. It's a capability we have to learn to use. As I study the responses of students to my assignments. I realize that I am not clear enough in what I ask of them. As I search for ways to clarify my class presentations, writing and rewriting assignments, I gradually see the problems more clearly and in larger perspective. How the camera functions in relation to light, in relation to space, in relation to time—those camera functions become more understandable when I realize that vision has got to do with seeing things in relation to one another—brighter/darker, nearer/farther, stationary/in motion. I think about people functioning in relation to light, to space, to time. Thinking "in relation to"

is different from thinking absolutes. Visual thinking, with its own logic, known as design, supplements, complements, enriches all of mind, all of living.

Half way through the foundation course at CAMERA WORKS I can begin to detect that some students have a strong sense of form, some a subtle sense of timing, some a feel for color—capabilities they probably did not know they had. I have watched countless people free their vision from the blinders of stereotype, but there is absolutely no predicting who is going to do well in photography.

Transactions: Is photography what we see, a representation of something, or does it mainly connect us with something we have experienced?

MNA: A simplistic answer is "all of the above." If you want to consider the question in depth, you have to ask whether "what we see" is physical world or mental construct. I have ideas about this, but I'll leave the discussion to others more qualified.

We can use photographic materials and processes in whatever way suits our purposes, and the results will bear some resemblance to whatever the camera is pointed at. The critical question then is the kind of resemblance and how it relates to your purpose: What is your interest in your subject?

You can use words to write a government document, a business letter, a sonnet, or a shopping list. So with photography. There are so many applications of photographic materials and methods that I cannot possibly speak for all. To me photography is a means of representing a person's vision/perception of a subject.

Transactions: If you see photography connected with vision/perception, do you also see it as a symbol, like language?

MNA: Yes, the photograph is a symbol in that it stands for or represents. The photographer learns technical basics as tools for building images with some sort of message content. When I speak of symbol, I do not mean just the flag or the cross. I refer to symbol systems and all the various carriers of message that human beings have devised: spoken and written words, numbers, music, dance, theater, as well as all the visual arts.

A photograph is, after all, a two-dimensional object, an emulsion on paper. But it can bear a powerful illusion of the three-dimensional world we walk around in. In a sense all representation is illusion. I sometimes think that a photograph is much like theater. It condenses. It intensifies. It demands the willing suspension of disbelief.

In an anecdote told about Picasso, a villager, finding the master in his garden, approaches him with a question, "Why don't you paint a woman the way a woman really looks?"

"How does a woman really look?" asks Picasso.

The man takes from his pocket a snapshot. "Here, this is how a woman looks. This is my wife."

Picasso looks intently, points to the photograph and asks, "This really is your wife?"

"Oh, yes, that's my wife."

"She's rather small, isn't she? And flat?"

Other creatures communicate (we are just beginning to learn how extensively), but we are the ones who have devised the elaborate, complex symbol systems we think with—and thereby structure the worlds we inhabit. It is a peculiar predicament we human creatures have made for ourselves, trying to live in physical world and symbolic world simultaneously. Here we sit at the junction, Janus-like, looking both ways: we *are* the joining, the transforming link our genius and our exquisite vulnerability.

I like to think of the first woman drawing the first picture on the wall of a cave. I can see her bursting with need . . . need to share more than food and shelter . . . need . . . to share vision. Suddenly she picks up a charred stick, rubs it against the rock, and out flows form. Need and capability and tools and vision, enhancing each other, evolving together . . . ; today we can scarcely separate the strands.

Transactions: Is what the woman produced "truth"? It is often said that cameras never lie.

MNA: That is like saying that words never lie, or statistics never lie. It is not the symbol system or technological device that does or does not speak truth. It is the human being. People can lie in any language, with or without technological device, if lying is their intent.

Often, I think, we confuse logical types. It is important to distinguish between authenticity, raw data, factual information, literal content, subliminal content, verbal interpretation. A photograph does not necessarily have any verbal equivalent. You can talk about it in words, but that is interpretation. Is the picture on your driver's license a "true" picture of you? A teenager may want to be photographed to look like the most recent celebrity. The teenager's parents and grandparents won't think photographs of themselves are "good pictures" if their warts show. Convention dictates that a studio portrait will make you appear attractive in accord with current fashion. Whether it reveals anything of your personality or character is another question. When a studio photographer uses lighting, makeup, retouching, etc., to make you look the way you would like to look, when this is carried a step further to create fantasy for marketing shirts, shoes, beer, or candidates for public office, she/he is following conventional procedures. Is this lying? Wherein does truth abide?

It is not the mechanical equipment, but the skill and hard work of the photographer that make portraits and ceremonial photographs look the way we expect them to. The photographer has to work fast, ever alert to include all elements necessary for a coherent image, and to exclude all distractions. The last time I photographed a wedding is a fine example of the hazards awaiting any photographer who suffers a momentary lapse of concentrated attention. Just before the ceremony I came upon a great scene—the bride and her mother conferring with the judge in a hallway. I failed to notice that behind them was a door slightly ajar. I failed to observe evidence that somebody back there was using the phone. My flash picked up the white telephone cord and suspended it, shiny-bright and droopy, from the nose of the mother of the bride.

Transactions: You appear to be saying that a photographer creates something from her/his vision. How would the vision of the observer relate to the photograph?

MNA: The viewing of a photograph can be as complex as human vision. It is possible to return again and again to a truly memorable image and experience anew the thrill of discovery. Just as words, used to write legal or scientific documents or stories or poetry or lists, will be read with differing expectations, so with photography. Most images invite interpretation. Some require interpretation by specially trained analysts. Others are adventures in seeing.

In 1979, as part of an Extension photography instructors exhibit, I tried an experiment which I called "Participatory Photography." Along with two of my photographs I provided a little book in which viewers were invited to write comments. The photographs I used are the first two in the collection that follows. I hope readers will take time to look at these two photographs and then make their own observations before reading further. Here are samples of what exhibition visitors wrote:

"Not too different—both couples appear financially secure. One couple waits and the good things come to them. The other goes out to get the good things and has to work for them."

"Two well-to-do couples. Right: Self-made hard-working couple proudly posing before their home."

"I think they are my grandparents."

"The beauty of old age—especially the beauty of relationships that have lasted a long time. My grandmother used to say, 'This is the last for which the first was made.' "

"Old age is not worth the price of admission."

"At age 52—AMEN!"

"The hell you say—I know. I'm 67 and I love it."

"The secret of old age is dying young at the last possible moment."

"They look so unhappy."

"In the final analysis we are all alone. That is the bottom line."

"Pictures are grey just like the people."

"The photos are ten years old. Do you want to talk them to death? It seems time to make some new ones, Mary."

"Good work should be shown and reshown."

"It is a relief to see some pictures of the elderly as opposed to glossy-color photos of young models."

"The first one is great. If I knew why, it wouldn't be art, would it?"

"Left: Not paying attention to each other—space between them has an uncomfortable feel to it. Right—together."

"It's interesting, the man walking behind the woman."

"Left: Unhappy situation because of female dominance."

"Unhappy for whom?"

"What dominance?"

"I hadn't even realized that the two people in the left photo were supposed to be together!—chilling comment on marriages of too-long standing."

"Do you know, for sure, that they're together?"

"The two people are not actually a couple."

"Left: The action and viewing angle are interesting."

"Left: Crop the picture more at top and left side to cut out extra people."

"Extra people are vital to composition. They balance the photograph."

"No, they unbalance."

"It's easy to read too much into these pictures, but again it's fun to think about them. It's good for the imagination."

"In the end, it seems appropriate to note that not only are the photographs themselves interesting and enlightening, but that the comments and reflections of others add greatly to the overall growing experience of the work. It should be added that this book, as a growing statement on art, is actually a living and growing example of art. For our perceptions and reflections are as significant a part of our experience as any tangible physical items.—Thomas R. G—"(last name illegible)

"It's interesting how much people tell about themselves when they comment on the photos. I found the comments much more interesting than the photos."

"Comment on the comments: Most people seem to have lost the gift of 'just looking' at an image without (at least subconsciously) naming it, interpreting verbally, editorializing, or otherwise bogging it down with words.—JT Beers"

I had selected these two photographs not because I thought they are the finest, but because of their potential as a pair. The photograph on the left I took as I was sitting on the steps of the National Gallery in London, watching people, wondering where they came from, where they were going, who they might be. It is an example of image seen intuitively, caught on the instant.

The photograph on the right: I had asked the Grabandts, retired grocer and his wife of Verona, Wisconsin, whether I might photograph them. They chose to present themselves exactly as they appear.

Transactions: So the photograph of the strangers is just an image without any intended meaning or message; the viewer has to bring meaning to it?

MNA: Two people can be seen in each photograph, but the message content is not the same. One photograph clearly questions, while the other presents a statement. Format and structure contribute to the sense of doubt of the one, the certainty of the other. The juxtaposition of the two pictures reinforces this difference. Each photograph has become part of the context in which the other is seen. Viewers did not find much to say about the one on the right; the picture has said most of what there is to say. Did you notice how many of the comments were attempts to answer implied questions that viewers read into the picture on the left?

Transactions: Does this experiment rule out the possibility that a picture can contain a universal idea? Can it have anything in common with all people?

MNA: Are you asking whether by means of photography a universal idea might be given

some form accessible to all people? I think that is asking a bit much for any medium. Between the message sent and the message received "falls the shadow."

Everyone is born and dies and in between experiences troubles and satisfactions. It is not difficult to take a picture that refers to the commonality of human experience, on some level. More often than not, the effect is to trivialize. A photography student taking a picture of a beautiful sunset discovers that the result is not automatically a beautiful image. A sensitive photographer who has witnessed and photographed a terrible event, such as an act of war, will be painfully aware that the photograph does not come anywhere near conveying the full sense of tragedy.

I believe that the true archetype lies very deep. The more profound, the more difficult to transform into profound image. I think that all great art arises from experience felt so deeply that the artist feels compelled to labor to give it form.

Viewer response will vary from individual to individual and culture to culture. Occasionally a work breaks barriers, and the image becomes part of cultural heritage. This can happen in photography. Almost everyone knows Dorothea Lange's "Migrant Mother."

I well remember the first time I saw an original Edward Weston print, a Minor White, a Cartier-Bresson. For full appreciation of fine photographs, people need to have access to original prints. The subtleties are lost in reproduction for publication unless the very finest book papers are used and the very finest printing methods, all of which are expensive. Fortunately, it is now possible to see original prints in many galleries, and I urge everyone to go and to take time looking. If you have never seen exhibition quality prints, you may be surprised to discover what a photograph can be.

Transactions: Michael Brenson, in a review of "An Uncertain Grace, the Photographs of Sebastaio Salgado," said that the photographer had, in fact, and I'm quoting, "turned African tribesmen and women into Biblical kings and queens." And he went on to talk about the emotion and energy in the photographs of the people. Does his conclusion incorporate your earlier point about what the viewer brings to the photograph? How can Brenson conclude that the photograph has changed, even metaphorically, a tribesman into a king? He implies that the photograph creates nobility.

MNA: I'm glad that you mentioned Salgado. He is one of the greats, one of those who tie me to humanity on a very deep level. Salgado came from Latin America where he had seen at first hand terrible poverty. He became an economist, but decided that nothing would be done about poverty until the world moved beyond thinking of poverty as an abstraction and the poor as statistics. Instead of supposing that anybody living under degrading conditions must be despicable, Salgado felt that human beings who manage to survive appalling circumstances without losing self-respect must have great inner strength. That is the quality Salgado sensed and made visible.

It is the rare artist who can give form to human suffering endured with spiritual strength. Only a person of great conviction would even try. Salgado has not given up hope for humankind. And, he has succeeded brilliantly in bringing his vision to the rest of us. His photographs are powerfully beautiful. The reviewer was reminded of Biblical kings. I am reminded of the writings of Elie Wiesel and Viktor Frankl. Same fundamental archetype expressed in different forms.

Transactions: If I showed you my photograph of my grandparents, you could evaluate it technically. When I look at it, I bring to it a set of memories and experiences profoundly different from yours. Can we ever bridge this space? Can there be any common understanding?

MNA: The way you phrased the question brings to mind a student I had in class a dozen years ago. Every photograph was, for him, evidence of this or that lens or gadget, and nothing more. I labored the entire semester to find ways to encourage him to see the image, and eventually he did. Of course,

technical decisions influence the way a picture looks, but concern for technique should never obscure vision.

Sometimes the photographic technology of the time has an influence we need to take into account when we look at old pictures. Were all those stern ancestors of a century ago really humorless people? Probably they were not greatly different from us today. You are observing the consequences of photographic materials and equipment now obsolete. Films were slow, lenses were slow. Portrait studios were equipped with head rests and other props so that people could hold still for up to several minutes. You might like to try photographing your next family reunion that way and see how you look and how it feels.

I had grandparents too, and I am a grandparent. I might look at your picture and say, "Hmm, Carl looks like his grandfather. Or, grandmother has keen eyes. Interesting dress she is wearing . . . " I don't have to share your family memories to enjoy looking at your picture and to pick up information about those two people.

I have included in this volume several photographs that might be considered of the family album type. Readers of *Transactions* are likely to find the pictures accessible, even though they have no acquaintance with the people photographed.

Outside the family, such memorabilia may be of great interest to cultural historians and social anthropologists who are wanting evidence of living habits and customs of ordinary folk. There is a scholarly journal called *Visual Anthropology,* and John Collier's classic book of that title is now back in print. Recently I received Robert Levine's book, *Images of History,* in which he discusses criteria for historians to use in determining authenticity of a photograph as document and for evaluating content.

Transactions: What about the other pictures you have chosen to include in these pages? I can see that many are about nature, but they don't look quite like most of the nature photographs I have seen. How do people respond to your photographs?

MNA: A forester making pictures for a field guide for trees would be certain that criteria for identifying species were clearly visible in his photographs. A plant pathologist would make sure that disease symptoms in trees were clearly visible. Their photographs would not look like mine, nor will the romantic nature pictures of vacationers and departments of tourism. All of these photographs are related to nature, but there the similarity ends.

I've been inquisitive for as long as I have memory. The life of being human presents dilemmas. I keep trying to reconcile it with the life of living earth. The older I grow, the less confident I am of easy answers or ultimate answers. Not surprisingly, my photographs raise questions, tweak the imagination, and, I hope, set viewers to wondering. When my intuitive vision is working, the resulting photographs might speak some poetic truth. I believe that is possible, but I do not know.

The woodland pictures came out of a deeply troubled time in my life. I didn't know it then, but the making of those photographs, in helping me to see my life in a larger context, was an act of affirmation.

I walk in the woods until some sight compels my attention. *Attention* . . . I surrender, becoming completely absorbed in seeing . . . spaces shaped by light and shadows and by trees . . .

In the last dozen years I have moved from exploring light and spaces to exploring motion and color: intensity and wave length, passage of time. I have been tinkering with color ever since a UW–Art Department course in color theory. Color photography simply requires use of a film that is sensitive to the full spectrum of visible light, but I wanted to use color to structure the image as a painter would, for making visible what I could see in mind's eye—an interplay of life processes and human experience. I wanted the added factor of interacting color. Thinking color is different from thinking monochrome. It took quite a few years of experimenting before I

began to get the sort of imagery I wanted.

I am envisioning all this in multidimensional forms for which I know no words. I have been reading systems theory and chaos theory. I'm imagining the joys and terrors of ordinary lives of ordinary folk flowing and ebbing like river currents joining and separating, mixing and rejoining, slowly wearing channels through soil, through rock, through improbable time.

I'm wading in a little stream, so shallow that rocky bottom colors show, a bit of sunlight catches a ripple, an autumn leaf floats by . . . I come in with a close-up lens on a little red rock barely breaking surface . . . I drop a pebble, the current shifts . . . I slow down the shutter, reflections pull out like taffy . . . I am eliminating any key to scale. The craft remains disciplined while result becomes deliciously unpredictable.

I'm a child playing; the old oatmeal carton has turned into a camera. I've got treasures to share with kindred spirits.

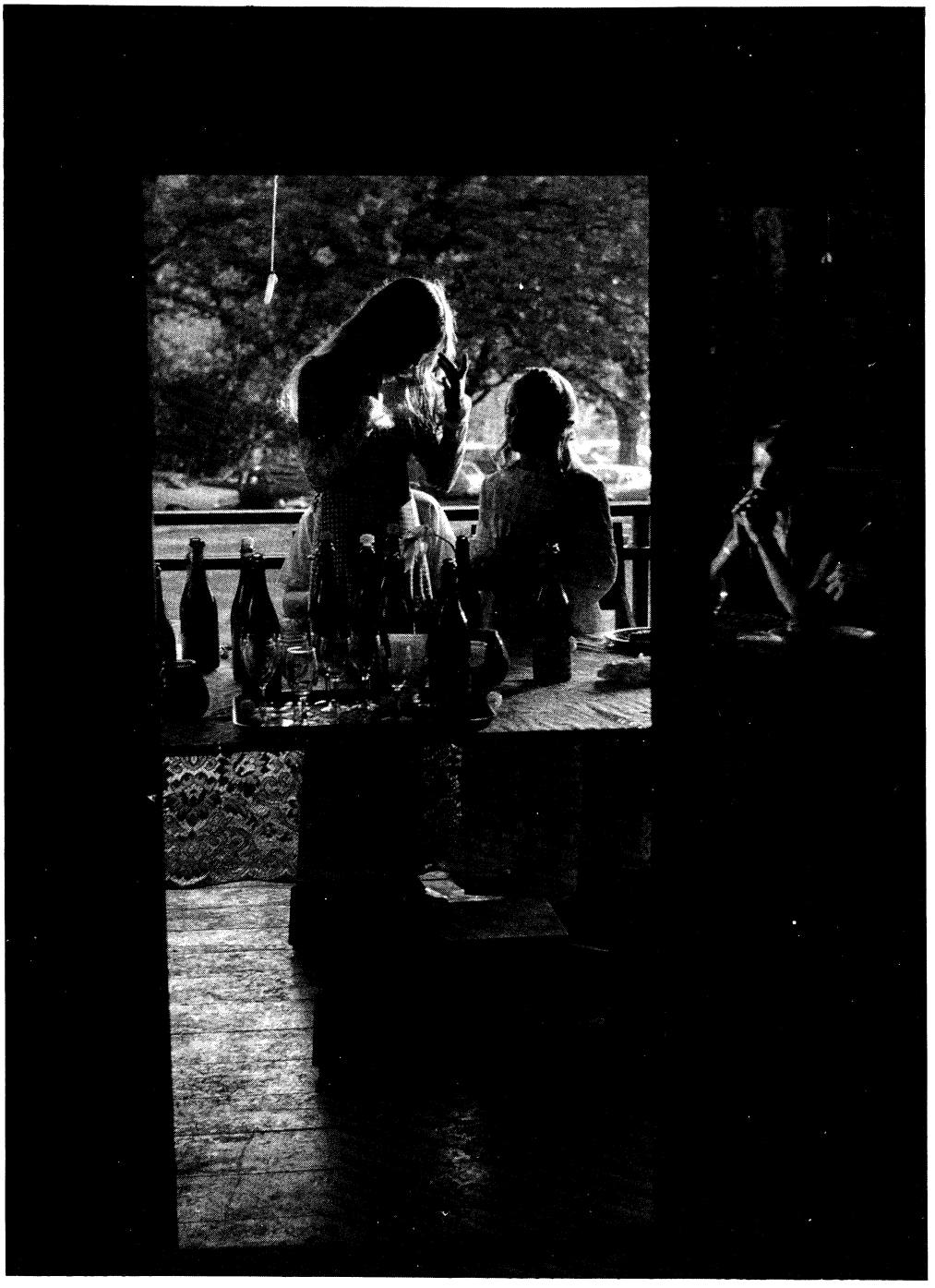
My work is an attempt to see eye to eye with other human beings. All I ask is an honest response. If one person sees a lament for vanishing forests and another itches for a chainsaw, so be it.

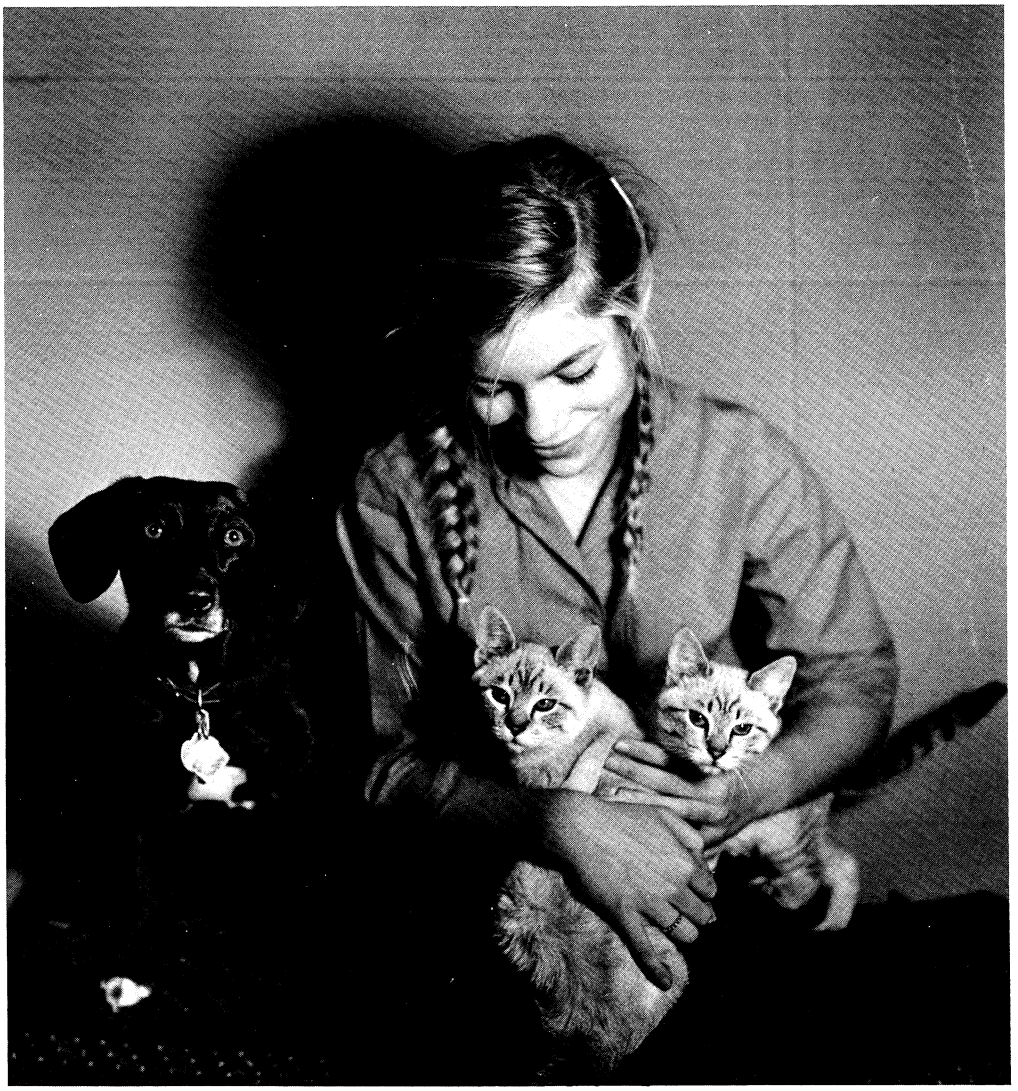
A visiting professor from Japan looked long, without words, and took home several tree prints.

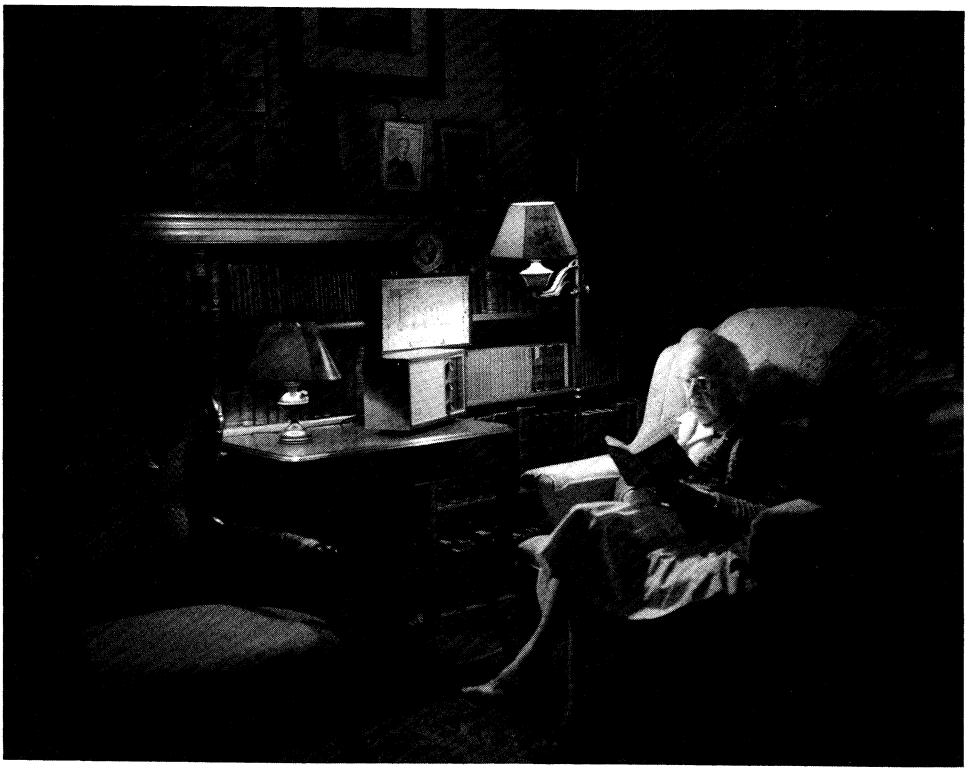
A farmer from southwest Wisconsin, unknown to me, saw one of my color photographs on the wall of the Johnston Gallery in Mineral Point. Later he told me that the picture jumped right out of the frame.

To see eye to eye with another human being is rare.

The Photography of Mary North Allen








HAIL
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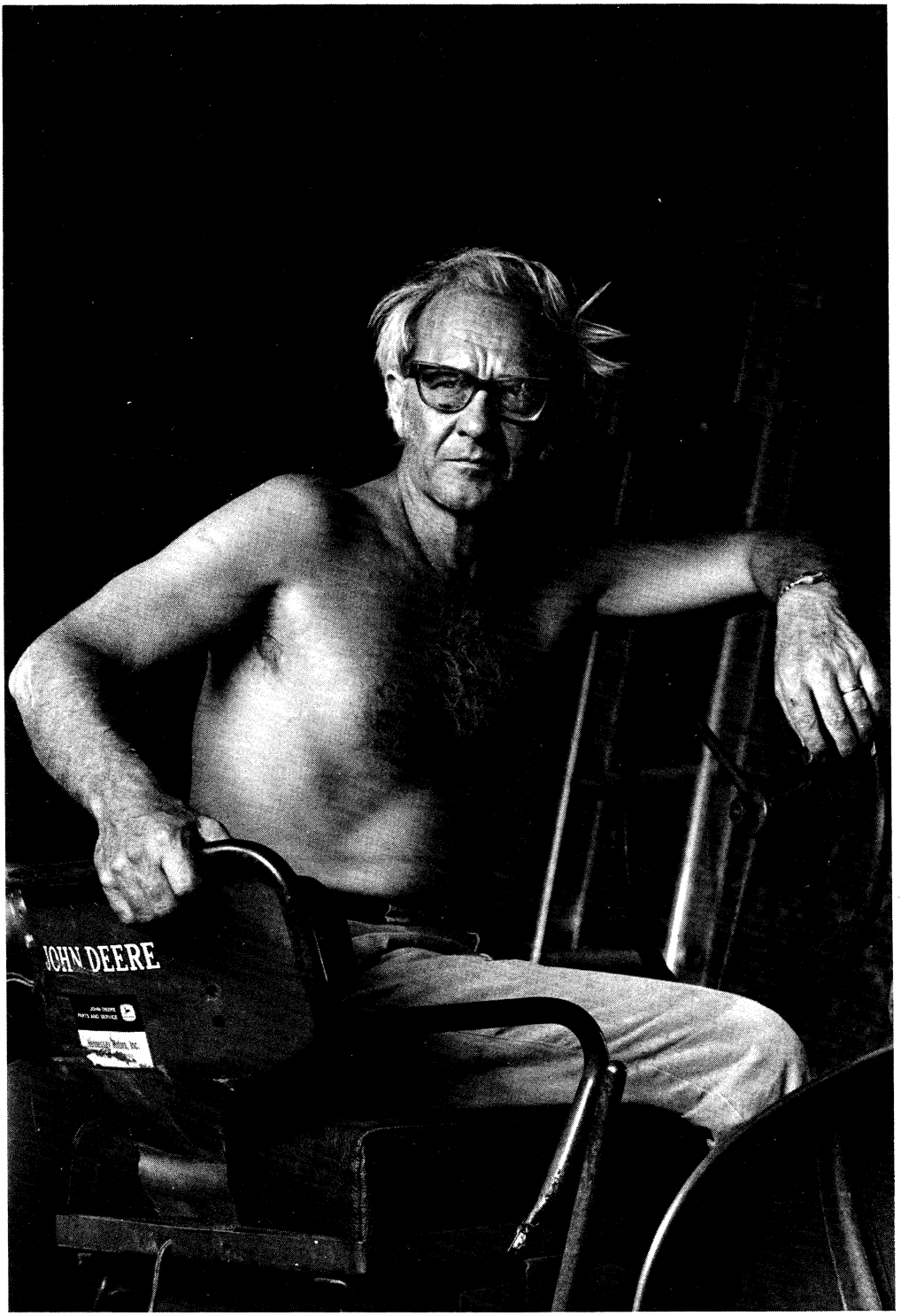
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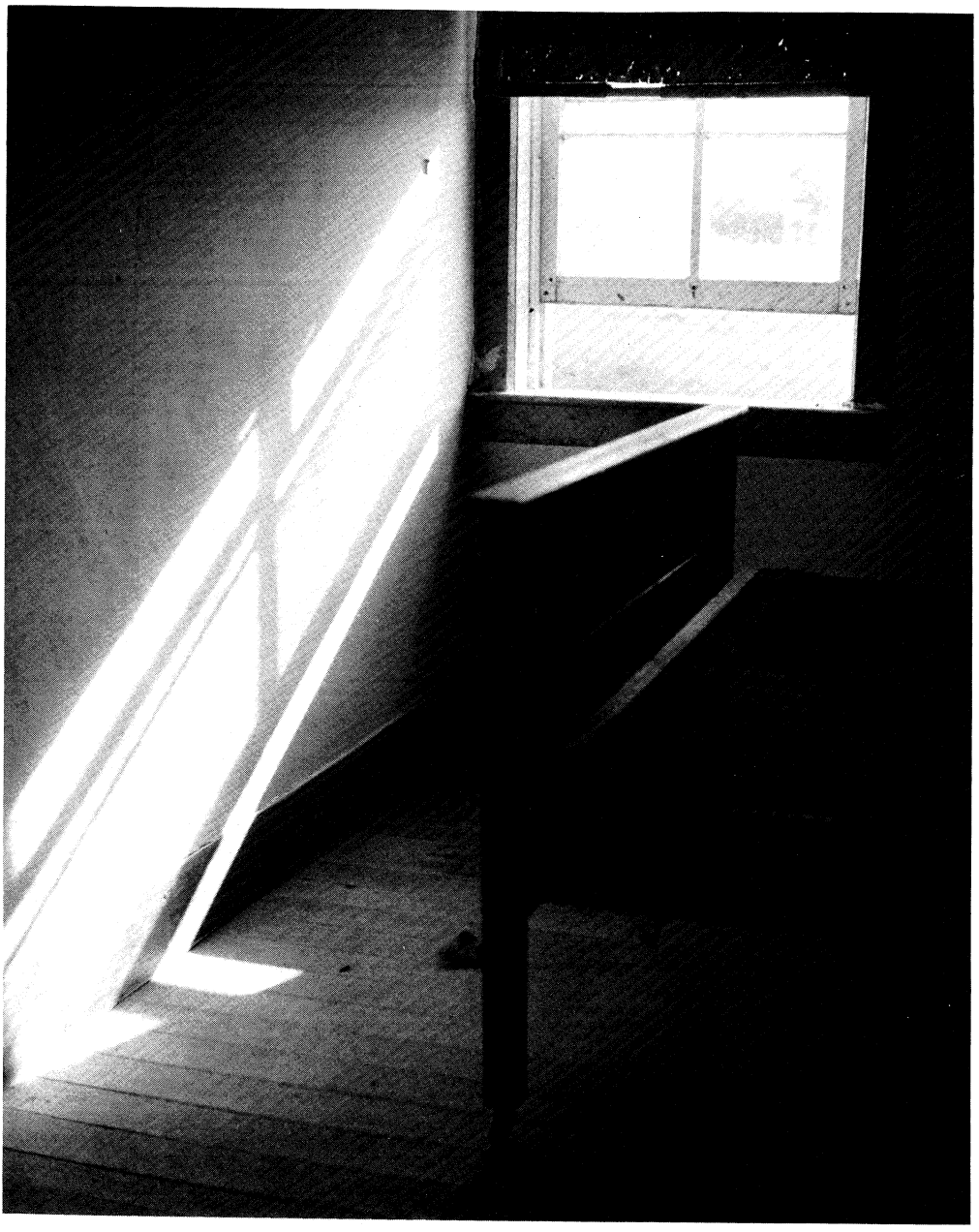

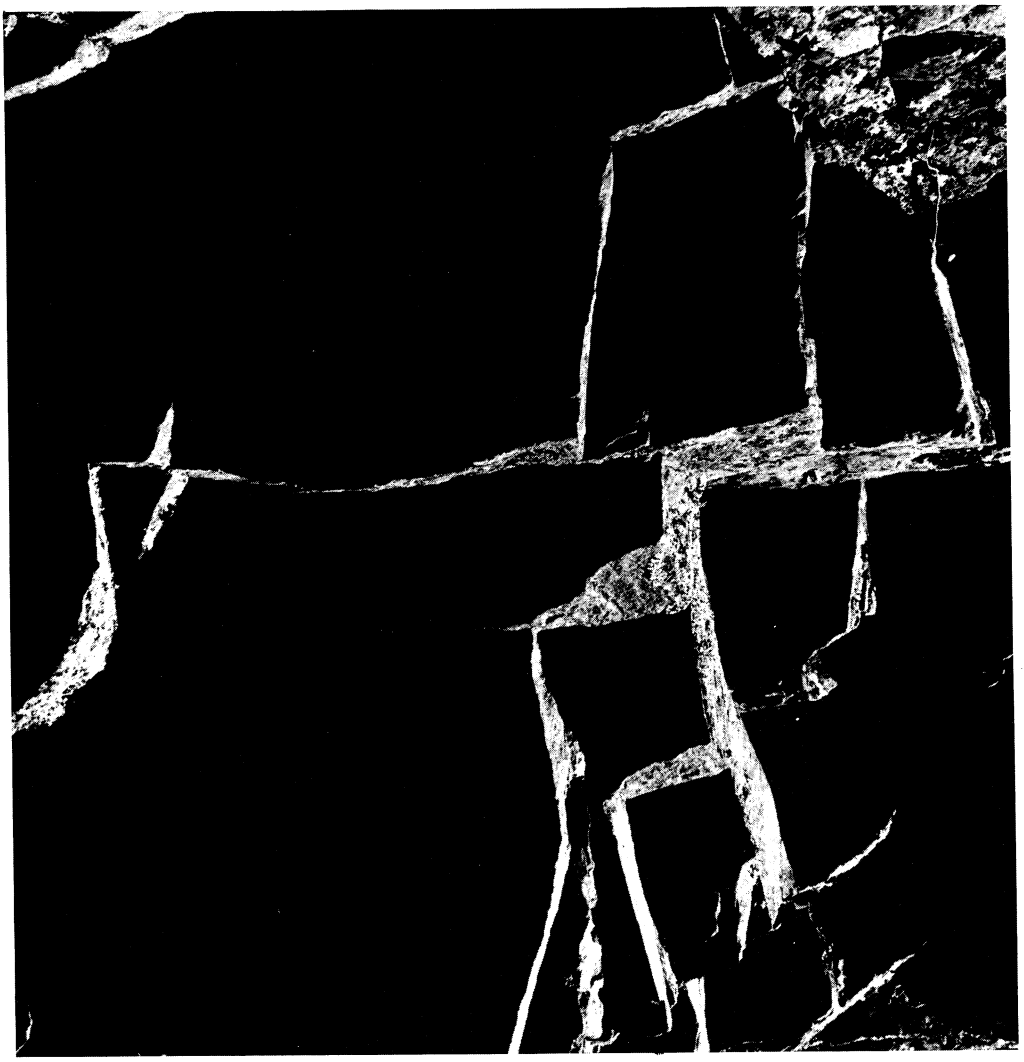

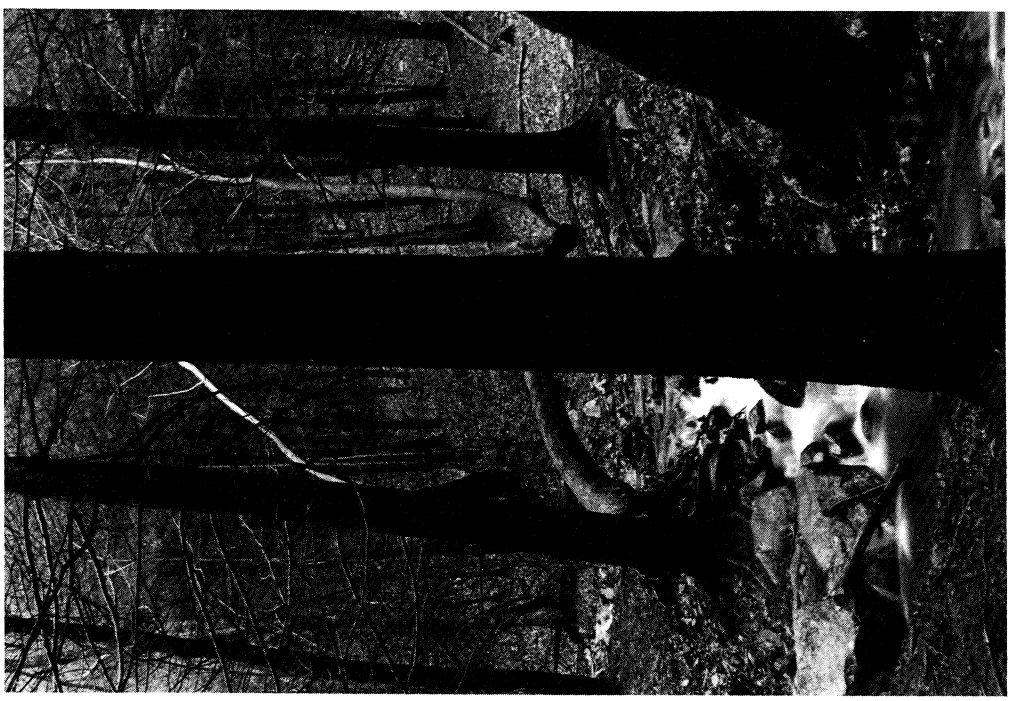

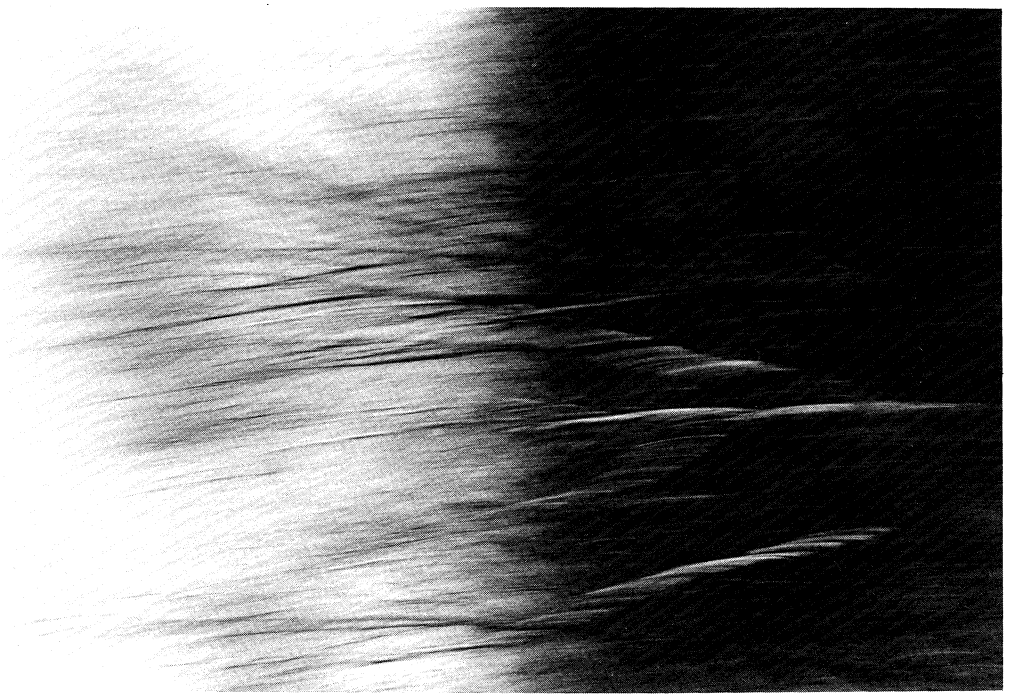

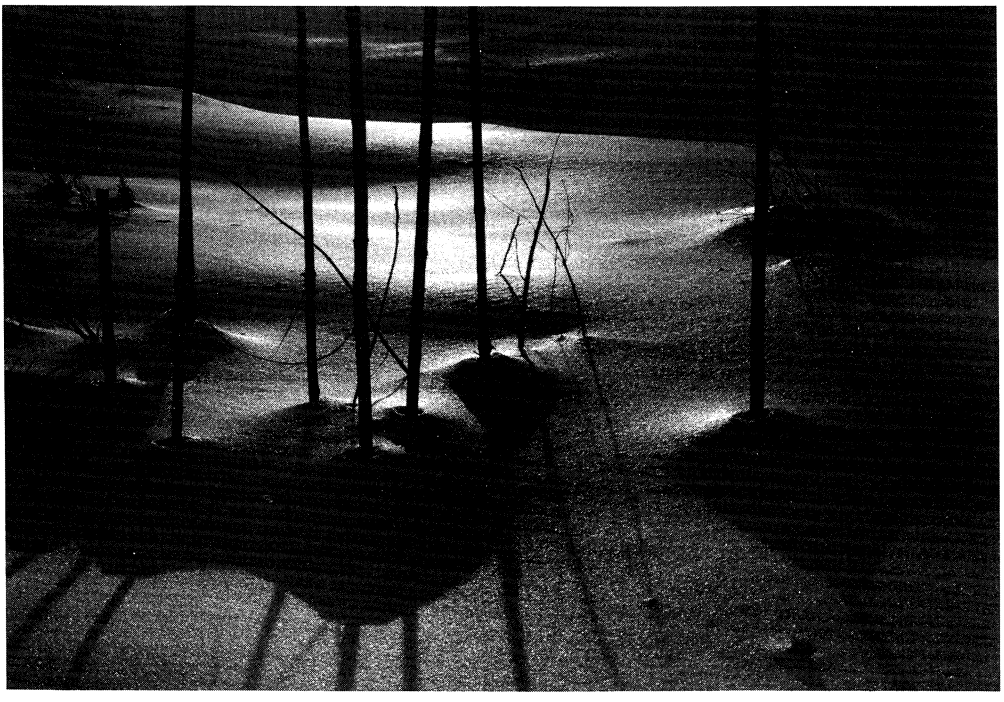

Community Response to Floodplain Relocation in Soldiers Grove, Wisconsin

Graham A. Tobin

Abstract. *The Soldiers Grove downtown relocation project is often cited in the hazards literature as a successful example of multipurpose, community-sponsored planning. Frequent flooding has been alleviated and the local economy stimulated. Nevertheless, spatial changes in the physical structure of the community suggest that social impacts should be examined. It was hypothesized that unforeseen problems arising from the relocation project could lead to a degree of disillusionment. A questionnaire survey of residents revealed that views were mixed. Conflicts have arisen because of perceived inequalities in the distribution of benefits accruing from the relocation. Additionally, internal dissatisfaction has disrupted community spirit. However, Soldiers Grove remains a model for community involvement and has been successful in many respects, although further lessons regarding spatial planning can be learned from this project.*

The relocation of Soldiers Grove, Wisconsin, is frequently cited as a successful example of multipurpose, community-sponsored planning. The stimulus for the project was a recurring flood problem exacerbated by a declining local economy. The plans included the complete removal and relocation of the downtown business district, the razing of several residential properties, flood proofing of other structures, and the incorporation of building ordinances zoning the new town for solar energy. In terms of flood alleviation, the project has been highly successful. The old downtown area now boasts a park and recreational facilities. However, the social impacts of the project have not been addressed. This research, therefore, looks at residents' opinions of relocation now that all major components of the project have been completed.

The flood hazard literature includes a number of examples of small-scale projects in which real estate property has been relocated out of the floodplain. Shawneetown, Illinois, for instance, is often presented as a "planning" failure since ultimately a portion of the town opted to remain at the old site (Murphy 1958). It is interesting to note that the new Shawneetown is now more prosperous than the decaying remnants of the old community. More recently, as the emphasis on flood alleviation has broadened to incorporate a greater range of nonstructural measures (Dzurik 1979), other attempts at partial relocation have been made. These have usually involved local residential areas subject to frequent or catastrophic flooding, rather than downtown business districts. A few examples include the following: Arnold, Missouri (U.S. Water Resources Council 1981); Robindale and Nelson, Pennsylvania; Clinchport, Virginia; Tulsa, Oklahoma; Rapid City, South Dakota (U.S. Department of Housing and Urban Development 1978); and Prairie

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du Chien, Wisconsin (Miller et al. 1983). However, none of these involved the comprehensive planning and community initiatives that were pursued in Soldiers Grove.

The Soldiers Grove Relocation Project

Soldiers Grove, along with several other communities situated on the Kickapoo River, had experienced severe flooding on eight occasions in the twentieth century. The U.S. Army Corps of Engineers' response was to begin construction on a storage dam at La Farge, thirty-six miles upstream from Soldiers Grove, and to plan levee systems for several communities. Building of the dam started in 1969, and levee plans were presented to the community in 1974 (U.S. Army Corps of Engineers 1975). Since the dam would protect only 9% of the hundred-year floodplain area in Soldiers Grove, the levee system was considered an essential component of the project. However, the high costs of the levees and the large annual maintenance charges forced Soldiers Grove to look for alternative solutions. Furthermore, in 1977, President Carter imposed a moratorium on water projects, which stopped dam construction and left the Kickapoo communities without any flood protection. By this time, substantial capital investment had already been made in the project (Tobin and Peacock 1982).

The declining economic base of the town accentuated the need for a major planning initiative if the community were to survive. Consequently, the flood alleviation project grew to include major socioeconomic changes incorporating several different goals: (1) to eliminate the flood problem, (2) to enhance local employment opportunities, and (3) to stimulate the local economy. The main thrust of the project entailed moving the central business district to a safer location out of the floodplain. In addition, plans were made to create further recreational facilities by converting the old downtown area into a park and erecting a community center in the new town. The project called for a general revitalization of Soldiers Grove. For detailed accounts of development, timing, and implementation of the relocation project, see Becker (1983); David and Mayer (1984); National Science Foundation (1980); and Tobin and Peacock (1982).

The flood hazard literature has often touted the Soldiers Grove relocation plan as a significant advance in floodplain management. For example, the successful relocation of property away from flood-prone areas has been commented on by Becker (1983) and by the U.S. Department of Housing and Urban Development (1978). Others have described the economic advantages accruing to the community (David and Mayer 1984) and the energy savings from the solar zoning ordinance (Jenson and Fantle 1979). The comprehensive planning initiated and undertaken by the local community has been praised by various authors (Becker 1983; Pierce and Hagstrom 1978; *Time* 1981; Tobin and Peacock 1982). Some criticisms have been raised, but generally these have focused on failings of federal government programs to make any long-term commitment to the locally sponsored project rather than on specific community-related problems (National Science Foundation 1980). Similar thoughts on appropriate mixes of local, state, and federal involvement are echoed in the Interagency Task Force on Floodplain Management report (FEMA 1986).

In many ways relocation has been worthwhile. The community clearly benefits from projected savings from flood losses and current economic enhancement. The population of Soldiers Grove grew from 530 in 1978 to 622 in 1980 (U.S. Department of Commerce 1982), although there has been little change in recent years, according to local officials. The community tax base, however, has increased by two million dollars (David and Mayer 1984). The economic success of the project, therefore, seems well established. However, what has not been seriously addressed is the impact the relocation plan may have had on the local population. What do residents of Soldiers Grove think of the project? In what ways has it affected daily liv-

ing? The literature suggests that residents were overwhelmingly supportive of the original relocation plan, and this aspect has often been cited as a reason for the apparent success (Pierce and Hagstrom 1978). To what extent is this true now that relocation has been completed? This paper examines some of the social impacts of the relocation project on the population of Soldiers Grove through a consideration of residents' perceptions.

Research Questions

It was hypothesized that residents of Soldiers Grove would perceive the relocation plan as socially beneficial to the community. The project was locally initiated and hence demonstrated all the characteristics of self-determination necessary to "guarantee" some degree of success (Hoggart and Buller 1987). However, it was further hypothesized that some internal conflicts would materialize between groups as the distribution of costs and benefits was gradually realized. Hoggart and Buller, for instance, warn against assuming that rural communities constitute homogeneous populations with uniform ideologies. In particular, the physical separation of the business district from the larger residential areas might be expected to present problems, especially to the elderly and those without adequate transportation.

Apart from age and location of residence, other factors thought to influence perceived satisfaction with the relocation project included household income, gender, level of education, and years of residence in the community. In the literature, there is ample evidence that such socioeconomic traits play important roles. Youmans (1977) suggested that the elderly rarely benefit from development projects and invariably carry any increased costs associated with transportation difficulties. Since the elderly are also often women in the lower income groups, they can be severely disadvantaged by community changes. In addition, attitudinal contrasts often exist between the elderly, who frequently look toward the past, and younger residents, who are usually more forward-looking. In other words, if benefits have accrued exclusively to local businesses, that is, the economic elite of Soldiers Grove, then others may now express some dissatisfaction with the relocation project.

Methodology

A personal, door-to-door questionnaire survey was conducted of Soldiers Grove residents in August 1988. A stratified random sample of households was surveyed such that a representative proportion was drawn from each residential area within the community. At the time of the 1980 census, the town had a population of 622, which included 249 households (U.S. Department of Commerce 1982). Of this population 54% were female, 77% were adults, and 37% of the adults were over sixty-five years of age. The survey strategy called for interviewing one adult from each of the randomly selected residences. Eighty-five interviews were successfully conducted with three rejections. An estimated accuracy rate for the overall survey, based on the response/no response rate, was plus or minus 1.5%, using the formula proposed by Moser and Kalton (1971).

The questionnaire was designed to elicit opinions on three aspects of the relocation plan and accumulate socioeconomic information on the residential population. The first set of questions required respondents to assess Soldiers Grove as a place to live in an attempt to determine community "spirit." The second set was used to examine the perceived impacts of the relocation plan on various aspects of the community, and the third set focused specifically on the flood hazard.

Data were analyzed using standard statistical techniques including chi-squared and simple frequency counts. Some recoding of raw data was undertaken to organize responses into larger groups. For instance, income was aggregated into three categories: less than $10,000, $10,000 to $20,000, and over $20,000. These were used to determine whether any significant differences existed among the responses of different groups within the community. Independent variables

included residential location, age, sex, number of years lived in Soldiers Grove, level of education, and household income. Except where otherwise stated, a probability level of .05 was used to determine significantly different responses.

Characteristics of Respondents

The survey sample consisted predominantly of elderly people, with nearly 50% over the age of fifty-five years and only 7% under twenty-five years. Most respondents had lived in Soldiers Grove for some time; the modal category was over twenty-five years (46%). Thirty-two percent of the respondents had moved to the town since the last flood in 1978, but only 15% since final decisions were made regarding the relocation plan (Table 1). It was expected that this combination of age and length of residence would contribute to a good understanding or awareness of the problems faced by the community and how the relocation strategy had sought to accommodate various interests.

Several other socioeconomic characteristics were collected. Sixty percent had graduated from high school, and nearly 15% had a college-level education. Reported household income for 1987 confirmed the generally low-income nature of the community that had been reported in the earlier studies (U.S. Senate Oversight Hearings 1975, 7149). Forty-nine percent of reporting households had incomes lower than $10,000 and 24% more than $20,000. As might be expected, level of education was positively related to income and inversely correlated with age of respondent. Consistency with the census data was maintained across the sexes with 58% of respondents being female.

Location of residence within Soldiers Grove was considered important, since the plan had resulted in distinct spatial changes to the physical structure of the community. In particular, the relocation of the downtown business district was expected to present transportation difficulties for the majority of residents. Initially, five areas were determined, but these were later regrouped to reflect proximity to the new downtown (Table 1). Most of the respondents resided in two areas, the Flats, which was flooded in 1978, and the Hill. These residential areas are immediately adjacent to the area that formerly housed the old central business district but are approximately 1.2 and 1.5 miles from the new town. A substantial number of respondents also lived in areas around Church Street and Pine Street. These two were somewhat closer to the new business district, less than 1 and 0.75 mile, respectively. Finally, very few respondents actually lived in the new town. The flooding that inundated the town in 1978 not only created problems for

Table 1. Characteristics of respondents

	N	%		*N*	%
Age			Education level		
Less than 35 years	15	17.9	Some high school	33	39.8
36 to 55 years	27	32.1	High school graduate	24	28.9
Over 55 years	42	50.0	Community college	14	16.9
Sex			College/graduate	12	14.5
Male	36	42.4	Residential location		
Female	49	57.6	New town	11	12.9
Income			The Flats	24	28.2
Less than $10,000	32	48.5	Hill	15	17.6
$10,000 to $20,000	18	27.3	Pine Street	22	25.9
Over $20,000	16	24.2	Church Street	13	15.3
Length of residence					
Up to 10 years	27	31.8			
11 to 25 years	19	22.4			
Over 25 years	39	45.9			

the businesses but also caused extensive damage throughout the Flats and parts of the Pine Street area.

Results

(1) Community spirit

As a general introductory question, respondents were asked to rate Soldiers Grove as a place to live on a scale from poor to excellent (Table 2). Of those responding, 75% rated the town satisfactory or better and only 5% as poor. There were no significant differences between responses based on the independent variables.

Two further questions required respondents to be more specific regarding perceived "community spirit." Participants were asked to assess the level of community spirit in Soldiers Grove both currently and in the pre-move period (Table 3). Opinions on the status of community spirit indicated a distinct decline. Whereas 31% rated pre-move community spirit in the highest category, this figure fell to 7% for the current situation. Similarly, the proportion rating community spirit as little or none rose from approximately 13% to 35%. These responses were significantly different. In 1988, therefore, residents perceived a downturn in community spirit in Soldiers Grove following implementation of the relocation plan. While this is not conclusive proof that social conditions had deteriorated, since selective memory is probably playing a role here, it is an indication at least that not everyone is entirely happy with current community affairs.

Perception of community spirit produced significantly different results based on independent variables of household income and age of respondent. There was a tendency for those with the highest incomes and to some extent those in the youngest age group (this latter variable was significantly different at the .1 level) to perceive a lower level of community spirit than others (Tables 4 and 5). Not surprisingly, it was found that those respondents who rated Soldiers Grove less favorably as a place to live also perceived little current community spirit.

(2) Impacts of the relocation project

Nearly 70% of the respondents thought that problems associated with the relocation plan outweighed any advantages. Contrary to previous findings described in the literature review, those in the oldest category (over fifty-five years) were less likely to report problems than those in the two younger age groups (significantly different at the .1 level, Table 6).

Since more specific information on the perceived impacts of the relocation project would help define the problems, participants were asked to respond to a series of questions related to service utilities such as water, electricity supply, and garbage collection; quality of the neighborhood environment; access to public facilities and businesses, including libraries, banks, and grocery stores; and

Table 2. Rating of Soldiers Grove as a place to live

	N	%
Poor	4	4.8
Fair	17	20.5
Satisfactory	26	31.3
Good	32	38.6
Excellent	4	4.8
Missing	2	

Table 3. Perceived community spirit*

	Pre-move		*Post-move*	
	N	%	*N*	%
A little/none	8	12.5	29	34.9
Good	36	56.3	48	57.8
Great/excellent	20	31.3	6	7.2

*X^2 = 19.08, 2 degrees of freedom, p = .001.

Table 4. Perceived community spirit (1988) by household income*

	<$10,000		$10–20,000		>$20,000	
	N	%	N	%	N	%
A little/none	7	22.6	4	23.5	9	56.3
Good/excellent	24	77.4	13	76.4	7	43.8

*X^2 = 6.212, 2 degrees of freedom, p = .05.

Table 5. Perceived community spirit (1988) by age*

	<36 years		36–55 years		>55 years	
	N	%	N	%	N	%
A little/none	6	40.0	13	48.1	9	22.5
Good/excellent	9	60.0	14	51.9	31	77.5

*X^2 = 5.074, 2 degrees of freedom, p = .1.

Table 6. Views on the relocation plan by age*

	<36 years		36–55 years		>55 years	
	N	%	N	%	N	%
Perceived problems	13	86.7	20	80.0	24	60.0
Perceived advantages	2	13.3	5	20.0	16	40.0

*X^2 = 5.146, 2 degrees of freedom, p = .076.

personal finances (Table 7). The perceived impact on public services and utilities was predominantly in the no change category (67%), although there was a large minority (23%) who perceived that service facilities had declined with implementation of the project. Those respondents who had perceived little or no spirit in the community were more likely to perceive a negative impact on services from the relocation plan (significance level .1). The distribution of responses regarding impact on neighborhood environment was more varied, but still nearly 50% perceived no change. However, a large proportion of respondents (36%) felt that the relocation project had enhanced neighborhood quality. Similar results were apparent for impact on personal finances. Over 65% perceived no change due to the relocation plan. It was noticeable, however, that no one from the new town area perceived any detrimental effect on their personal finances.

The greatest negative effect of the relocation plan appears to have been the impact on access to public and private facilities. Forty-seven percent of respondents believed that access had got worse since the relocation plan was implemented. However, 22% thought the opposite. Responses from different areas within Soldiers Grove were significantly different (Table 8). Residents living in the new town were more likely to perceive either no change or some improvement in access, whereas those living in the area farthest from the new business district (the Flats and Hill area) were most likely to see increasing problems with access. This question generated the most open-ended comments from participants, many of whom complained about the distance to stores and the general lack of focus of the community.

The relocation project has had a recognizable impact on the businesses of Soldiers Grove. Both David and Mayer (1984) and

Table 7. Perceived impact of the relocation project

	Services		*Environment*		*Access*		*Finances*	
	N	%	*N*	%	*N*	%	*N*	%
Greatly improved	0		3	3.6	3	3.7	0	
Improved somewhat	9	10.7	27	32.5	15	18.5	10	12.0
No change	56	66.7	41	49.4	25	30.9	54	65.1
Somewhat worse	15	17.9	8	9.6	24	29.6	17	20.5
Much worse	4	4.8	4	4.8	14	17.3	2	2.4
Missing	1		2		4		2	

Table 8. Perceived impact on access by residential area*

	New town		*Flats/Hill*		*Pine/Church*	
	N	%	*N*	%	*N*	%
Improved/no change	7	70.0	14	36.8	22	66.7
Worse access	3	30.0	24	63.2	11	33.3

*X^2 = 7.619, 2 degrees of freedom, p = .022.

Becker (1983) have described the changes that actually occurred during implementation of the project. Eight businesses were lost, including a restaurant, grocery store, meat locker plant, laundromat, three bars, and the local newspaper, while there were seven gains, a restaurant/hotel, dental clinic, real estate agency, craft store, pharmacy, an insurance office, and an expansion to a nursing home. On the other hand, there was a net gain in permanent jobs of 46.5 (Becker 1983). The number of persons employed in the business district increased from 66 full-time equivalent jobs to 123. Residents' perception, however, was one of decline; 76% believed the number of businesses had fallen. There was a significantly different response based on length of residence in Soldiers Grove. Those residents new to the community were more likely to perceive no change or an increase in the number of businesses operating in Soldiers Grove (Table 9). This response may reflect the gradual growth and change in emphasis of the new businesses. Many basic commercial enterprises were replaced by those related to secondary services. It was also noticeable that residents in the new town were more likely to perceive an improvement than residents from other parts of town.

Respondents were also asked to comment on the relative success of remaining businesses (Table 10). Twenty-nine percent believed that businesses were poorer than before the move compared to 41% who perceived that they were more successful. Once again, respondents living in the new town perceived greater success than other respondents (significantly different at the .1 level).

(3) Flood hazard

Sixty-six percent of respondents indicated that flooding was no longer a problem for Soldiers Grove. This is a high negative response rate and certainly does not reflect the serious nature of the flood hazard. Parts of the residential community are still prone to inundation, and public facilities, roads, sewers, etc. will suffer periodically from flooding. A failure to maintain old levees in the area could also increase the incidence of flooding in lower parts of the new parkland. Nevertheless, this is a typical reaction, and the hazard literature is full of discussions focusing on the "false sense of security" generated by implementing alleviation projects (Burton, Kates, and White 1978).

The Soldiers Grove relocation plan had been developed and financially supported to

Table 9. Perceived number of businesses by length of residence*

	<10 years		11–25 years		>25 years	
	N	%	N	%	N	%
Increased/no change	11	42.3	2	10.5	6	15.8
Decreased numbers	15	57.7	17	89.5	32	84.2

*X^2 = 8.093, 2 degrees of freedom, p = .02.

Table 10. Perceived success of local businesses

	N	%
Very successful	5	6.0
Somewhat successful	29	34.9
Okay	25	30.1
Somewhat poor	17	20.5
Very poor	7	8.4
Missing	2	

a large extent by the local community. In light of this direct experience, two questions were asked regarding responsibility toward flooding (Table 11). Financial responsibility for correcting flood problems was placed primarily on the federal government (72%) and secondly on state government (47%). Local sponsorship of adjustments to flooding was suggested by only 25% of the respondents. In this question respondents were permitted to nominate more than one option. These results conflict with what actually occurred in Soldiers Grove, where local financial commitment amounted to a substantial share of total costs. However, some explanation is forthcoming from the next question: Who should take responsibility to oversee flood control work? Here the response pattern was different. While 51% still believed the federal government should be held responsible, significant groups supported state (38%) and local (45%) control. These results indicate that respondents would like a greater role by the federal government financially but would also like to retain some control over what is actually undertaken in the community.

As a final analysis respondents were asked their opinions on completion of the La Farge dam several miles upstream from Soldiers Grove. This dam had been shelved by the Presidential moratorium on water projects in 1977 even though it was almost complete and approximately fifty million dollars had already been spent on it (Tobin and Peacock 1982). During discussions on the relocation project the lack of protection offered by the dam had been used as a strong argument for an alternative project for Soldiers Grove. In spite of this, 64% of respondents believed that the dam should be completed, 14% said no, and the rest (22%) did not know. Significantly different responses were found between the sexes. Males were overwhelmingly in favor of completing the dam, whereas females were less likely to express an opinion.

Discussion and Conclusions

The response of residents in Soldiers Grove to the relocation plan can be explained by current thinking on rural communities. Not surprisingly, given the degree of change,

Table 11. Responsibility for flooding

	Financial		Work control	
	N	%	N	%
Federal government	54	72.2	41	51.3
State government	35	46.7	31	38.3
Local authorities	19	25.3	36	45.0
Private individuals	10	18.3	8	10.0

problems have arisen following implementation of the project. In particular, there is a consensus that community spirit is not good. Over 25% rated the town as only fair or lower as a place to live. This attitude was particularly evident amongst those younger residents of the town. Furthermore, respondents perceive an inequality in the distribution of costs and benefits accruing from the project. Residents are now paying the costs of business revitalization. The spatial disassociation prevalent within the community is especially troubling for many individuals. Consequently, more attention needs to be addressed to these questions before Soldiers Grove can be cited as the "planning ideal" (David and Mayer 1984) or model for small community floodplain planning (Tobin and Peacock 1982).

It is clear that residents came to accept the idea of major change in the community and gradually overcame any fears and uncertainty about the future. Undoubtedly, residents perceived many gains in comparison with few losses from relocation, which pushed the project toward the certainty end of the scale (Becker 1983, 38). The severe nature of the flood hazard (combined with a timely reminder of flooding in 1978) and the declining economic base of the community must have been powerful incentives to accept this radical change. These stimuli may not be found in other communities contemplating such drastic action.

Residential opinions on authority involvement could be explained within the context of the theoretical structure described earlier. The Soldiers Grove relocation project involved a high level of local commitment and support and hence was perceived as a successful planning venture. Criticisms were generally leveled at the federal government for its vacillating policies and intermittent funding (Hirsch 1980; National Science Foundation 1980). Given the high local contribution to funding and the difficulties in obtaining money from other sources, it is not surprising to see respondents requesting greater federal financial commitment. At the same time, many residents wished to maintain strong local control over any projects, thus retaining an element of self-determination in community affairs.

The socioeconomic elite in Soldiers Grove had been responsible for developing the relocation project in the first place. The local newspaper and several businesses had taken very active roles in promoting the acceptance of the project (Becker 1983, 20). This also conforms to the theoretical structure described at the beginning of the paper, with local leaders taking the initiative. It was very much a locally inspired project that retained local control, but this has also generated conflict within the society. The heterogeneity of groups within the community has led to differences of opinion about the perceived success of the project.

While the community tended to present a united face to the problems confronting Soldiers Grove, it is clear that some internal conflicts now exist. Many residents are dissatisfied with the relocation project and see it as destroying the spirit, or sense, of community. Results of the questionnaire survey showed that residents are not entirely happy with how benefits have been distributed. Many residents perceive costs to have been borne by all the community, especially regarding the changing physical structure of the town. Most residents now must drive to the new downtown for groceries, for instance. Consequently, while the basic cost-benefit analysis for the relocation plan was favorable (David and Mayer 1984), attention should also be devoted to particular gainers and losers of the project.

In conclusion, the relocation project in Soldiers Grove has not been the solution to all the community's problems. Certainly, there have been economic gains, and flood losses should no longer devastate the town. However, the social costs have also been high, and it remains to be seen whether Soldiers Grove can recapture or develop a sense of community that at present appears to be lacking. The structural changes in use of space throughout the town have clearly had

repercussions on the community. The planning process in Soldiers Grove, therefore, can continue to serve as a model for other communities, but it may also serve as an example of the need to monitor carefully social implications of such changes.

Acknowledgments

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Depth, Substrate, and Turbidity Relationships of Some Wisconsin Lake Plants

Stanley A. Nichols

Abstract. *The depth distribution and substrate and turbidity preferences are described for 78 aquatic plant taxa found in 68 Wisconsin lakes. In general it was found that 1) taxa numbers decrease with increasing depth; 2) taxa richness is not different between substrate types; 3) many species are restricted to shallow water, while others are broadly tolerant of water depth variation; 4) the depth distribution of many species is skewed towards shallow water; 5) the maximum growth depth for many species is highly variable; 6) there is a significant linear relationship between water clarity and maximum depth of plant growth; and 7) water clarity, water depth, turbidity tolerance, and substrate preference influence species association.*

Water depth, substrate, and turbidity are important factors affecting the growth and distribution of aquatic plants in lakes (Spence 1967; Swindale and Curtis 1957; Pearsall 1920; Barko, Adams, and Clesceri 1986; Lind 1976; Dale 1981). Shallow-water plants may be limited by mechanical damage from ice, waves, or fluctuating water levels; deep-water plants may be restricted by light penetration, temperature, or nutrients. Turbidity decreases light penetration and acts selectively, favoring species more adapted to turbid conditions. Nutrient concentrations, texture, amount of organic matter, and siltation rate are some substrate parameters that influence plant growth and distribution. Water depth, turbidity, and substrate are interrelated. Increasing water depth decreases soil particle size, turbulence, and light (Spence 1967).

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Is is difficult to describe habitat preferences without detailed ecophysiological studies of individual species. Variations in life cycle, morphology, physiology, and reproduction determine how a species relates to the aquatic environment. Detailed life history and ecophysiological studies are available for relatively few, usually nuisance, species (Nichols and Shaw 1986).

The depth, substrate, and turbidity preferences of 78 species of submergent, emergent, and floating-leaved plants in 68 Wisconsin lakes are described in this paper. Specifically, the depth range where species were found; the species preference for habitats described by substrate, water depth, and turbidity; and the species response to various substrate-depth habitats are described. In addition, growth and distribution of species in Wisconsin lakes are compared to responses at other geographic locations. This information is useful for conducting further ecophysiological studies of individual species and for management purposes.

Methods and Analysis

Between 1975 and 1983 detailed macrophyte surveys were completed for 68 Wis-

consin lakes. The lakes were sampled by Wisconsin Department of Natural Resources (WDNR) field staff or by private consultants for the WDNR Office of Inland Lake Renewal (OILR). The primary purposes of the surveys were to design lake management strategies or to collect benchmark limnological data.

The lakes represent a broad range of Wisconsin lake types with regard to geographic distribution (Fig. 1), water chemistry (Table 1), and human impact. Physical and chemical data for each lake were collected during macrophyte sampling or were collected earlier as part of surface-water resource inventories for each county.

Field methods

To assure geographical coverage of a lake, the surveyors selected sampling points using a grid system. Grid size and the number of sampling points per lake varied with lake size, i.e., larger lakes contained more sampling points on a larger grid.

At every sampling point water depth was measured to the nearest 0.1 m, and substrate was categorized as being hard (type 1: sand or gravel) or soft (type 2: silt, muck, or flocculent). All plants within a circle 2 m in diameter around the sampling point were recorded and were assigned a 1 to 5 density rank based on the criteria established by Jessen and Lound (1962). Unknown species were collected and sent to the Wisconsin Geological and Natural History Survey for identification. Plant identification followed Fassett (1969). Specimens were then sent to the University of Wisconsin–Madison herbarium as voucher specimens.

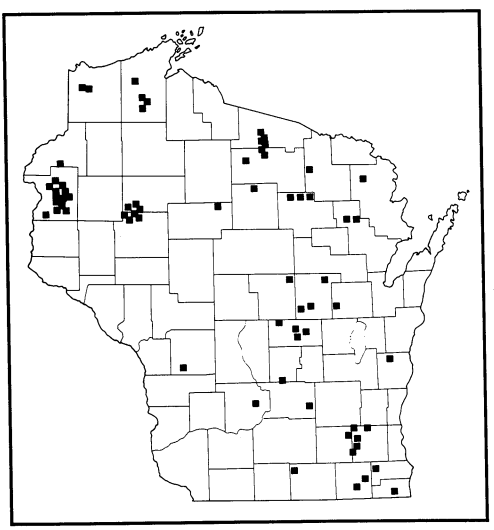

Figure 1. *Location of sampled lakes*

Analysis

Because the study is meant to determine where plants grow, only quadrats with plants were analyzed. Due to differing water clarities, plant depth for some analyses is expressed as a percentage of the maximum depth at which plants grew in each lake. Depth classes of 0–25%, 26–50%, 51–75%, and 76–100% of maximum growth are reported as depths 1, 2, 3, and 4.

Data were analyzed using standard descriptive statistics, boxplots, chi-square, analysis of variance, correlations, and linear regression (SAS Institute 1985; Lotus Development Corporation 1985). Because more information is available about common species than about rare ones, different levels of analysis were necessary.

Results

Species occurrence and habitat richness

A total of 123 plant taxa were found in the 68 lakes. The numbers of taxa are nearly the same for the two substrate types but declined with relative depth (Table 2). The decreasing taxa number with increasing depth was expected. The similar number of taxa for both substrates was not expected.

The similarity of species occurrence was also compared for each depth-substrate class. This was done by calculating the relative frequency of species occurrence for each depth-substrate class from information provided in Table 3. The classes were compared using the similarity index $2W/A + B$ (Bray and Curtis 1957). The vegetation in the shallow-water, hard-substrate habitat (i.e., depth 1, substrate 1) was least similar (i.e., most dissimilar) to

Table 1. Limnological characteristics of sampled lakes

Lake name	County	Total alkalinity	pH	Specific conductance at 25° C	Secchi	Area	H_2O >3m	H_2O <1m	Quadrats sampled	Depth of maximum plant growth	Biotic influence
		mg/l $CaCO_3$		umhos/cm	m	ha	%	%		m	
Allequash Lake	Vilas	39	7.8	87	3.1	172.5	25	12	135	4.8	
Amnicon Lake	Douglas	24	6.6	56	1.8	172.5	4	15	123	3.6	
Anodanta Lake	Bayfield	90	6.8	238	2.5	10.5	15	15	225	3.9	
Apple River Flowage	Polk	126	7.2	264	2.1	258.8	0	20	190	3.6	
Ashippun Lake	Waukesha	220	8.4	500	2.4	34.0	50	4	231	6.1	
Balsam Lake	Polk	84	7.2	186	2.4	831.9	25	10	188	4.5	Algae
Bear Lake	Oneida	31	7.0	70	3.1	126.4	20	5	123	4.2	
Bear Paw Lake	Oconto	21	6.8	71	3.1	19.8	0	10	100	3.0	
Big Butternut Lake	Polk	83	7.2	186	2.4	153.1	0	20	87	4.0	Algae
Big Hills Lake	Waushara	105	8.6	252	2.1	53.9	0	0	36	2.4	
Black Otter Lake	Outagamie	194	7.3	412	0.9	30.4	0	10	75	2.7	
Blake Lake	Polk	108	6.8	340	1.5	122.3	0	25	50	2.7	
Bone Lake	Polk	122	6.8	194	3.1	721.3	20	15	105	3.9	
Cary Pond	Waupaca	148	8.3	315	2.9	10.5	0	10	111	2.1	
Cedar Lake	Polk	125	7.8	225	1.5	448.3	15	15	228	2.7	
Chain Lake	Chippewa	37	6.8	120	4.3	189.5	50	8	48	3.2	
Chute Pond	Oconto	100	7.9	230	1.5	168.9	0	20	134	3.0	
Clear Lake	Rusk	88	7.0	156	4.0	38.5	59	7	70	5.0	
Clear Lake T39 R7 S16	Oneida	10	6.8	27	5.9	342.6	85	3	134	7.8	
Como Lake	Walworth	180	8.2	417	2.4	383.1	0	20	160	1.4	
Decorah Lake	Juneau	53	8.6	137	0.9	42.1	0	40	117	2.6	
Devil's Lake	Sauk	21	7.2	99	5.2	151.1	75	4	221	3.6	Algae
Dowling Lake	Douglas	22	6.3	56	1.5	62.4	0	25	24	2.1	
Ennis Lake	Marquette	201	8.2	339	1.7	10.1	15	10	294	3.6	
Enterprise Lake	Langlade	30	7.0	44	1.2	204.5	7	10	102	3.1	
Frank Lake	Vilas	10	7.1	29	3.1	57.1	10	6	24	5.2	
George Lake	Kenosha	103	9.9	253	0.3	23.9	0	50	62	1.8	Carp, algae
Half Moon Lake	Polk	89	6.6	122	3.4	234.5	35	9	142	5.0	
Half Moon Lake T47 R8 S17	Bayfield	47	7.4	74	3.1	42.1	0	30	100	2.6	
Helen Lake	Portage	110	7.7	281	3.4	31.6	0	15	165	4.8	

Continued on next page

Table 1—*Continued*

Lake name	County	Total alkalinity	pH	Specific conductance at 25° C	Secchi	Area	H_2O >3m	H_2O <1m	Quadrats sampled	Depth of maximum plant growth	Biotic influence
		mg/l $CaCO_3$		umhos/cm	m	ha	%	%		m	
Island Lake	Rusk	65	7.0	82	3.1	213.0	35	9	84	4.2	
Lazy Lake	Columbia	214	9.2	373	1.2	65.2	0	40	58	2.4	Carp
Leota Lake	Rock	250	7.8	641	0.3	16.6	0	25	24	1.5	Carp, algae
Little Arbor Vitae Lake	Vilas	55	7.8	120	2.1	215.9	20	6	128	5.1	Algae
Little Elkhart Lake	Sheboygan	133	8.5	246	2.1	21.9	1	10	190	4.5	
Long Lake T20 R09 S17	Waushara	54	8.5	120	0.9	18.2	0	85	69	1.5	
Long Lake T32 R8 S8	Chippewa	42	7.2	97	4.9	429.3	55	5	46	1.8	Crayfish
McCann Lake	Rusk	68	6.8	94	2.7	53.9	21	26	94	3.3	
Mid Lake	Oneida	49	6.5	113	1.5	87.1	0	25	103	3.3	
Moon Lake	Marinette	79	6.8	200	4.4	39.3	15	15	73	4.8	
Mount Morris Lake	Waushara	136	8.4	239	2.7	66.0	5	5	188	5.1	
Mud Hen Lake	Burnett	85	8.4	174	3.4	228.0	30	30	159	4.2	
Muskellunge Lake	Lincoln	32	6.4	76	3.4	64.4	5	15	111	3.3	
Oconomowoc Lake, Upper	Waukesha	221	8.0	488	2.4	17.4	0	10	117	4.1	
Okauchee Lake	Waukesha	139	8.9	287	5.5	480.7	40	5	348	5.2	
Ottawa Lake	Waukesha	265	7.8	462	2.3	11.3	0	10	338	5.1	
Pearl Lake	Waushara	123	8.5	208	4.9	37.3	65	2	198	6.0	
Perch Lake T45 R7 S5	Bayfield	8	6.0	28	3.1	28.4	45	8	146	5.1	
Pigeon Lake	Waupaca	191	8.2	388	1.8	66.0	0	0	139	3.3	
Pike Lake	Polk	130	7.4	271	2.3	64.4	15	15	130	6.0	
Pine Lake	Waukesha	139	8.5	360	3.3	284.7	80	5	118	5.4	
Pine Lake	Forest	35	7.6	90	3.7	676.4	0	20	224	3.9	
Pine Lake	Chippewa	17	5.8	26	4.6	106.1	75	4	122	5.0	
Post Lake, Upper	Langlade	48	7.2	95	0.9	306.6	0	20	96	2.7	
Pretty Lake	Waukesha	155	8.4	400	2.4	25.9	10	35	57	4.5	
Prong Lake	Vilas	5	6.6	20	4.5	12.2	47	8	133	5.4	
Rib Lake	Taylor	65	6.8	156	1.2	129.6	0	40	136	3.3	Algae
Rolling Stone Lake	Langlade	77	7.7	142	2.1	272.2	0	0	106	3.6	
Round Lake	Polk	94	8.4	160	1.6	411.1	0	25	124	3.6	
Silver Lake (Anderson) T22	Waupaca	180	8.5	367	1.5	13.0	0	12	75	2.3	

Continued on next page

Table 1—*Continued*

Lake name	County	Total alkalinity	pH	Specific conductance at 25° C	Secchi	Area	H_2O >3m	H_2O <1m	Quadrats sampled	Depth of maximum plant growth	Biotic influence
		mg/l $CaCO_3$		*umhos/cm*	*m*	*ha*	*%*	*%*		*m*	
Tahkodah Lake	Bayfield	9	6.8	15	2.7	61.6	0	15	9	1.2	
Tichigan Lake	Racine	244	8.2	842	0.6	458.9	8	32	30	1.8	Carp, algae
Town Line Lake	Chippewa	9	6.0	35	1.3	19.4	15	10	152	4.0	
Twin Lake, North	Polk	129	7.0	263	1.9	54.7	0	25	148	6.0	
Twin Lake, South	Polk	135	7.2	279	1.5	30.0	0	25	145	3.0	
Vienna Lake (Honey)	Walworth	315	8.1	670	0.3	17.8	0	30	23	1.2	Carp
White Ash Lake	Polk	93	7.0	284	1.2	62.0	0	25	46	2.4	
White Ash Lake, North	Polk	113	7.4	175	2.0	48.2	0	25	131	2.7	

other stands (Table 4). The shallowest water was the least similar of all the depth classes. There was little difference in similarity between hard and soft substrates.

Taxa with fewer than ten total occurrences, taxa identified only to the generic level except for *Chara* spp. and *Nitella* spp., and free floating species such as *Lemna* spp. and *Wolfia* spp., which have little relationship to depth and substrate, were eliminated from further consideration. *Ceratophyllum demersum* was the most common species. It occurred in 34% of the quadrats and in two-thirds of the lakes. All species with more than two hundred occurrences are common aquatic plants in Wisconsin. All occurred in at least 10% of the lakes. Many of the less common species are either emergent, or they are found in bogs or extremely hard- or extremely soft-water lakes. They have the most restricted habitat requirements.

Depth distribution and maximum depth of growth

The maximum depth of any macrophyte was 7.8 m in Clear Lake, Oneida County. Clear Lake also had the greatest secchi disk reading (Table 1). A least-squares regression of $2.12 + 0.62\,X$ describes the linear relationship between maximum growth depth and secchi depth in these lakes (Fig. 2). There is a significant positive correlation between the two factors ($r = .58$, $N = 68$, $p < .001$). A maximum growth depth versus secchi disk regression was calculated for lakes where a charophyte (*Chara* sp. or *Nitella* sp.) occurred in the deepest quadrat. This regression was not significantly different from the regression in which only non-charophytes were found in the deepest quadrat.

The linear relationship between the maximum depth of growth and secchi depth was tested for the 43 species that occurred in five or more lakes (Table 3). A significant positive correlation ($p < .05$) was found for 13 species (Table 5). *Eriocaulon septangulare* showed the strongest correlation, and all but one of the species showing correlation were submergent.

Table 2. Distribution of taxa by relative depth-substrate class

	Relative depth (% of maximum)				
Substrate	*0–25%*	*26–50%*	*51–75%*	*76–100%*	*Total taxa*
Hard	105	89	81	44	114
Soft	107	100	64	61	113
Total taxa	120	112	88	64	
Grand total taxa = 123					

Boxplots (Fig. 3) show the depth distribution of individual species with ten or more occurrences. The species are arranged in descending order of median depth. More than 75% of all plants were found in less than 3 m of water. *Chara* spp. was found at 7.8 m, the maximum depth for any species. It also occurred over the broadest depth range. *Najas flexilis* followed closely behind *Chara* with a maximum depth of 7.5 m. Both species had a broad outlier range. *Nitella* spp. had the greatest median depth and the greatest depth for the 75% quartile. *Myriophyllum heterophyllum, M. farwellii,* and *Isoetes macrospora* had the broadest depth range when outliers were not considered.

Species common in deep water were also found in shallow water, but species common in shallow were often not found in deep water. Generally speaking, species with shallow median depths are emergent species. However, *Potamogeton foliosus, P. oakesianus,* and *P. vaginatus* are submerged species with a shallow median depth.

The maximum depths of plant growth for 46 species were compared to literature values (Sheldon and Boylen 1977; Wilson 1941; Schmid 1965; Denniston 1921; Lillie 1986; Lind 1976). Twenty-three species were found at a greater maximum depth in other lakes (Table 6), including six species that were found at greater maximum depth in a later study of Devil's Lake (Lillie 1986). Some differences in maximum depth probably relate to limnological conditions and others to the sampling technique used to establish maximum depth (see Spence, 1967, for a discussion of problems related to determining maximum depth of growth).

Various depth statistics were tested, using correlation analysis, to determine how useful they might be for predicting the sequential order of maximum growth depth in a lake (i.e., in a lake with a given flora, which species will have the deepest maximum depth of growth, the second deepest, and so forth). The statistics tested were median depth, the trimmed maximum depth (i.e., the maximum depth or the maximum depth not considering outliers, whichever is the most shallow), the maximum depth, the median of the maximum depth for species that occurred in five or more lakes, and the median of the maximum depth/secchi disk for species that occurred in five or more lakes (Table 6). Based on median correlation values, the best predictor of the sequential order of maximum growth depth is median maximum depth (Table 7). Median depth and median of maximum depth/secchi ratio predicted maximum depth order nearly as well. Maximum depth was the poorest predictor of maximum depth order. On the average, all methods were better at predicting maximum depth order for Wisconsin lakes than for non-Wisconsin lakes.

Substrate and depth preference

Substrate and depth preferences were tested using a chi-square analysis on species occurrence. The hypothesis tested was that the distribution of a species is not significantly different from the distribution of all vegetated quadrats (Table 8).

Because each species acts as an individual, significant variation from the all-species distribution is expected. More interesting and informative are how and to what degree each species varies. A Z score of (observed/

Table 3. Number of species occurrence

Species	Substrate 1 Depth 1	Substrate 1 Depth 2	Substrate 1 Depth 3	Substrate 1 Depth 4	Substrate 2 Depth 1	Substrate 2 Depth 2	Substrate 2 Depth 3	Substrate 2 Depth 4	Occurrence of turbid water	No. lakes occurring	Association of turbid water*
Brasenia schreberi	64	25	2	0	163	134	32	13	146	16	+ + +
Carex aquatilis	0	0	0	0	11	0	0	0		1	Nocalc
Ceratophyllum demersum	147	287	130	67	440	759	655	387	663	45	+ + +
Ceratophyllum echinatum	2	1	0	0	10	9	2	1		1	Nocalc
Chara spp.	299	204	32	20	378	318	194	112	105	36	− − −
Cyperus engelmannii	0	0	0	0	3	2	4	1		1	Nocalc
Dulichium arundinaceum	28	2	0	0	33	10	0	0	42	11	+ + +
Elatine minima	8	4	0	0	0	0	0	0		2	Nocalc
Eleocharis acicularis	21	9	4	0	8	5	7	4	24	12	+ + +
Eleocharis palustris	5	7	2	1	2	3	1	0		3	Nocalc
Eleocharis robbinsii	6	6	1	0	2	39	19	6		3	Nocalc
Elodea canadensis	81	117	67	38	246	414	271	150	342	46	+ + +
Eriocaulon septangulare	22	12	3	0	8	10	0	0	0	6	− − −
Gratiola aurea	8	5	0	0	0	0	0	0		1	Nocalc
Heteranthera dubia	97	59	12	3	100	115	54	39	123	26	+ + +
Isoetes echinospora	4	3	3	0	7	17	1	0		3	Nocalc
Isoetes macrospora	8	28	9	2	1	6	5	3		3	Nocalc
Leersia oryzoides	0	0	1	0	1	8	1	0		1	Nocalc
Lobelia dortmanna	8	10	0	0	0	0	0	0		3	Nocalc
Megalodanta beckii	17	23	6	0	55	53	11	1	2	9	− − −
Myriophyllum exalbescens	52	101	37	16	108	300	297	90	148	28	− − −
Myriophyllum farwellii	0	1	1	0	28	43	17	8		1	Nocalc
Myriophyllum heterophyllum	2	67	7	1	25	30	12	2		2	Nocalc
Myriophyllum spicatum	26	47	44	32	69	158	79	37	77	9	− − −
Myriophyllum tenellum	13	13	0	0	0	3	1	0		2	Nocalc
Myriophyllum verticillatum	89	86	46	15	158	230	92	21	28	12	− − −
Najas flexilis	226	184	45	9	171	296	144	106	248	42	− − −
Najas gracillima	0	3	3	2	0	0	4	1		2	Nocalc
Najas marina	2	1	1	0	19	45	21	3		3	Nocalc
Nitella spp.	4	6	10	8	14	37	33	28	28	12	Nonsig

Continued on next page

Table 3—*Continued*

Species	Substrate 1 Depth 1	Substrate 1 Depth 2	Substrate 1 Depth 3	Substrate 1 Depth 4	Substrate 2 Depth 1	Substrate 2 Depth 2	Substrate 2 Depth 3	Substrate 2 Depth 4	Occurrence of turbid water	No. lakes occurring	Association of turbid water*
Nuphar advena	1	3	2	0	11	48	6	3	13	5	Nonsig
Nuphar variegatum	62	54	9	9	208	200	36	11	105	39	– –
Nymphaea odorata	53	37	9	2	107	120	34	5	160	17	+ + +
Nymphaea tuberosa	57	19	2	2	271	161	23	13	102	26	Nonsig
Polygonum amphibium	14	0	0	0	75	16	4	0	47	6	+ + +
Pontederia cordata	26	20	1	2	61	49	3	1	18	20	– – –
Potamogeton amplifolius	35	92	25	14	108	274	108	53	138	44	Nonsig
Potamogeton berchtoldii	15	24	14	8	7	24	14	9	33	5	+ +
Potamogeton crispus	41	43	23	10	87	97	58	36	105	18	+ + +
Potamogeton diversifolius	2	0	0	0	17	29	6	0		2	Nocalc
Potamogeton epihydrus	10	1	1	1	14	23	5	2	10	12	Nonsig
Potamogeton filiformis	0	5	3	2	4	6	11	1		3	Nocalc
Potamogeton foliosus	23	8	4	0	77	51	56	29	96	9	+ + +
Potamogeton gramineus	98	89	21	16	51	79	37	19	100	24	Nonsig
Potamogeton illinoensis	33	23	3	0	58	55	20	8	17	15	– – –
Potamogeton natans	62	42	4	0	134	95	16	0	70	28	Nonsig
Potamogeton nodosus	21	9	1	0	8	18	0	2	24	6	+ + +
Potamogeton oakesianus	0	0	0	0	16	3	0	0		2	Nocalc
Potamogeton obtusifolius	0	1	0	0	6	8	0	0		2	Nocalc
Potamogeton pectinatus	87	84	13	3	150	162	119	55	151	32	Nonsig
Potamogeton praelongus	21	24	16	2	100	215	184	64	47	21	– – –
Potamogeton pusillus	8	18	4	2	99	105	30	11	123	15	+ + +
Potamogeton richardsonii	80	155	45	23	71	196	112	71	172	31	Nonsig
Potamogeton robbinsii	29	78	48	38	90	204	97	109	146	20	Nonsig
Potamogeton strictifolius	18	9	0	0	15	13	3	0		2	Nocalc
Potamogeton vaginatus	15	2	0	0	52	7	3	2		2	Nocalc
Potamogeton vaseyi	1	0	0	0	1	5	6	1		2	Nocalc
Potamogeton zosteriformis	115	159	67	33	247	401	282	112	246	41	– – –
Ranunculus longirostris	7	3	0	0	6	8	3	0	6	9	Nonsig
Ranunculus reptans	7	13	0	0	0	1	2	0		2	Nocalc

Continued on next page

Table 3—*Continued*

Species	Substrate 1				Substrate 2				Occurrence of turbid water	No. lakes occurring	Association of turbid water*
	Depth 1	Depth 2	Depth 3	Depth 4	Depth 1	Depth 2	Depth 3	Depth 4			
Ranunculus trichophyllus	5	0	2	0	4	4	0	0		3	Nocalc
Sagittaria graminea	2	0	2	0	8	3	0	0		3	Nocalc
Sagittaria latifolia	9	0	0	0	21	2	3	0	10	9	Nonsig
Sagittaria rigida	3	0	0	0	15	7	1	0	11	5	+ + +
Scirpus americanus	5	1	0	0	11	12	1	0		4	Nocalc
Scirpus validus	97	62	2	1	175	18	0	0	11	26	− − −
Sparganium angustifolium	2	2	1	0	4	0	1	0		3	Nocalc
Sparganium chlorocarpum	3	1	0	0	15	14	1	0		4	Nocalc
Sparganium eurycarpum	3	1	0	0	21	0	0	0	5	7	Nonsig
Typha angustifolia	0	0	0	0	14	0	0	0		2	Nocalc
Typha latifolia	28	0	0	1	88	9	1	3	8	19	− − −
Utricularia geminiscapa	3	3	0	1	32	43	3	3		2	Nocalc
Utricularia gibba	3	0	0	0	41	37	9	3		1	Nocalc
Utricularia intermedia	3	0	1	0	35	30	2	1		2	Nocalc
Utricularia vulgaris	3	3	0	0	50	59	14	0		4	Nocalc
Vallisneria americana	215	318	86	33	94	266	114	36	316	44	+ + +
Zanichellia palustris	19	8	3	1	3	1	4	5		3	Nocalc
Zizania aquatica	6	4	1	0	59	26	3	0	15	9	Nonsig

*Nocalc = no calculation; nonsig = nonsignificant association using chi-square ($p < .05$). + + − −, + + + − − − = moderate or strong positive or negative association.

Table 4. Similarity of stands based on relative frequency

		Substrate 1				*Substrate 2*		
	Depth	*1*	*2*	*3*	*4*	*1*	*2*	*3*
Substrate 1	1	1.00						
	2	0.74	1.00					
	3	0.58	0.76	1.00				
	4	0.53	0.69	0.83	1.00			
Substrate 2	1	0.69	0.65	0.54	0.49	1.00		
	2	0.64	0.72	0.70	0.64	0.76	1.00	
	3	0.54	0.67	0.73	0.69	0.63	0.79	1.00
	4	0.53	0.66	0.72	0.71	0.57	0.71	0.84
Total similarity		5.24	5.89	5.85	5.75	5.33	5.95	5.86

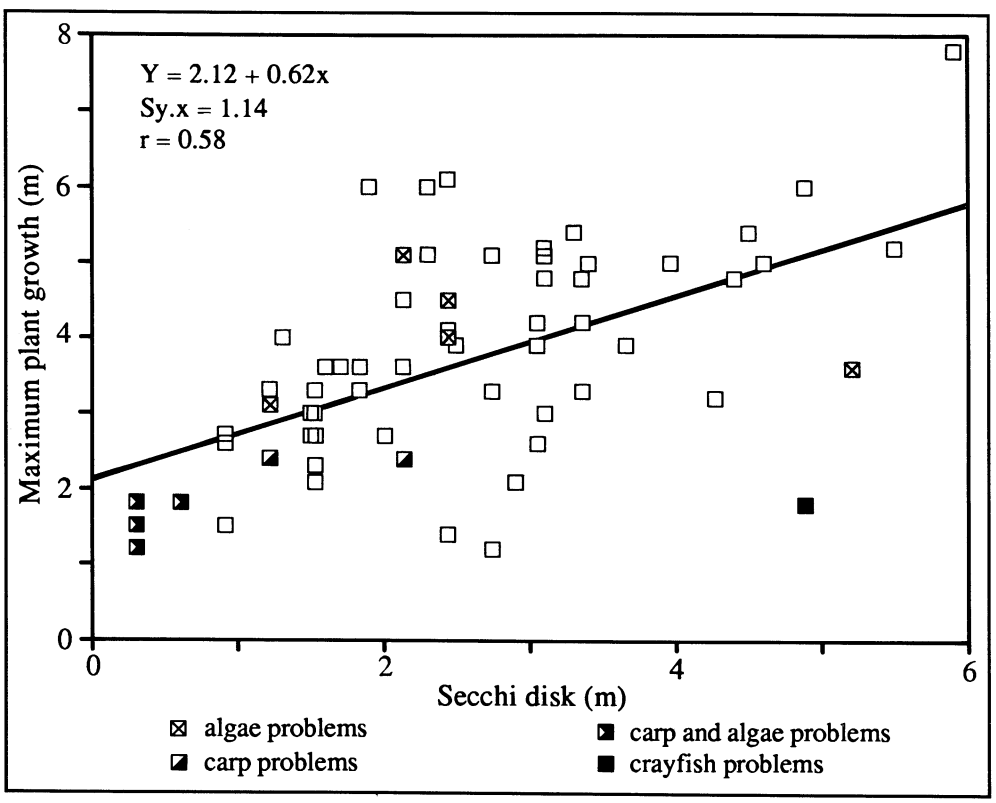

Figure 2. *Secchi disk reading versus maximum depth of plant growth*

expected)/(square root expected) was calculated for each cell of the chi-square table. If the score was less than ± 1 *Z*, the association is weak (designated + or − in Table 9). If it ranged from 1 to 2 *Z*, the association is moderate (designated + + or − − in Table 9). If *Z* was greater than 2, it is a strong association (designated + + + or − − − in Table 9).

A valid chi-square test requires a minimum number of occurrences in each cell. To fit the criteria of a valid test, species with dif-

Table 5. Positive correlation between maximum plant growth depth and secchi depth ($p < .05$)

Species	*Correlation coefficient*
Chara spp.	0.61
Ceratophyllum demersum	0.29
Elodea canadensis	0.38
Eriocaulon septangulare	0.93
Myriophyllum exalbescens	0.42
Najas flexilis	0.57
Potamogeton amplifolius	0.40
Potamogeton gramineus	0.48
Potamogeton pectinatus	0.51
Potamogeton pusillus	0.54
Potamogeton richardsonii	0.49
Vallisneria americana	0.39
Zizania aquatica	0.70

ferent numbers of occurrences had to be tested in different ways. All species with 50 or more occurrences were tested with the full eight-cell chi-square pattern of four depth classes and two substrate types. Species with 25 to 50 occurrences were analyzed separately in a four-cell depth preference test and a two-cell substrate preference test. Species with 15 to 25 occurrences were analyzed with a two-cell substrate preference pattern. Species with fewer than 15 occurrences were not analyzed.

The patterns of positive and negative associations were sorted until species with like patterns occurred close to each other in a list. The list was subjectively split, and species groups were labelled with habitat preference based on the pattern of positive and negative associations (Table 9).

Twenty-six species showed a preference for soft sediment; 14 species preferred hard bottoms. A depth preference with no substrate preference was evident for 27 species. The majority of these species showed a preference for shallow water. No species showed a unique preference for hard bottom and deep water. With minor exceptions, species showed a smooth transition between adjacent habitats. No species showed a strongly bimodal distribution.

Myriophyllum heterophyllum, M. verticillatum, Potamogeton epihydrus, P. pectinatus, P. illinoensis, Heteranthera dubia, and *Chara* spp. are classified as shallow species by this technique. They may have a deeper distribution than mid- to deep-water species when boxplots are compared. Depth in this test is relative to the maximum depth of plant growth in a lake, whereas boxplots compare absolute depth. Therefore, the two tests need not give the same results.

Species association with turbid water

Twenty-one percent of the quadrats occurred in turbid lakes (lakes with secchi disk readings of 1.5 m or less, Table 1). A chi-square test was done on the 43 species that occurred in five or more lakes to determine whether they were found more or less frequently than expected in turbid water (Table 3). A Z score was calculated as noted previously to describe the strength of the association.

No significant association was found for 14 of the species, 15 species showed a positive association for turbid water, and 14 species showed a negative association with turbid water (Table 3).

Species density and habitat type

Differences in species density ranking for the four depth classes and two substrate types were tested using a two-way analysis of variance. Because of differences in occurrence, the test had to be modified for some species. Originally all species with 50 or more occurrences were tested for depth, substrate, and depth-substrate interaction. Because of data limitations, two-way analysis of variance could not provide a valid interaction model for some species. In these cases the interaction test was dropped and the analysis was recalculated for only depth and substrate.

This test asks whether there is a significant difference in mean density rank for a single species between habitats where it is found. A probability of $F < .05$ and at least a .5 difference between the largest and smallest mean density were the criteria established to

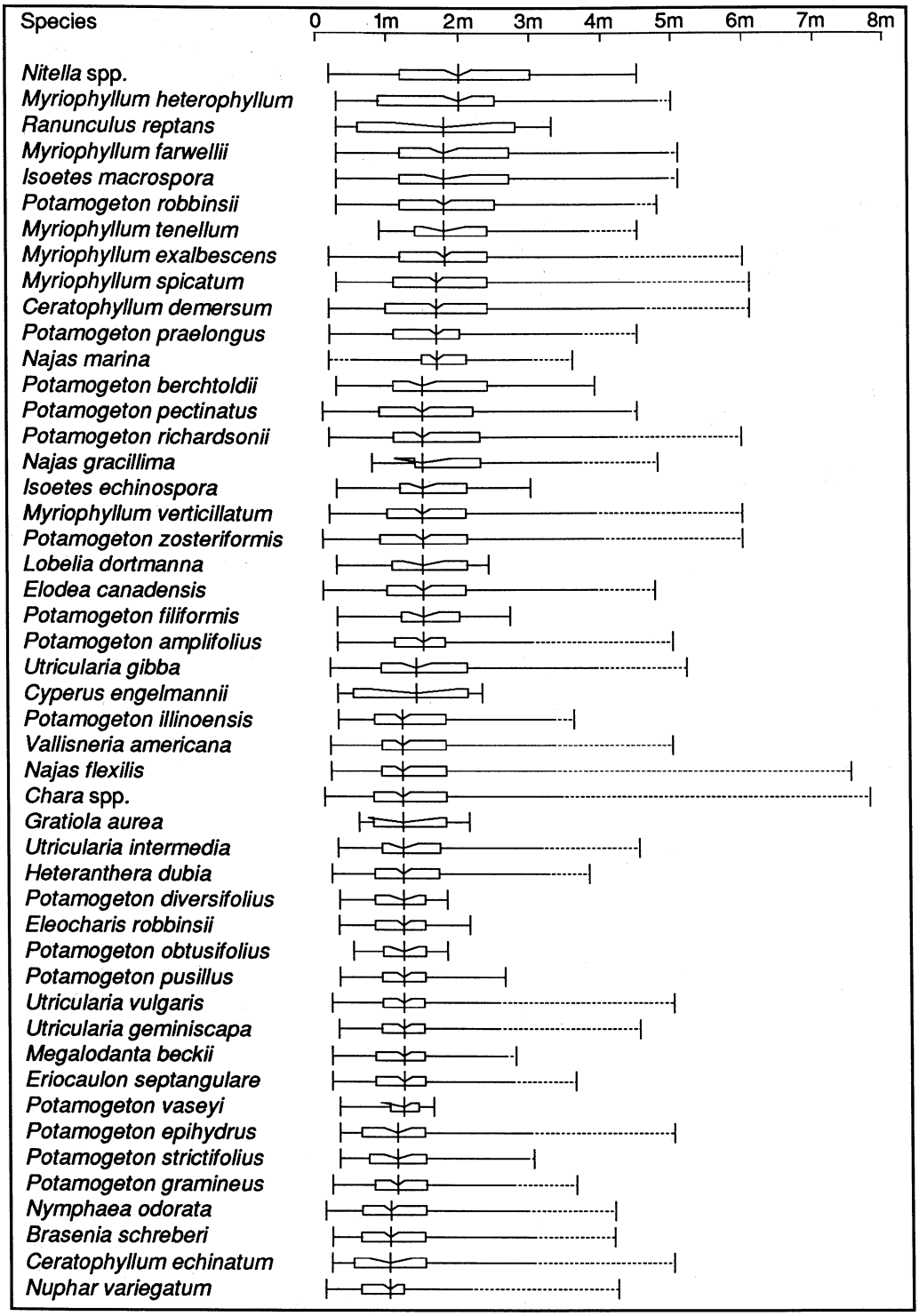

Figure 3. *Boxplots of species depth distributions. Definitions follow Ryan, Joiner, and Ryan (1981)*

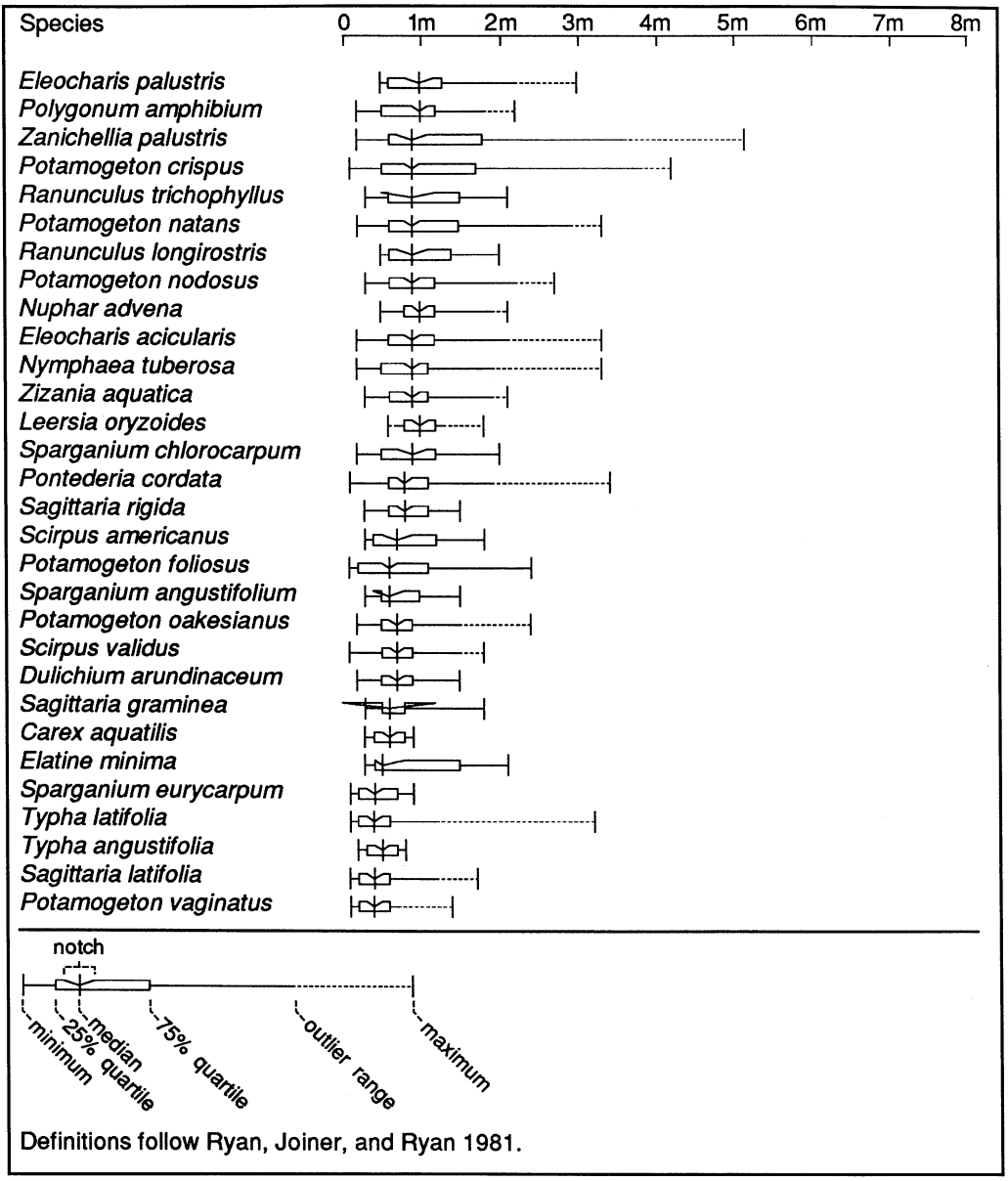

Figure 3—*Continued*

test for significant differences. For any depth-substrate cell in a single test to be significantly different from another cell, the $p < .05$ criterion was used, but the mean density difference of .5 was not used.

Twenty-six species showed no significant difference across the range of depths and substrates. Five species showed significantly higher densities on soft substrates (Fig. 4). Seven species showed significantly different densities according to depth (Fig. 5). Density of *Elodea canadensis* and *Eriocaulon septangulare* differed depending on depth and substrate, but the depth-substrate interaction was not significant (Fig. 4 and 5).

The density of the remaining ten species

Table 6. Comparison of maximum plant growth depths

	Study lakes					Comparison lakes					
Species	*Median depth*	*Trimmed maximum depth*	*Maximum depth*	*Median maximum depth*	*Median maximum/ secchi*	*1* Lake Mendota*	*2* Devil's Lake*	*3* Trout Lake*	*4* SE Minn. lakes*	*5* Long Lake*	*6* Lake George*
	m	*m*	*m*	*m*		*m*	*m*	*m*	*m*	*m*	*m*
Brasenia schreberi	1.0	2.9	4.1	1.5	0.6				1.8		
Ceratophyllum demersum	1.7	4.5	6.1	3.0	1.6	6.0	8.7	6.5	4.7		
Chara spp.	1.2	3.3	7.8	2.6	1.1	2.9	1.8	5.0	1.6	8.8	
Elatine minima	0.3	2.1	2.1								2.0
Eleocharis acicularis	0.9	2.1	3.3	1.5	0.5		2.0	1.5			
Eleocharis palustris	1.0	2.1	3.0					0.5			
Elodea canadensis	1.5	3.9	4.8	2.6	1.1		6.7	4.5	3.4	7.5	12.0
Eriocaulon septangulare	1.2	2.6	3.6	1.4	0.4						3.0
Gratiola aurea	1.2	2.1	2.1					0.3			
Heteranthera dubia	1.2	3.1	3.8	1.9	1.1				1.7	5.5	5.0
Isoetes echinospora	1.5	3.0	3.0				1.7				7.0
Isoetes macrospora	1.8	5.0	5.1					2.5			9.0
Lobelia dortmanna	1.5	2.4	2.4					0.3			2.0
Megalodanta beckii	1.2	2.6	2.7	2.1	0.7			3.5			7.0
Myriophyllum exalbescens	1.8	4.2	6.0	2.5	1.3				3.7	6.8	
Myriophyllum spicatum	1.7	4.4	6.1	3.6	1.2		9.0				
Myriophyllum tenellum	1.8	3.8	4.5					4.0			3.0
Myriophyllum verticillatum	1.5	3.9	6.0	3.2	1.3	5.8		3.5			
Najas flexilis	1.2	3.2	7.5	2.3	1.1	5.3		5.5	1.6	4.5	9.0
Nitella spp.	2.0	4.5	4.5	2.6	1.4		9.0	5.0		11.5	
Nuphar advena	0.9	1.8	2.1	1.2	0.7	1.4					
Nuphar variegatum	1.0	2.1	4.2	1.5	0.7				2.8		
Nymphaea odorata	1.0	2.9	4.1	1.4	0.5	1.0		1.0			
Nymphaea tuberosa	0.9	1.9	3.3	1.4	0.9				1.6		
Potamogeton amplifolius	1.5	2.9	5.0	2.4	1.1	3.9	4.7	5.0	3.9	5.5	7.0
Potamogeton crispus	0.9	3.9	4.2	2.1	1.3		2.9		2.8		3.0
Potamogeton diversifolius	1.2	1.8	1.8				3.7				
Potamogeton epihydrus	1.1	2.9	5.0	1.5	0.5			0.3			

Continued on next page

Table 6—*Continued*

Species	Study lakes					Comparison lakes					
	Median depth	Trimmed maximum depth	Maximum depth	Median maximum depth	Median maximum/ secchi	1* Lake Mendota	2* Devil's Lake	3* Trout Lake	4* SE Minn. lakes	5* Long Lake	6* Lake George
	m	m	m	m		m	m	m	m	m	m
Potamogeton gramineus	1.1	2.6	3.6	2.0	0.7			4.5			7.0
Potamogeton illinoensis	1.2	3.3	3.6	2.1	0.7						7.0
Potamogeton natans	0.9	2.9	3.3	1.5	0.6			1.8	1.6		
Potamogeton nodosus	0.9	2.1	2.7	1.8	0.7				1.3		
Potamogeton pectinatus	1.5	4.4	4.5	2.3	1.0	4.5		2.5	2.2	4.5	3.0
Potamogeton praelongus	1.7	3.6	4.5	3.0	1.3			4.5	2.6	5.5	7.0
Potamogeton pusillus	1.2	2.6	5.0	2.4	1.2			6.0			9.0
Potamogeton richardsonii	1.5	4.1	6.0	2.8	1.1	3.7		5.0	1.6		
Potamogeton robbinsii	1.8	4.5	4.8	2.7	1.0		6.5	6.0	4.3		10.0
Potamogeton vaseyi	1.2	1.8	1.8						2.3		
Potamogeton zosteriformis	1.5	3.9	6.0	2.7	1.4	5.7			4.7	6.8	5.0
Ranunculus longirostris	0.9	2.0	2.0	1.2	0.9				2.4		5.0
Ranunculus reptans	1.8	3.3	3.3					0.3			
Sagittaria graminea	0.6	1.8	1.8					4.0			3.0
Sparganium angustifolium	0.6	1.5	1.5					0.3			
Utricularia vulgaris	1.2	2.4	2.6			0.9			1.7		
Vallisneria americana	1.2	3.2	5.0	2.2	1.1	5.3	3.5	4.5	2.4		7.0
Zanichellia palustris	0.9	3.6	5.1						1.6		

*1, Denniston 1921; 2, Lillie 1986; 3, Wilson 1941; 4, Lind 1976; 5, Schmid 1965; 6, Sheldon and Boylen 1977.

Table 7. Correlation coefficients of depth order predictors

	Mendota	Devil's	Trout	Minn.	Long	George	Median correlation
Median	0.71	0.73	0.35	0.63	0.40	0.43	0.53
Trimmed maximum	0.71	0.61	0.50	0.46	0.35	0.37	0.48
Maximum	0.56	0.22	0.64	0.20	0.10	0.52	0.37
Median maximum	0.75	0.72	0.73	0.47	0.36	0.50	0.61
Median maximum/secchi	0.88	0.53	0.79	0.58	0.42	0.08	0.55
Average correlation	0.72	0.56	0.60	0.47	0.33	0.38	

Table 8. Distribution of vegetated quadrats by depth-substrate type

	Depth				
	1	2	3	4	Total
Substrate					
1	917	1111	439	224	2691
	10.9%	13.2%	5.2%	2.7%	32.0%
2	1362	2034	1400	932	5278
	16.2%	24.2%	16.6%	11.0%	68.0%
Total	2279	3145	1839	1156	8419
	27.1%	37.4%	21.8%	13.7%	100.0%

varied significantly in the interaction between depth and substrate (Fig. 6). Plants commonly displayed significant density differences across depth on one substrate but not the other. This is the pattern displayed by *Ceratophyllum demersum, Heteranthera dubia, Myriophyllum verticillatum, Nymphaea odorata,* and *Vallisneria americana.* The first two species showed no significant density difference with depth on hard bottom; the other three species showed no significant density difference with depth on soft bottom.

Another common pattern is increasing density with depth on soft substrates and decreasing density with depth on hard substrates. *Potamogeton berchtoldii, P. gramineus,* and *P. richardsonii* displayed some variation of this response. *P. robbinsii* was the only species that showed an increased density with depth on both substrates.

Discussion

The decreasing number of taxa found with increasing depth confirmed results found by Lind (1976) and Sheldon and Boylen (1977). Most deep-water species also occur in shallow water, and species distributions are skewed toward shallow water. Lind (1976) nicely summarizes this relationship by stating, "Many species are restricted to shallow water while others are broadly tolerant of water depth variation."

Since hard substrates appear less suitable for plant growth (Barko, Adams, and Clesceri 1986), it is surprising that taxa richness is not influenced more by substrate type. Where species density is influenced by substrate, higher densities are found on soft substrates. This is especially true in deep water. The shallow-water, hard-bottom communities are probably most dissimilar to other areas because they contain higher frequencies of emergent and rosette species. Emergent species are not found in deep water, and rosette species are found less frequently in deep water and in shallow, soft-sediment areas.

The 1.2-to-7.8-m range of maximum plant growth depths for lakes in this study is similar to that reported by Hutchinson (1975) and

Table 9. Substrate-depth relationships

Species								
*Substrate-depth preference**	*Hard bottom*				*Soft bottom*			
	1	*2*	*3*	*4*	*1*	*2*	*3*	*4*
	Soft-bottom, shallow-depth species							
Zizania aquatica	−−	−−−	−−	−−	+++	+	−−−	−−−
Potamogeton crispus	−	−−	+	−	+++	+	−−	−−
Potamogeton pusillus	−−−	−−−	−−−	−−−	+++	+++	−−−	−−−
Utricularia gibba	−−−	−−−	−−−	−−	+++	+++	−−−	−−−
Utricularia geminiscapa	−−−	−−−	−−−	−−	+++	+++	−−−	−−−
Utricularia vulgaris	−−−	−−−	−−−	−−	+++	+++	−−	−−−
Nymphaea tuberosa	−	−−−	−−−	−−−	+++	+++	−−−	−−−
Nuphar variegatum	−	−−−	−−−	−−−	+++	+++	−−−	−−−
Potamogeton diversifolius	−−	−−−	−−	−−	+++	+++	−−	−−−
Utricularia intermedia	−−	−−−	−−	−−	+++	+++	−−−	−−−
Megalodanta beckii	−	+	−	−−−	+++	+++	−−−	−−−
	Soft-bottom, shallow- to mid-depth species							
Myriophyllum farwellii	−−−	−−−	−−	−−	+++	+++	+	−
Najas marina	−−−	−−−	−−	−−	++	+++	++	−−−
Potamogeton zosteriformis	−−−	−−	−	−−	++	+++	+++	−−−
Elodea canadensis	−−−	−−−	−	−	++	+++	+++	−
Nuphar advena	−−−	−−−	−	−−	−	+++	−−	−−−
Potamogeton amplifolius	−−−	−	−−	−−	−	+++	−−	−−−
	Soft-bottom, mid- to deep-depth species							
Potamogeton praelongus	−−−	−−−	−−−	−−−	+	+++	+++	−
Potamogeton foliosus	−	−−−	−−−	−−−	+++	−−	+++	+
Myriophyllum exalbescens	−−−	−−−	−−	−−−	−−−	+++	+++	−−
Eleocharis robbinsii	−	−−	−−	−−	−−−	+++	++	−
Ceratophyllum demersum	−−−	−−−	−−	−−−	−	+++	+++	+++
	Mid- to deep-depth species							
Myriophyllum spicatum	−−−	−−−	+++	+++	−−	+++	−	−−−
Nitella spp.	−−−	−−−	++	++	−−	+	++	+++
Potamogeton robbinsii	−−−	−−	+++	+++	−−	+++	−−	+++
Potamogeton richardsonii	−	+++	++	+	−−−	++	−−	−−
	Shallow-depth species							
Myriophyllum heterophyllum	−−−	+++	−	−−	+	−	−−−	−−−
Myriophyllum verticillatum	+	−−	++	−−	+++	+++	−−−	−−−
Polygonum amphibium	+	−−−	−−−	−−	+++	−−	−−−	−−−
Nymphaea odorata	++	−−	−−−	−−−	+++	+++	−−−	−−−
Pontederia cordata	++	−	−−−	−−	+++	++	−−−	−−−
Potamogeton epihydrus	++	−−−	−−	−	++	+++	−−	−−
Potamogeton pectinatus	++	−	−−−	−−−	+++	+	+	−−−
Brasenia schreberi	+++	−−−	−−−	−−−	+++	+++	−−−	−−−
Potamogeton vaginatus	+++	−−−	−−−	−−	+++	−−−	−−−	−−−
Typha latifolia	+++	−−−	−−−	−−	+++	−−−	−−−	−−−
Dulichium arundinaceum	+++	−−−	−−	−−	+++	−−−	−−−	−−−
Potamogeton illinoensis	+++	−	−−−	−−−	+++	++	−−−	−−−
Potamogeton natans	+++	−	−−−	−−−	+++	++	−−−	−−−
Heteranthera dubia	+++	−	−−−	−−−	+++	+	−−−	−−
Chara spp.	+++	+	−−−	−−−	+++	−−	−−−	−−−
Potamogeton nodosus	+++	+	−−	−−	−	++	−−−	−−
Scirpus validus	+++	+++	−−−	−−−	+++	−−−	−−−	−−−

Continued on next page

Table 9—*Continued*

Species	Substrate-depth preference*							
	Hard bottom				Soft bottom			
	1	2	3	4	1	2	3	4
	Hard-bottom, shallow- to mid-depth species							
Potamogeton strictifolius	+++	+	−−	−−	−−	−	−−−	−−−
Eleocharis acicularis	+++	+	+	−−	−	−−−	−	−
Eriocaulon septangulare	+++	++	+	−−	−	−	−−−	−−−
Najas flexilis	+++	+++	−−	−−−	−−	+	−−−	−−−
	Hard-bottom species							
Vallisneria americana	+++	+++	+++	−	−−−	−	−−−	−−−
Potamogeton gramineus	+++	+++	+	++	−−	−−	−−−	−−−
Isoetes macrospora	+	+++	+++	+	−−−	−−−	−−	−−
Potamogeton berchtoldii	+	+++	+++	+++	−−−	−	−−	−−

Substrate and depth preference	Bottom		Depth			
	Hard	Soft	1	2	3	4
Sagittaria latifolia	Nonsig		+++	−−−	−−	−−−
Sparganium eurycarpum	Nonsig		+++	−−−	−−−	−−
Scirpus americanus	Nonsig		+++	+	−−−	−−−
Ranunculus longirostris	Nonsig		+++	+	−−	−−
Isoetes echinospora	Nonsig		+	++	−−	−−−
Potamogeton filiformes	Nonsig		−−	−	+++	−
Sparganium chlorocarpum	−−−	++	+++	+	−−−	−−
Ceratophyllum echinatum	−−−	+++	+++	+	−−	−−
Sagittaria rigida	−−	++	+++	−	−−	−−
Zanichellia palustris	+++	−−−	+++	−−	−	−
Myriophyllum tenellum	+++	−−−	++	++	−−−	−−−
Substrate preference						
Ranunculus trichophyllus	Nonsig					
Sagittaria graminea	Nonsig					
Potamogeton obtusifolius	−−	++				
Ranunculus reptans	+++	−−−				
Lobelia dortmanna	+++	−−−				
Potamogeton oakesianus	+++	−−−				
Eleocharis palustris	+++	−−−				

*+ −, + + − −, + + + − − − represents weak, moderate, or strong association. Nonsig = nonsignificant association using chi-square test ($p < .05$).

broader than the 1.0-to-4.5-m range reported by Lind (1976) for eutrophic lakes in southeastern Minnesota. They are more shallow than the 12-m maximum depth for Lake George, New York (Sheldon and Boylen 1977), the 11-m depth for Long Lake, Minnesota (Schmid 1965), or the 9-m depth of Devil's Lake, Wisconsin (Lillie 1986). They are considerably more shallow than the 18-m maximum depth for *Utricularia geminiscapa* (Singer, Roberts, and Boylen 1983) in Silver Lake, New York, the 20-m maximum depth for bryophytes in Crystal Lake, Wisconsin (Fassett 1930), or the approximately 150-m maximum depth for charophytes and bryophytes in Lake Tahoe, California (Frantz and Cordone 1967).

This study supports the findings of Hutch-

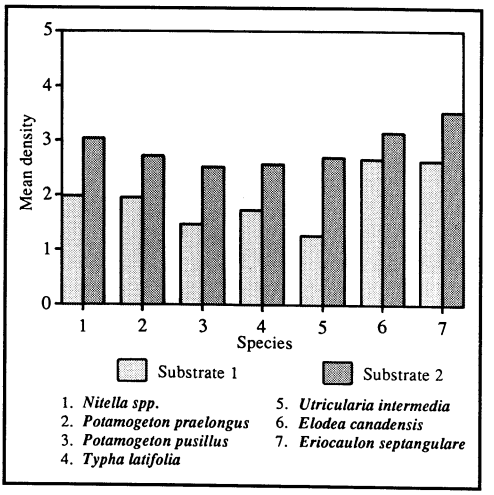

Figure 4. *Mean density of species by substrate*

inson (1975), Dunst (1982), Chambers and Kalf (1985), and Canfield et al. (1985) that there is a significant regression between secchi disk and maximum depth of plant growth. The regression line is not significantly different from one based on Hutchinson's data and one reported by Chambers and Kalf (1985). Not enough statistical information is provided by Canfield et al. (1985) to compare regressions. The regression calculated in this study is significantly different from Dunst's regression (1982). His equation predicts deeper plant growth. This is surprising because the Dunst regression is based on data from 51 lakes in southeastern Wisconsin (Modlin 1970; Belonger 1969).

A possible explanation for the difference is the strong presence of charophytes or *Najas flexilis* in the lakes used by Dunst. This study shows that *Chara* spp. and *Najas flexilis* had the deepest maximum growth depths and *Nitella* spp. had the greatest median and 75% quartile depths. However, a regression equation for lakes where charophytes occurred in the deepest quadrat was found to be significantly different from and would not

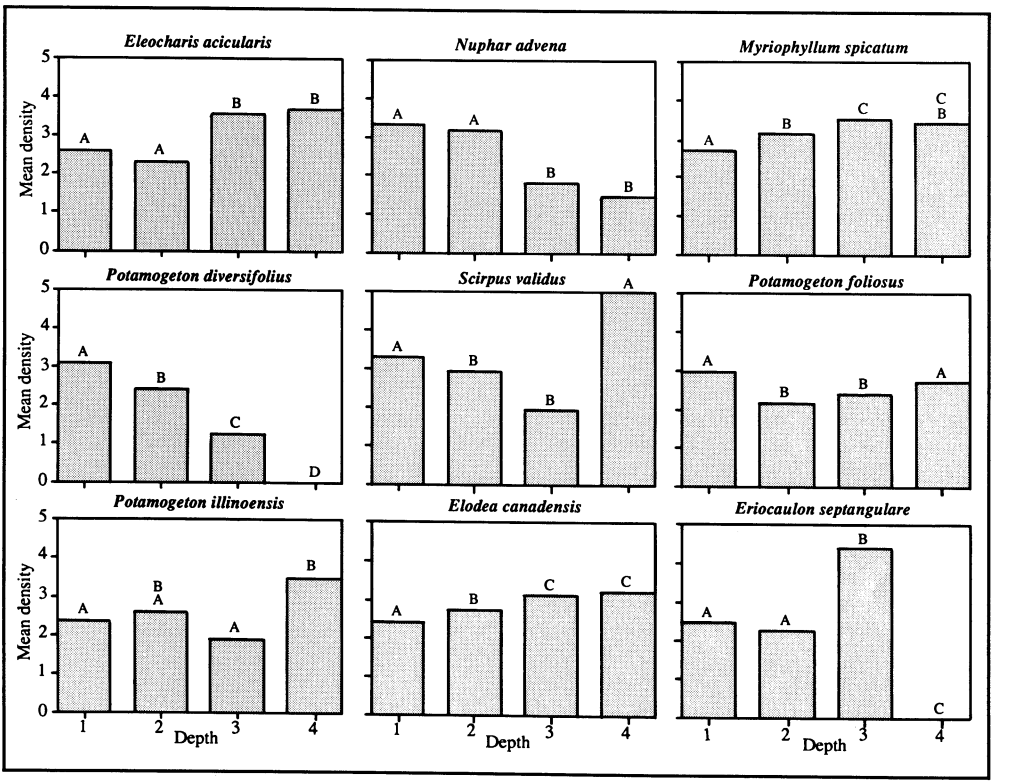

Figure 5. *Mean density of species by depth class*

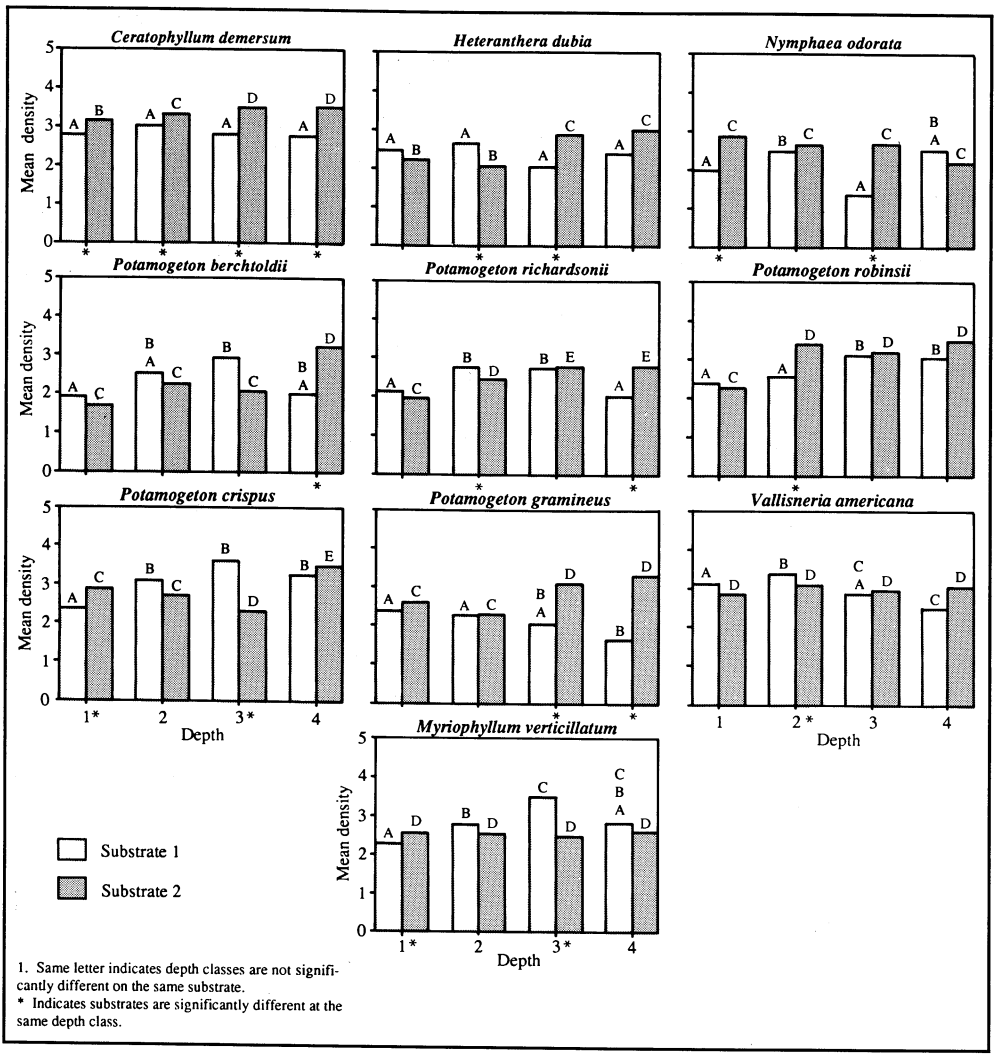

Figure 6. *Mean density of species by substrate type and depth class*

predict plant growth as deep as Dunst's regression.

Decreases in maximum depth of plant growth with increased turbidity have been previously reported (Vander Zouwen 1982; Hutchinson 1975; Spence 1982). The lakes in this study with the shallowest secchi reading and shallow plant growth were strongly influenced by carp and algae (Fig. 2). Their influence appears to be turbidity related. All lakes with carp problems had maximum plant growth depths below the regression line. All lakes but one with heavy algae blooms had maximum plant growth depths above the regression line. This may provide insights into the overall impact these two biotic factors have on plant growth.

Similar to the findings of Davis and Brinson (1980), a linear relationship was found between secchi disk reading and maximum plant growth for some submerged species. Theories that ascribe the maximum depth of plant growth to a single factor are deficient. Actual limitation may be brought about by a combination of factors (Singer, Roberts, and Boylen 1983). Therefore, it is not surprising

that maximum depth growth for many submerged species was not correlated with secchi reading. *Zizania aquatica,* the only emergent species significantly correlated to secchi reading, is an annual species that grows from seed each year. Light penetration could influence its growth. It is also a species that is highly susceptible to water turbulence at a critical period in its life cycle. Clear water could be an indication of quiet water.

This study found no correlation between maximum depth/secchi ratio, which Davis and Brinson (1980) call a turbidity tolerance index, and the association with turbid water (Table 3). The results of the chi-square habitat preference test and the analysis of the variance density test need not be complementary. If they are complementary, habitat preference is reflected in species density. This could mean that depth and/or substrate has a strong influence on species density. Species that show a similarity between tests are *Nitella spp., Potamogeton praelongus, P. pusillus, Utricularia intermedia, Myriophyllum spicatum, P. diversifolius, P. foliosus, Elodea canadensis, Ceratophyllum demersum, Myriophyllum verticillatum, P. richardsonii, P. robbinsii,* and *Vallisneria americana.*

Lack of similarity is more difficult to explain. One possibility is that a species was found only in preferred habitats, so densities were similar wherever it was found. A second, and probably more likely, possibility is that something that was not measured in this study limits species distribution or density. One easily overlooked possibility is interspecific competition, which could limit a species in a lake even though the habitat is suitable for its growth.

Summary

This study reinforces information from other studies that taxa numbers decrease with increasing depth; that many species are restricted to shallow water, while others are broadly tolerant of water depth variation; that the depth distribution of many species is skewed towards shallow water; that the maximum growth depth for many species is highly variable; that there is a significant linear relationship between water clarity and maximum depth of plant growth; and that water clarity, water depth, turbidity tolerance, and substrate preference influence species association. It was an unexpected finding that taxa richness is not different between substrate type. This study differs from other studies because it provides descriptions of depth distribution and substrate and turbidity preferences for a variety of Wisconsin lake plants. The information should be very useful for managing Wisconsin's lake plant resources and for doing further ecophysiological studies on individual species.

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From Wisconsin Poets

Three years ago when Carl Haywood asked me to collect and edit a selection of poetry for each issue of *Transactions,* I leapt at the chance to share the joy and insight that I find in poetry with members of the Academy and other readers of the journal. I have been nothing but astounded and immensely pleased at the level of support I have had for this project from the Academy Board, the staff of *Transactions,* and the poets themselves, who have given unstintingly of their work and their time. This ground swell of interest and support found perhaps its epitome with the recent publication of the special issue of *Transactions* entitled *Wisconsin Poetry,* an anthology of three hundred poems by sixty-five Wisconsin poets, which represents the largest and most comprehensive collection of Wisconsin poetry published in nearly fifty years.

I am especially thankful for the interest and support expressed to me by members of the Academy I have met at readings throughout the state held in conjunction with publication of that special issue. It is a direct result of that interest, and the efforts of Carl Haywood, that there will be an ongoing session devoted to Wisconsin poetry at the yearly meeting of the Academy, as well as sponsorship of the publication of individual collections of poetry by Wisconsin poets.

The editorship of *Transactions* is changing, along with the site of its publication. I am sure that poetry will continue to be a part of *Transactions* as well as a part of the mission and service of the Wisconsin Academy of Sciences, Arts, and Letters.

Bruce Taylor

About the Poets

Art Lyons *manages tutoring programs at UW–Eau Claire. He has published a text-workbook titled* Writing for Workplace Success *(Paradigm 1991). His poems have appeared in* Wisconsin Poetry, Slant, Confluence, Upriver 4, Wisconsin Dialogue, *and* Black Buzzard Review.

Jeri McCormick, *of Madison, teaches creative writing at senior centers and elderhostels and works as an editor in the State Department of Administration. She has published* The Sun Rides in Your Ribcage, *a chapbook of poems, and co-authored* Writers Have No Age, *a text for older adults. Her poems have appeared in the* Wisconsin Academy Review, *the* Wisconsin Poets' Calendar, Poet Lore, Isthmus, *and* Wisconsin Poetry.

Kyoko Mori *received her doctorate from UW–Milwaukee and teaches English at St. Norbert College. She has published a book of short fiction,* The Ritual in Roses and Silk. *Her poems have appeared in the* South Florida Poetry Review, The Forbidden Stitch, *the* Denver Quarterly, *and the* Madison Review.

Thomas R. Smith *is a poet and essayist living in Minneapolis. He has one book of poems,* Keeping the Star, *from New Rivers Press and a second,* Horse of Earth, *nearly completed. He is an Associate Editor for Ally Press, where he is editing a* festschrift *for Robert Bly.*

Jean Tobin *lives in Black River, along the shore of Lake Michigan. She is Professor of English at the University of Wisconsin Center–Sheboygan.*

Marilyn Taylor *recently earned her doctorate at UW–Milwaukee, where she received the 1991 Academy of American Poets Prize. Her work has appeared in* Poetry, Wisconsin Review, *and* Poetry Northwest. *Her first collection,* The Accident of Light, *was published by Thorntree.*

Laurence Giles *is a Madison physician who says, "Medicine is my life, but poetry is one of my more positive obsessions." He has published a slender volume entitled* Goat Cottage Dream Poems, *and his poems have appeared in* Abraxas *and* The Literary Preview. *He is also a licensed private pilot and a scuba diver.*

Joan Rohr Myers, *Director of Human Relations and Affirmative Action at UW–Eau Claire, has received the Catholic Press Association award for poetry as well as the Wisconsin Regional Writers' Association Jade Ring and Bard's Chair awards for her poems. Her poetry has appeared in over a hundred journals and anthologies.*

Bruce Taylor, *the Poetry Editor of* Transactions, *is Professor of English at UW–Eau Claire. He has published two chapbooks,* Idle Trade: Early Poems *(Wolfsong Press) and* The Darling Poems *(Red Weather Press). His poems have appeared in* The Nation, New York Quarterly, *and the* New Orleans Review.

Ralph Schneider *is Professor of English at UW–Eau Claire. A country dweller, he finds much of his poetic material in the Wisconsin natural environment. He spent the spring semester of 1991 on a poetry-writing sabbatical, and "Breakfast" was one of the poems that developed during that regenerative period.*

Child to Father (later)

That all truths have their time, you never knew.
In your white ranch house, your Buick four-door,
you never knew the lies time chose for you.

You loved the timely truth of screw or be screwed;
in your time, a fuller garage bought a higher score.
That all truths have their time, you never knew,

so you hated every nigger, every spic and jew,
but loved white men whose cars out-buicked yours.
You never knew the lies time chose for you,

and wily time chose lies for me too—
truths against your lies—but let me ignore
that all truths have their time. You never knew,

I'm sure, that my spiteful words with every new
disgust meant I doubted you, doubted myself more;
you never knew the lies time chose for you.

Out of time now, your body tells the truth:
We live in time and time decides what for.
That all truths have their time, you never knew.
You never knew the lies time chose for you.

—Art Lyons

Looking at Skulls

The first skull I saw
  gleamed from a stereoscope
in Grandma's front room.

The scene was a Mideast catacomb,
  Jerusalem, perhaps, or Babylon;
Grandma favored the Bible lands.

In three scoped dimensions
  two shadowy orbs leered at me
from a knob of chalky bone.

I scrambled for the next card—
  benign camels crossing the desert
or the somber stillness of Golgotha,

anything to squelch that deep vacancy.

Now, all these years later,
  I've met Hamlet and others
who do not turn from skulls;

I've lost Grandma
  whose hidden remains still comfort,
whose skull is surely beautiful.

And I've made peace
  with my own scaffolding—
femur, tibia, clavicle—

gliding me through this life
  like a fine ghost ship,
at sea with lofty captain

intent on solid grace,
  yet content with the usual gear:
a nose, an ear or two, eyes,
  the accoutrements of face.

—Jeri McCormick

Vehicles of Change

i.

Our last week together, I borrow his
car to move my boxes. Daily, I cross
the bridge with books, dishes. The brake shoes are

slipping. By Wednesday, every stop grinds
to the roar of airplanes descending,
urgent upon the car roof. I am crash-landing

through lost time. I maneuver my craft
to lose it. I want to walk away from its
burning in some farmer's field as the camera

crew rushes to record the miracle
of my get-away. In the ditches, cow
parsnips rotate purple shafts; rank white

crowns rise above the odor of burning
metal. Black smoke trails my path and becomes
a pack of cats skulking in my shadow.

ii.

The First of June, my friend's
driving the panel van, the radio's
stuck on a country station, and
I'm in the passenger's seat

with furniture rattling in
back. The world shrinks up and
jumps into the side mirrors:
the lanes are parallel and skewed

both like corridors in
perspective drawings. You could
wrap them around the earth's
core without their crossing. Never

the twain shall meet. I tower
over traffic; below, sunlight
glints off car tops like
pebbles I could flick over

water. Across the bridge, the wind
takes the words from my mouth and
erases.

iii.

Unpacking, I re-enact the Apartment
Within I've carried from place to place like
an absurd parody of the Soul, the God

imprinted in my heart. Its universals
include cups eye-level on a kitchen
shelf, scissors in the left-hand utility

drawer, the vacuum cleaner plopped among
coats conspicuous as a widower
in a grocery line. In this enactment,

white walls scrape easily to reveal
a fuzzy grey almost of cardboard. I
welcome this lightness—no more solid

doors, dark cabinets. I perform my life
inside a pop-up book, every moving part
collapsible, seamed to the center.

iv.

The next day in his absence, I
clean the house, wipe away the traces—
the dust of shed skin, an ear-ring
long lost, thrums from scarves woven

for gifts, and the inevitable
hair—thrums of daily life
unwoven. The house unravels
into a place where I've paid

rent. Already, its hallways
darken and merge into
others, each room floats up
disjointed in my mind. My

steps no longer connect them.

v.

In my dream that night, a giraffe
wades leisurely in the wake
of a barge across shallow
waters. The big cats, one of each,

feed from my hands while I wait
in a windowed cubicle for
a ride in some vehicle I
cannot begin to imagine. Far

off, planes dive into the sea
to rise as dolphins, whales
breach and send up a horizon-
ful of sheep clouds, and the world

spins back into flickers of light
struggling to become the animals.

—Kyoko Mori

End of Summer

1.

September rain slants into the heavy alfalfa. Water pours from the square and brutish mouth of the spout and runs away into the boyish grass. Circles of rust at the bottom of the bucket are thoughts, growing inward, of a mind simplified by solitude, monotony of rain. . .

2.

Things done or not done for a long time lodge in odors, in old clothes furrowed with brooding, in soot of bygone cooking black on the widower's stove, in the small varnished cross nailed to a bedroom door, and in the dirty rose curtain on tarnished brass rings, all left as they were when the old man died.

3.

Did he paint near the end so as not to have to watch night shambling toward the barns? We find on the obverse of a cornfield scene with pheasants a far older landscape of lacquered trees and rocks. Implacably symmetrical, halved precisely by the glass knife of a falls, the left side is green, the right side ochre, this picture turned toward the wall. . .

—Thomas R. Smith

A Readiness to Weep

Five years later, we have returned
to the lake where we spent our
honeymoon, two people who knew
even less about marriage than we do.
I had refused for years, then
gave in because I feared some damage
to your happiness with me.
"I did it," I told you,
"but I don't know what it means,"

and wept. Today, a day clear
as that one we drove down the dirt
road to the cabin after the wedding,
I squat in these marshy woods
that have always been, in my mind, October
and give again my gift from
five years ago, a readiness to weep.

I sit quietly in the still sunlight
with you and feel the years, and
do not feel them. I let the peach-
flushed leaf I saved fall from my hand—
Yes, I want time to stop for us,
doesn't everyone?—No, I let it go.

The fallen branch we sat on breaks
suddenly but lets us down unharmed—
the ground isn't in the least sentimental.
We laugh together, then the tears again.
I soak my knees leaning to cup
in hands chill water from the lake
to splash over my burning eyes.

When I look up, every man
and woman ever married look with me
out across the autumn lake
toward the gold pavilions of uncertainty.

—Thomas R. Smith

Poems from Paintings

Dream of MOMA

(Rousseau's *Yadwiga's Dream,* 1910)

A confounded round-eyed lion looks straight out
the canvas. She, poised calmly, lying nude
upon a jungle divan hears intrude
a black man garbed in rainbow loincloth, doubt-
lessly hears melodies to ravish. His
seductive clarinet beguiles the moon,
now rising round and ghostly, begs full blooms
of heavy-headed lotus, blue and reddish
pink, entreats gold-winged, long birds to listen
to his song on silent canvas. Toward
her lifting high his trunk, an elephant
is hidden in the background—leaves that glisten
brightly, edged in yellow, sharp as swords,
precisely painted from Jardin des Plantes.

—*Jean Tobin*

Miss Martin at Four O'Clock

I am LaShanda's teacher
and to LaShanda that is all
I am. Every day she waits
for this, the breakaway hour
when the windows of my eyes
start to blacken behind
the neat rows of paper cutouts
facing the street
and the wide broom of darkness
comes, pushing blood-red
dust along my corridors.

LaShanda thinks I sleep
in a wooden drawer, folded
on a bed of thumbtacks—my
left hand gripping a bone
of chalk that screams
by day, while my right
brandishes a scarlet
Eversharp, scattering
the swarm of butterflies
that will drift forever
in LaShanda's head.

—Marilyn Taylor

Tercets from the Train

Human dramas implode without trace.
—Marge Piercy

Gorgeous, they are gorgeous, these two women getting
on the train, one in lime green silk, black hair
a mile wide, the other slim as a whip, coiled

in red linen. Their two small boys, grinning,
have squirmed into facing seats, bubbling with spare
energy, the cuffs of their designer jeanlets rolled

at the ankles, their studded shirts glinting.
I overhear the women talking over what to wear
to some convention (should it be the gold

Armani or the St. Laurent?) while the boys are gazing
through the rain-spattered window, practicing their
locomotive lingo in shrill, five-year-old

voices, demanding information: are we going
faster than a plane, where is the engineer,
does this train have electricity or coal?

But the women's eyes are fierce, they are grumbling
over Lord & Taylor, which was once a store
to be reckoned with, although the one with wild

hair points out that even Bloomingdale's is growing
unmistakably more K-Martish than it was before.
Don't you ever interrupt me, child,

she hisses to the boy who wonders why the train is grinding
so slowly through the towns, and where
the bathroom is and what the ticket-man is called

until she bends over him, glaring
from beneath her shadowed eyes, a crimson flare
on either cheek. *You're interrupting me,* she growls.

Now you'll be sorry. His mouth is gaping
as the flat of her pale hand splits the air,
annihilating two long rows of smiles.

I warned you, didn't I, darling?
Now don't you dare cry. Don't you dare.
Up and down the aisle, the silence howls.

—*Marilyn Taylor*

Are There Sounds You Shouldn't Hear?

(A Poem for William Stafford)

Are there sounds you shouldn't hear?

No, not trumpets of god
the walls of cities falling
the lamentations of Jeremiah
the doors closing at Auschwitz

Nor whispers behind my back
nor drill sergeants' words
the slavers' whips
newborn whimpers for food in a starved world

The end of history, the voice of Zeus in shrieking wind
the convulsive roar of the Minoan volcano 35 centuries into time
the Aegean tidal wave that pummels ships to death
the screaming horses that trample my children

The conductor dropping his baton
the crack of the firing squad
the drums of Autumn
birds and no singing, like Beethoven and the *Song of Joy*

The trap slam of King Henry's scaffold
the avalanche in the High Himalayas
the teeth of the shark that grind my bones
the fall of the dagger in the Aztec Temple

The crash of trees into fire and prairie
the engine that sputters out over oceans
the ice freezing in great cracks round Arctic ships
the man who cries with his tongue cut out

The gnawing of rats in dark dungeons
the forever farewell from voices of love
the sound boom of the comet that streaks to my feet
the whistling train over the dynamited trestle

The singer breaking glass and ear drums with notes gone cracked
the frenzied still of the oscilloscope beat in the Intensive Care Unit
the suicide striking the pavement
Russian Roulette and no click from the pistol

The rafters smashing in the mine shaft, the end of Welsh and Appalachian songs
the snort of the Cape Buffalo in my frozen face
the flutter of Robert Scott's tent in the South Polar wind
the screams of the *castrati* under the knife

The prayers of every prisoner and captured woman
the cries of "Bring out your dead," in plague-filled Warsaw, and Angkor-wat
the birth of babies, and no breath
the planes, the bombs ripping houses into falling night and screaming rain

No, none, not one
we shall not listen, heed, or obey
but

there is, yes, finally, one sound
I should not hear:
the last sound, the last

vaporized into a shadow on the wall
we shall see that sound as light before we hear it
the last sound, last.

—Laurence T. Giles

December Lights

Beyond the mall's warrens of promise
we drive to snow-stilled streets
where trees dance in small lights.

Before every bright fresco, I wonder
how things create lives—
how houses hand out habits
like how much to drink
and when to wake up,
how kitchens coax hearts
to always want more.

If the owner's away
from the fading grey stucco
and we pass out of our bodies
and through the glass
to a past accrued
on porcelain plates,
would we learn
what a body softens to
when love is traced
on monogrammed sheets
and hands are shaped
by the garden gate?

Or are we bound
in the warm current
of this car
to watch tints of the known
expand
into the opening arms
of the galaxy?

—Joan Rohr Myers

Flight

(from the notebooks of Leonardo da Vinci)

See tomorrow to all these matters and the copies. Leave them in Florence so that if you lose those you take with you, the invention will not be lost.

[birds]

The science of birds
is the science of the wind
which is the science of water.
If you would know how things fly,
you must first study
what floats and what falls.

[of man]

The life of birds conforms
better to the needs of flight
than the will of man,
especially in the almost
imperceptible movements which
preserve an equilibrium.

[with drawings]

spring of horn
of steel fastened upon wood,
of willow encased in reed—

Let A be the first movement.
Undo one and remove.
Double canes—soaped—
of rag, of skin, of flying fish.

spring with lock,
wire that holds the spring,
spring of wing—

Tomorrow morning
the second of January
I'll make the thong and the attempt.

[in which the figure of the man is seen
exerting force with arms and legs]

If you stand up on the roof at the side of the tower
the men at work on the cupola will not see you.

The machine should be tried over a lake
and you should carry a large inflated wineskin so
if you fall you will not drown.

Let the machine be 12 braccia high
and let the span of the wings
be 40 braccia
and the body from stem to prow
20 braccia
and the outside all covered
with cane and with cloth—

Ladder for ascending and descending.

[the atmosphere]

The air moves like a river
and carries the clouds with it
just as moving water carries
all things that float upon it.

Surface is the name
of that division which the body
makes with the bodies it encloses.

It does not partake
of the body which surrounds it,
or of the body which it surrounds.

Surface has a name
but not a substance
for that which has
substance has place.

[words crossed out in manuscript]

Just as a stone thrown
into water becomes the center
and the cause of various circles,
so a motion made in the air
spreads itself out in circles.

So every body in the luminous air
spreads itself out in circles
and fills the sky with
infinite images of itself.

—Bruce Taylor

Breakfast

After feet find the dark floor
after the pulling-on of socks and shirt and pants
after building up the fire with oak and breath
and putting the kettle on

there's the sizzle of cold potatoes browning
as tomato's upstart bite jangles the mouth
and chunks of yesterday's ham color the potatoes' hiss
and a brighteyed egg tops it off
with a sprinkle of salt for savor.

Then coffee in a chair
while the red comes up behind the horizon
past the silhouettes of hill and branch
that turn to gray and then
to glowing brown detail:
bark and leaf and blade of grass.

The empty cup is the origin of philosophy
as is the end of this dawn
fallen to the dingy day incapable
of this gray illumination.

—Ralph Schneider

First Report of Natural Bridges in Eastern Wisconsin

Richard A. Paull

Abstract. *Although natural bridges are well-known features in the Driftless Area of Wisconsin and adjacent states, none of these delicate landforms is documented in the recently glaciated region of Wisconsin. This report describes natural bridges at two localities along the Silurian escarpment in eastern Wisconsin.*

A bridge 40 feet (12 m) high with a span of 14.5 feet (4.4 m) has developed in the Lower Silurian Mayville Dolomite at Fonferek Glen in Brown County, 4.3 miles (7 km) south of Green Bay. This feature was created in two stages. The first was differential undercutting of bedrock on the outside of a meander at a higher elevation than present-day Bower Creek during the waning stage of glaciation in late Wisconsinan time. Collapse of the inner part of the overhang along prominent joints in the Holocene completed the bridge.

Six bridges have developed at the contact between the Lower Silurian Mayville Dolomite and the overlying Middle Silurian Byron Dolomite at Oakfield Ledges in Fond du Lac County, 10.5 miles (17 km) east of Waupun. The bridges vary in dimensions from 15 feet (4.5 m) to 20 feet (6 m) high, 3.3 feet (1 m) to 15 feet (4.5 m) wide, and 4 feet (1.2 m) thick, with spans of 4 feet (1.2 m). These features formed by the opening of three solution-enlarged joints in the Mayville Dolomite by downslope movement at the escarpment after retreat of the Green Bay glacial lobe. The Byron Dolomite remained in place as the underlying Mayville moved outward. This created a roof of Byron Dolomite for these bridges. It is possible that the present-day bridges along each joint were once part of cave-like features.

Natural bridges are common in the Driftless Area of Wisconsin and parts of immediately adjacent states (Fig. 1). According to Martin (1932, 353), "All of these features . . . are of the sort that can exist only in the Driftless Area. They are relatively fragile and would certainly have been eroded away or buried in glacial deposits." The one exception known prior to this paper is a small natural bridge in Middle Ordovician dolomite at Krape Park, Freeport, Illinois (Paull and Paull, 1980, 85) (Fig. 1). The genesis of this bridge is similar to the developmental history for the one at Fonferek Glen described below.

This report describes seven natural bridges developed in dolomite along the Silurian escarpment in the recently glaciated area of eastern Wisconsin. One of these bridges is in Fonferek Glen south of Green Bay, Brown County, Wisconsin (Fig. 1). I first observed this feature while studying Ordovician and Silurian rocks in this area in 1967. Donn P. Quigley of the Neville Public Museum, Green Bay (verbal communication 1988), had discovered this bridge earlier in the 1960s.

At least six natural bridges are present in, or adjacent to, the Wisconsin Department of Natural Resources Oakfield Ledges Scientific Area in southern Fond du Lac County (Fig. 1). A descriptive article about this scenic locality

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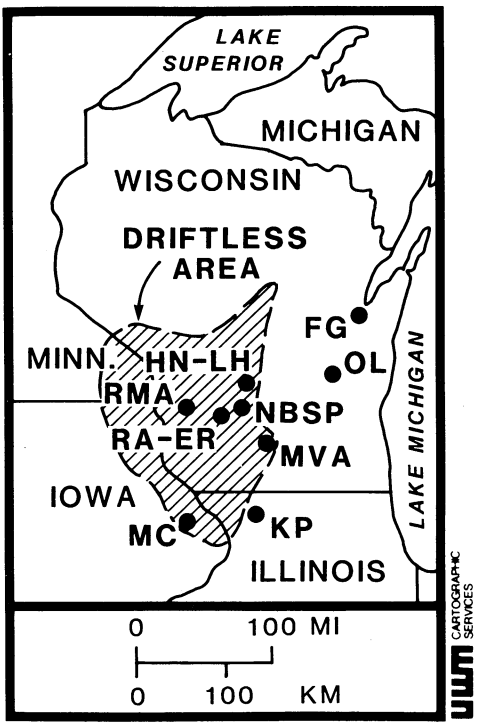

Figure 1. *Location map showing natural bridges in Wisconsin and adjacent parts of Iowa and Illinois. Most of these delicate landforms are within the Driftless Area (HN and LH, Hornets Nest and Luncheon Hall, Martin 1932; MC, Maquoketa Caves, Paull and Paull 1980; MVA, Mt. Vernon Arch, Martin 1932; NBSP, Natural Bridge State Park, Martin 1932; Paull and Paull 1977; RA and ER, Rockbridge Arch and Elephant Rock, Martin 1932; Paull and Paull, 1980; and RMA, Readstown Multiple Arch, Martin 1932), but several occur within the recently glaciated region (FG, Fonferek Glen Bridge; KP, Krape Park Bridge, Paull and Paull 1980; OL, Oakfield Ledges Bridges). The bridges in eastern Wisconsin (FG and OL) are described in this paper.*

by Peter Toepfer (1979) suggested that natural bridges might be present here, and this proved to be correct.

When I started this project, I thought I knew what a natural bridge is. The deeper I have delved into the problem, the more uncertain I have become. The *Glossary of Geology* (Bates and Jackson 1980, 442) defines a natural bridge as an arch-like rock formation created by erosion that spans a drainage, or the remnant of the partial collapse of the roof of a cave. The water becomes muddier when the editors referenced above define an arch as a natural bridge resulting from erosion, or a landform similar to a natural bridge not formed by erosive agencies. Leading geomorphology textbooks fail to clarify the issue. One thing that all features called bridges and arches have in common is a relatively resistant uppermost lithologic unit that forms the span. It is also apparent that these delicate features are short-lived geologic landforms.

In this paper I define a natural bridge as a free-standing rock formation that allows human passage across a relatively narrow span. Such features could result from either erosion or selective gravity-induced movements or a combination of the two processes. Specifically excluded, however, are down-dropped blocks of rocks that result in "bridging" across openings (usually joints). Examples of this type of feature are Devil's Doorway at Devil's Lake State Park (Paull and Paull 1977, 127) and several rock fall "bridges" at Oakfield Ledges.

Fonferek Glen Natural Bridge

A single natural bridge occurs in the Lower Silurian Mayville Dolomite along Bower Creek in Fonferek Glen, about 800 feet (240 m) downstream from Fonferek Falls (Polish Falls in older literature) (Fig. 2 and 3). The glen is a narrow, deeply cut reentrant in the east-west trending Silurian escarpment. This locality is 1.15 miles (1.85 km) east of the crossroad community of Kolb along County Highway MM, and about 4.3 miles (7 km) south of Green Bay in Brown County (SW¼, SE¼, NE¼, NW¼, Sec. 34, T.23N.–R.21E., Bellevue 7.5′ quadrangle, 1954) (Fig. 2). The Fonferek natural bridge is 40 feet (12 m) high, 5 feet (1.5 m) wide, and 5 feet (1.5 m) thick. It spans 14.5 feet (4.4 m) at the top and opens to more than 40 feet (12 m) in the erosional alcove below (Fig. 4 and 5).

The genesis of the natural bridge at Fonferek Glen has a long geologic history. The

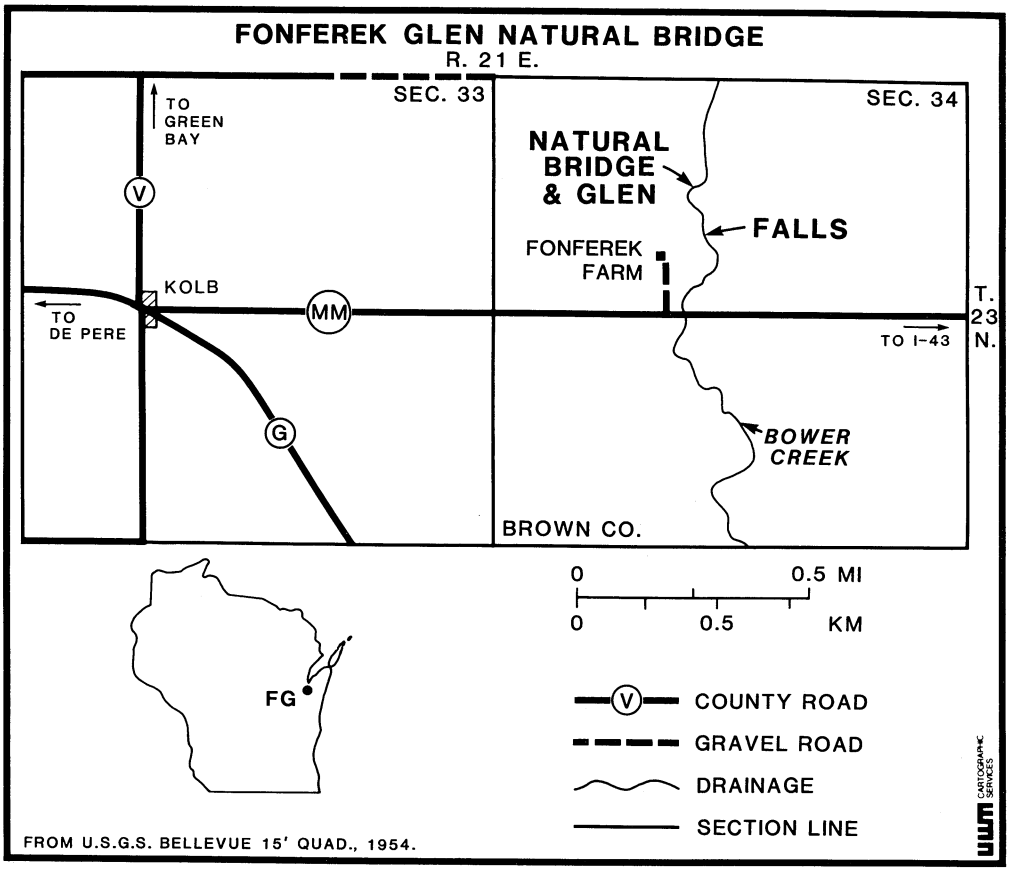

Figure 2. *Location map of Fonferek Glen Natural Bridge in Brown County, Wisconsin. Fonferek Falls, at the head of the glen, is a southerly reentrant cut by Bower Creek into the Silurian escarpment, which trends east-west across the northern part of the map area.*

Lower Silurian Mayville Dolomite at this locality consists of three distinctive lithologic units that are described in Figure 5. The upper and lower units are resistant dolomite, and the uppermost forms Fonferek Falls and the span of the natural bridge. The middle unit is a relatively nonresistant, chert-rich dolomite that weathers more readily than the overlying and underlying rock.

The Lower Silurian bedrock surface at Fonferek Glen was polished and striated by southerly moving glacial ice that deposited reddish till of the Glenmore Member of the Kewaunee Formation in late Wisconsinan (Greatlakean) time (Need 1985, 1). The gently rolling till plain in this area is locally overlain by deposits that accumulated in Glacial Lake Oshkosh, an impoundment that formed in the Green Bay lowland behind the northeasterly retreating ice dam.

Fonferek Glen developed when the late Wisconsinan ice retreated far enough to allow Glacial Lake Oshkosh to drain easterly into ancestral Lake Michigan. Rapidly falling lake levels allowed an earlier version of Bower Creek to downcut across the Silurian escarpment. At this time, precipitation rates were apparently high, and Bower Creek carried significant amounts of runoff. As erosion proceeded, the waterfall that initially was at the edge of the Silurian escarpment retreated upstream, leaving a narrow gorge behind.

When Bower Creek eroded downward into the chert-rich middle unit of the Lower

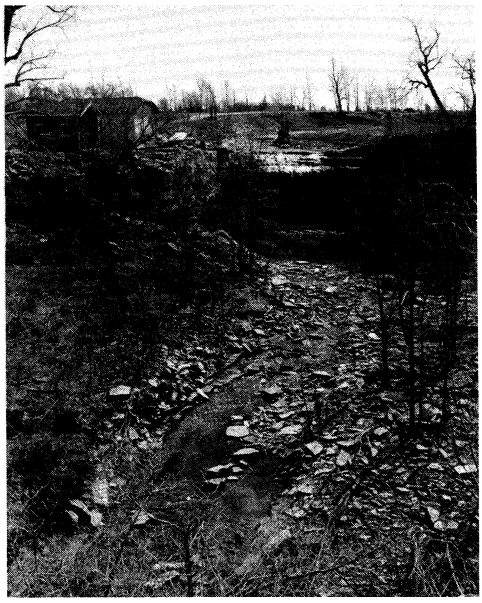

Figure 3. *Fonferek Falls plunges over Lower Silurian Mayville Dolomite at the head of Fonferek Glen.*

Silurian Mayville Dolomite, it carved two caves in this relatively erodible rock at the outside of meanders in the canyon below the waterfall (Fig. 6 and 7). At the upstream meander an eddy current developed, and a third cave formed (Fig. 6). As downcutting continued into the basal resistant unit of the Mayville, the bedrock valley narrowed.

Two sets of joints in the upper unit of the Mayville Dolomite facilitated frost wedging, and rock falls enlarged the eddy-formed cave to create a large alcove. In the middle 1950s two horses strayed onto the prominent overhang and broke through the roof to create the natural bridge (Norbert Fonferek, verbal communication 1988) (Fig. 8). Both horses were pulled free, and the opening was fenced off for safety reasons. Joint blocks continue to fall, and ultimately Fonferek Glen Natural Bridge will collapse.

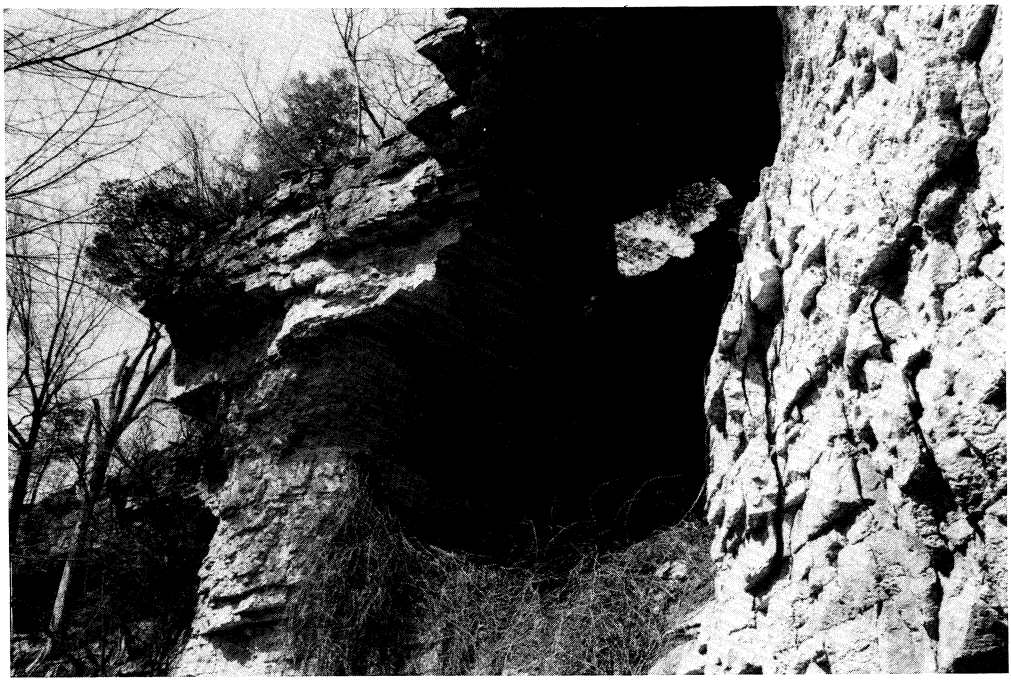

Figure 4. *Fonferek Natural Bridge spans an alcove carved by fluvial erosion in the relatively nonresistant, chert-rich, middle unit of the Lower Silurian Mayville Dolomite. The span of this feature is formed from the resistant, upper unit of the Mayville Dolomite. The well-jointed nature of the roof rock is apparent in the photo.*

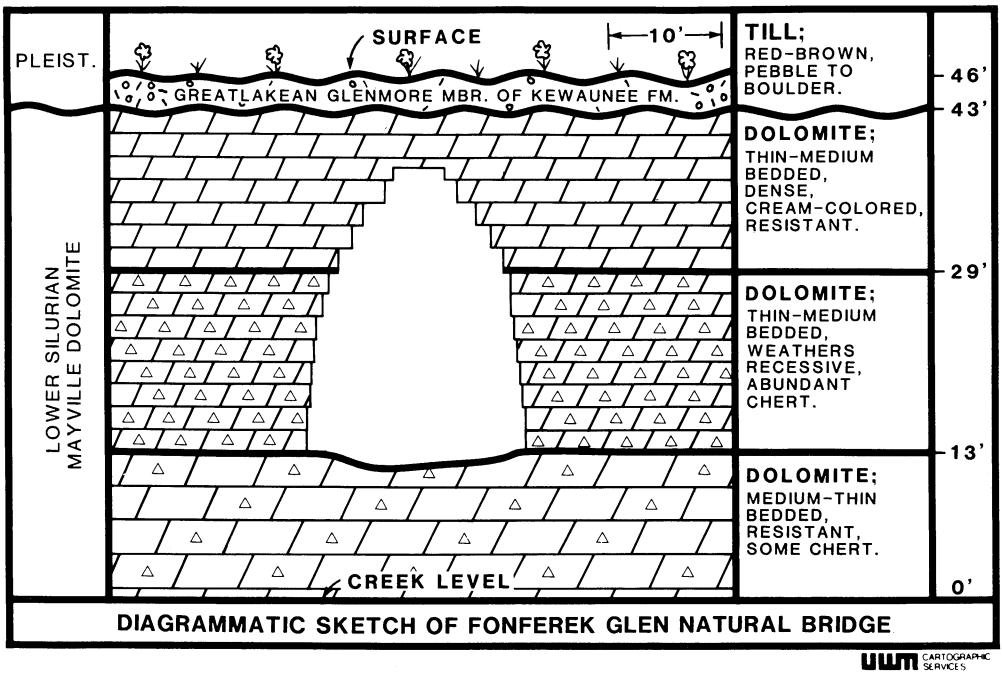

Figure 5. *A diagrammatic sketch of Fonferek Natural Bridge detailing the geology at this locality.*

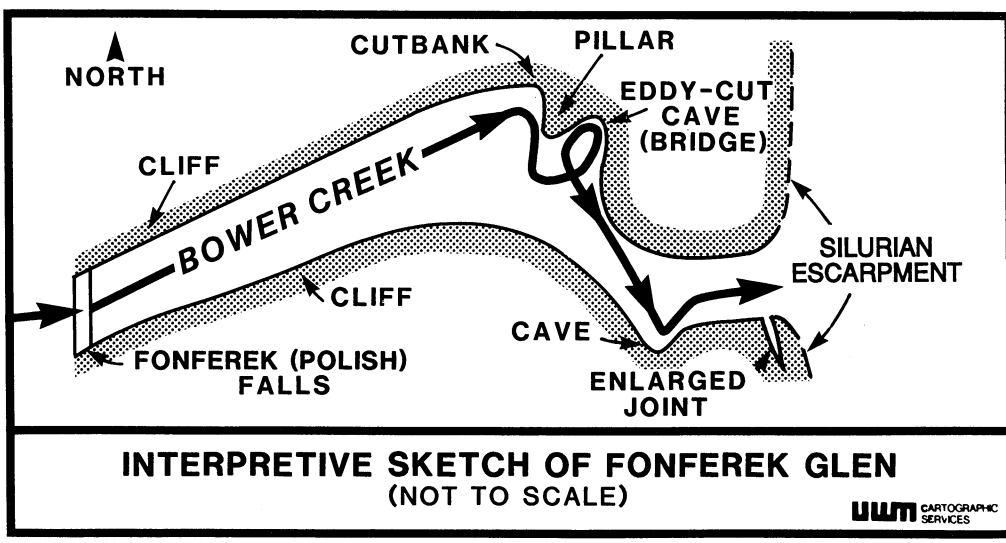

Figure 6. *A schematic sketch detailing the development of three caves in Fonferek Glen during high stream flow at an earlier erosional level of Bower Creek.*

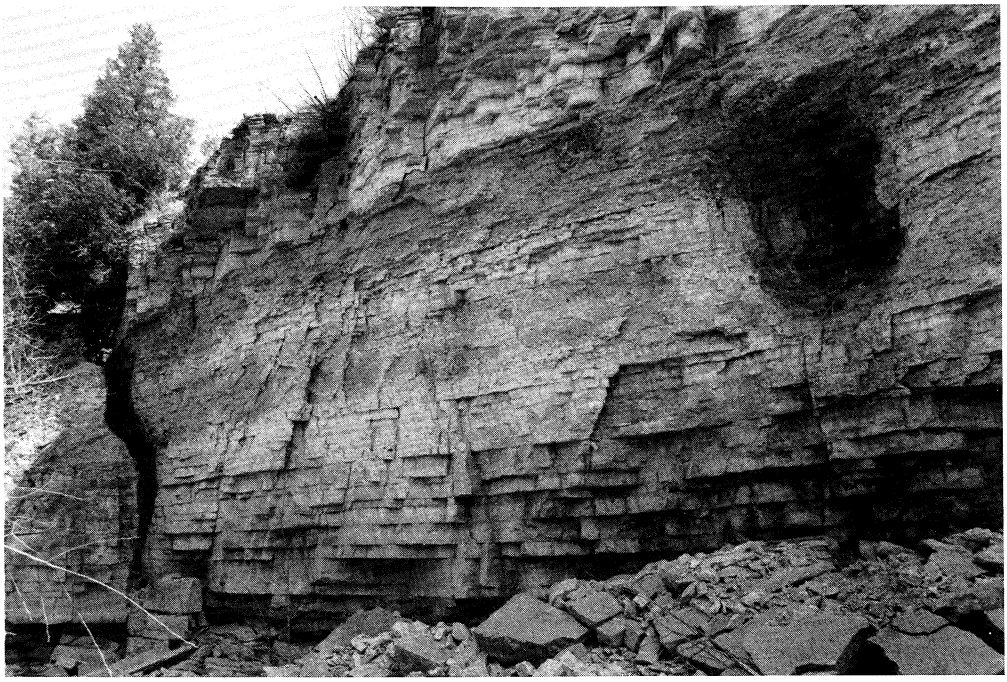

Figure 7. *This cave was developed in the relatively nonresistant, chert-rich, middle unit of the Lower Silurian Mayville Dolomite at the outside of the second meander downstream from Fonferek Falls (Fig. 6). This feature is a precursor of the type of opening that developed into the Fonferek Glen Natural Bridge upstream from this locality. A well-developed, open joint is also visible to the left of the cave. Jointing facilitated the formation of the natural bridge in this area.*

Figure 8. *A downward view of the Fonferek Natural Bridge from the top of the Silurian escarpment.*

Oakfield Ledges Natural Bridges

Six natural bridges occur within three joints along the southwest-northeast trending Silurian escarpment in, and adjacent to, the Wisconsin Department of Natural Resources Oakfield Ledges Scientific Area. This locality is about 10.5 miles (17 km) east of Waupun in the W½, NW¼, SW¼, Sec. 27, T.14N.–R.16E., Fond du Lac County (Waupun 15′ quadrangle, 1955) (Fig. 9). The bridges range from 15 feet (4.5 m) to 20 feet (6 m) high, 3 feet (1 m) to 15 feet (4.5 m) wide, and 4 feet (1.2 m) thick, with spans of 4 feet (1.2 m). Other bridges may also be present along joints in the talus-mantled, westward-facing Silurian cliff face in this general area.

The Silurian escarpment at Oakfield Ledges consists of medium- to massive-bedded Lower Silurian Mayville Dolomite and the overlying thin- to medium-bedded, relatively resistant, Middle Silurian Byron Dolomite (Shrock 1939; Mikulic and Klussendorf 1983) (Fig. 10). These rocks dip gently eastward into the Michigan Basin.

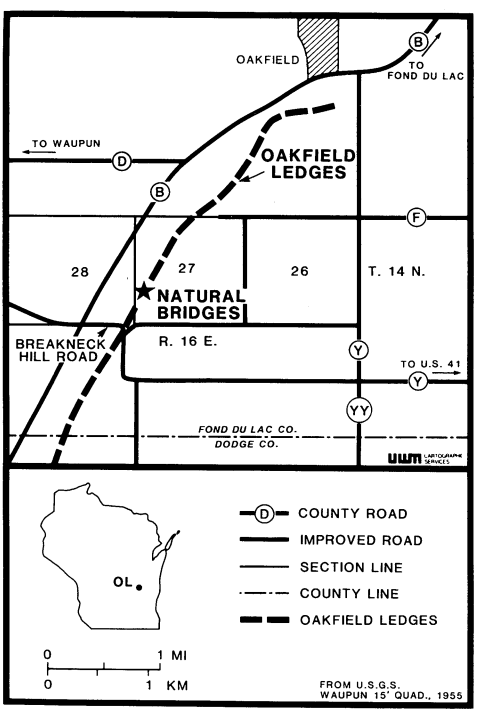

Figure 9. *Location map of Oakfield Ledges, part of the Silurian escarpment in Fond du Lac County, Wisconsin.*

Silurian bedrock in this region was polished and striated by the southerly moving Green Bay glacial lobe in late Wisconsinan time. The thin, reddish, bouldery till of the Horicon Formation was also deposited during this glaciation (Mickelson et al. 1984). This lobe, and previous ice advances, scoured the relatively nonresistant shale of the Upper Ordovician Brainard Formation of the Maquoketa Group to create the lowland region west of the Silurian escarpment now occupied by Green Bay, Lake Winnebago, and Horicon Marsh.

Upon retreat of glacial ice from the Green Bay lowland, the Silurian dolomite overlying the relatively soft shale of the Brainard Formation was unsupported. Rock falls from the cliff face and rotational downslope movement of Silurian rock along the Brainard surface were facilitated by solution-enlarged joints that generally parallel the cliff face (Fig. 11). This rotational type of slope failure along the Silurian escarpment in Brown County was previously detailed by Stieglitz (1980, 83).

The unique aspect of the downslope movement of jointed masses of Silurian rock at Oakfield Ledges is the differential separation along individual joints in the Mayville and Byron formations (Fig. 12). This allowed the Mayville to move along the unstable Brainard surface, while part of the Byron remained in place to bridge the gaps over the enlarging joints (Fig. 13). This created caves along three solution-enlarged joints. Selective collapse of the roof rock created a series of three bridges in one joint and two in another. A single bridge is present along the third joint.

The natural bridges at Oakfield Ledges are unusual features, but they meet the criteria previously defined for natural bridges. As downslope movement continues along these major joints within the Mayville Dolomite, the bridging roof rock of the Byron Dolomite will become unsupported. Collapse will follow, and the natural bridges at Oakfield Ledges, as well as at Fonferek Glen, will no longer enrich the Wisconsin landscape.

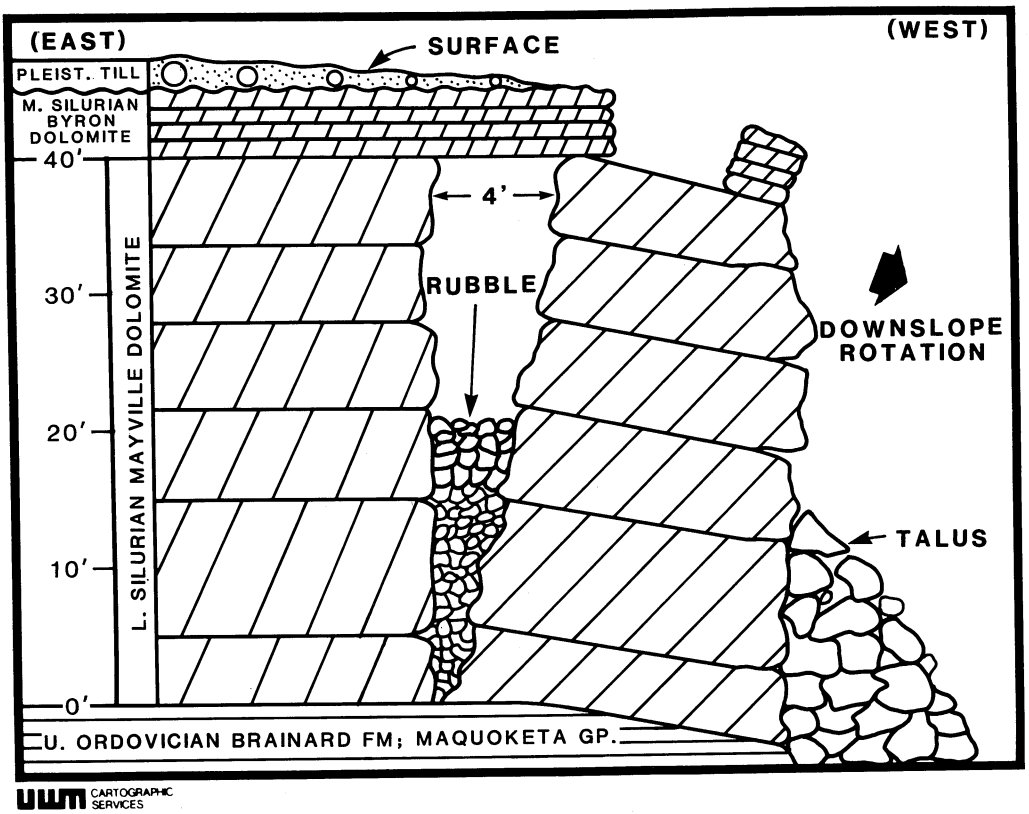

Figure 10. *A schematic sketch defining the geology of Oakfield Ledges and illustrating the formation of the natural bridges at this locality.*

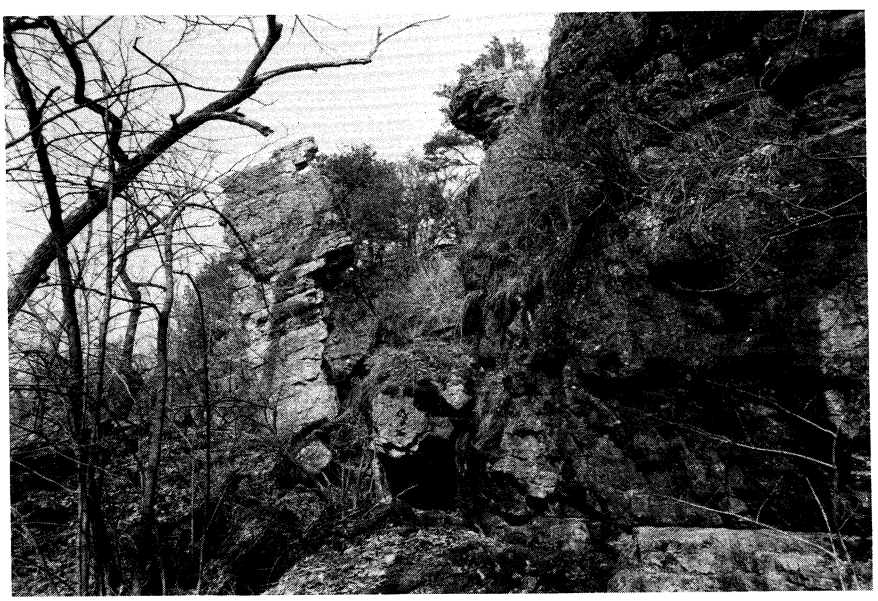

Figure 11. *View along a major joint essentially parallel to the Silurian escarpment at Oakfield Ledges shows the rotational downslope movement of a major mass of dolomite. The overhanging rock at the top of the rotated block is the Middle Silurian Byron Dolomite.*

Figure 12. *Overhang of the thin- to medium-bedded Middle Silurian Byron Dolomite across an enlarged joint in the Lower Silurian Mayville Dolomite at Oakfield Ledges.*

Figure 13. *View along a major joint at Oakfield Ledges illustrates bridging by the Middle Silurian Byron Dolomite.*

Acknowledgments

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Live Capture Methods of Sympatric Species of Flying Squirrel

Thomas C. Engel, Michael J. Lemke, and Neil F. Payne

Standard methods of capturing other tree squirrels are not as effective for flying squirrels, which spend proportionately less time foraging on the ground (Sollberger 1940; Sonenshine et al. 1979). They can be captured in natural or artificial dens (Sonenshine et al. 1973) or in Sherman live traps attached to trees (Sonenshine et al. 1979). Sumner (1927) captured flying squirrels with rat (kill) traps nailed in trees. Burt (1927, 1940), Jackson (1961), Sonenshine et al. (1979), and Mowrey and Zasada (1984) reported that traps set in trees are effective but did not present trapping details or trap sympatric species of flying squirrels. The objective of this study was to determine the trapping success for sympatric species of flying squirrel relative to tree species, trap type, and height of trap in tree.

The study area was the 83-ha Schmeeckle Reserve, University of Wisconsin–Stevens Point, an area within the vegetational tension zone (Curtis and McIntosh 1951; Curtis 1959) that includes plants and animals typical of both the prairie and boreal forest ecotone extending northwest-southeast in Wisconsin. Forest composition was 5.7 ha of mixed hardwoods including oak (*Quercus* spp.), maple (*Acer* spp.), elm (*Ulmus* spp.), white birch *(Betula papyrifera),* and quaking aspen *(Populus tremuloides);* 14.3 ha of pine *(Pinus strobus, P. banksiana, P. resinosa);* 15.6 ha of mixed woods containing mature hardwoods and scattered mature white pine; and 8.9 ha of oak savanna (Engel 1980).

Methods

To test trap type, we used wooden box traps (Mosby 1955 in Day, Schemnitz, and Taber 1980), Sherman sheet metal box traps 7.5 × 7.5 × 26 cm (Sonenshine et al. 1979) and 13 × 13 × 45 cm, and Havahart wire cage traps 13 × 13 × 45 cm; all were baited with peanut butter. In 1978 we added tree traps to three traplines consisting of wooden box traps set on the ground 30 m apart, which had produced 0.2 flying squirrels per 100 trapnights in 1977. Because the size and weight of the wooden box traps made them awkward to secure in trees, we set Sherman and Havahart traps 60 m apart in trees next to the ground traps. Trees for trap placement were selected for convenience to the trapline; height of trap placement was determined by the ease of climbing without spikes. Trap heights were grouped as 0 (ground), 1–3.1 m, and > 3.1 m. Tree species of trap placement were pooled as red maple *(Acer rubrum),* other hardwoods, jack pine *(Pinus banksiana),* red pine

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(P. resinosa), and white pine *(P. strobus)*. Traps were secured in trees with a rubber band cut from an auto tire inner tube and looped around one end of the trap and passed beneath a branch, or around the tree trunk of smaller trees and looped over the opposite trap end. When large branch size precluded this method, the rubber band was cut and extended with a short length of light rope. Traplines were operated 24 September–3 October, 10–20 October, and 22 October–2 November 1978 in three locations within the study area and checked at dawn. Flying squirrels were sexed, tagged in each ear with a numbered aluminum fingerling tag No. 1 (National Band and Tag Co., Newport, KY), and released. After two flying squirrels died in traps early in the study, we added shredded wood packing materials and/or cotton to the tree traps to provide insulation and help absorb moisture from respiration. We used loglinear models (Fienberg 1980) to analyze capture data.

Results

In 1978 we captured 13 *G. volans* and 14 *G. sabrinus* in live traps 39 and 31 times, respectively. Tree sets were nearly sixteen times more effective than ground sets for capturing flying squirrels ($X^2 = 300.3$, $p < .001$, df = 2) (Table 1). No difference existed ($p > .05$) in capture rates of traps set 1–3.1 m from the ground and > 3.1 m. Small sample sizes precluded statistical comparisons of the ease of trapping the two species, although *G. sabrinus* seemed slightly more predisposed to ground traps (Table 1).

The number of flying squirrels trapped per 100 trapnights (Nelson and Clark 1973) in trees was 15.4 in wire traps, 10.8 in large Sherman traps, and 10.2 in small Sherman traps. These catch rates are not different, although wire traps might have been superior had sample sizes been larger. No squirrels died in the wire cage traps; squirrel mortality was 10% in the other traps. No difference existed in survival due to squirrel species or trap type ($G^2 = 6.89$, $p = .44$, df = 7), but sample size was small.

We caught flying squirrels in all species of trees (Table 2). The best loglinear model ($G^2 = 6.33$, $p = .90$, df = 12) indicates that the tree species in which traps were placed was more important than trap type or trap height in determining capture rates. Indications are that the most successful combination of trap and tree used was a wire trap set in a white pine (Table 2).

Discussion

The lack of differences among trap types and the importance of ground versus tree placement suggest that wooden traps set in trees would be effective and that other types of traps set on the ground would not, although study design precluded testing these combinations. The relatively high capture rates of both species in white pines in our study area (Table 2) might not reflect habitat preference or tree species as much as size of tree, especially for *G. volans*, because pines were available in all habitat types and were the biggest trees. Most white pines in the study area were taller than the forest canopy. Post-

Table 1. Trapping success for flying squirrels*

Trap height above ground	N *trapnights*†	N *captures*		*Total captures/100 trapnights*
		G. volans	G. sabrinus	
m				
0.0	1484.5	2	8	0.7
1.0–3.1	387.0	18	20	9.8
3.1	155.5	19	3	14.12
Total	2027.0	39	31	3.5

*University of Wisconsin–Stevens Point, September–November 1978.
†Adjusted for sprung traps (Nelson and Clark 1973).

Table 2. Trapping efficiency for flying squirrels for traps set in various tree species*

Tree species	N *trapnights*†	N *captures* G. volans	N *captures* G. sabrinus	*Total captures/100 trapnights*
Hardwoods	178.5	4	3	3.9
Red maple	66.5	5	0	7.5
Jack pine and red pine	88.5	3	6	10.2
White pine	209.0	25	14	18.7
Total	542.5	37	23	11.1

*Three types of trap were used, but there was no difference in catch rates. University of Wisconsin–Stevens Point, September–November 1978.
†Adjusted for sprung traps (Nelson and Clark 1973).

release observations of *G. volans* and *G. sabrinus* indicated that squirrels choose the most direct route to a large (> 40-cm diameter at breast height [dbh]) mature tree. Squirrels climbed only 2–3 m up smaller (12–30 cm dbh) trees before gliding to the base of another small tree in a direct route to a large white pine or oak. Squirrels climbed to canopy height and glided longer distances only from large trees. Trees > 40 cm dbh typically were selected as targets for glides initiated at canopy heights. Sonenshine and Levy (1981) and Ando and Imaizami (1982) also found strong positive associations with extreme height and gliding. Bendel and Gates (1987) suggested that trees > 40 cm dbh and open upper-understory (> 10–15 m) aid locomotion and escape, and that clearcuts > 75 m wide are barriers. Mowrey and Zasada (1984) suggested clearcuts not be > 40 m wide, with ≤ 20 m preferable.

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Range Extension of Northern Flying Squirrels

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While trapping small mammals in Stevens Point, Portage County, Wisconsin, we examined a northern flying squirrel *(Glaucomys sabrinus)* collected on the University of Wisconsin–Stevens Point campus in 1976. In 1977 in the same area we captured an adult female northern flying squirrel in a Museum Special snap trap set on the ground for small mammals. Dr. C. Long, museum curator at the university, identified and retained the specimen (no. 4927). This evidence extends the known range of the northern flying squirrel south of the previously known range, into Portage County, Wisconsin.

Our study area was the 83-ha Schmeeckle Reserve, University of Wisconsin–Stevens Point, an area within the vegetational tension zone (Curtis and McIntosh 1951; Curtis 1959) that includes plants and animals typical of both the prairie and boreal forest ecotone extending northwest-southeast in Wisconsin. Forest composition was 5.7 ha of mixed hardwoods including oak (*Quercus* spp.), maple (*Acer* spp.), elm (*Ulmus* spp.), white birch *(Betula papyrifera),* and quaking aspen *(Populus tremuloides);* 14.3 ha of pine *(Pinus strobus, P. banksiana, P. resinosa);* 15.6 ha of mixed woods containing mature hardwoods and scattered mature white pine; and 8.9 ha of savanna (Engel 1980).

Our population estimates from live trapping (Overton 1965; Davis and Winstead 1980) were 17 ± 2.5 southern flying squirrels (0.4 per ha) and 14 ± 2.8 northern flying squirrels (0.3 per ha). Density of southern flying squirrels in Virginia was 31–38 per ha (Sawyer and Rose 1985); for northern flying squirrels in Alaska density was 0.3 per ha (Mowrey and Zasada 1984). The lower population estimates of southern flying squirrels in our study area, where sympatry occurred, might be due to limited availability of large trees for dens, suitable understory (Sonenshine and Levy 1981; Bendel and Gates 1987), and food in this type of presumably marginal habitat normally associated with range limitation.

A broad zone of potential sympatry of northern flying squirrels and southern flying squirrels exists in North America, coinciding with northern hardwood or mixed vegetation (Hall and Kelson 1959). But little actual overlap in the ranges of the two species of flying squirrel exists, with little evidence of sympatry due to highly variable and often exclusive niches (Weigl 1978). In Wisconsin, records of sympatry exist in Jackson (Rausch and Tiner 1948), Clark (Jackson 1961), and now Portage counties, and in the Upper Peninsula of Michigan (Stormer and Sloan 1976). The potential zone of sympatry in Wisconsin comprises the tension zone (Curtis and McIntosh 1951; Curtis 1959) within which Jackson, Clark, and Portage counties occur. Sympatry of northern flying squirrels and southern flying squirrels is likely in other counties within the tension zone.

We found northern flying squirrels almost exclusively in pine habitat and southern flying squirrels mostly in mixed woods but also in deciduous habitat. Weigl (1978) also found northern flying squirrels associated with conifers and southern flying squirrels with deciduous or mixed woods in North Carolina, where altitude influences habitat. Much (67%) of our study area is pine or a mixture of oak and pine, which Sonenshine and Levy (1981) found southern flying squirrels to use less than lowland deciduous areas. Wells-Gosling

(1985) compiled a list of habitat types in North America occupied by both species of flying squirrel.

The northern range of mast trees limits distribution of southern flying squirrels (Weigl 1978). Both species are omnivores, but southern flying squirrels eat mainly mast in winter, while northern flying squirrels eat fungi and the abundant lichens which most animals do not eat, resulting in an exclusive energy source for northern flying squirrels and little competition for food (Weigl 1978). Also, northern flying squirrels feed on cached fungi in red squirrel *(Tamiasciurus hudsonicus)* middens (Mowrey and Zasada 1984); both species generally are found together in coniferous forests. Population densities were 0.4 per ha for red squirrels and 1.4 per ha for gray squirrels *(Sciurus carolinensis)* in the study area.

Southern flying squirrels use only tree cavities for dens (Weigl 1978). They are not hibernators, and den in aggregations for warmth in winter (Muul 1968). Northern flying squirrels are larger, more thickly furred, and thus more tolerant of cold temperatures. They use tree cavities and outside nests. More tree cavities are available in deciduous than coniferous forests. Although smaller, southern flying squirrels are more aggressive in defending a home range. When both species occupy a deciduous forest, southern flying squirrels can displace northern flying squirrels into less suitable habitat, thus possibly reducing their reproductive success (Weigl 1978).

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The Modern Spiritual Condition and the Ancient Wisdom of the *I Ching*

Claire E. Matthews

We are in a period of religious crisis, Mircea Eliade tells us. Many elements of modern life are attempts to recover the sacredness of life and nature and to recover the religious dimension of authentic and meaningful "human existence in the cosmos." As evidence, Eliade cites the contemporary rediscovery of nature, uninhibited sexual mores, and emphasis on "living in the present." He points to these as creative and therefore unrecognizable answers to the crisis and expressions of potentially new experiences of the sacred (Eliade 1969, preface).

Joseph Campbell states that "one of our problems today is that we are not well acquainted with the literature of the spirit" (Campbell and Moyers 1988, 3). Myths are stories that give us a perspective on what is happening to us. We have lost the function of myth in contemporary society, and there is nothing comparable to take its place. Themes that have supported human life and informed religions over the millennia are gone. Gone also are the pieces of information that gave us guidance concerning deep inner problems, mysteries, and rites of passage. Without them we are left to "work it out" ourselves (Moyers and Campbell 1989, 3f).

According to Eliade, when myth is living and functioning in a society, it supplies models of human behavior and gives meaning and value to life (Eliade 1969, 2). Myth also narrates a sacred history and explains, through the deeds of supernatural beings, how reality, the cosmos, or a portion of it, came into being (Eliade 1969, 5–6). Through his work in comparative mythology, Joseph Campbell found that there are certain timeless, universal themes from every culture but with varying cultural inflections. He also believes that mythology is what lies behind literature and the arts. Mythology likewise informs our personal lives, particularly in relation to certain life stages. Mythology imparts structure and meaning to the initiation ceremonies that move the individual from childhood to adult responsibilities, from the unmarried to the married state, for example, or into a responsible new role. Campbell maintains that the conservative call for "old-time religion" is a terrible mistake, that it would be trying to return to something vestigial that no longer serves us (Campbell and Moyers 1988, 10–12).

The *I Ching* or *Book of Changes* as it is often called in English, is an ancient Chinese manual of divination and wisdom that functions as a means of access to these transcultural, mythic patterns. It did this historically for the ancient Chinese and can do the same contemporarily for Western humanity. It also offers a paradigm of Eastern thought that has implications for the Western mind. The kind of assumptions that the *I Ching* makes—that physical and psychological realities have a connection at some deep level—have significance for our Western society.

Marie Louise von Franz points out that the unconscious aspect of the psyche is con-

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nected to matter; we know only that this is so, and our scientific knowledge has come to an end in this respect for the time being (1980a, 79). In a sense, this perspective or world view of the ancient Chinese points to a religious attitude that instructs us never to act only in accordance with conscious reasoning, but with constant attention to what could be termed irrational or unknown participating factors. This might mean consulting a valid oracle, such as the *I Ching,* or concentrating on an attempt to get a sign from within ourselves as to the right thing to do, the proper path to take. In Chinese philosophy this would mean paying constant attention to the Tao to see if the personal action is in Tao. Applying Chinese philosophy to Western thought would yield a new definition of living in a religious way: being constantly on the alert for those unknown powers that guide one's life. This may be a feeling as to whether something is the right thing to do or an instinctive feeling against it. As von Franz puts it, "A bell does not always ring warning us, but if it comes and one ignores it, then something goes wrong" (1980a, 96).

One of the most important books in the history of Chinese culture, the *I Ching* is one of the Five Classics that, along with four other works, made up the basic Confucian canon (Gentzler 1988, 339). John Blofeld, who made a modern translation of the *I Ching* (1965) and who is obviously taken with its value as an oracle, remarks that it was very common for a Chinese individual to be Taoist, Confucian, or Buddhist and something more as well. He states, "There are whole segments of traditional Chinese religion which don't fit into those categories and have existed for several thousand years without acquiring a name" (1965, 38). The *Book of Changes* reflects all of these Chinese attitudes toward religion, cosmology, and metaphysics because much of it took shape before distinctions between religions had arisen and Taoism and Confucianism became separate entities. According to Blofeld, the text contains the seeds or prototypes of both religions and is not contradictory.

The archaic mode of expression used in the *I Ching* adds to the difficulty in understanding the oracles. Blofeld states that frequently the meaning is so esoteric that the mind is baffled until intuition, careful thought, or some unforeseen experience provides sudden illumination. The obtuse language, as well as the 2500 to 3000 years, creates a vast period of time separating us from King Wen and his contemporaries, who edited the *I Ching,* and the disparity between Eastern and Western culture further hinders clear understanding (Blofeld, 32).

There are many varying explanations of the origins of the *I Ching,* although the most probable is that, like many other ancient works, it assumed its present form through a long process of evolution. According to R. L. Wing, the *Book of Changes* was probably a cooperative effort spanning many centuries. The oldest stratum of ideas may have been handed down from the elders of the nomadic Siberian tribes. The early authors of the *I Ching* observed all the cycles of life, natural and human—the tides and the stars; plant and animal life; the seasons; patterns of relationships in families and in societies, in business and in warfare; and the eternal human dramas of life, ambition, and conflict—and made a guide to the way things change. This system is not a fixed chart of the cosmos, but fluid and interconnected. These writers created a guide that offers a perspective on the eternal, universal human drama (Wing, 8).

There are also discrepancies as to the exact date of its conception. James Legge (1899) states in his translation that the basic text was prepared before 1000 B.C. in the last days of the Shang Dynasty and the early part of the Chou Dynasty. Confucius edited and wrote commentaries on it that still exist as part of some editions today. The Confucian commentaries often refer to the "superior man," the *"chün-tzu";* there is also frequent reference to the inferior man who is not *"chün-tzu."* The commentary usually relates what the "superior man" would do in a situation and frequently uses politics or government as an example of the arena (Blofeld 1965, 24).

The term "superior man" in the original text was used to indicate a person striving to live his life in the best possible way (Wing 1979, 30). It is reported that Confucius wished he had fifty more years of life so that he could study the *I Ching*. King Wen wrote commentaries on the social and political implications of the hexagrams, making a monumental addition to the ancient hexagrams. His son, the Duke of Chou, completed his father's work by writing commentaries on each of the six lines within each of the sixty-four hexagrams. Interestingly, both Taoist and Confucian schools have claimed the *I Ching* as their own classic. Later, even certain Buddhists consulted, studied, and commented on it.

The core of the *I Ching* is a divination manual overlaid with the explanations and commentaries already mentioned. To consult the oracle, we follow a simple divination ritual of tossing coins or sorting yarrow stalks. We would approach the oracle as we would a wise spiritual mentor, bringing the concerns that we would like to see in a larger perspective. In this way the more appropriate action can be chosen. This is thought to work because a mutual resonance echoes between the currently active pattern informing the situation under question, the objects used in the divination (the coins or the yarrow stalks), and the symbolic form described by the book. Each coin toss (or sorting of the yarrow stalks) is translated into a line which is either yin (represented as broken: – –) or yang (represented as unbroken: —). The casting or meditation is done six times, giving six lines that are grouped in two sets of three lines each called trigrams.

The six lines constituting the hexagram represent the interrelationship of two fundamental forces, "yin" and "yang," two concepts that are an integral part of ancient Chinese philosophy and the Chinese spiritual perspective. The Chinese frequently looked to nature as a representation of the macrocosm and microcosm. Yin and yang refer to basic principles that are purely symbolic representations of energies of what we commonly call "maleness" and "femaleness" (Whitmont 1969, 171). Originally these words referred to the sunny and shady sides of a stream but were more generally symbolically representative of the female (passive) and male (active) principles in human beings, nature, and the macrocosm. No moral verdict was intended; neither principle is "better" or "stronger" than the other. The Chinese saw them as two equally potent, grounding principles on which all the world rests, and in their interaction they inform, constitute, and decompose all things. Their belief in this universal diad also informs the *I Ching* (Campbell 1972, 119).

As previously mentioned, casting the coins six times gives six lines that are either yin or yang and form two groups of three lines each, called trigrams. There is a traditional belief that the legendary sage-emperor Fu-hsi came by the idea for the trigrams from a map found on the back of a horse or dragon-horse (or, according to another source, a turtle) that emerged from the Yellow River. The map was supposedly preserved for some time but has long since perished. It was composed of a concentric configuration of lines made of dark and light dots. In Legge's opinion, the purpose of perpetuating the legend was "to impart a supernatural character to the trigrams and produce a religious veneration for them." Legge (1899, 15–17) believed that King Wen first used lines instead of circles and was supposedly the first to combine two trigrams to form a six-line figure called a hexagram, of which I have more to say later.

The trigrams had an interesting evolution from the supreme absolute as understood by the ancient Chinese. They regarded the supreme absolute as the yin and yang of the cosmos out of which all that exists is produced. They saw yang as always turning into yin and yin in the process of becoming yang, a process called enantiodromia, in which one energy or thing turns into its opposite when it has reached a zenith or nadir of development. This dynamic interplay in the cosmos creates life, and this creative energy of life manifests the cosmos. The ancient Chinese

have this to say in reference to the creative force: "From the Creative (yang) and the Receptive (yin) emerge the ten thousand things" (Wing 1979, 13). The yin and yang lines combined in four different ways to represent the seasons. A third line was added to represent humanity as the synthesis of yin and yang, heaven and earth, thereby creating the eight elemental trigrams meant to represent all the cosmic and physical conditions on earth. The trigrams and their attributes are as follows:

☰	☱	☲	☳
Ch'ien	Tui	Li	Chên
heaven, sky	water (as in a marsh or lake)	fire, the sun; lightning	thunder
☴	☵	☶	☷
Sun	K'an	Kên	K'un
wind and wood	water (as in rain, the clouds, springs, streams); the moon	hill, mountain	the earth

The trigrams were used in early forms of divination since they could easily be recognized and memorized. They represented, for example, family members, parts of the body, seasons, and many sets of ideas, as well as more abstract attributes, so that they constituted a very useful almanac for the ancient Chinese to use in understanding the tendencies of change. The trigrams were also used for divination in an arrangement of polar opposites (e.g., heaven across from earth, water from fire). A later arrangement according to periodicity is attributed to King Wen. Various pairings of the trigrams by Chinese scholars later led to the sixty-four hexagrams. The union of the two trigrams represents the dynamism of heaven and earth, their interaction representing cosmic forces as they affect human affairs (Wing 1979, 14–15).

Carl G. Jung wrote an illuminating preface to the English edition of Richard Wilhelm's translation. Blofeld praised Jung's introduction as a joy to read and declared that Jung "courageously dared the scorn of his fellow scientists by publicly asserting his belief in the *I Ching*'s predictions. He even went so far as to attempt to show why they are correct" (1965, 25). Jung's concepts of acausality, synchronicity, and archetypes are essential to understanding the reliability of the *I Ching*.

Concerning the causal view of the world, Jung writes in *Mysterium Coniunctionis* (1970, 464):

> The causalism that underlies our scientific view of the world breaks every thing down into individual processes which it punctiliously tries to isolate from all other parallel processes. This tendency is absolutely necessary if we are to gain reliable knowledge of the world, but philosophically it has the disadvantage of breaking up, or obscuring, the universal interrelationships of events so that a recognition of the greater relationship, i.e., of the unity of the world, becomes more and more difficult.

Jung regarded this idea as a world view that could be seen as valid, although very different from our Western perspective.

According to Marie Louise von Franz, the Jungian author of *On Divination and Synchronicity,* synchronistic reasoning is the classical Chinese way of thinking. The Chinese think in terms of "fields" and know innately that certain things "like" to happen together in a meaningful way. In their thinking, no differentiation has been made between "psychological" and "physical" facts. In synchronistic thinking, both inner and outer facts can occur together. Causal thinking regards time as linear and each moment as qualitatively equal to any other; in acausal, synchronistic thinking, time is viewed as a qualitative "field" in which groupings of events typically occur. Thus in a certain moment in time a complex of events made of inner (i.e.,

thoughts, dreams) and outer (i.e., physical) events constellate (1980b, 8).

Jung (1931, 85) stated in his commentary on *The Secret of the Golden Flower* (which Richard Wilhelm had translated from the Chinese) that the Chinese developed intuition to a very high degree. Because of this keenly developed intuition, the Chinese were able to recognize the polarity and paradox in what is alive. Whether this gave them a greater predisposition to comprehend the spiritual—specifically the cosmos and the individual's right place in it as evidenced by the use of the *I Ching* as a tool—is an interesting speculation for the Western mind to ponder.

Blofeld also sheds some light on the essential difference between Eastern and Western thinking. "Asia's thinkers," he states, "were chiefly occupied with the search for life's meaning (or at any rate, man's true goal) and for ways of utilizing that knowledge for self cultivation and self-conquest" (Blofeld 1965, 23). He felt the *I Ching* invaluable as an aid to understanding life's rhythmic process with a view to bringing man back into harmony with it.

The ancient Chinese perspective—almost opposite to our Western view but possibly complementary in its introverted, intuitive way that takes into account the simultaneous reality of spirit and matter—may hold something valuable for us if we can be open to it.

In an essay on one of the hexagrams of the *I Ching*, Rudolph Ritsema (1976, 191) states that if the philosophical system and the cosmological as well as social and historical implications of the *I Ching* are left behind, what remains is a book that contains a whole web of interrelated archetypal images underlying our world. He views the *I Ching* as a door to the archetypal realm, its position between a dream and a mythology. Dreams, he states, reveal the individual relevance of an archetypal pattern or image, and mythology shows the archetypal patterns at work in their own world. The *I Ching* enables one to connect with the archetypal pattern underlying the specific situation in time. The ancient Chinese language lends a particular advantage to this in that it allows images and concepts to join in single words as well as in sentences of the *I Ching*.

Just what are archetypes, and why is it important to be in proper relationship to them? According to Frieda Fordham (1957) in *An Introduction to Jung's Psychology,* archetypes are unconscious and can therefore only be postulated, but we can become aware of them through certain typical primordial images. We may hazard a guess that these primordial images or archetypes formed in the unconscious during the thousands of years when the human brain and human consciousness were emerging from the animal state, and are modified or altered according to the era in which they appear. They can be experienced as emotions as well. When we encounter a level of deep human experience such as birth or death, triumph over obstacles, transitional stages of life, or extreme danger, the personal level of experience taps a deeper level. These "impressive" experiences break through into an old, previously unconscious riverbed, and the experience is extremely powerful.

According to Whitmont's interpretation of Jung, archetypes manifest in individuals as automatic or instinctive emotions and drives. The archetype appears as an experience of fundamental importance and presents itself as numinous. Its power can be either constructive or destructive, depending on the form of actualization and the attitude taken by consciousness (Whitmont 1969, 103f).

This does not mean that God is "nothing but an archetype." Rather, the transpersonal power of archetypes that expresses itself to us subjectively through psychological experience as if it were personal guidance and confronts us with meaning in our personal lives and destinies is the transpersonal power that has been called God, and this is one of the ways we can experience Him. This may shed some light on the nature of this ancient book and how it was able to function as the core of Chinese spirituality for so many years.

Blofeld (1965, 31) quotes a Chinese friend who had written a newspaper article in which he explained:

> The responses to be won from the *Book of Changes* are sometimes of such tremendous import that they may save us from a lifetime of folly, or even from premature death. It must be treated with the deference due to its immense antiquity and to the wealth of wisdom it contains. No living man can be worthy of equal deference, for it is not less than a divine mirror which reflects the processes of vast and never-ending cosmic change, those endless chains of actions and interaction which assemble and divide the myriad objects proceeding from and flowing into T'ai Chi—the still reality underlying the worlds of form, desire and formlessness. It has the omniscience of a Buddha. It speaks to the transient world as though from the Womb of Change itself—Change, the one constant factor amidst all the countless permutations and transformations of mental and material objects which, when the eye of wisdom is closed, appear to us as meaningless flux. That their infinite number can be mirrored in so small a compass is because they all proceed according to adamantine laws and all are facets of that spotless purity and stillness which some men call T'ai Chi or the Tao and others the Bhutatathata, the Womb of the Tathagatas (Buddhas), the Source of All.

Jung felt that man needs to find a new religious attitude, a new realization of our dependence upon superior dominants (archetypes), that he is frequently operated on and maneuvered by "archetypal forces" instead of his "free will." "He should learn that he is not master in his own house and that he should carefully study the other side of his psychic world which seems to be the true ruler of his fate." Jung stated that "if the archetype, which is universal, i.e., identical with itself always and anywhere, is properly dealt with in one place only, it is influenced as a whole, i.e., simultaneously and everywhere." Paraphrasing Confucius' commentary in the *I Ching*, Jung said, "The right man sitting in his house and thinking the right thought will be heard 100 miles away" (*Letters* 2:594).

Since the *I Ching* is an ancient oracle, and since the thesis of this paper is that the *I Ching* can address our contemporary condition with its wisdom, I asked *I Ching* how it would like to be presented in this paper. The divination procedure yielded hexagram number 58, "The Joyous," one of eight hexagrams formed by doubling a single trigram, "Tui," the image of the "smiling lake" whose attribute is joyousness (Wilhelm 1967, 223).

With each hexagram in the *I Ching*, the reader finds a "judgment" and a statement of the "image." This is the judgment attached to hexagram 58:

> The joyous. Success.
> Perseverance is favorable.

Wilhelm comments that "true joy, therefore, rests on firmness and strength within, manifesting itself outwardly as yielding and gentle" (1967, 224). In each trigram, a "strong" or yang line (i.e., unbroken) lies "within," that is, flanked ("without") by a "weak" or yin (broken) line. Here is the image accompanying hexagram 58:

> Lakes resting one on the other:
> The image of The Joyous.
> Thus the superior man joins with friends
> For discussion and practice.

Wilhelm (1967, 224f) interprets the image in these words:

> A lake evaporates upward and thus gradually dries up; but when two lakes are joined they do not dry up so readily, for one replenishes the other. It is the same in the field of knowledge. Knowledge should be a refreshing and vitalizing force. It becomes so only through stimulating intercourse with congenial friends with whom one holds discussion and practices the application of the truths of life. In this way learning becomes many-sided and takes on a cheerful lightness, whereas there is always something ponderous and one-sided about the learning of the self-taught.

The enduring wisdom of the *I Ching* is manifest in this answer to the question. The joy and success come through my inner enthusiasm coupled with a genuine feeling of wanting to share this information with others. Use of the present paper would do well to take the form of a discussion among friends with whom one would ponder the truths of life and their practical application.

The Western mind may agree or disagree that the *I Ching* is a vehicle to tap the unconscious for its guidance and perspective, and that it has as much relevance for modern Western man as for the ancient Chinese as an alternate but valid spiritual world view. But even without this perspective, the *I Ching* exists like a venerable old Chinese master, an example of the Chinese philosophical and religious world view, with many secrets to be explored and pondered.

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Distribution, Abundance, and Diversity of Mollusks (Bivalvia: Unionidae) from the Lower Chippewa River, Wisconsin

Terry Balding

Abstract. *The lower Chippewa River, from the dam in Eau Claire to its mouth at Mississippi River Mile 763.4, was divided into 37 sampling stations each about 2 km in length. During the summers of 1986–1989, mollusks from each station were collected, mainly by wading; 4,832 empty shells were identified to species and kept. In addition, 2,161 live shells were identified as to species, measured, and returned to the river substrata. Twenty-six different species were found, 24 having living representatives. The lower half of the river had significantly fewer species and individuals* ($p < 0.01$).

Freshwater mollusks or freshwater mussels of Wisconsin have been studied by Baker (1928) and by Mathiak (1979). These two studies were statewide in scope and therefore did not give intensive coverage to the mussels of the Chippewa River. Data of an intensive scope are needed for the Chippewa because mussels are good ecological indicators of water quality, and the expanding human population is placing an increasing burden on water quality. Freshwater mussel base-line data need to be obtained so that they may be used as a biological monitor of the environment or as a means of detecting changes by a comparison to future studies. Any plan to impound the lower Chippewa River should refer to these data in order to assess the detrimental effect on the mussels, which are a river species. A recent Wisconsin income tax checkoff for non-game species has made money available and created interest in determining the presence and status of species such as mussels.

Study area. According to Simons et al. (1980), the Chippewa River begins in the Upper Peninsula of Michigan, drains about 17% of Wisconsin, and empties at Mississippi River Mile 763.4. The Chippewa averages 243 m in width at its mouth and deposits 553 million kg of sediment per year into the Mississippi (recurrence interval, two years). It is impounded many times, with the last dam in Eau Claire, Wisconsin, where it averages 158 m in width and discharges .028 cubic meters per second. The last 92 km of the Chippewa River is free flowing from the dam in Eau Claire downstream to its junction with the Mississippi River. The 64-km portion from Eau Claire to Durand has a sinuosity of 1.49 and slope of 1.5 feet per mile. The substrata are primarily sand, gravel, and glacial rocks. There is stratification of these substrata as the channel meanders. Occasionally there are areas of silt deposits, but in others the bottom is sandstone bedrock. The last 27 km of river from Durand to the Mississippi is less sinuous. Erosion from

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stream banks and islands results in a braided channel with shifting sand sediments. In a few places the channel cuts into large hills, and sandstone bedrock breaks off into angular pieces and falls into the channel.

Methods

The first segment of river within the city limits of Eau Claire was an 8-km stretch from the dam to Interstate 94. This segment was designated as an area for intensive study. All shorelines were searched diligently to find mussel concentrations. The remaining 84 km of the Chippewa was divided into 36 segments numbered from upstream to downstream. Convenient landmarks such as islands, small streams, bridges, and hills were used to divide segments. Segments in this portion of the river averaged about 2 km and were searched by boat or by walking rapidly along the shoreline. Once an area was found to have mussels, it was searched more intensively using a wading-pollywogging technique. This technique was used because the upper part of the study area has extensive amounts of rocks, making the brailing method impractical. A SCUBA technique, searching 1 m on each side of a 30-m transect (60 m^2), when compared to the wading-pollywogging technique showed no statistical difference. SCUBA is a more expensive method of sampling and is more important in deeper water. The shallow nature of this river seemed to lend itself to wading-pollywogging. The severe drought of 1988 and a lesser drought in 1987 reduced the water level and made the wading-pollywogging technique more effective. Lakes, side channels, and sloughs adjacent to the main channel were not searched. In some areas, which seemed likely to harbor mudpuppies (*Necturus maculosus*), rocks were turned over to search for the salamander mussel (*Simpsonaias ambigua*).

Except for specimens that were kept as vouchers, all live mussels were identified as to species, enumerated, measured for length, and returned to the river substrata. The length, in millimeters, was the longest straight-line distance from the anterior end of the shell to the posterior end. The identification of the voucher specimens was confirmed by Dr. David Stansbery, and they were deposited with him to be catalogued into the Ohio State University Museum of Zoology.

All empty shells were collected and deposited at the University of Wisconsin–Eau Claire, where they were later identified. However, two empty shell specimens, the only representatives of their respective species, were sent as vouchers to Dr. Stansbery, who confirmed their identifications.

Results and Discussion

Twenty-six species of mussels were identified from the Chippewa River between Eau Claire and its junction with the Mississippi River (Table 1). Twenty-four species were collected alive, whereas only empty shells were found for *Elliptio dilatata* and *Pleurobema sintoxia*. The most abundant live species were *Fusconaia flava* and *Obovaria olivaria*, with other abundant species including *Leptodea fragilis, Lampsilis ventricosa,* and *Lasmigona complanata*. However, *Lampsilis ventricosa* and *Obovaria olivaria* occurred more frequently than other species (Table 1). One species that was found frequently yet not abundantly was *Potamilus alatus*.

In Table 1 the mean length is given along with the range length and the standard deviation. The importance of these numbers can be seen by noting *Quadrula metanevra*. The mean length shell is large, but there is a small range and standard deviation. This indicates that only older shells exist and no recruitment of new individuals for this species has occurred in several years. The small number of shells and the observation that all live specimens had considerable erosion would support the theory that this shell may soon be extinct in the study area.

Simpsonaias ambigua can almost be considered colonial, in that under a single rock large numbers of specimens were found tightly packed together. Total numbers of this species might not be a true reflection of its abun-

dance relative to other species; therefore, total numbers were not recorded. Of the three sites where live salamander mussels were found, one site was searched for a long time before they were discovered; on the other two sites they were found without much effort. In contrast, a fourth site about 100 m long was searched for four hours by two persons, and while several mudpuppies were observed, no salamander mussels were found. Since it was time-consuming to turn over rocks in search of the salamander mussel, only a few sites were searched for this species. Therefore, the 8.1% frequency found in this study may not be a true representation of the occurrence (Table 1).

Comparisons between the rank in abundance for species found alive versus dead (Table 1) reflect only general agreement. This could be because of collector bias or some other cause. Nevertheless, finding empty shells in pristine condition very likely indicates that a species presently lives in the vicinity and is a general indication of the relative proportions of each species.

Mussels do not occur uniformly dispersed in a river, but rather large numbers may be found clustered in one area and none in another. If a cluster is examined, several species will probably be found. The proportionate numbers of a species in a cluster may differ from cluster to cluster. This needs to

Table 1. Data for freshwater mussel species found on the lower Chippewa River

	No. live	*No. dead*	*Frequency of occurrence of a live species*	*Live length range*	*$\bar{X}$ live lengths*	*Standard deviation*
				mm	*mm*	
Actinonaias ligamentina (Lamarck 1819)	6	9	8.1	51–168	112.6	4.16
Alasmidonta marginata (Say 1818)	69	185	37.8	40–116	81.2	1.50
Amblema plicata (Say 1817)	37	8	48.6	18–153	105.4	3.25
Anodonta grandis (Say 1829)	50	24	54.0	50–155	116.8	2.17
Elliptio dilatata (Rafinesque 1820)	D*	1				
Fusconaia flava (Rafinesque 1820)	453	578	67.6	20–117	63.3	.33
Lampsilis radiata (Lamarck 1819)	38	184	37.8	54–132	89.3	2.10
Lampsilis ventricosa (Barnes 1823)	187	1072	81.1	38–154	107.9	2.28
Lasmigona complanata (Barnes 1823)	183	330	64.9	47–190	129.0	2.56
Lasmigona costata (Rafinesque 1820)	60	105	40.5	71–124	97.4	1.35
Leptodea fragilis (Rafinesque 1820)	212	785	78.4	24–170	113.0	2.87
Ligumia recta (Lamarck 1819)	52	120	51.4	56–161	123.7	2.33
Obliquaria reflexa (Rafinesque 1820)	4	37	10.8	45–63	53.2	.83

*D = no live specimens found.

Continued on next page

Table 1—*Continued*

	No. live	No. dead	Frequency of occurrence of a live species	Live length range	$\bar{X}$ live lengths	Standard deviation
				mm	mm	
Obovaria olivaria (Rafinesque 1820)	420	647	81.1	20–126	76.6	2.09
Plethobasus cyphyus (Rafinesque 1820)	12	31	13.5	43–133	107.2	2.51
Pleurobema sintoxia (Rafinesque 1820)	D*	1				
Potamilus alatus (Say 1817)	119	89	73.0	63–180	126.8	2.77
Potamilus ohiensis (Rafinesque 1820)	11	12	10.8	44–152	95.0	3.88
Quadrula metanevra (Rafinesque 1820)	10	34	5.4	108–124	112.7	.41
Quadrula pustulosa (Lea 1831)	16	15	27.0	47–100	72.4	1.61
Simpsonaias ambigua (Say 1825)	12	4	8.1	None measured		
Strophitus undulatus (Say 1817)	120	372	59.5	30–165	97.6	1.42
Toxolasma parvus (Barnes 1823)	15	6	8.1	15–36	28.7	.59
Tritogonia verrucosa (Rafinesque 1820)	45	31	32.4	91–184	144.7	2.08
Truncilla donaciformis (Lea 1827)	9	64	24.3	24–41	31.5	.71
Truncilla truncata (Rafinesque 1820)	33	88	40.5	28–69	49.0	1.17
	2161	4832				

*D = no live specimens found.

be kept in mind when examining Table 1, as the figures can be misleading. For example, it would appear that *Fusconaia flava* (453 live specimens) might be very common. However, the actual data show nearly 300 live shells taken in only two small areas of the entire river.

The Wisconsin Department of Natural Resources has listed *Plethobasus cyphyus* as endangered and *Quadrula metanevra, Simpsonaias ambigua,* and *Tritogonia verrucosa* as threatened. These species were found live in the study area. Our general observations and the abundance, frequency, and size data indicate that all but *Quadrula metanevra* are surviving and reproducing.

The number of species per station is shown in Figure 1. Data recorded for the number of specimens per station, shown in Figure 2, reflect a similar trend. A paired t-test ($p < .01$) demonstrated that the number of species found per station was significantly greater for the first 18 stations than for the last 18 stations. The difference is that at Station 19 the Red Cedar River enters the Chippewa River, and downstream there is a gradual loss of sinuosity combined with more erosion of stream banks and islands, which creates shifting sand sediment. Observations revealed that stations downstream of Station 19 with high species diversity were related to areas where the channel cut into sandstone hills and pieces of bedrock were found in the channel. In a few instances populations were found where islands or peninsulas created pockets of water that were protected from shifting sand sedi-

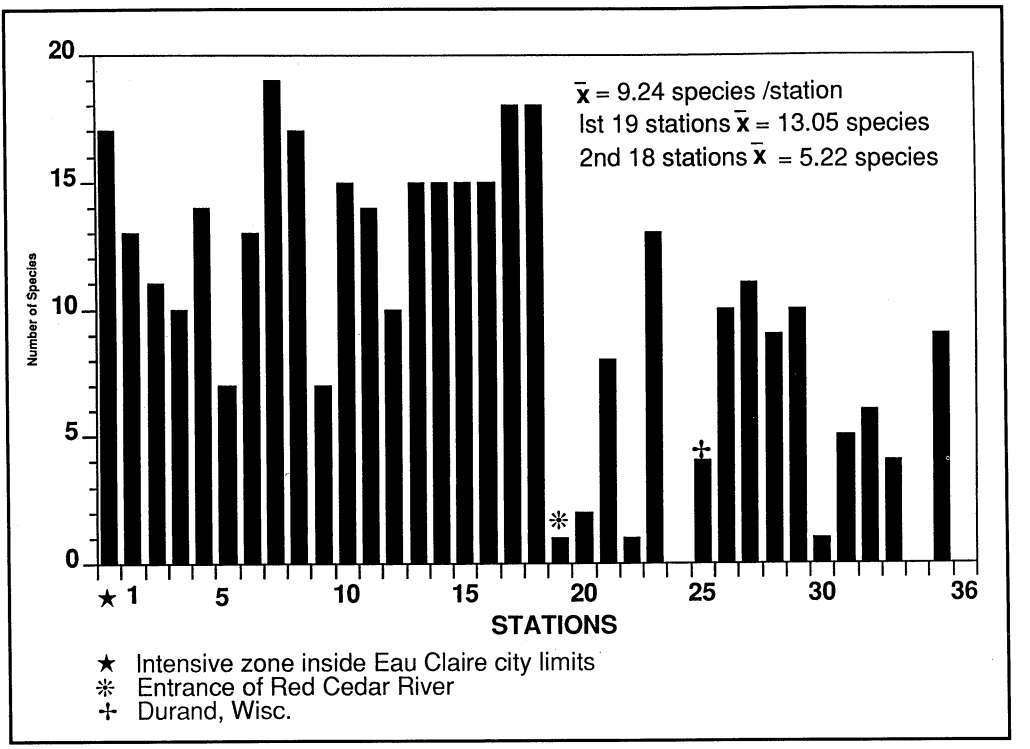

Figure 1. *Number of species found at each station on the lower Chippewa River. Station 1 is 8 km downstream from Eau Claire; station 36 joins the Mississippi River at Mile 763.4.*

ments. The only species found to inhabit the shifting sand were *Anodonta grandis, Lampsilis ventricosa, Leptodea fragilis, Obovaria olivaria, Potamilus ohiensis,* and *Potamilus alatus;* most were younger specimens.

Besides the entrance of the Red Cedar, another site where there were conspicuously fewer mussels was the first 5 km downstream of the Eau Claire dam. The author intends to continue this study to the source of the Chippewa River and then its tributaries. It will be interesting to see whether a trend exists regarding the virtual absence of mussels below a dam or entrance of a large tributary.

Mussels were found marooned in a small pool (maximum depth 15 cm) at Station 1. Since the pool would soon go dry, it was decided to transplant the mussels to a nearby suitable habitat with deeper water. Ninety-seven live specimens (all that were visible) were identified, measured, and transplanted on 13 September 1988. On a return visit four days later an additional 112 live specimens were found and transplanted. A chi-square test showed no significant difference in the species composition between the two visits. On 7 October 1988 a third visit proved not all the living mussels on the first two visits were found. Another 100 specimens were discovered but not moved. There was a significant difference (chi-square test, $p < .01$) between the species composition on the third visit compared to either of the first two visits. Clearly, mussels are not always detected because they must totally bury themselves for periods of time. Perhaps also some species may remain buried longer than others. In fact, on one occasion a live mussel was found buried under at least 5 cm of sand and gravel where there had been no water for several hours. The mussel had good adductor reflexes and seemed healthy.

Overall, the Chippewa River shells seem to be in rather poor condition, especially the

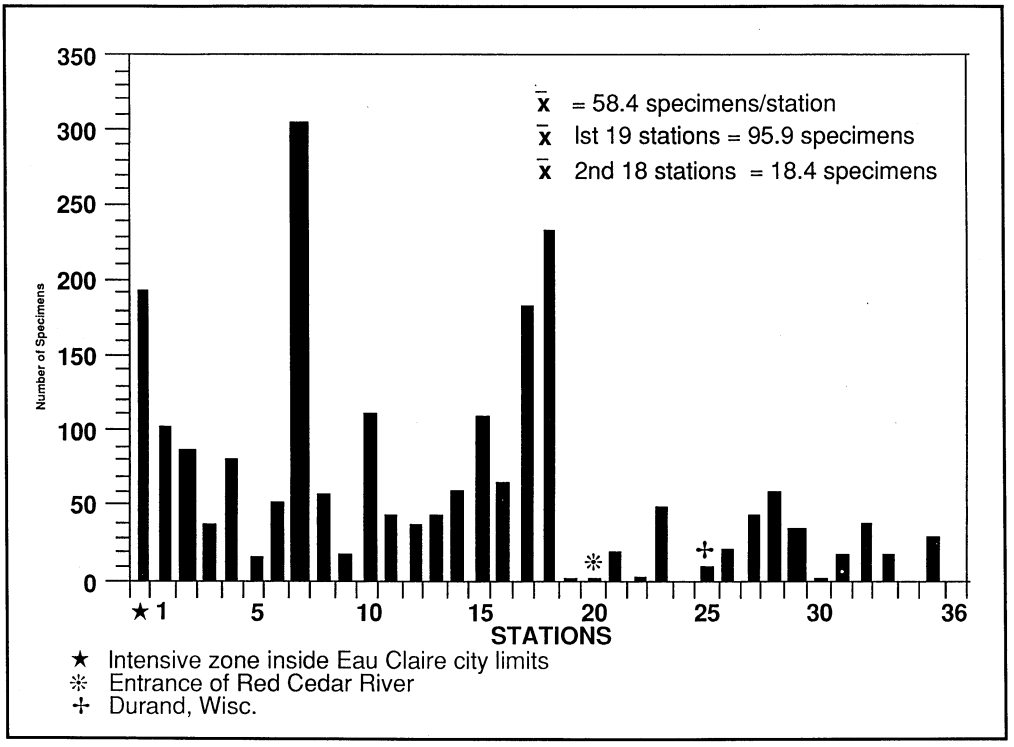

Figure 2. *Number of specimens found at each station on the lower Chippewa River.*

umbone area, probably because of the glacial rocks rolling into them; then when the periostracum is injured the acid water of the Chippewa River erodes the shell considerably. There is good mussel species diversity on the Chippewa, and some species seem to have healthy populations. Some are apparently in decline, and species represented by only a few specimens do not give much indication as to the health of their population. Densities do not seem to be as high as in other rivers I have visited such as the Mississippi, Namekagon, and St. Croix. The highest density on the Chippewa was about 30 mussels per m^2. This collecting location was markedly better than any other site on the Chippewa.

Acknowledgments

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